

Mammalia, Estação Ecológica do Panga, a Cerrado protected area in Minas Gerais state, Brazil

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ABSTRACT: We present a species list of the mammals of the Estação Ecológica do Panga, a 404 ha Cerrado reserve in Minas Gerais state, Brazil. Using methods ranging from camera traps to direct observations, we documented 46 species in the reserve. Among medium and large-sized mammals, the order Carnivora was the most commonly observed (N=12 species). The highest relative frequencies of observation were of *Mazama guazoubira* and *Cerdocyon thous*. *Pecari tajacu* was the most frequent species in camera traps. Over the course of 7320 trap nights there were 105 captures of small mammals from seven species, with an overall capture rate of 1.6 %. The highest capture rates were for the marsupial *Gracilinanus agilis*, with *Calomys tener* the most commonly caught rodent. Our survey suggests that many of the Cerrado's mammal species can persist in landscapes that are a mosaic of natural areas and some types of agriculture.

INTRODUCTION

Savannas are one of the most widespread ecosystems in the tropics (Huntley and Walker 1982). Throughout much of South America the savanna biome is called the *Cerrado*, and with a distribution of 2 million km² it is second only to Amazonia in total land area. Like most savannas, the Cerrado is not a homogenous habitat type – it is a mosaic of plant physiognomies that range from open grassland to closed woodlands. It is also one of the most threatened ecosystems in South America, with over 40 % of the biome converted to agriculture and the remainder highly fragmented (Mistry 1998; Arroyo *et al.* 1999; Klink and Moreira 2002).

Most of the Cerrado is highly modified due to a long history of human occupation (Klink and Machado 2005), and less than 3 % of the biome is formally protected (Klink and Machado 2005). Though some of these protected areas are very large (e.g. Emas National Park: 133,063 ha; Grande Sertão Veredas National Park: 230,000 ha) many reserves range in size from 100-1000 ha. Though these smaller reserves are often subject to disturbances such as the presence of invasive species and wildfires, they can also play an important role in the conservation of biodiversity in fragmented landscapes if they support viable populations of smaller species and are important stepping stones for the movements of larger ones (Turner and Corlett 1996).

Here we report on the mammal fauna of the Estação Ecológica do Panga (404 ha) one of the few protected areas in the Triângulo Mineiro region in Minas Gerais state, Brazil (Figure 1). The objectives of our study were to generate a species list of the mammals occurring in the

reserve, as well as provide data on their relative abundance in different vegetation types.

MATERIALS AND METHODS

Study site

Estação Ecológica do Panga (EEP, 19°10' S, 48°23' W) is a 404 ha protected area located 30 km south of Uberlândia, Minas Gerais state, Brazil (Cardoso *et al.* 2009). The region is characterized by a subtropical climate with two well-defined seasons: a dry winter (May to September) and a rainy summer (October to April). The mean annual temperature and precipitation are 22 °C and 1650 mm, respectively; soils at the site are primarily red latosols that vary from moderately to strongly acidic (Embrapa 1982). The ecological station has been described as one of the best-preserved Cerrado sites in southeastern Brazil (Costa and de Araújo 2001) in part because despite its size it includes many plant physiognomies typical of the Cerrado biome.

Data collection: medium and large-sized mammals

We considered medium and large-sized mammals all those with adult biomass > 1 kg (*sensu* Chiarello 2000). To identify medium and large-sized mammal species within the protected area we conducted monthly surveys from November 2007-February 2009. These surveys were conducted by walking trails in the different plant physiognomies found in the protected area and looking for any signs of mammal activity (e.g. direct observations of animals, prints, dens, feces). The eight trails used ranged in length from 0.3 -1.5 km (Table 1); we sampled for a total of 45 days along each trail.

We also used camera traps (Tomas and Miranda 2003) in each of the physiognomies in which we conducted direct observations. We used four analog camera traps with a movement sensor: two in the first seven months (Trigrinus®, Santa Catarina, Brazil) and two additional ones (Trapa-Câmera, São Paulo, Brazil) starting the eighth month of data collection. Cameras were set in areas where there was evidence of animal activity, such as the edges of streams and trails. The cameras were attached to trees at a height of approximately 40 cm with steel wire and their position recorded with a GPS. The cameras remained in each point for a minimum of 30 days. There were a total of 373 trap nights.

