

Mammals of medium and large size from a fragmented seasonal forest landscape in Mato Grosso do Sul state, central-western Brazil

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ABSTRACT: The southern cone of Mato Grosso do Sul state is poorly known in terms of mammal community composition. This information is very important to propose an environmental management plan. The present study provides information on the composition of medium and large size mammals in the municipality of Batayporã, in the Ivinhema river basin, southwestern Brazil. The mammal community was sampled during 19 field sampling occasions by the identification of vestiges, such as burrows, feces, vocalization and tracks, as well as through direct observations. I recorded 24 mammal species distributed in eight taxonomic orders. Thirteen species were frequently recorded, six species were rarely recorded, and six species are considered threatened in Brazil or in global level. The area presents almost half of the medium and large-sized mammal fauna from Mato Grosso do Sul state, but fragmentation and sugarcane plantations may represent a threat to the local biodiversity conservation.

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INTRODUCTION

The Brazilian state of Mato Grosso do Sul presents a rich mammal fauna comprising 151 species, 44 of which are medium and large-sized species (Cáceres *et al.* 2008a). Nevertheless, there are still few studies about the mammalian fauna for the state, and the lists of medium and large mammals available refer to areas of the Pantanal (Tomas *et al.* 2010; Alho *et al.* 2011) and highland regions surrounding the Pantanal, like the Urucum mountains (Mauro and Campos 2000), Amolar mountains (Porfirio *et al.* 2014), Bodoquena mountains (Cáceres *et al.* 2007) and regions of Aporé and Sucuriú rivers, in the northeastern part of the state (Bordignon *et al.* 2006).

The Ivinhema river basin is located in the southeastern region of Mato Grosso do Sul state. This region is considered “poorly known” and has been recommended for biological inventories (MMA 2002). Moreover, in the basin is located the Environmental Protection Area “APA das Ilhas e Várzeas do Rio Paraná” which harbor threatened mammals, such as the Marsh Deer *Blastocerus dichotomus* (Illiger, 1815), Tapir *Tapirus terrestris* (Linnaeus, 1758), Ocelot *Leopardus pardalis* (Linnaeus, 1758) and Jaguar *Panthera onca* (Linnaeus, 1758) (MMA 2014). Thus, the goal of the present study is to provide a list of the medium and large-sized mammals present in the seasonal forest of the Batayporã municipality, located in the Ivinhema river basin, located in the southeastern region of the Brazilian state of Mato Grosso do Sul.

MATERIAL AND METHODS

Study area

The study was carried out in the municipality of Batayporã, southeastern Mato Grosso do Sul, in the Environmental

Protection Area “APA das Ilhas e Várzeas do Rio Paraná”. The protected area is composed by semideciduous seasonal forest, gallery forest and wet grassland. The climate is tropical with a dry season, Aw according to Köppen classification (Köppen 1948). The annual precipitation in the region is approximately 1,612 mm, with two well-defined seasons: a wet season, from October to April, with the highest precipitation in October (267 mm), and a dry season, from May to September, with the lowest precipitation in July (23 mm). The average annual temperature is 22°C, with higher temperatures in the wet season (mean of 24.9°C) and lower temperatures during the dry season (mean of 18.4°C) (Rivas-Martínez and Rivas-Sáenz 2009) (Figure 1).

Data Collection

The species inventory was carried out at five sampling sites of differing vegetation types: site 1 (22°27'58" S,

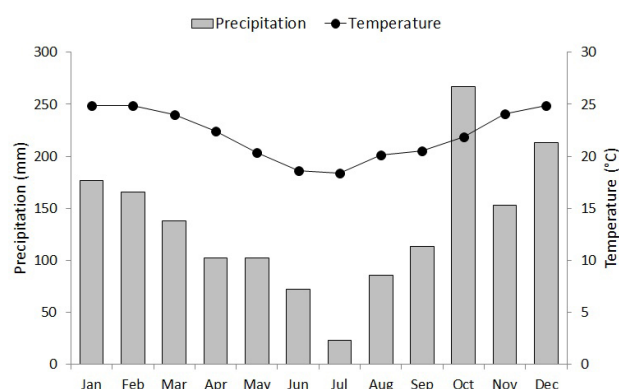


FIGURE 1. Precipitation and temperature in the municipality of Batayporã, Mato Grosso do Sul state. Data for 1996–2009 (Rivas-Martínez and Rivas-Sáenz 2009).

