

Preliminary survey of the nonvolant mammals of a remnant of coastal restinga habitat in eastern Sergipe, Brazil

Levantamento preliminar de mamíferos não-voadores em um remanescente de restinga do litoral sul de Sergipe, Brasil

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Abstract The present study reports on the diversity of nonvolant mammals in a remnant of coastal restinga habitat in eastern Sergipe, Brazil, the RPPN Caju, in the municipality of Itaporanga d'Ajuda. The species inventory was based on 24 Sherman-type traps, nine camera traps, interviews with local residents, and the identification of vestiges such as feces and tracks. The study was conducted between the 21st and the 31st of October, 2014. We recorded 13 native species, four of them were captured by Sherman-type traps, two species of Didelphimorphia and other two of Rodentia. Other four species – *Callithrix jacchus*, *Cerdocyon thous*, *Procyon cancrivorus* and *Dasyprocta* sp. – were recorded by the camera-traps. Vestiges of *Puma yagouaroundi*, *Euphractus sexcinctus*, *Hydrochoerus hydrochaeris*, *Sylvilagus brasiliensis*, and *Tamandua tetradactyla* were encountered. Two domestic taxa (*Canis lupus familiaris* and *Felis catus*) were also recorded, al-

though not counted in species list. Most of the species recorded in this study are habitat generalists, with an ample geographic distribution in Brazil. The reduced species richness recorded in this study is typical of other sites in Sergipe, and may be related to a number of different factors, such as naturally low densities to a long history of habitat degradation in the study area. The RPPN Caju may nevertheless represent an important refuge for the local mammalian fauna, given its location within a region of considerable environmental fragility. The presence of domestic mammals represents an additional threat, and may be a major factor in population decline and local extinctions. The present inventory is preliminary, however, and further fieldwork will be required to confirm the local occurrence of less common species known to inhabit the region. Even so, this study represents an important contribution to the understanding of the distribution of nonvolant mammals in the

coastal restinga systems of the Brazilian Northeast.

Keywords: Brazilian Northeast, Mammal inventory, Atlantic Forest, RPPN Caju.

Resumo O presente estudo relata sobre a diversidade de mamíferos não-voadores em um remanescente de restinga do litoral sul de Sergipe, Brasil, com foco na Reserva Particular do Patrimônio Natural do Caju (RPPN Caju), no município de Itaporanga d'Ajuda. O inventário das espécies foi baseado em 24 armadilhas do tipo Sherman, nove armadilhas fotográficas, relatos de moradores locais, bem como a identificação de vestígios (fezes e rastros). O estudo foi realizado entre 21 e 31 de outubro de 2014. Foram registradas 13 espécies de mamíferos nativos, quatro dos quais foram capturados por armadilhas do tipo Sherman, duas espécies de *Didelphimorphia* e outras duas de *Rodentia*. Outras quatro espécies *Callithrix jacchus*, *Cerdocyon thous*, *Procyon cancrivorus* e *Dasyprocta* sp. - foram registradas por armadilhas fotográficas. Foram encontrados vestígios de *Puma yagouaroundi*, *Euphractus sexcinctus*, *Hydrochoerus hydrochaeris*, *Sylvilagus brasiliensis* e *Tamandua tetradactyla*. Doze taxa domésticos (*Canis lupus familiaris* e *Felis catus*) também foram registrados, embora não tenham sido considerados na listagem de espécies. A maioria das espécies registradas neste estudo é hábitat generalista, com ampla distribuição geográfica no Brasil. A reduzida riqueza de espécies registrada neste estudo é típico de outros locais em Sergipe, e pode estar relacionada a uma série de fatores, como densidades naturalmente baixas a uma longa história de degradação do habitat na área de estudo. A RPPN Caju pode, todavia, representar um importante refúgio local para a fauna de mamíferos, dada a sua localização dentro de uma região de grande fragilidade ambiental. A presença de mamíferos domésticos, no entanto, representa uma ameaça adicional, e pode ser um fator importante na diminuição e extinções na população local. O presente inventário é preliminar e mais trabalhos de campo serão necessários para confirmar a ocorrência local de espécies menos comuns, embora com ocorrência conhecida para a região. Mesmo assim, este estudo representa uma importante contribuição para o entendimento da distribuição de mamíferos não-voadores nos sistemas de restingas do nordeste brasileiro.