Data collection: small mammals

We conducted a preliminary survey from 10-16 June 2004 to test our baits and methodology (total effort = 1091 trap-nights). Following this initial survey, we then trapped

small mammals monthly from April 2005 to April 2006 in four Cerrado physiognomies, which to remain consistent with previously published studies we refer to throughout the manuscript by their Portuguese names: cerradão, cerrado denso, cerrado sentido restrito, and cerrado ralo (for a complete description of these physiognomies see Oliveira-Filho and Ratter 2002). In each physiognomy we established an 800 m transect with 80 points every 10 m. At each point we placed a Sherman trap (23 x 8 x 9 cm) baited with a 150 g mixture of peanut butter, cornmeal, canned corn and banana. Traps were opened in the evening and checked each morning for four consecutive nights; fresh bait was placed in the trap on the third night; we marked all animals captured with a numbered ear-ring. We alternated between cerradão and campo cerrado in one month and cerrado sentido restrito and cerrado denso in the next for a total of six surveys in each physiognomy.

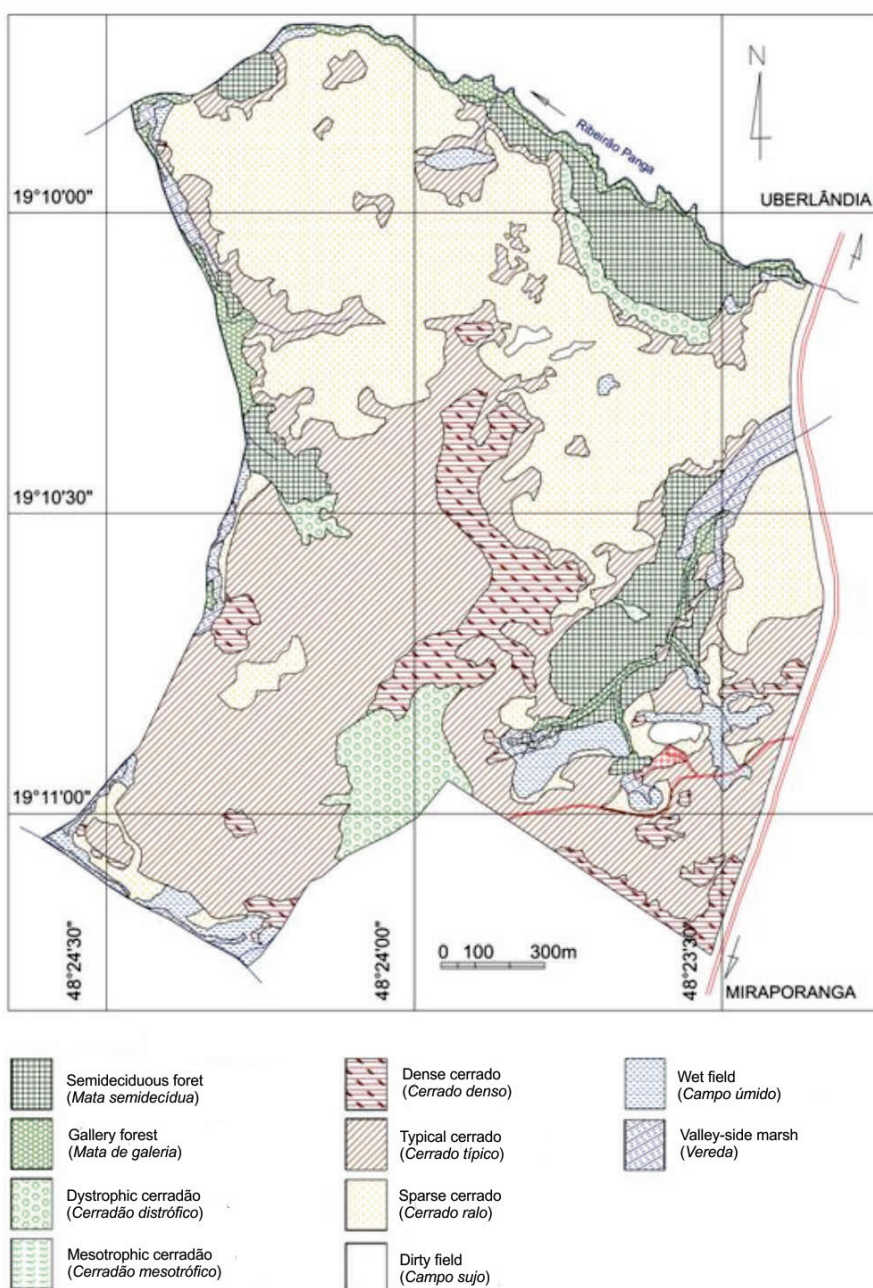


FIGURE 1. Map showing the location of the Estação Ecológica do Panga and the different vegetation physiognomies present in the reserve in 2005 (see Cardoso et al. 2009 for additional details on vegetation classification).