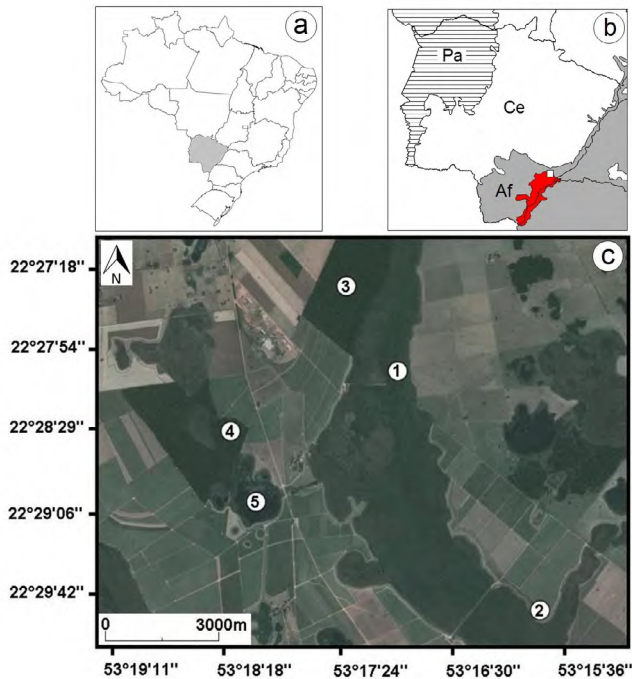


FIGURE 2. (a) The state of Mato Grosso do Sul, Brazil; (b) Environmental Protection Area "APA das Ilhas e Várzeas do Rio Paraná" (red), municipality of Batayporã (white square) and its three main vegetation formations: Af=Atlantic forest, Ce=Cerrado, Pa=Pantanal; (c) sampling sites in the study area.

53°16'57" W) and site 2 (22°29'43" S, 53°16'21" W) were composed of predominantly flooded alluvial seasonal forest; site 3 (22°27'21" S, 53°17'21" W) and site 4 (22°28'25" S, 53°18'16" W) were composed by fragments of semideciduous seasonal forest; and site 5 (22°28'56" S, 53°18'04" W) was characterized by the presence of *várzea* — a floodplain that accompanies rivers and streams (Figure 2) (Veloso *et al.* 1991). The shortest distance between sites was 1.5 km and the longest was 7 km. All forest remnants are inserted in a matrix composed of sugarcane plantations (Figure 2), the main economic activity of the region. This study covers data collected during 19 sampling occasions, with three days each, carried out every three months between September of 2009 and July of 2014.

Medium and large mammals were recorded in the sampling sites by: i) direct observations; ii) tracks; iii) burrows (armadillos); iv) vocalization (primates); and v) feces. The sampling effort in the field comprised two hours at each site for each sampling occasion, with a total of 190 sampling hours. The threat category of mammalian species was classified according to the Brazilian list of threatened mammals (Chiarello *et al.* 2008) and the Red List of the Threatened Species published by the International Union for Conservation of Nature (IUCN 2013). The taxonomic classification follows Paglia *et al.* (2012). The tracks and others signs were identified according to Lima Borges and Tomas (2004).

Data collected was analyzed through the composition and species richness (observed and estimated). Estimated richness was calculated using the Jackknife 1. The species accumulation curve (collector curve) was provided using the software EstimateS 8.2 (Colwell 2005) based on the number of new species added as a function of the field sampling effort, including all sampling methods.

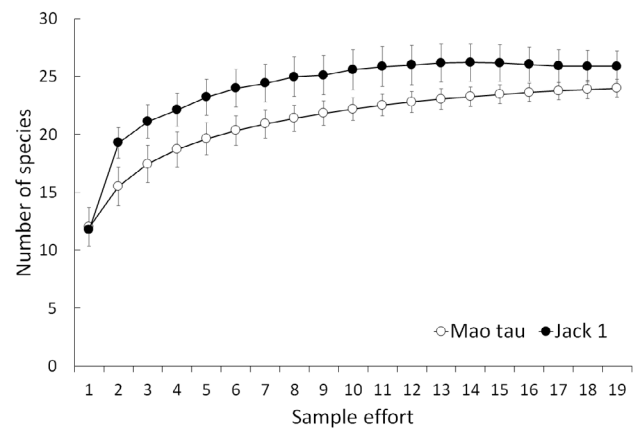


FIGURE 3. Curves of the increased number of species observed (Mao Tau) and estimated (Jackknife 1) in relation to sampling effort (19 sampling occasions between September/2009 and July/2014), municipality of Batayporã, Mato Grosso do Sul state, Brazil.

