

ARTIGO ORIGINAL

## Medium and Large-sized Mammals of the Municipality of Pirajuí, São Paulo, Brazil

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### RESUMO

**Mamíferos de médio e grande porte do município de Pirajuí, São Paulo, Brasil.** Mamíferos desempenham um papel ecológico importante e estão relacionados a vários processos ecológicos. O objetivo do estudo foi listar espécies de mamíferos de médio e grande porte que ocorrem no município de Pirajuí, SP. O estudo foi realizado em área urbana, estradas que percorrem áreas rurais e em pequenos fragmentos de Mata Atlântica. Os dados foram obtidos durante um período de três anos por diferentes métodos: observação direta, registros de pegadas e por armadilhas fotográficas. Foram registradas 18 espécies de mamíferos de médio e grande porte pertencentes a 13 famílias e oito ordens, representando 40% das espécies de mamíferos de médio e grande porte que ocorrem no estado de São Paulo. Carnívora foi a ordem com o maior número de representantes, com sete espécies. Assim, o estudo fornece dados importantes sobre a ocorrência de certas espécies de mamíferos nesses ambientes frequentemente negligenciados, onde a falta de conhecimento pode levar a futuras extinções locais.

**Palavras-chave:** Biodiversidade, Conservação, Levantamento, Mastofauna, Região neotropical.

### ABSTRACT

Mammals play an important ecological role and are related to several ecological processes. The objective of the study was to list medium and large-sized mammals species which occur in the municipality of Pirajuí, SP. The study was carried out in an urban area, roads that run through rural areas and in small fragments of Atlantic Forest. The data were obtained during a period of three years by different methods: direct observation, footprints records and by camera traps. We recorded 18 medium and large-sized mammals species belonging to 13 families and eight orders, representing 40% of medium and large-sized mammals species that occur in the State of São Paulo. Carnivora was the order with the highest number of representatives, with seven species. Thereby, the study provides important data about the occurrence of certain species of mammals in these often-neglected environments, where the lack of knowledge may lead to a future local extinctions.

**Keywords:** Biodiversity, Conservation, Mastofauna, Neotropical region, Survey.

## INTRODUCTION

Brazil has the greatest mammal richness in the Neotropical region, with 732 mammal species distributed in 12 Orders and 50 families (Paglia et al., 2012; MMA, 2016). In the state of São Paulo, 231 taxa were registered of which 45 account for medium and large-sized mammals (Vivo et al., 2011).

Due to a historical agricultural and urban expansion, current mammals have taken refuge in small forest remnants, which are common in the State of São Paulo, but their composition is poorly studied (Briani et al., 2001). They play an important role in the environment and are associated with several ecological processes such as: forest regeneration, prey control, seed dispersal, pollination, herbivory, among others (Abreu-Jr & Köhler, 2009).

The greatest threats to terrestrial mammals in Brazil come from the loss and fragmentation of their habitat resulting from human activities and strong hunting pressure (Costa et al., 2005). In the Atlantic Forest area, one of the world's biodiversity hotspots (Myers et al., 2000), mammals are the group with the highest proportion of endangered species, with approximately 25% of the species included in the Red List of Endangered Brazilian Fauna (ICMBio, 2018). Seasonal Semideciduous Forest are one of the most fragmented ecosystems in the Atlantic Forest with few protected areas and less than 10% of the remaining vegetation (Ribeiro et al., 2009).