In addition to our quantitative sampling, we also (1) recorded any incidental observations of animals, tracks, or scats outside of our sampling period and (2) identified all small mammals collected in pitfall traps during a one year survey of terrestrial anurans that began in September 2000 (described in detail in Giaretta *et al.* 2008). While we report the species collected in these pitfall traps and casual observations in our species list for the protected area (Table 2), they are not included in our analyses of relative observation frequency.

We followed the taxonomy of Reis *et al.* (2006), with the exception of the revision of the primate genus *Callicebus* and Rodentia, for which we used Van Roosmalen (2002) and Bonvicino *et al.* (2008), respectively. Vouchers were deposited in the mammal collection of the Museu de Biodiversidade do Cerrado (MBC) of the Universidade Federal de Uberlândia (voucher numbers 188, 197, 266,

335, 336, 350, 543-549 e 553-556).

Data analysis

Because transects were of unequal length and sampling effort was inconsistent among habitat types, we could not estimate absolute density of large and medium-sized mammals in the protected area. We therefore pooled all direct and indirect observations from all habitat types to calculate the relative frequency of occurrence of these species. Similarly, we calculated the relative frequency of the different species recorded with camera traps as the number of individuals per camera day (Tomas and Miranda 2003); to avoid overestimating abundance multiple photos of the same species taken in the same day were treated as a single individual of that species. For small mammals, we calculated the capture rate of each species during the 12 mo. sampling period as: Capture rate (%) = (total no. of individuals captured / total number of trap nights)* 100.