RESULTS

Twenty-four species of medium and large mammals were recorded, encompassing eight orders and 15 families. Carnivora was the richest order with nine species (Table 1). The species accumulation curves for observed and estimated richness showed a tendency to stabilization (Figure 3) suggesting that most mammal species of the area were sampled.

Thirteen species were recorded in more than half of the sampling occasions, specially the Brown Capuchin Monkey *Sapajus cay* (Illiger, 1815), Crab-eating Fox *Cerdocyon thous* (Linnaeus, 1758), Tapir *Tap. terrestris*, Capybara *Hydrochoerus hydrochaeris* (Linnaeus, 1766), Azara's Agouti *Dasyprocta azarae* Lichtenstein, 1823, were recorded all occasions, and the Crab-eating Raccoon *Procyon cancrivorus* (G. Cuvier, 1798) and the Puma *Puma concolor* (Linnaeus, 1771), were recorded in approximately 79% of occasions (Table 1, Figure 4). Brocket Deer of genus *Mazama*, the Tapeti *Sylvilagus brasiliensis* (Linnaeus, 1758), the Striped Hog-nosed Skunk *Conepatus semistriatus* (Boddaert, 1785), the Brazilian Guinea Pig *Cavia aperea* Erxleben, 1777, the Long-tailed Otter *Lontra longicaudis* (Olfers, 1818), the Lesser Grison *Galictis cuja* (Molina, 1782) and the White-lipped Peccary *Tayassu pecari* (Link, 1795) were recorded less frequently (Table 1; Figure 5).

DISCUSSION

This study recorded 54.5% of the medium and large mammals present in the state of Mato Grosso do Sul (Cáceres *et al.* 2008a). In addition to contributing with new research on the southern region of the state, this study also registered nine species that have not been recorded for the Atlantic Forest of Mato Grosso do Sul (see Cáceres *et al.* 2008a). These species are: the Giant Anteater *Myrmecophaga tridactyla* Linnaeus, 1758, Maned Wolf *Chrysocyon brachyurus* (Illiger, 1815), *Ga. cuja*, *Pr. cancrivorus*, Collared Peccary *Pecari tajacu* (Linnaeus, 1758), *Tay. pecari*, Red Brocket Deer *Ma. americana* (Erxleben, 1777), Gray Brocket Deer *Ma. gouazoubira* (G. Fischer, 1814) and *Da. azarae* (Figure 4 and 5). The paucity of data on the mammal community in the Atlantic Forest of Mato Grosso do Sul is due mainly to the absence of research on this region, but may also be related to the poor state of conservation of

the entire region, where only small fragments (most of them smaller than 100 ha) of semideciduous seasonal forest remain (Cáceres *et al.* 2008a).

Species such as *Ce. thous*, *Hy. hydrochaeris*, *Tap. terrestris*, *Pr. cancrivorus*, *Da. azarae*, *Sa. cay* and *Pu. concolor* are frequently recorded species in the central-western portion of Brazil (Cáceres *et al.* 2008b). On the other hand, *Lo. longicaudis*, *Ga. cuja* and *Tay. pecari* are species rarely recorded in this region. The abundance or rarity of the species of mammals may be related to one or two main factors. The first is the natural abundance or rarity of species in the habitats investigated and the second is a sensitivity of each species to changes in

habitat (Cáceres *et al.* 2008b).

For the non-volant mammals, habitat fragmentation, poaching and road kills are the main factors that threaten the conservation of species (Chiarello 1999; Cullen Jr. *et al.* 2000; 2001; Costa *et al.* 2005; Cáceres *et al.* 2010). Road kills perhaps have the biggest impact on the population of some species of mammals (*e.g.*, *My. tridactyla*, *Tamandua tetradactyla* (Linnaeus, 1758), *Ch. brachyurus*, *Pu. concolor* and *Tap. terrestris*) (Cáceres *et al.* 2010), many of which are already becoming rare due to the hunting pressure, loss and fragmentation of habitats (Chiarello 1999; Cullen Jr. *et al.* 2000; Costa *et al.* 2005).