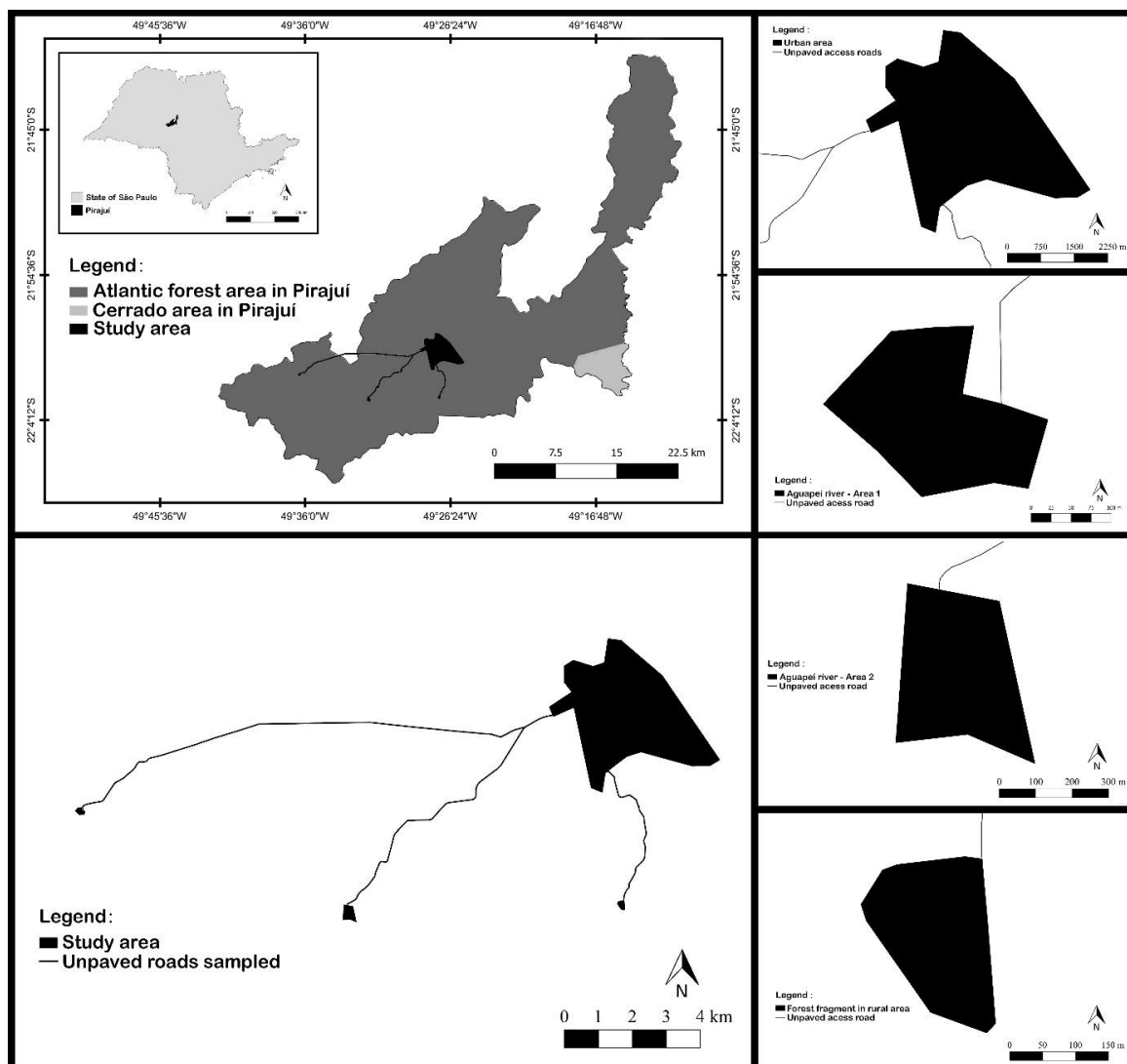
Studies concerning the consequences of forest fragmentation and biodiversity conservation have increased substantially because a significant part of this biodiversity is located in small forest fragments, which are poorly studied and historically forgotten by conservation initiatives (Viana & Pinheiro, 1998; Santos et al., 2013). For the development of conservation actions, basic knowledge of the species as well as its spatial distribution is indispensable, including inventories of mammals (Kasper et al., 2007).

Aiming to contribute with data on the occurrence and distribution of mammals in the region, the objective of this study was to inventory medium and large-sized mammals in an area under anthropogenic influence such as rural areas and small forest fragments associated with them in the municipality of Pirajuí, state of São Paulo, Brazil.