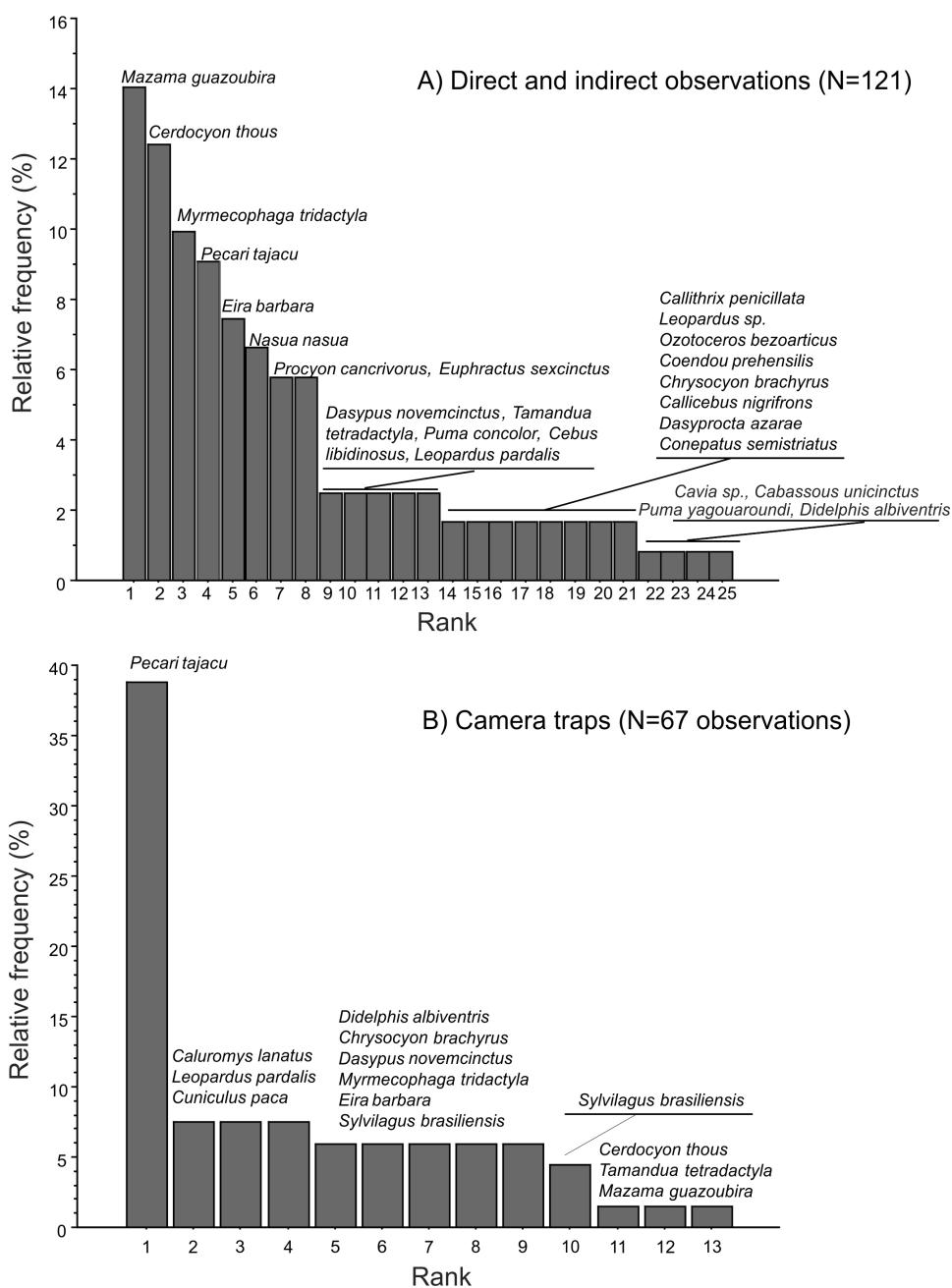


FIGURE 2. Relative frequency of medium and large-sized mammal species registered in each habitat type at the Estação Ecológica do Panga by (A) direct and indirect observations and (B) camera traps.



FIGURE 3. Photographic records of mammals captured with camera traps or observed indirectly at the Estação Ecológica do Panga (Minas Gerais State, Brazil). (A) *Leopardus pardalis* in mata ciliar, (B) *Chrysocyon brachyurus* in vereda, (C) *Mazama guazoubira* in cerrado sentido restrito, (D) Adult *Myrmecophaga tridactyla* carrying juvenile in mata ciliar, (E) *Puma concolor* tracks in cerrado sentido restrito, (F) *Mazama guazoubira* track in cerrado ralo, (G) *Tamandua tetradactyla* in cerrado ralo.

RESULTS AND DISCUSSION

We registered 46 species of mammals during our surveys and incidental observations (Table 2). During our surveys of medium and large-sized mammals the order Carnivora was the most commonly observed, with 12 species from five different families registered in the protected area (Table 1). The highest relative frequencies of observation, based on direct and indirect observations, were of *Mazama guazoubira* (14.1 %), *Cerdocyon thous* (12.4 %), *Myrmecophaga tridactyla* (9.9 %), and *Pecari tajacu* (9 %; Figure 2A). The highest relative frequency of observation with camera traps was of *Pecari tajacu* (38.8 %), with thirteen other species having relative frequencies of observation ranging from 1.5-7.5 % (Figure 2B). The greatest number of large and medium-sized mammal species was recorded in the cerrado sentido restrito (N=22), followed by mata ciliar (N=16) and cerradão (N=7; Table 2).