Palavras-chave: Nordeste brasileiro, Inventário de Mamíferos, Mata Atlântica, RPPN Caju.

Introduction

The Brazilian Atlantic Forest harbors a high diversity and endemism of species (Myers et al. 2000), encompassing a variety of climatic zones and phytophysiognomies (Tabarelli et al. 2005) such as the coastal Restinga. The term Restinga, in general, refers to a complex of distinct vegetation types influenced by marine and fluvial-marine variables (Assumpção et al. 2000; Sacramento et al. 2007). The location of this complex ecosystem along the whole Brazilian coast – which is inhabited by 70% of the country's population – highlights its importance (MMA 2010). Anthropogenic pressures are high in this region, and there is a long history of deforestation, for the exploitation of natural resources, agricultural activities, and urban expansion (Rocha et al. 2007; Sacramento et al. 2007).

In Brazil, the diversity of mammals of the Atlantic Forest biome is second only to that of the Amazon basin (Paglia et al. 2012), and 54.6% of the 69 terrestrial mammal species considered to be under some risk of extinction are found in this biome (MMA 2014). Habitat loss and fragmentation are the main threats (Chiarello et al. 2008).

In the Brazilian state of Sergipe, the decimation of the Atlantic Forest has reached critical levels, with only approximately 10% of original forest cover remaining (Santos et al., 2013). This situation is exacerbated by the scarcity of data on the local mammalian fauna, highlighted by the relatively recent discovery of a primate species, *Callicebus coimbrai* Kobayashi and Langguth, 1999, in eastern Sergipe, and the expansion of the known ranges of other mammals, including primates (Beltrão-Mendes et al. 2011; Marques et al. 2013), marsupials (Rocha et al. 2012), and sloths (Chagas et al. 2009). There have been very few systematic surveys of nonvolant mammal communities (Stevens et al. 1998; Oliveira et al. 2005; Chagas et al. 2010), and none in Restinga habitats. Given this, the present study investigated the diversity of nonvolant mammals in a remnant of Restingan habitat on the coast of Sergipe in northeastern Brazil.

Material and methods

Study Site

The study focused on the Caju Private Natural Heritage Reserve, (RPPN Caju), a private protected area owned by the Brazilian Agricultural Research Corporation, EMBRAPA. The RPPN Caju is located in the municipality of Itaporanga d'Ajuda (11°6'8"S, 37°11'5"W; Figure 1), on the southern coast of Sergipe, and has a total area of 763.37 hectares (Embrapa 2013).

The RPPN Caju is located within a complex network of tidal creeks, mangroves, sand dunes, and lagoons associated with the estuary of the Vaza-Barris River. It contains remnants of both shrubby-arboreal Restinga habitats and riparian forest (Santos and Vilar 2012) on mainly flat, nutrient-poor soils. The climate is tropical, with a main annual precipitation of 1250 mm (Embrapa 2013). In Köppen's classification system, the climate is As, that is, tropical megathermal with a dry season in the summer months (Alvares *et al.* 2013).

Sampling techniques

As mammals vary considerably in body size and habitat preferences (see Emmons and Feer 1997), four different methods were used to compile the species list. Small mammals were captured using 24 Sherman-type traps (250 mm x 80 mm x 90 mm), which were set along three 150 m transects (300 m apart from each other), each with four sampling points at least 50 m apart (Figure 1). Two traps were set at each

sampling point, one on the ground, and the other in the understory, attached to branches or lianas, in order to sample terrestrial, arboreal or scansorial mammals. As the RPPN Caju has open and forested habitats (shrubby-arboreal restinga), we tendentially set the live-traps/transects in the forest and riparian patches, in order to sample forest dwelling species. As no mammals were captured on one of the transects after five days, a new transect with the same characteristics was established for the final five days of trapping. The traps were baited with a mixture of corn and corn flour, peanut flour, sardines, soybean oil and banana.