## MATERIAL AND METHODS

## Study Area

The municipality of Pirajuí is located in the northwest region of the State of São Paulo, Brazil ( $21^{\circ}59'56''\text{S}$ ;  $49^{\circ}27'25''\text{W}$ ). The municipality has an area of  $823,350 \text{ km}^2$ , covering a transition area of Atlantic Forest and Cerrado (Savannah) biomes (IBGE, 2000). This study was carried out in the urban area, on unpaved roads that cross rural areas and in small fragments of seasonal semideciduous forest (Figure 1). The forest fragments, which are the main ones with free access, are isolated within matrix of cultivated areas, mainly sugarcane, orange and eucalyptus plantations and pasture areas for cattle.



**Figure 1.** Map of the municipality of Pirajuí, in the interior of the state of São Paulo, Brazil, highlighting the studied area.

## Sampling

Data from this study were obtained over a three-year period, from April 2014 to March 2017, when the mammalian species were recorded through different methods: direct observation, footprint records and records from camera traps (Covert 'The Deuce' Trail Camera). At least 5 hours of monthly inventory was taken in the area, with an average of 1 h 30 min in each fragment and 30 minutes in the urban area, with a total of 180 hours sampling effort. Domestic mammals found in the study area were not considered. The species nomenclature followed Paglia et al. (2012).

## Analysis

By means of the survey of medium and large-sized mammals, a list of species for the municipality of Pirajuí was elaborated and, in addition, the registered species were classified into trophic guilds based on their diets. Dietary information on each species was based on Paglia et al. (2012) and on field observations.

## RESULTS

A total of 18 species of medium and large-sized mammals, belonging to 13 families and eight orders, were registered. This richness represents 40% of the total medium and large-sized mammal species in the State of São Paulo (Table 1).

The Order Carnivora showed the highest number of records with seven species (38,88%). We recorded two species (11,11%, each Order) for Cingulata, Lagomorpha, Primates and Rodentia. We recorded one species (5,55%) for Didelphimorphia, Pilosa and Artiodactyla.

Among the cataloged species, 13 were registered using the methodology of direct observation. Using the footprint records methodology, eight species were recorded and seven species were recorded using cameras traps.

In relation to the food categories, five species (27,77%) were classified as frugivore/omnivore, three species (16,66%) were classified as insectivore/omnivore and three as herbivore grazer, two species (11,11%) as carnivore and there was only one record (5,55%) for the guilds myrmecophage, piscivore, folivore/frugivore, frugivore/herbivore and frugivore/granivore.

**Table 1.** List of medium and large-sized mammals species of municipality of Pirajuí, State of São Paulo, Brazil. Trophic guild: Fr = Frugivore; On = Omnivore; In = Insectivore; Myr = Myrmecophage; Fo = Folivore; Hb = Herbivore grazer; Ca = Carnivore; Os = Piscivore e Gr = Granivore. Registration method: DO = direct observation; F = footprint records e CAM = records from camera traps.

