

Mammals from Duas Bocas Biological Reserve, state of Espírito Santo, Brazil

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RESUMO: (Mamíferos da Reserva Biológica de Duas Bocas, estado do Espírito Santo, Brasil). Tal como em outras regiões, a Mata Atlântica do estado do Espírito Santo é um ecossistema fragmentado e as maiores áreas estão protegidas em unidades de conservação. Os estudos realizados sobre a mastofauna nessa região da Mata Atlântica têm mostrado uma alta diversidade, o que torna a pesquisa de grande relevância. Descreve-se aqui um levantamento da fauna de mamíferos voadores e não voadores na Reserva Biológica de Duas Bocas, realizado entre janeiro de 1987 e dezembro de 1988. Para a captura dos pequenos mamíferos não voadores, foram usadas armadilhas do tipo gaiola, enquanto que os de médio e grande porte foram registrados por observações diretas e indiretas. Os morcegos foram capturados em abrigos diurnos com redes manuais e à noite por redes de neblina. Sete ordens, 17 famílias e 35 espécies não voadoras foram registradas. *Trinomys paratus* (37,3%) e *Didelphis aurita* (24%) foram os mais capturados. *Callithrix geoffroyi* foi muito visualizado, e deve ocorrer em densidade de mais de um indivíduo por hectare. Dentre os morcegos, duas famílias e 12 espécies foram registradas, sendo as capturas de *Carollia perspicillata* e *Artibeus lituratus* as mais frequentes, compreendendo 50% da comunidade estudada. *Caluromys philander*, *Leopardus guttulus*, *Puma concolor*, *Galictis cuja*, *Hydrochoerus hydrochaeris*, *Pecari tajacu*, *Sylvilagus brasiliensis*, *Mazama* sp. e os morcegos são novas ocorrências de mamíferos para essa reserva florestal. Somando-se às espécies já registradas, a Reserva Biológica de Duas Bocas passa a abranger 59 espécies de mamíferos.

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Considerando as espécies listadas nesse estudo, sete de médio e grande porte e uma de morcego estão nas listas de espécies ameaçadas do Brasil.

Palavras-chave: Mata Atlântica; biodiversidade; checklist

ABSTRACT: The Atlantic Forest in the state of Espírito Santo, as in other regions, is a fragmented ecosystem and larger areas are protected in Conservation Units. The studies on the mammals in this region of Atlantic Forest have shown a high diversity, which makes it a highly relevant research. Herein we describe a survey of volant and non-volant mammal fauna in Duas Bocas Biological Reserve, carried out between January 1987 and December 1988. Live traps were used in order to capture non-volant small mammals. Medium- and large-sized mammals were recorded by direct and indirect observations. Bats were caught in day roost with hand nets and at night by standard mist nets. Seven orders, 17 families, and thirty-five non-volant species were recorded. *Trinomys paratus* (37.3%) and *Didelphis aurita* (24%) were the most captured species. *Callithrix geoffroyi* was much observed and may occur in population density of more than one individual per hectare. Among bats, two families and twelve species were recorded, with *Carollia perspicillata* and *Artibeus lituratus* captures being the most frequent, comprising 50% of the community surveyed. *Caluromys philander*, *Leopardus guttulus*, *Puma concolor*, *Galictis cuja*, *Hydrochoerus hydrochaeris*, *Pecari tajacu*, *Sylvilagus brasiliensis*, *Mazama* sp. and all bat species are new records for this forest reserve. Adding to the already recorded species, the Duas Bocas Biological Reserve comprises 59 mammalian species. Taking into account the species listed in this study, seven of medium- and large-sized and a bat are on the Brazilian lists of endangered species.

Keywords: Atlantic Forest; biodiversity; checklist

Introduction

The Atlantic Forest, which extends from the Brazilian state of Rio Grande do Sul to the northeast of Brazil, especially over the coastal mountain ranges, is today a fragmented ecosystem, and the bulk of its main remaining forests are represented in officially protected Conservation Units (Ribeiro *et al.*, 2009). In the state of Espírito Santo, southeastern Brazil, major remnants of the Atlantic Forest are also represented by Conservation Units, generally of reduced size for the conservation of flora and fauna over the long term (IPEMA, 2011).