TABLE1. Composition of medium and large size mammals recorded in the municipality of Batayporã, Mato Grosso do Sul state, southwestern Brazil. Legend: threatened species: asterisk=vulnerable (Chiarello *et al.* 2008) and VU=vulnerable (IUCN 2013). Habitat type: (SAF) alluvial seasonal forest, (SSF) semideciduous seasonal forest, (VAR) várzea. N=number of occasions. Type of record: (B) burrow, (D) direct observation, (F) feces, (V) vocalization, (T) tracks.

TAXON	COMMON NAME	HABITAT TYPE	SAMPLING OCCASIONS	N	TYPE OF RECORD
CINGULATA					
Dasypodidae					
<i>Dasyus novemcinctus</i> Linnaeus, 1758	Nine-banded Armadillo	ASF, SSF, VAR	2, 8–11, 13–17 and 19	11	B, T
<i>Euphractus sexcinctus</i> (Linnaeus, 1758)	Yellow Armadillo	ASF, SSF	1, 3, 6, 7, 10, 11, 13, 14 and 17	9	B, T
PILOSA					
Myrmecophagidae					
<i>Myrmecophaga tridactyla</i> Linnaeus, 1758 ^{*VU}	Giant Anteater	ASF, SSF, VAR	2–4, 6–8, 11, 14, 16–18 and 19	12	D, T
<i>Tamandua tetradactyla</i> (Linnaeus, 1758)	Collared Anteater	ASF, SSF, VAR	2–4, 6, 10, 11, 15, 16, 18 and 19	10	D, T
PRIMATES					
Cebidae					
<i>Sapajus cay</i> (Illiger, 1815)	Brown Capuchin Monkey	ASF, SSF	all	19	D, T, V
Atelidae					
<i>Alouatta caraya</i> (Humboldt, 1812)	Black Howler Monkey	ASF, SSF	1, 5, 9 and 12	4	D, T
LAGOMORPHA					
Leporidae					
<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758)	Tapeti	ASF, SSF	4, 5 and 13	3	D, T
CARNIVORA					
Felidae					
<i>Leopardus pardalis</i> (Linnaeus, 1758) *	Ocelot	ASF, SSF, VAR	1, 3–8, 11, 14, 17 and 19	11	T
<i>Puma concolor</i> (Linnaeus, 1771) *	Puma	ASF, SSF, VAR	1–4, 7–11, 13–16, 18 and 19	15	T
Canidae					
<i>Cerdocyon thous</i> (Linnaeus, 1766)	Crab-eating Fox	ASF, SSF, VAR	all	19	D, T
<i>Chrysocyon brachyurus</i> (Illiger, 1815) *	Maned Wolf	ASF, SSF, VAR	1, 6, 8, 9, 11–14 and 17–19	11	T
Melphitidae					
<i>Conetapus semistriatus</i> (Boddaert, 1785)	Striped Hog-nosed Skunk	SSF	15	1	T
Mustelidae					
<i>Eira barbara</i> (Linnaeus, 1758)	Tayra	ASF, SSF	3–6, 8, 11 and 18	7	D, T
<i>Galictis cuja</i> (Molina, 1782)	Lesser Grison	SSF	4 and 17	2	D
<i>Lontra longicaudis</i> (Olfers, 1818)	Long-tailed Otter	ASF	8 and 11	2	F, T
Procyonidae					
<i>Procyon cancrivorus</i> (G. Cuvier, 1798)	Crab-eating Raccoon	ASF, SSF, VAR	1–6, 8, 9 and 11–19	17	T
PERISSODACTYLA					
Tapiridae					
<i>Tapirus terrestris</i> (Linnaeus, 1758) ^{VU}	Tapir	ASF, SSF, VAR	all	19	F, T
ARTIODACTYLA					
Tayassuidae					
<i>Pecari tajacu</i> (Linnaeus, 1758)	Collared Peccary	ASF, SSF, VAR	2, 5, 6, 8, 9, 14 and 16	7	T
<i>Tayassu pecari</i> (Link, 1795) ^{VU}	White-lipped Peccary	SSF	4 and 17	2	T
Cervidae					
<i>Mazama americana</i> (Erxleben, 1777)	Red Brocket Deer	ASF, SSF	2, 7, 12 and 17	4	D, T
<i>Mazama gouazoubira</i> (G. Fischer, 1814)	Gray Brocket Deer	ASF, SSF	2, 3, 7 and 11	4	T
RODENTIA					
Caviidae					
<i>Cavia aperea</i> Erxleben, 1777	Brazilian Guinea Pig	ASF, SSF	8 and 10	2	D, T
<i>Hydrochoerus hydrochaeris</i> (Linnaeus, 1766)	Capybara	ASF, SSF, VAR	all	19	D, F, T
Dasyproctidae					
<i>Dasyprocta azarae</i> Lichtenstein, 1823	Azara's Agouti	ASF, SSF, VAR	all	19	D, T