Order / Family	Taxa	Common name	Trophic guild	Registration method
<b>Didelphimorphia</b> <b>Didelphidae</b>	<i>Didelphis albiventris</i> Lund, 1840	White-eared Opossum	Fr/On	DO/CAM
<b>Cingulata</b> <b>Dasypodidae</b>	<i>Dasytus novemcinctus</i> Linnaeus, 175	Nine-banded Armadillo	In/On	DO/CAM
	<i>Euphractus sexcinctus</i> (Linnaeus, 1758)	Six-Banded Armadillo	In/On	CAM
<b>Pilosa</b> <b>Myrmecophagidae</b>	<i>Tamandua tetradactyla</i> (Linnaeus, 1758)	Southern Tamandua	Myr	CAM
<b>Primates</b> <b>Cebidae</b>	<i>Sapajus nigritus</i> Goldfuss, 1809	Black-capped Capuchin	Fr/On	DO/F
<b>Primates</b> <b>Atelidae</b>	<i>Alouatta guariba</i> (Humboldt, 1812)	Brown Howler Monkey	Fo/Fr	DO
<b>Lagomorpha</b> <b>Leporidae</b>	<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758)	Forest Rabbit	Hb	DO
	<i>Lepus europaeus</i> Pallas, 1778	European Hare	Hb	DO
<b>Carnivora</b> <b>Felidae</b>	<i>Puma concolor</i> (Linnaeus, 1771)	Puma	Ca	F
	<i>Leopardus pardalis</i> (Linnaeus, 1758)	Ocelot	Ca	F/CAM
<b>Carnivora</b> <b>Canidae</b>	<i>Cerdocyon thous</i> (Linnaeus, 1766)	Crab-eating Fox	In/On	DO/F
<b>Carnivora</b> <b>Mustelidae</b>	<i>Eira barbara</i> (Linnaeus, 1758)	Greyheaded Tayra	Fr/On	DO/CAM
	<i>Lontra longicaudis</i> (Olfers, 1818)	Neotropical Otter	Ps	DO
<b>Carnivora</b> <b>Procyonidae</b>	<i>Nasua nasua</i> (Linnaeus, 1766)	South American Coati	Fr/On	DO
	<i>Procyon cancrivorus</i> (G.[Baron] Cuvier, 1798)	Crab-eating Raccoon	Fr/On	F
<b>Artiodactyla</b> <b>Cervidae</b>	<i>Mazama gouazoubira</i> (G. Fischer [von Waldheim], 1814)	Brown Brocket	Fr/Hb	DO
<b>Rodentia</b> <b>Caviidae</b>	<i>Hydrochoerus hydrochaeris</i> (Linnaeus, 1766)	Capybara	Hb	DO/F
<b>Rodentia</b> <b>Dasyproctidae</b>	<i>Dasyprocta azarae</i> Lichtenstein, 1823	Azara's Agouti	Fr/Gr	DO/F/CAM

## DISCUSSION

We highlight the conservation importance of the studied region in Pirajuí where we recorded species with great ecological importance, such as individuals of the Order Carnivora. Due to its great mobility and ability to explore anthropic environments, species of Carnivora Order often occur in fragmented landscapes (Lyra-Jorge et al., 2008), such as the area where the study was carried out.

Carnivores are crucial for balancing ecosystems as they maintain and restore the diversity and resilience of the environment through prey control and seed dispersal processes (Terborgh, 1992), and the animals of this order usually rely on forested areas and have a low population density (Robinson & Redford, 1986). In addition, the high proportion of species in this order seems to be common in surveys conducted in areas of Atlantic forest and Cerrado biomes (Chiarello, 1999; Santos-Filho & Ferreira da Silva, 2002; Negrão & Valladares-Pádua, 2006; Modesto et al., 2008; Prado et al., 2008; Eduardo & Passamani, 2009; Pessôa et al., 2009; Bocchiglieri et al., 2010; Bruna et al., 2010; Penido & Zanzini, 2012).

Despite the absence of records during the study period, it was expected the occurrence of some species that have been recorded in inventories carried out in municipalities close to our study area: Gália, SP and Alvinlândia, SP (Tabanez et al., 2005); Anhembi, SP (Antunes & Eston, 2009); Botucatu, SP (Alves et al., 2012); São Carlos, SP (Dias et al., 2012) and Jaú, SP (Reale et al., 2014). These species are those of the genus *Cabassous* sp. (Tabanez et al., 2005; Antunes & Eston, 2009; Alves et al., 2012; Reale et al., 2014); *Chrysocyon brachyurus* (Illiger, 1815) (Dias et al., 2012; Reale et al., 2014); *Conepatus* sp. (Alves et al., 2012; Dias et al., 2012); *Didelphis aurita* (Wied-Neuwied, 1826) (Tabanez et al., 2005); *Galictis cuja* (Molina, 1782) (Antunes & Eston, 2009); *Galictis vittata* (Schreber, 1776) (Tabanez et al., 2005; Dias et al., 2012); *Mazama americana* (Erxleben, 1777) (Tabanez et al., 2005; Antunes & Eston, 2009); *Myrmecophaga tridactyla* Linnaeus, 1758 (Alves et al., 2012); *Coendou spinosus* (F. Cuvier, 1823) (Dias et al., 2012) and *Coendou villosus* (F. Cuvier, 1823) (Tabanez et al., 2005; Antunes & Eston, 2009; Reale et al., 2014). The absence of these species can be attributed to a local low population density. It is also possible that the methodology used in the study was not suitable for the registration of these species or a local extinction.