Studies on mammalian fauna are of great importance, especially in the Atlantic Forest region, given its high diversity and endemism (Brooks *et al.*, 2002; Ceballos & Ehrlich, 2006). Moreover, these studies may contribute to

medical sciences, since many wild mammals are natural reservoirs for parasites that cause human diseases (Barreto *et al.*, 1980). Several studies have been conducted on the mammalian fauna of the Neotropical region. However, taking into account the diversity of the ecosystems found, the geographical extent of the area covered, and the existing taxonomic and ecological issues, it is clear that we still know little about this zoological group.

The present study aimed to conduct a survey of mammals in one of the most important officially protected Atlantic Forest areas of the state of Espírito Santo, the Duas Bocas Biological Reserve. It is one of the few remnants of the Atlantic Forest in this state. Part of its mammalian fauna was already described (Paresque *et al.*, 2004; Tonini *et al.*, 2010), as well as of the mountainous region nearby (Passamani, 1995, 2000; Passamani *et al.*, 2000; Passamani & Fernandez, 2011).

Materials and Methods

Study site. The study was carried out at the Duas Bocas Biological Reserve (DBBR) (Fig. 1). This area is administered by the Instituto Estadual de Terras, Cartografia e Florestas (ITCF-ES). It is located in the municipality of Cariacica, between the coordinates 20°16'21" S and 40°28'40" W, lying about 17 km west of Vitória, capital city of the state of Espírito Santo. Altitudes in the area range from 200 to 800 m above sea level. The DBBR is a large protected area of continuous forest in the state of Espírito Santo, covering a total of 2,910 ha, about 80% of which is made up of native forest. The remaining 20% comprise

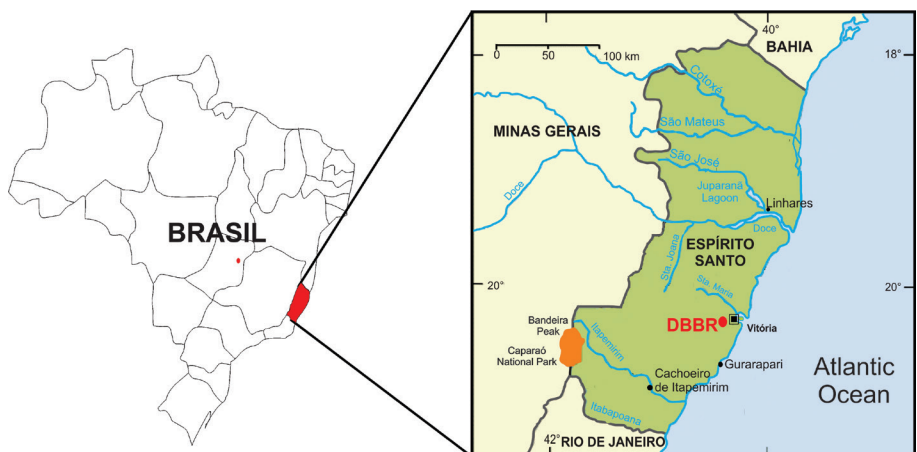


Figure 1. Geographic location of Duas Bocas Biological Reserve, Espírito Santo, Brazil.



Figure 2. Duas Bocas Biological Reserve. Photo: Helder-José.

secondary forest, a dam, creeks and streams. Geomorphologically, the region belongs to the domain of Scarps and Massifs modelled on the Crystalline Complex rocks, in the Coastal Table Land Unit. The relief of the area consists of elevations alternated with narrow steep-sloped valleys (Brasil, 1977). The lower region of the reserve has an artificial reservoir run by the State Sanitation Company, to which all streams and creeks converge (Fig. 2). According to data from the Brazilian Institute for Geography and Statistics (Brasil, 1977), the climate of the region where the DBBR is located is sub-humid with sub-dry tropical warm/sub-warm. The average monthly temperatures vary from 19 °C in winter (July-September) to 25.5 °C in summer (January-March), at an elevation of 200 m. The average annual rainfall is around 1500 mm, being more abundant in summer, with a short period of drought in winter, mainly in August.