The inventory of medium and large mammals (> 1 kg, see Chiarello 2000) was based on the use of nine camera traps (Acorn Ltl-5210A) set along existing trails or at the margins of lagoons, with a minimum distance of 400 m between each trap. The traps were set at a height of 40 cm above the ground. Multiple photographs of a mammal obtained by the same trap at an interval of less than 30 minutes were counted as a single record (Davis *et al.* 2011).

The traps were baited with the same combination of foods described above, with the addition of a portion of sardine oil. All traps were inspected every morning and rebaited whenever necessary. In both cases, sampling effort was measured by the number of trap-days, i.e., the number of working traps multiplied by the number of days they were set.

During trap checks, the area surrounding each



Figure 1 The location of the Caju Private Natural Patrimony Reserve (RPPN Caju) in the municipality of Itaporanga d'Ajuda, Sergipe, Brazil.

trap was searched for indirect evidence of the presence of mammals, including feces, tracks, burrows, and characteristic marks on tree bark. These data were complemented with informal interviews with the EMBRAPA staff, some of whom have more than 30 years of experience and contact with the local fauna.

Data were collected in the last 10 days (21st–31st) of October, 2014. The taxonomic nomenclature and classification was based on Emmons and Feer (1997), Eisenberg and Redford (1999) and Feijó and Langguth (2013) to the medium- and large-mammal species, while to marsupials we use Gardner (2007) and Bonvicino *et al.* (2008). For the identification of tracks, we follow Borges and Tomás (2008). The collection of voucher specimens was authorized by SISBio/ICMBio (research license 11283-2), and the specimens were deposited in the vertebrate collection of the Conservation Biology Laboratory, at the Federal University of Sergipe in São Cristóvão, Sergipe, Brazil.

Results

Trapping consisted of 240 trap-days with the Sherman-type traps and 90 trap-days with the camera traps. Overall, the occurrence of 13 mammalian species, representing seven different orders, was confirmed at the site (Table 1). The most representative orders were Rodentia ($n = 4$) and Carnivora ($n = 3$). Four mammal species were collected in the Sherman traps, and other four species were recorded by the camera traps. A further five species were recorded opportunistically, through direct observations or through vestiges. We also recorded two additional exotic and domestic species. However, they were not counted in species list.

The four small mammals trapped, belong to the orders Didelphimorphia ($n = 2$) and Rodentia ($n = 2$) (Figure 2). The small-bodied common marmoset (*Callithrix jacchus* Linnaeus, 1758; Primates) was recorded by three different methods, direct observation, camera traps, and by its characteristic gouge ho-

Species	Common Name	Type of Record
DIDELPHIMORPHIA		
<i>Didelphis marsupialis</i> Linnaeus, 1758	White-eared Opossum	Ca, Vi
<i>Marmosops incanus</i> (Lund, 1840)	Gray Slender Mouse Opossum	Ca
PILOSA		
<i>Tamandua tetradactyla</i> (Linnaeus 1758)	Southern Tamandua	Tr
CINGULATA		
<i>Euphractus sexcinctus</i> (Linnaeus 1758)	Six-Banded Armadillo	Bu, Re
PRIMATES		
<i>Callithrix jacchus</i> (Linnaeus, 1758)	Common Marmoset	Ct, Vi
CARNIVORA		
<i>Cerdocyon thous</i> (Linnaeus, 1766)	Crab-eating Fox	Ct, Tr
<i>Puma yagouaroundi</i> (É. Geoffroy, 1803)	Jaguarundi	Re, Tr
<i>Procyon cancrivorus</i> (G. Cuvier, 1798)	Crab-eating Raccoon	Ct, Tr
LAGOMORPHA		
<i>Sylvilagus brasiliensis</i> (Linnaeus 1758)	Tapeti	Tr, Re
RODENTIA		
<i>Hydrochoerus hydrochaeris</i> (Linnaeus 1766)	Capybara	Tr, Fe
<i>Oligoryzomys</i> sp. Bangs, 1900	Pygmy Rice Rat	Ca
<i>Dasyprocta</i> sp. Illiger, 1811	Agouti	Ct, Tr
<i>Trinomys setosus</i> (Desmarest, 1817)	Hairy Spiny Rat	Ca

