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.

**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 (Porfírio 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’. This 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).

**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, 53°10’40″ W).
mammals (Chiarello et al. 2012) was classified according to the Brazilian list of threatened species that have not been recorded for the Atlantic Forest of Mato Grosso do Sul (see 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 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. Ouvier, 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 (Boddart, 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).

**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.

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 species (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.

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

Species such as Ge. thous, Hy. hydrochaeris, Tup. 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 Tup. 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).

**Table 1.** 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) semidecidual seasonal forest, (VAR) varzea. 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 | Dasypus novemcinctus (Linnaeus, 1758) | Nine-banded Armadillo | SAF, SSF, VAR | 2, 8–11, 13–17 and 19 | 11 | B, T |
| Euphractus sexcinctus (Linnaeus, 1758) | Yellow Armadillo | SAF, SSF | 1, 3, 6, 7, 10, 11, 13, 14 and 17 | 9 | B, T |
| Pilosa | Myrmecophagidae | Myrmecophaga tridactyla (Linnaeus, 1758) | Giant Anteater | SAF, SSF, VAR | 2–4, 6–8, 11, 14, 16–18 and 19 | 12 | D, T |
| Tamandua tetradactyla (Linnaeus, 1758) | Collared Anteater | SAF, SSF, VAR | 2–4, 6, 10, 11, 15, 16, 18 and 19 | 10 | D, T |
| Primates | Cebidae | Sapajus cay (Illiger, 1815) | Brown Capuchin Monkey | SAF, SSF | all | 19 | D, T, V |
| Atelidae | Alouatta caraya (Humboldt, 1812) | Black Howler Monkey | SAF, SSF | 1, 5, 9 and 12 | 4 | D, T |
| Lagomorpha | Sylvilagus brasiliensis (Linnaeus, 1758) | Tapeti | SAF, SSF | 4, 5 and 13 | 3 | D, T |
| Carnivora | Felidae | Leopardus pardalis (Linnaeus, 1758) * | Ocelot | SAF, SSF, VAR | 1, 3–8, 11, 14, 17 and 19 | 11 | T |
| Puma concolor (Linnaeus, 1771) * | Puma | SAF, SSF, VAR | 1–4, 7–11, 13–16, 18 and 19 | 15 | T |
| Canidae | Cerdocyon thous (Linnaeus, 1766) | Grab-eating Fox | SAF, SSF, VAR | all | 19 | D, T |
| Chrysocyon brachyurus (Illiger, 1815) * | Maned Wolf | SAF, SSF, VAR | 1, 6, 8, 9, 11–14 and 17–19 | 11 | T |
| Melphitidae | Conetapus semistriatus (Boddart, 1765) | Striped Hog-nosed Skunk | SSF | 15 | 1 | T |
| Mustelidae | Eira barbara (Linnaeus, 1758) | Tayra | SAF, SSF | 3–6, 8, 11 and 18 | 7 | D, T |
| Galictis cuja (Molina, 1782) | Lesser Grison | SSF | 4 and 17 | 2 | D |
| Lontra longicaudis (Olfers, 1818) | Long-tailed Otter | SAF | 8 and 11 | 2 | F, T |
| Procyonidae | Procyon cancrivorus (G. Cuvier, 1817) | Grab-eating Raccoon | SAF, SSF, VAR | 1–6, 8, 9 and 11–19 | 17 | T |
| Perissodactyla | Tapiridae | Tapirus terrestris (Linnaeus, 1758) * | Tapir | SAF, SSF, VAR | all | 19 | F, T |
| Artiodactyla | Tayassuidae | Pecari tajacu (Linnaeus, 1758) | Collared Peccary | SAF, SSF, VAR | 2, 5, 6, 8, 9, 14 and 16 | 7 | T |
| Tayassu pecari (Link, 1795) * | White-lipped Peccary | SSF | 4 and 17 | 2 | T |
| Cervidae | Mazama americana (Erxleben, 1777) | Red Brocket Deer | SAF, SSF | 2, 7, 12 and 17 | 4 | D, T |
| Mazama gouazoubira (G. Fischer, 1814) | Gray Brocket Deer | SAF, SSF | 2, 3, 7 and 11 | 4 | T |
| Rodentia | Caviidae | Cavia aperea (Erxleben, 1777) | Brazilian Guinea Pig | SAF, SSF | 8 and 10 | 2 | D, T |
| Hydrochoerus hydrochaeris (Linnaeus, 1766) | Capybara | SAF, SSF, VAR | all | 19 | D, F, T |
| Dasyproctidae | Dasypodidae | Dasypodidae | SAF, SSF, VAR | all | 19 | D, T |
Although the region of this study is mainly composed by monocultures of sugarcane, threatened species occur there such as *Myrmecophaga tridactyla*, *Leopardus pardalis*, *Puma concolor*, *Chrysocyon brachyurus*, *Tapirus terrestris* and *Tayassu pecari*. Habitat generalist species such as *Myrmecophaga tridactyla*, *Leopardus pardalis*, *Puma concolor* and *Tapirus terrestris* are very common in central-western Brazil (Cáceres *et al.* 2008b). *Chrysocyon 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 phytosociology where few studies on mammals have been done.

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