The predominant vegetation of the Reserve is Low-Montane Atlantic Rainforest. This vegetation occurs between 300 m and 800 m of altitude in wide extensions in the states of Minas Gerais, Espírito Santo and Rio de Janeiro (Rizzini, 1979), characterized by high richness of epiphyte and tree species, with trees up to 25-30 m tall (Fig. 2). In the lower region of the Reserve (between 200 and 400 m above sea level), where the mammals were captured and most of the observations of this study were carried out, secondary forests predominate in different stages of regeneration.

Data collection. The study period was from January 1987 to December 1988. Twice a month, traps were set up over 2, 3 or 4 consecutive days, in a stretch of secondary forest situated near the reservoir, on a slope ranging from 200 m to

340 m in altitude. For the captures, three parallel transects were installed, two measuring 300 m and one of 250 m, 100 m equidistant from each other, and a capture point was established at every 25 m. At ground level, at each point a 15x15x30 cm galvanized wire trap was set up and, at alternating points, a 20x20x45 cm trap was arranged. A total of 37 smaller traps and 20 larger ones were set up.

Baits such as banana, pineapple, orange, or peanut butter on bread slices were used. The traps were inspected on consecutive days in the morning and, whenever possible, for the released specimens, the sex of the captured animals was determined and their mass and biometric data were recorded. Since all released specimens were not marked, and due to the probable recapture of some individuals, we could not estimate the relative abundance of the species surveyed. Voucher specimens were deposited in the mammalogy collection of the Biology Museum Mello Leitão (Appendix 1). The taxonomic arrangement and nomenclature for non-volant mammals followed Paglia *et al.* (2012), except for the genus *Leopardus*, which followed the taxonomic arrangement of O'Brien & Koepfli (2013).

The bats were collected with hand nets during the day in different types of shelters as tunnels, drains, small caves, foliage, and tree holes. Additionally bats were captured with two mist nets set in natural trails inside the reserve. We used 12 × 2.5 m mist nets set at ground level, which were opened at 18:00 and closed at 22:00. Nets were closed during strong rain. The capture effort was 12,000 m².h, calculated following Straube & Bianconi (2002). The nomenclature and taxonomic arrangement for the bats followed Nogueira *et al.* (2014).

Medium and large-sized mammal records were obtained through direct and indirect observations during the survey of the small mammals. The observations were made along the trails used for the traps and on hikes inside and along the edges of the Duas Bocas Biological Reserve.

Results

A total of seven orders, 17 families, and 35 species were recorded. Among the small mammals, 391 captures were made, representing specimens belonging to three orders (Didelphimorphia, Rodentia and Primates), five families, and 16 species. A sampling effort of 2,559 traps.night yielded a capture success of 15.3%. Specimens from the order Didelphimorphia had the highest capture rate (51.4%), followed by Rodentia (45.5%) and Primates (3.1%). We recorded 19 medium- and large-sized mammals, some through direct observation (visualization) and others by indirect means (tracks, faeces, vocalizations and trails). They were included in six orders and 13 families (Table 1).

Table 1. Non-volant mammal species from Duas Bocas Biological Reserve, State of Espírito Santo, southeastern Brazil, recorded in 1987 and 1988, with respective captures and percentages, types of records and conservation status according to the Espírito Santo (Chiarello et al., 2007) and Brazilian (MMA, 2014) fauna threatened species. Conservation status categories: VU: Vulnerable; EN: Endangered; CR: Critically endangered. PS: present study.