Table 1 Nonvolant mammal species recorded in the RPPN Caju, Sergipe, Brazil. Type of record: Burrow (Bu), Camera trap (Ct), Feces (Fe), Live capture (Ca), Reported by local inhabitant (Re), Tracks (Tr) and Visual encounter (Vi).

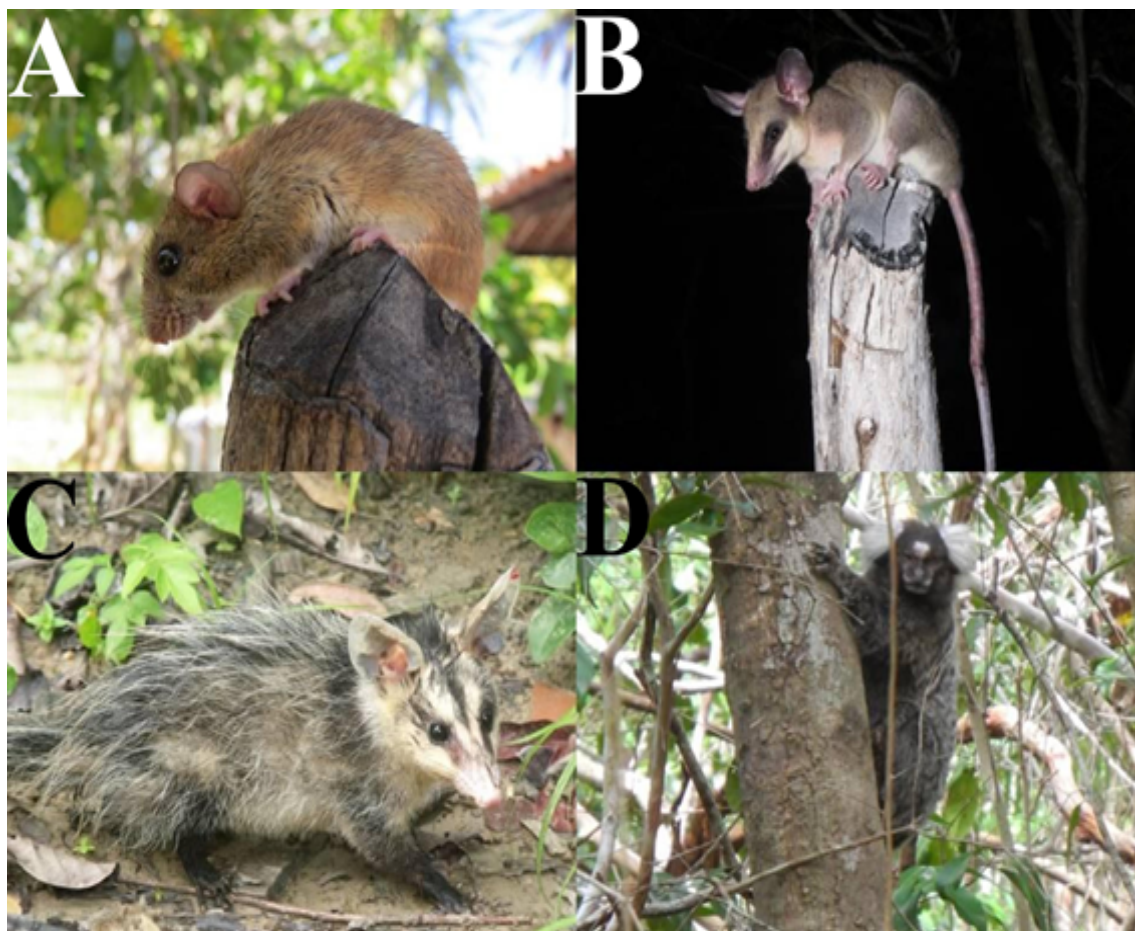


Figura 2 Photographic records of small mammals recorded in the RPPN Caju, Sergipe, Brazil: (a) *Oligoryzomys* sp.; (b) *Marmosops incanus*; (c) *Didelphis marsupialis*; and (d) *Callithrix jacchus*.

Table 2 Mammal species richness recorded in previous inventories in Sergipe (Small mammals < 1 kg; medium and large-sized mammals > 1 kg).

Locality	Total of Recorded Species (Small/Medium and Large)	Habitat	Reference
Mata do Crasto	9 (8/1)	Seasonal semidecidual	Stevens and Husband 1998
PN Serra de Itabaiana	12 (6/6)	Seasonal semidecidual	Oliveira <i>et al.</i> 2005
Fazenda Trapsa	14 (1/13)	Arboreal Restinga; Seasonal semidecidual	Chagas <i>et al.</i> 2010
Fazenda São Pedro	9 (4/5)	Caatinga shrub forest; hypoxerophytic	Freitas <i>et al.</i> 2011
Nossa Senhora da Glória	8 (5/3)	Caatinga shrub forest; hypoxerophytic	Bezerra <i>et al.</i> 2014
Monte Alegre de Sergipe	7 (4/3)	Caatinga shrub forest; hypoxerophytic	Bezerra <i>et al.</i> 2014
Porto da Folha	4 (2/2)	Caatinga shrub forest; hypoxerophytic	Bezerra <i>et al.</i> 2014