Over the course of 7320 trap nights there were 105 captures of small mammals from seven species (Table 3). The overall capture rate was 1.6 %, with the highest capture rates in the cerrado denso (3.24 %) and lowest in the campo cerrado (0.82; Table 3). Capture rates varied considerably from one month to the next, but were generally higher in the rainy season. The highest capture rates were for the marsupial *Gracilinanus agilis*, with *Calomys tener* the most commonly caught rodent (Table 3). We captured two species during our preliminary survey that were not captured during our long-term sampling: *Rattus rattus* (N=1 capture in 1091 trap nights, CR=0.09 %) and *Oecomys bicolor* (N=2 captures in 1091 trap nights, CR=0.18 %). Additional species captured in pitfall traps include *Oligoryzomys fornesi*, *Pseudoryzomys simplex*, *Calomys expulsus*, *Necromys lasiurus*, *Rhipidomys* sp., and *Oxymycterus delator*.

There are approximately 194 species of mammals from 30 families and nine orders in the Cerrado (Marinho-Filho et al. 2002). Of the 51 species of rodents that are the primary component of the Cerrado's nonvolant mammal fauna (Fonseca et al. 1996), most appear to be locally rare (Marinho-Filho et al. 2002). Though making

direct comparisons of abundance is complicated by the influence of fire history and habitat structural diversity on cerrado mammal abundance (Vieira and Marinho-Filho 1998; Henriques et al. 2000), the fact that our capture rates were comparable or slightly lower than those from other mammals surveys conducted in the Cerrado (Alho 1981; Alho et al. 1986; Vieira 1999; Caceres et al. 2010) suggests this is true in our field site as well. Furthermore, our survey provides additional support for the hypothesis that many of the Cerrado's mammal species may be able to persist in landscapes that are a mosaic of natural areas and agriculture (Trolle et al. 2007; Lyra-Jorge et al. 2008; Caceres et al. 2010). Indeed, it is notable that in this single protected area we recorded approximately 18 % of the Cerrado's mammal species (Marinho-Filho et al. 2002), including the Maned Wolf (*Chrysocyon brachyurus*), Giant Anteater (*Myrmecophaga tridactyla*), and other iconic species that are flagships for Cerrado conservation (Figure 3). Despite the anthropogenic influence indicated by the occasional presence of three domesticated species (*Bos taurus*, *Canis lupus familiaris*, *Rattus rattus*), the Estação Ecológica do Panga may play an important role in promoting the persistence of species in this biome in general and this region in particular.

TABLE 1. Description of trails used for surveys of medium and large-sized mammals at Estação Ecológica do Panga. For a complete description of the plant physiognomies in which transects were located see Oliveira-Filho and Ratter (2002); see Figure 1 and Cardoso et al. (2009) for the distribution of these physiognomies at Estação Ecológica do Panga.

TRAIL NUMBER	TRAIL LENGTH (KM)	PLANT PHYSIOGNOMY
1	1	cerrado sentido restrito
2	0.6	cerrado ralo
3	0.3	mata semidecídua
4	1	mata ciliar
5	0.65	cerradão & vereda
6	1	cerradão & vereda
7	0.8	cerrado sentido restrito & mata ciliar
8	1	cerrado ralo & mata ciliar

TABLE 2. Mammals of the Estação Ecológica do Panga (Minas Gerais State, Brazil), the means by which they were recorded, and the habitat in which they were observed.

TAXON	COMMON NAME (PORTUGUESE)	COMMON NAME (ENGLISH)	RECORD ¹	HABITAT ²
DIDELPHIMORPHIA				
Didelphidae				
<i>Didelphis albiventris</i> (Lund, 1840)	Gambá	White-eared Opossum	C, P	MG, CE
<i>Caluromys lanatus</i> (Olfers, 1818)	Cuíca-lanosa	Brown-eared Woolly Opossum	C	MG
<i>Gracilinanus agilis</i> (Burmeister, 1854)	Cuíca-graciosa	Agile gracile mouse opossum	Sh	CD, CE, CC, CR
<i>Thylamys karimii</i> (Petter, 1968)	Cuíca de rabo grosso	Karimi's fat-tailed opossum	Sh ⁶	NR
PRIMATES				
Cebidae				
<i>Callithrix penicillata</i> (Linnaeus, 1758)	Sagui	Black-pencilled Marmoset	V	CE
<i>Cebus libidinosus</i> (Spix, 1823)	Macaco-prego	Black-striped Capuchin	V	NR
Pitheciidae				
<i>Callicebus nigrifrons</i> (Spix, 1823)	Sauá	Black-fronted Titi	V, Vo	MS, MG
CARNIVORA				
Canidae				
<i>Chrysocyon brachyurus</i> (Illiger, 1815)	Lobo guará	Maned wolf	P, F, C	VE, CR

TABLE 2. CONTINUED.