Taxon	Total of captures (%)	Type of record	Conservation status ES	Conservation status BR	References
DIDELPHIMORPHIA	201 (51.4)				
Didelphidae					
<i>Cathuromys philander</i> (Linnaeus, 1758) *	1	Capture			PS
<i>Chironectes minimus</i> (Zimmermann, 1780)	-	Visual	CR		PS; Tonini et al. (2010)
<i>Didelphis aurita</i> (Wied-Neuwied, 1826)	94 (24)	Capture			PS; Paresque et al. (2004); Tonini et al. (2010)
<i>Gracilinanus microtarsus</i> (Wagner, 1842)	1 (0.26)	Capture			PS; Tonini et al. (2010)
<i>Marmosa murina</i> (Linnaeus, 1758)	3 (0.8)	Capture			PS; Paresque et al. (2004)
<i>Marmosops incanus</i> (Lund, 1840)	43 (11)	Capture			PS; Paresque et al. (2004); Tonini et al. (2010)
<i>Metachirus nudicaudatus</i> (Desmarest, 1817)	44 (11.3)	Capture			PS; Paresque et al. (2004); Tonini et al. (2010)
<i>Micoureus paraguayanus</i> (Tate, 1931)	6 (1.6)	Capture			PS; Paresque et al. (2004); Tonini et al. (2010)
<i>Philander frenatus</i> (Olfers, 1818)	9 (2.3)	Capture			PS; Tonini et al. (2010)
CINGULATA					
Dasyppodidae					
<i>Dasyypus novemcinctus</i> Linnaeus, 1758	-	Visual			PS; Tonini et al. (2010)
<i>Dasyypus septemcinctus</i> Linnaeus, 1758	-	Capture			PS; Tonini et al. (2010)
ARTIODACTYLA					
Cervidae					
<i>Mazama</i> sp.	-	Visual/ Footprints			PS
<i>Pecari tajacu</i> (Linnaeus, 1758)	-	Footprints	VU		PS

Table 1 (cont.)

Taxon	Total of captures (%)	Type of record	Conservation status ES	Conservation status BR	References
PRIMATES	12 (3.1)				
Atelidae					
<i>Alouatta guariba</i> (Humboldt, 1812)	-	Visual/Vocalization		CR	PS; Tonini et al. (2010)
Callitrichidae					
<i>Callithrix geoffroyi</i> (Humboldt, 1812)	12 (3.1)	Capture/Visual			PS; Tonini et al. (2010)
Cebidae					
<i>Sapajus nigritus</i> (Goldfuss, 1809)	-	Visual/Vocalization	VU	VU	PS; Tonini et al. (2010)
CARNIVORA					
Canidae					
<i>Cerdocyon thous</i> (Linnaeus, 1766)	-	Visual			PS; Tonini et al. (2010)
Felidae					
<i>Leopardus guttulus</i> (Hensel, 1872)	-	Footprints	VU	VU	PS
<i>Puma concolor</i> (Linnaeus 1771)	-	Footprints	EN	VU	PS
Mustelidae					
<i>Lontra longicaudis</i> (Olfers, 1818)	-	Visual/Feces			PS; Helder-José & Andrade (1997); Amado (2004)
<i>Eira barbara</i> (Linnaeus, 1758)	-	Visual			PS; Tonini et al. (2010)
<i>Galictis cuja</i> (Molina, 1782)	-	Visual			PS
Procyonidae					
<i>Procyon cancrivorus</i> (G. Cuvier, 1798)	-	Footprints			PS; Tonini et al. (2010)
<i>Nasua nasua</i> (Linnaeus, 1766)	-	Visual			PS; Tonini et al. (2010)

Table 1 (cont.)

Taxon	Total of captures (%)	Type of record	Conservation status ES BR	References
LAGOMORPHA				
Leporidae				
<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758)	-	Visual		PS
RODENTIA				
Caviidae				
<i>Hydrochoerus hydrochaeris</i> , (Linnaeus, 1766)	-	Visual/Footprints/ Feces		PS
Cricetidae				
<i>Akodon cursor</i> (Winge, 1887)	1 (0.26)	Capture		PS; Paresque et al. (2004); Tonini et al. (2010)
<i>Euryoryzomys russatus</i> (Wagner, 1848)	14 (3.6)	Capture		PS; Paresque et al. (2004)
<i>Nectomys squamipes</i> (Brats, 1827)	6 (1.6)	Capture		PS; Paresque et al. (2004); Tonini et al. (2010)
<i>Oxymycterus</i> sp.	1 (0.26)	Capture		PS
Cuniculidae				
<i>Cuniculus paca</i> (Linnaeus, 1766)	-	Trails/Footprints		PS; Tonini et al. (2010)
Dasyproctidae				
<i>Dasyprocta azarae</i> Lichtenstein, 1823	-	Visual	VU	PS; Tonini et al. (2010)
Echimyidae				
<i>Phyllomys pattoni</i> Emmons, Leite, Kock & Costa, 2002*	1	Capture		PS; Tonini et al. (2010)
<i>Trinomys paratus</i> (Moojen, 1948)	146 (37.3)	Capture		PS; Paresque et al. (2004); Tonini et al. (2010)
Sciuridae				
<i>Guerlinguetus ingrami</i> (Thomas, 1901)	9 (2.3)	Capture		PS; Tonini et al. (2010)

(*) These animals were not captured using the working methodology, but rather by a trap positioned on a branch about 1.8 m high, designed to capture marmosets.