Poço Redondo	6 (4/2)	Caatinga shrub forest; hyperxerophytic	Bezerra <i>et al.</i> 2014
Canindé do São Francisco	11 (7/4)	Caatinga shrub forest; hypoxerophytic	Bezerra <i>et al.</i> 2014
Serra dos Macacos	13 (2/11)	Arboreal Caatinga	Dias <i>et al.</i> 2014; D.M. Dias pers. obs.
RPPN do Caju	13 (4/9)	Shrubby Tree Restinga	This study

les on the bark of gum-producing trees. Large-bodied mammal species were registered mainly through indirect evidence, except for the crab-eating fox (*Cerdocyon thous* Linnaeus, 1766) and the crab-eating racoon (*Procyon cancrivorus* G. Cuvier, 1798), which were recorded by the camera traps (Figure 3). The two domestic species, *Canis lupus familiaris* (Linnaeus, 1758) and *Felis catus* (Linnaeus, 1758), were recorded through direct observations. Here we adopt the correct name of *Didelphys marsupialis* (Linnaeus, 1758), according to Guargel-Filho *et al.* (2015), that shed light in the misunderstand of the former name commonly used (*Didelphys albiventis*) (see authors to clarification). The identification of the mouse species (*Oligoryzomys* sp.) was compromised due to the need of molecular approach; while the identification of the agouti (*Dasyprocta* sp.) was not possible, since the individual captured in the video footage was running, avoiding any specific identification.