FIGURE 4. Mammals of medium and large size most frequently recorded in the municipality of Batayporã, Mato Grosso do Sul, Brazil. Tracks: (a) *Cerdocyon thous*, (b) *Hydrochoeris hydrochaeris*, (c) *Tapirus terrestris*, (d) *Procyon cancrivorus*, (e) *Sapajus cay*, (f) *Puma concolor*, (g) *Leopardus pardalis*, (h) *Dasyprocta azarae*.

Although the region of this study is mainly composed by monocultures of sugarcane, threatened species occur there such as *My. tridactyla*, *Leopardus pardalis*, *Pu. concolor*, *Ch. brachyurus*, *Tap. terrestris* and *Tay. pecari*. Habitat generalist species such as *My. tridactyla*, *L. pardalis*, *Pu. concolor* and *Tap. terrestris* are very common in central-western Brazil (Cáceres *et al.* 2008b). *Ch. brachyurus* is uncommon in this region, however, this species is omnivorous, with a broad diet including 68 species or morphospecies of fruits (mainly *Solanum lycocarpum*) and animals (mainly mammals such as armadillos and small rodents) (Bueno *et al.* 2002). Armadillos and small rodents are common in the study area (W. Hannibal personal communication). In conclusion, almost half of medium and large mammals of the Mato Grosso do Sul state were recorded in the study area, contributing to the inventory of mammalian fauna in seasonal forests (Atlantic slope), a threatened phytophysognomy where few studies on mammals have been done.

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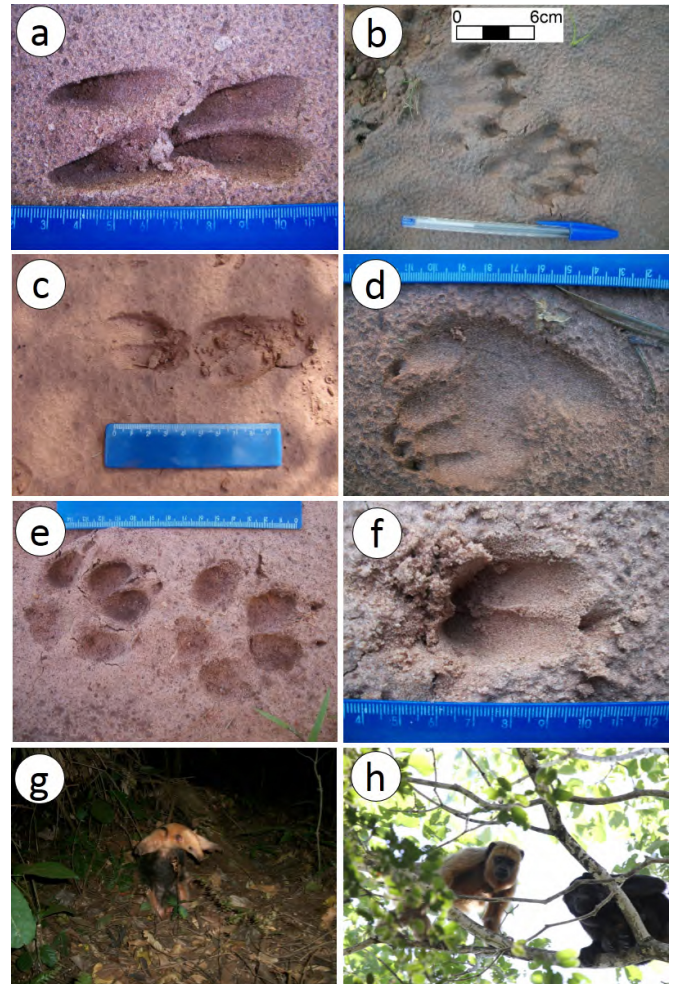


FIGURE 5. Mammals of medium and large size less frequently recorded in the municipality of Batayporã, Mato Grosso do Sul, Brazil. Tracks: (a) *Mazama americana*, (b) *Lontra longicaudis*, (c) *Tayassu pecari*, (d) *Myrmecophaga tridactyla*, (e) *Chrysocyon brachyurus*, (f) *Pecari tajacu*. Direct observation: (g) *Tamandua tetradactyla*, (h) *Alouatta caraya*.

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