Twelve species of bats belonging to two families (Phyllostomidae and Vespertilionidae) were captured (Table 2). *Carollia perspicillata* and *Artibeus lituratus* were the two most commonly captured species, contributing to more than 50% of the captures. We observed in several shelters cohabitation between *Anoura caudifer* and *C. perspicillata*. In a tunnel on the edge of the reservoir, the co-habitation of *C. perspicillata*, *A. caudifer*, *Trachops cirrhosus*, and *Lonchorhina aurita* was observed.

Table 2. Bats captured and their capture sites at the Duas Bocas Biological Reserve.

Taxon	Sites
Phyllostomidae	
<i>Mimon bennettii</i> (Gray, 1838)	4
<i>Phyllostomus discolor</i> (Wagner, 1843)	4
<i>Trachops cirrhosus</i> (Spix, 1823)	3
<i>Lonchorhina aurita</i> Tomes, 1863	3
<i>Anoura caudifer</i> (É. Geoffroy, 1818)	2, 3, 4
<i>Carollia perspicillata</i> (Linnaeus, 1758)	2, 3, 4
<i>Rhinophylla pumilio</i> Peters, 1865	1
<i>Artibeus lituratus</i> (Olfers, 1818)	1, 4
<i>Vampyressa pusilla</i> (Wagner, 1843)	1
<i>Desmodus rotundus</i> (É. Geoffroy, 1810)	4
<i>Platyrrhinus lineatus</i> (É. Geoffroy, 1810)	4
Vespertilionidae	
<i>Myotis nigricans</i> (Schinz, 1821)	2

Capture sites: 1 – tents (see Zortéa, 1995; Zortéa & Brito 2000); 2 – grooves in rocks; 3 – caves and tunnels; 4 – pristine and secondary forest with mist net.

Discussion

The methodology used in this study for non-volant small mammals was limited to the capture of almost exclusively terrestrial animals, explaining the low capture level of predominantly arboreal species.

Low capture rates have been obtained in different studies: 2.4% by Fonseca and Kierulff (1989), 3.2% by Stallings (1989), 3.2% by Passamani (2000), 3.7% by Pardini (2004), 1.16% and 3.06% by Paresque *et al.* (2004), 3.59% by Tonini *et al.* (2010) in the Atlantic Forest. On the other hand, high

rates were obtained by Bergallo (1994) (15.1%), by Olmos (1991) (17.23%) and by us (15.3%) also in the Atlantic Forest. The hypothesis of an inverse correlation between capture indices and the availability of food resources has been put forward: the higher the food availability, the lower the rate of capture (Davis, 1945; Stallings, 1989; MacCleary *et al.*, 1994; Bergallo & Magnusson, 1999; Passamani 2000; Bergallo & Magnusson, 2002; Santos-Filho *et al.*, 2008).

Didelphis aurita is a well-dispersed species and abundant in the Atlantic Forest, captured in almost all studies undertaken in this biome (e.g. Davis, 1945; Leite *et al.*, 1994; Pardini & Umetsu, 2006; Pessoa *et al.*, 2009; this study). Its abundance and range are probably due to an omnivorous diet with great flexibility in eating habits, having one, two or three litters with many offspring per breeding season, and it being capable of exploiting disturbed environments more efficiently. This species is also found in peridomestic areas and even in urban areas. It was also the marsupial with the highest capture index in the studies of Fonseca and Kierulff (1989) and Barros-Battesti (2000); in alluvial forests at the mouth of the Doce River, state of Espírito Santo (Falqueto & Helder-José, 2005; Giacomini, 2006; Fernandes, 2008; Lauss, 2010), and in the restinga (Helder-José, personal observation). The average mass of most males was above 1,000 g, while that of females was below that measure, suggesting sexual dimorphism in body mass, as was also proposed by Fonseca and Kierulff (1989).