Discussion

The combination of methods used in the present study (live-traps, camera-traps and search for cues) proved useful for the compilation of an preliminary inventory of the mammal fauna of the study site. Most of the species identified in the RPPN Caju are habitat generalists and widely distributed in other Brazilian biomes (Paglia *et al.* 2012). The low species richness recorded in the study site is typical of that observed at sites in Sergipe (Table 2), where inventories have recorded four to 19 species (Stevens *et al.* 1998; Oliveira *et al.* 2005; Chagas *et al.* 2010; Freitas *et al.* 2011; Bezerra *et al.* 2014; Dias *et al.* 2014; Rocha *et al.* 2014; Dias and Bocchiglieri 2016). The small number of species and specimens, as well as the variation among sites may be at least partly due to differences in sampling methods and effort, as well as the local configuration of habitats, including anthropogenic degradation. The inclusion of other efficient

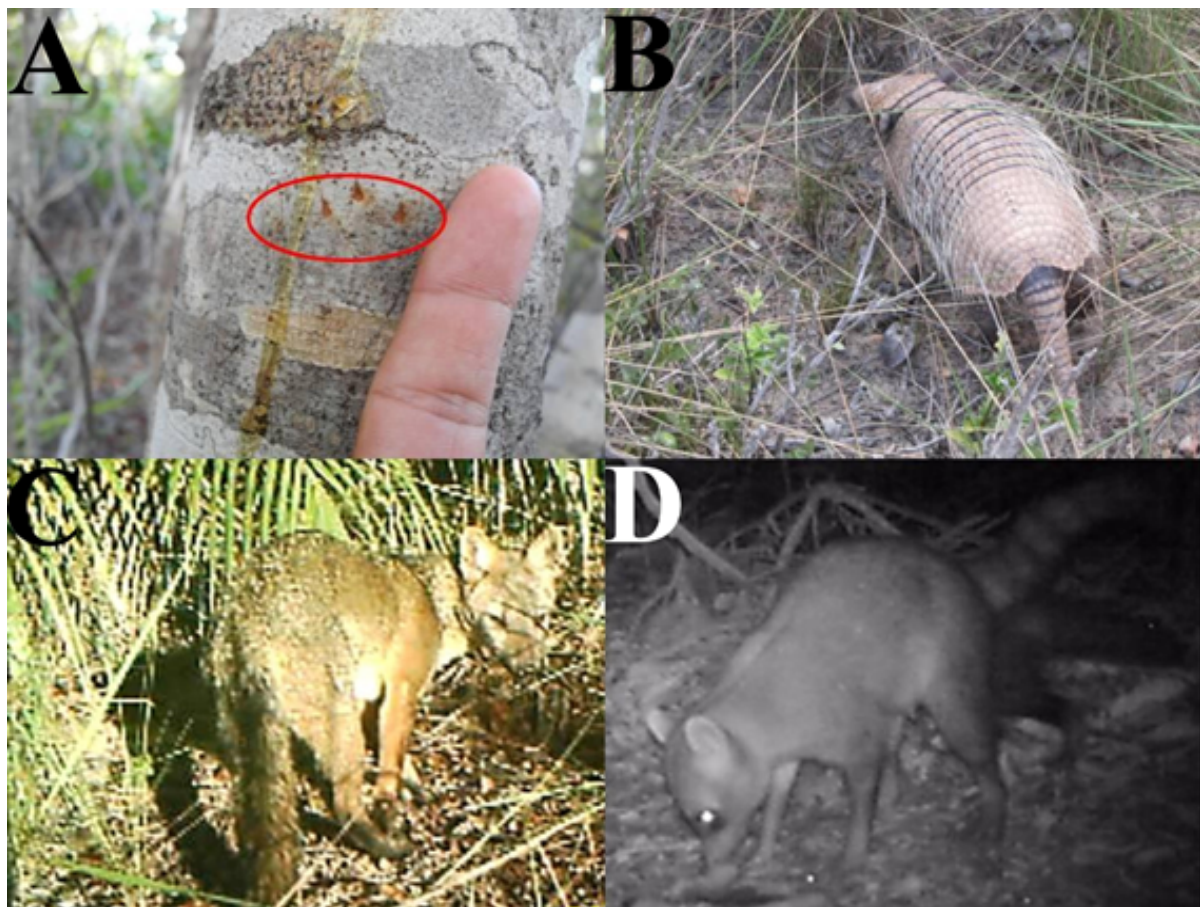


Figure 3 Photographic records of the medium and large mammals or their vestiges recorded in the RPPN Caju, Sergipe, Brazil: (a) marks of *Tamandua tetradactyla* claws on tree bark; (b) *Euphractus sexcinctus*; (c) *Cerdocyon thous*; and (d) *Procyon cancrivorus*.