TAXON	COMMON NAME (PORTUGUESE)	COMMON NAME (ENGLISH)	RECORD ¹	HABITAT ²
<i>Cerdocyon thous</i> (Linnaeus, 1766)	Cachorro do mato	Crab-eating Fox	C, P, F, V	CE, CC, CR
<i>Lycalopex vetulus</i> (Lund, 1842)	Raposa-do-campo	Hoary fox	P, V ⁶	NR
<i>Canis lupus familiaris</i> (Linnaeus, 1758)	Cachorro doméstico	Domestic dog		
Procyonidae				
<i>Nasua nasua</i> (Linnaeus, 1766)	Quati	Coati	V, P	CE
<i>Procyon cancrivorus</i> (Cuvier, 1798)	Mão pelada	Crab-eating Raccoon	P	CE, MG
Mustelidae				
<i>Eira barbara</i> (Linnaeus, 1758)	Irara	Tayra	V, C, P	CE, MG
Mephitidae				
<i>Conepatus semistriatus</i> (Boddaert, 1784)	Jararataca	Striped Hog-nosed Skunk	P	CC
Felidae				
<i>Puma concolor</i> (Linnaeus, 1771)	Onça parda	Puma	P	VE, CE
<i>Puma yagouaroundi</i> (Geoffroy, 1803)	Gato mourisco	Jaguarundi	V	CR
<i>Leopardus pardalis</i> (Linnaeus, 1758)	Jaguatirica	Ocelot	C, P	CR, MG
<i>Leopardus</i> sp.	---	---	P	CE
ARTIODACTYLA				
Cervidae				
<i>Mazama gouazoubira</i> (Fischer, 1814)	Veado-catingueiro	Gray brocket deer	P, V, C	CE, CC, MG
<i>Ozotoceros bezoarticus</i> (Linnaeus, 1758)	Veado-campeiro	Pampas deer	P	CE
Pecaridae				
<i>Pecari tajacu</i> (Linnaeus, 1758)	Cateto	Collared peccary	P	CE, CR, MG, VE
Bovidae				
<i>Bos taurus</i> (Linnaeus, 1758)	Boi	Cow		
RODENTIA				
Cuniculidae				
<i>Cuniculus paca</i> (Linnaeus, 1766)	Paca	Paca	C	MG
Dasyproctidae				
<i>Dasyprocta azarae</i> (Lichtenstein, 1823)	Cutia	Azara's Agouti	P	CE, CR
Caviidae				
<i>Cavia</i> sp. (Pallas, 1766)	Preá	Guinea pig	P	CE
Muridae				
<i>Rattus rattus</i> (Linnaeus, 1758)	Rato-do-telhado, rato-preto	Common brown rat	Sh ³	CR
Cricetidae				
<i>Calomys expulsus</i> (Lund, 1841)	Rato-calunga	Caatinga Laucha	PF ⁶	NR
<i>Calomys tener</i> (Winge, 1887)	Rato-do-campo	Delicate vesper mouse	Sh, PF ⁶	CD, CE, CC, CR
<i>Cerradomys subflavus</i> (Wagner, 1842)	Rato-de-cana	Terraced rice rat	Sh	CE, CC, CR
<i>Hylaeamys megacephalus</i> (Fischer, 1814)	Rato-do-mato	Large-headed rice rat	Sh	CR
<i>Necomys lasiurus</i> (Lund, 1841)	Pixuna, rato-do-mato	Hairy-tailed bolo mouse	PF ⁶	NR
<i>Oligoryzomys fornesi</i> (Massoia, 1973)	Rato-do-mato, ratinho-de-rabo-comprido	Black-footed colilargo	PF ⁶	NR
<i>Oligoryzomys nigripes</i> (Olfers, 1818)	Rato-do-mato, ratinho-de-rabo-comprido	black-footed pygmy rice rat	Sh	CD, CR
<i>Oxymycterus delator</i> (Thomas, 1903)	Rato-da-vereda	Spy Hociudo	PF ⁶	NR
<i>Pseudoryzomys simplex</i> (Winge, 1887)	Rato-do-mato	Brazilian false rice rat	PF ⁶	NR
<i>Rhipidomys macrurus</i> (Gervais, 1855)	Rato-de-árvore	Long-tailed <i>Rhipidomys</i>	Sh	CD, CE, CC, CR, MG ⁴
<i>Rhipidomys</i> sp.	Rato-da-árvore	---	PF ⁶	NR
<i>Oecomys bicolor</i> (Tomes, 1860)	Rato-do-mato	Bicolored Arboreal Rice Rat	Sh ⁵	MG
Erethizontidae				
<i>Coendou prehensilis</i> (Linnaeus, 1758)	Ouriço-cacheiro	Brazilian Porcupine	V	CE
LAGOMORPHA				
Leporidae				
<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758)	Tapeti	Brazilian rabbit	C	CE, MG