Metachirus nudicaudatus has wide geographical distribution, covering Central America and most of South America (Paglia *et al.*, 2012), being very common in certain regions and scarce or absent in others. For instance, it had a high rate of capture in the studies of Stallings (1989), Fonseca and Kierulff (1989), Bergallo (1994) and in this study, while in other landscapes it is rare (Passamani, 2000; Falqueto & Helder-José, 2005; Fernandes, 2008) or seems to be absent (Davis, 1945; Passamani, 1995; Palma, 1996; Voltolini, 1997; Barros-Battesti *et al.*, 2000; Uchôa, 2006; Lauss, 2010). The body masses of adult males ranged from 238 g to 588 g ($\bar{x} = 433.2 \text{ g} \pm 83.2$; $n = 20$) and that of adult females ranged from 224 g to 333 g ($\bar{x} = 266.8 \text{ g}$; $n = 4$). The difference observed between them is an indication of sexual dimorphism in size.

Some studies have commented on the preference of species of the genus *Philander* to occur in the proximities of standing or running water (Davis, 1945; Nowak & Paradiso, 1983; Alho *et al.*, 1986; Passamani, 2000). *P. frenatus* specimens in this study were not associated with any form of water body.

At the Juréia-Itatins Ecological Station in the Atlantic forest, São Paulo State (Brazil), Bergallo (1995) found *Trinomys iheringi* (classified as *Proechimys iheringi*) and *Euryoryzomys russatus* (classified as *Oryzomys intermedius*) as the most common species, comprising 69% of the total captures. Thirty-nine

individuals of *T. iheringi* were recaptured 196 times. According to Bergallo (1995) and Bergallo and Magnusson (1999), this species is polyestrous and shows a year-round pattern of reproduction (Davis, 1945), with peaks during the dry season. Also according to Bergallo (1995), it can produce up to four litters per year. The age at first breeding of *T. iheringi* females was estimated at eight months. The mean density estimated monthly was 5.32 ± 3.81 ind/ha. *T. iheringi* exhibited two different classes of individuals: resident and transient. Resident females had home ranges with little overlap. In contrast, the home ranges of resident males overlapped with those of both males and females. The above characteristics may help explain the adaptive success of *T. iheringi* in Juréia-Itatins Ecological Station and *T. paratus* in DBBR, since these species are very similar.

At the Santa Lúcia Biological Station (SLBS) (another mountainous region of Espírito Santo), Passamani (2000) captured the same species of marsupials. However, *Gracilinanus microtarsus* was the most abundant whereas, in our study, only one specimen was captured, similar to the observed for *Caluromys philander*. This might be explained because we did not use arboreal traps. The first species is preferentially arboreal and the second is strictly arboreal. A reversal of capture rate occurred with *M. nudicaudatus* and *P. frenatus*: while at the SLBS the former was relatively rare and the latter was relatively well sampled, in the DBBR the opposite occurred. The other marsupial species had proportionally similar captures.

Paresque *et al.* (2004) and Tonini *et al.* (2010) also surveyed the small mammals in the DBBR (13 and 20 years later, respectively). The latter showed that an effort of 11,880 traps/night resulted in 427 captures and a success of 3.59%. Although our capture success was much greater, Tonini *et al.* (2010) obtained greater richness, perhaps explained by the use of multiple capture methods, greater effort, and the different location of the study, which was in a primary forest area of the reserve.

Interestingly, only seven out of twenty-five species of small mammals recorded for DBBR were captured in all three studies: *Didelphis aurita*, *Metachirus nudicaudatus*, *Marmosops incanus*, *Micoureus paraguayanus*, *Trinomys paratus*, *Nectomys squamipes* and *Akodon cursor*. On the other hand, *Monodelphis iheringi*, *Blarinomys breviceps*, *Juliomys pictipes*, *Thaptomys nigrita* and *Rattus rattus* were recorded only by Tonini *et al.* (2010), *Sphiggurus villosus* by Paresque *et al.* (2004) and *Caluromys philander* and *Oxymycterus* sp. exclusively in this study. This shows that the methodology of small mammal surveys should be more carefully managed in order to be more effective, taking into account spatial and temporal parameters, methods of capture, and sampling effort, among others.