sample methods in the combination approach, as pitfall traps (see Umetsu *et al.* 2006) and snap traps (see Santos-Filho *et al.* 2006), should increase the number of individuals and species, in order to compensate the small time typical of preliminary surveys. However, the increase in number of sample methods implies in the time of implementation and monitoring, mainly when dealing with pitfall traps, that demand a high effort and high cost of mounting.

One important comparison here is with the long-term inventory at Fazenda Trapsa (5 km from the RPPN Caju), where a total of 14 nonvolant mammal species were recorded during visual surveys (Chagas *et al.* 2010). These species include a top predator, the Puma (*Puma concolor* Linnaeus, 1758), large-bodied primates (*Callicebus coimbrai* and *Sapajus xanthos-ternos*), and the maned sloth (*Bradypus torquatus*), none of which were recorded at RPPN Caju. This difference between the sites, rather than their size (RPPN Caju ~760 ha; Trapsa > 500 ha), may be related primarily to factors such as the better preservation of the habitats, as well as natural differences in the vegetation, given that Fazenda Trapsa is further inland, and is more typical of the large-tree forest habitat of Atlantic Forest than the coastal arbustive-arboreal restinga. Despite being a protected area, the RPPN Caju has a long, ongoing history of deforestation, hunting, and other impacts (Embrapa 2013).

Despite the relatively low mammal species richness recorded in the present study, considering mainly the small-bodied species, the RPPN Caju can be considered to be an important refuge for the local fauna, given the overall situation in Sergipe, especially in coastal areas (Braghini and Vilar 2013). In addition to its restinga habitats, the area protects a number of seasonal lagoons and floodplain environments (IBGE 2004) that are vital to some migratory species, and important reproduction sites for a number of autochthonous species.

Domestic animals (dogs and cats) are relatively common in the RPPN Caju due to the proximity of settlements in the surrounding area, and include a number of individuals that are resident at the EMBRAPA headquarters. Local informants reported that dogs may often persecute and capture wild mammals, particularly capybaras, armadillos and foxes. Dogs are known to exert a high pressure on the native fauna through predation (Churcher and Lawton 1987; Butler *et al.* 2004; Lacerda *et al.* 2009; Paschoal *et al.* 2012) and disease transmission (Courtenay *et al.*

2001; Deem *et al.* 2001), and may even cause local extinctions (Taylor 1979; Galetti and Sazima 2006).

The present study provides the first data on the occurrence of nonvolant mammals in the coastal restinga of Sergipe. Although the results are preliminary, it fills the lack of knowledge about the mammalian fauna present in habitats of restinga, as well as the mammalian community of the whole state of Sergipe. Currently, the State has poor information about the composition and distribution of mammal species. Even preliminary studies like the present one may be crucial to the adoption of proper conservation strategies. The low species richness ($S = 13$) is typical of Sergipe and consistent with previous surveys in the region, which may reflect both naturally low diversity and anthropogenic pressures. The local diversity of carnivores is also encouraging, especially in a region where so few data are available and anthropogenic impacts are so intense. It also seems likely that a larger number of rodents and marsupials may occur in the RPPN Caju. Then, further research is needed to provide a more definitive inventory of species, increasing the complementary methods, investigating how the species lead with seasonal floating of resources and the definition of ecological parameters, such as density and distribution of different species, to support conservation measures. These measures should involve local communities, with the aim of reducing impacts such as the extraction of firewood and hunting, as well as the reduction of the presence of domestic animals within the reserve.

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