TABLE 2. CONTINUED.

TAXON	COMMON NAME (PORTUGUESE)	COMMON NAME (ENGLISH)	RECORD ¹	HABITAT ²
CINGULATA				
Dasypodidae				
<i>Dasybus novemcinctus</i> (Linnaeus, 1758)	Tatu-galinha	Nine-banded armadillo	C, P, B	CE, CR, MG
<i>Euphractus sexcinctus</i> (Linnaeus, 1758)	Tatu-peludo	Hairy armadillo	V, P, B	CE, MG
<i>Cabassous unicinctus</i> (Linnaeus, 1758)	Tatu-do-rabo-mole	Southern armadillo	B	CE
PILOSA				
Myrmecophagidae				
<i>Myrmecophaga tridactyla</i> (Linnaeus, 1758)	Tamanduá-bandeira	Giant Anteater	V, C, P, F	CE, CR, CL, MG, VE
<i>Tamandua tetradactyla</i> (Linnaeus, 1758)	Tamanduá-mirim	Collared Anteater	V, P, C	CE, CC

1 Abbreviations: C=Camera trap, V=visual observation, F=feeces, P=Prints, B=Burrows, Vo=Vocalizations, Sh=Sherman Trap, PF=Pitfall trap, NR=not recorded.

2 Abbreviations: CC= cerrado ralo, CE= cerrado sentido restrito, CR=cerradão, MG= mata galeria, VE=vereda, MS=Mata semidecídua, CD=cerrado denso

3 One individual captured during the preliminary survey only.

4 Twenty individuals captured during the preliminary survey.

5 Two individuals captured during the preliminary survey only.

6 Observation outside of quantitative sampling period (pit-fall traps).

TABLE 3. Number of captures (N) and the capture rates (CR, %) of small mammals in four different habitat types at the Estação Ecológica do Panga (Minas Gerais State, Brazil). Sampling was conducted from April 2005-2006.

SPECIES	HABITAT TYPE							
	Cerrado ralo (1840 trap nights)		Cerrado sentido restrito (1920 trap nights)		Cerrado denso (1850 trap nights)		Cerradão (1710 trap nights)	
	N	CR (%)	N	CR (%)	N	CR (%)	N	CR (%)
<i>Calomys tener</i>	7	0.38	6	0.31	1	0.06	1	0.06
<i>Cerradomys subflavus</i>	4	0.22	2	0.10	4	0.23	4	0.23
<i>Hylaeamys megacephalus</i>	0	0.0	0	0.0	1	0.06	1	0.06
<i>Oligoryzomys nigripes</i>	0	0.0	0	0.0	4	0.23	4	0.23
<i>Rhipidomys macrurus</i>	1	0.05	3	0.16	1	0.06	1	0.06
<i>Gracilinanus agilis</i>	1	0.05	8	0.42	5	0.29	5	0.29
Unidentified rodents	2	0.11	5	0.26	2	0.12	2	0.12
Overall Capture Rate	15	0.82	24	1.25	18	1.05	18	1.05

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