Most species of medium- and large-sized mammals were recorded through visual and/or footprints in the mud at the dam margins. Several of these species have been added to the list of Tonini *et al.* (2010) for DBBR (Table 1). Among them, *Leopardus guttulus*, *Puma concolor* and *Pecari tajacu* are present in the lists of endangered species (Chiarello *et al.*, 2007; MMA, 2014).

The white-headed marmoset, *Callithrix geoffroyi*, was the primate more frequently observed in the DBBR, especially in the area of secondary forest, which probably occurs in population density of more than one individual per hectare. Conversely, the primate *Alouatta guariba*, classified as vulnerable in Brazil (MMA, 2014), was rarely seen, and their vocalizations heard more often in the high places of pristine forest.

Two other important species for the conservation status are the marsupial *Chironectes minimus* (water opossum) and the rodent *Dasyprocta azarae* (agouti). The first is classified as critically endangered and the second is vulnerable in the state of Espírito Santo (Chiarello *et al.*, 2007). Both were seen only once by Tonini *et al.* (2010) and by us.

Among the non-volant mammals recorded in this study, six and three species, respectively (Table 1), are on the list of threatened species of the state of Espírito Santo (Chiarello *et al.*, 2007) and for Brazil (MMA, 2014).

Regarding the bat fauna, the high capture rate of *Carollia perspicillata* and *Artibeus lituratus* observed in this study was expected, since they are very common species throughout their distribution area and especially in the Atlantic Forest (Esberard, 2003; Zortéa, 2007; Dias & Peracchi, 2008). The roost co-habitation of *Anoura caudifer* and *C. perspicillata* has been described by Ruschi (1953a, b), Trajano (1984), and Marques (1985). The two species were found together in 69% of the drains in the Manaus region (Marques, 1985).

Rhinophylla pumilio and *Vampyressa pusilla* are two species that use tents as diurnal roosts in the DBBR and records of these species have been reported in previous studies (Zortéa, 1995; Zortéa & Brito, 2000).

All bat species recorded herein have already been mentioned for the state of Espírito Santo. Among the species recorded in the reserve, just *Lonchorhina aurita* is threatened with extinction in Brazil (MMA, 2014). This cave-dwelling species is relatively rare, but widely distributed (Lassieur & Wilson, 1989).

To conclude, Tonini *et al.* (2010) listed 39 species of non-volant mammals for Duas Bocas Biological Reserve. As the species *Caluromys philander*, *Leopardus guttulus*, *Puma concolor*, *Galictis cuja*, *Hydrochoerus hydrochaeris*, *Pecari tajacu*, *Sylvilagus brasiliensis*, and *Mazama* sp. were not cited before and we had indications of their presence, this number may grow to 47 species. Including the bats herein surveyed (12 species), DBBR may comprise 59 mammal species.

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Literature Cited

- Alho, C. J. R.; Pereira, L. A. & Paula, A. C. 1986. Patterns of habitat utilization by small mammal populations in cerrado biome of central Brazil. *Mammalia*, 50(4): 447-460.
- Amado, M. V. 2004. Ecologia Alimentar da lontra (*Lontra longicaudis*) numa represa no Sudeste do Brasil. Dissertação de Mestrado, Universidade Federal do Espírito Santo, Vitória.
- Barreto, M. P.; Ribeiro, R. D. & Ferrioli-Filho, F. 1980. Estudos sobre reservatórios e vetores silvestres do *Trypanosoma cruzi*. LXXV: Estudo de amostras de *T. cruzi* isoladas de gambás do gênero *Didelphis*. *Revista Brasileira Biologia*, 40(2): 387-391.
- Barros-Battesti, D. M.; Bertim, C. R.; Yoshinari, N. H.; Bonoldi, V. L. N.; Leon, E. P.; Miretzki, M. & Schumaker, T. T. S. 2000. Land fauna composition of small mammals of a fragment of Atlantic Forest in the State of São Paulo, Brazil. *Revista Brasileira de Zoologia*, 17: 241-249.
- Bergallo, H.G. 1994. Ecology of a small mammal community in an Atlantic Florest area in southeastern Brazil. *Studies on Neotropical Fauna and Environment*, 29(4): 197-217.
- Bergallo, H.G. 1995. Comparative life-history characteristics of two species of rats, *Proechimys iheringi* and *Oryzomys intermedius*, in an Atlantic Forest of Brazil. *Mammalia*, 59(1): 51-64.
- Bergallo, H. G. & Magnusson, W. E. 1999. Effects of climate and food availability on four rodent species in southeastern Brazil. *Journal of Mammalogy*, 80(2): 472-486.
- Bergallo, H. G. & Magnusson, W. E. 2002. Effects of weather and food availability on the condition and growth of two species of rodents in Southeastern Brazil. *Mammalia*, 66(1): 17-31.
- Brasil. 1977. Geografia do Brasil. Região Sudeste. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.