Moreover, in the studies mentioned above, carried out in nearby localities, the researchers found, in addition to the species registered in Pirajuí, others that present greater sensitivity to environmental changes, such as: *Brachyteles arachnoides* (É. Geoffroy, 1806) (Antunes & Eston, 2009); *Callicebus* sp. (Dias et al., 2012); *Callicebus nigrifrons* (Spix, 1823) (Antunes & Eston, 2009); *Cuniculus paca* (Linnaeus, 1766)

(Tabanez et al., 2005; Antunes & Eston, 2009; Alves et al., 2012; Reale et al., 2014); *Lycalopex vetulus* (Lund, 1842) (Reale et al., 2014); *Pecari tajacu* (Linnaeus, 1758) (Tabanez et al., 2005; Antunes & Eston, 2009); *Puma yagouaroundi* (É. Geoffroy, 1803) (Tabanez et al., 2005; Antunes & Eston, 2009; Reale et al., 2014); *Tapirus terrestris* (Linnaeus, 1758) (Tabanez et al., 2005) and *Tayassu pecari* (Link, 1795) (Tabanez et al., 2005; Antunes & Eston, 2009). These species need larger forest areas and, within these areas, they need to find specific resources such as food and/or habitat resources. Unlike the small fragments sampled in Pirajuí, who suffered a greater degree of anthropic degradation, the sample areas of the studies that recorded the presence of these species are larger and probably provide the conditions for these species to maintain viable populations.

In relation to registered species, we highlight those with conservation concerns, being in the State of São Paulo *Leopardus pardalis* and *Puma concolor* are categorized as threatened; *Sapajus nigritus* and *Lontra longicaudis* as nearly-threatened (São Paulo - Decreto 60.133, 2014). At national level, *Puma concolor* and *Alouatta guariba* are considered vulnerable (VU) (ICMBio, 2018) and at global level, IUCN (2018) classifies *Sapajus nigritus* and *Lontra longicaudis* on its Red List as nearly-threatened species (NT).

Among the registered species, the puma (*Puma concolor*) is found throughout the entire national territory and has suffered with deforestation, habitat fragmentation, hunting, retaliation due to domestic animal predation, forest fires and roadkill, which can cause a future decline on the national subpopulation (Azevedo et al., 2013). The conservation of large felines such as the puma requires extensive areas, once these animals need large life territories and many environmental resources.

The Brown Howler Monkey (*Alouatta guariba*) is endemic to the Atlantic Forest and may live in primary or secondary forests, as well as highly man-disturbed habitats, since they have an eclectic diet adaptable to environmental conditions (Reis et al., 2011). Nonetheless, habitat loss, hunting and capturing are the main reasons why this species is framed as vulnerable. In addition, individuals have been dying due to cases of Yellow Fever in some regions of Brazil, as in the State of São Paulo (Bicca-Marques et al., 2018). The species is host and very susceptible to the virus, which is transmitted by mosquitoes of the genera *Haemagogus* and *Sabethes* in the wild environment and *Aedes aegypti* in the urban environment (Monath & Vasconcelos, 2015; Silva et al., 2019; Ministério da Saúde, 2019).

Knowing the species that occur in a certain area is an important tool because without this information it is practically impossible to develop any conservation initiatives (Cullen-Jr et al., 2003). Therefore, studies carried out in environments similar to the studied area become important, since these sites can present a high species richness, which reinforces the need to develop conservation measures for these forest remnants.

## CONCLUSION

This study showed the importance of wildlife inventories performed in areas under anthropic influence, such as rural sites and small fragments associated with them, providing important data about the occurrence of certain species in these often-neglected environments, where the lack of knowledge may lead to a future local extinction. This study contributes to acknowledging the wildlife potential in the region and the need for conservation measures in the studied area.

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