- Brooks, T. M., Mittermeier, R. A.; Mittermeier, C. G.; Fonseca, G. A. B.; Rylands, A. B.; Konstant, W. R.; Flick, P.; Pilgrim, J.; Oldfield, S. & Magin, G. 2002. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology*, 16: 909-923.
- Ceballos, G. & Ehrlich, P.R. 2006. Global mammal distributions, biodiversity hotspots and conservation. *Proceedings of the National Academy of Science USA*, 103: 19374-19379.
- Chiarello, A. G., Costa, L. P., Leite, Y .L. R., Passamani, M., Siciliano, S. & Zortéa, M. 2007. Os mamíferos ameaçados de extinção no Estado do Espírito Santo, p. 29-45. In: Passamani, M. & Mendes, S. L. (Orgs.). *Espécies da fauna ameaçadas de extinção no Estado do Espírito Santo*. Vitória: Instituto de Pesquisas da Mata Atlântica. 280 p.
- Davis, D. E. 1945. The annual cycle of plants, mosquitoes, birds and mammals in two Brazilian forests. *Ecological Monographs*, 15(3): 243-295.
- Dias, D. & Peracchi, A. L. 2008. Quirópteros da Reserva Biológica do Tinguá, estado do Rio de Janeiro, sudeste do Brasil (Mammalia: Chiroptera). *Revista Brasileira de Zoologia*, 25(2): 333-369.
- Esberard, C. E. L. 2003. Diversidade de morcegos em uma área de Mata Atlântica regenerada no sudeste do Brasil (Mammalia: Chiroptera). *Revista Brasileira de Zootecias*, 5(2): 189-204.
- Falqueto, J. N. & Helder-José. 2005. Fauna de Pequenos Mamíferos da Floresta Nacional de Goytacazes, Linhares – Espírito Santo. *Anais do III Congresso Brasileiro de Mastozoologia, Aracruz - ES*. 29 p.
- Fernandes, A. S. 2008. Levantamento de pequenos mamíferos não voadores na Floresta Nacional de Goytacazes em Linhares, ES. Monografia. Faculdade Pitágoras de Linhares.
- Fonseca, G. A. B. & Kierulff, M. C. 1989. Biology and natural history of Brazilian Atlantic forest small mammals. *Bulletin of Florida State Museum, Biological Sciences*, 34: 99-152.
- Giacomin, G. 2006. Efeito de borda sobre a abundância, riqueza e diversidade de pequenos mamíferos não-voadores da Floresta Nacional de Goytacazes, Linhares, Espírito Santo. Monografia. Faculdade Pitágoras de Linhares.
- Helder-José & Andrade, H. K. 1997. Food and feeding habits of the neotropical river otter *Lontra longicaudis* (Carnivora, Mustelidae). *Mammalia* 61(2): 193-203.
- IPEMA. 2011. Áreas e ações prioritárias para a conservação da biodiversidade da Mata Atlântica no estado do Espírito Santo. Instituto de Pesquisas da Mata Atlântica, Vitória, 64 p.
- Lassieur, S. & D. E. Wilson. 1989. *Lonchorhina aurita*. *Mammalian Species* 347: 1-4.

- Lauss, F. 2010. Levantamento de pequenos mamíferos terrestres e arborícolas no interior da Flona de Goytacazes, Linhares, ES. Monografia. Faculdade Pitágoras de Linhares.
- Leite, Y. L. R.; Stallings, J. R. & Costa, L. P. 1994. Partição de recursos entre espécies simpátricas de marsupiais na Reserva Biológica de Poço das Antas. *Revista Brasileira de Biologia*, 54(3): 525-536.
- MacCleary, D.; Kohler, J.; McGowan, K. J.; Cedeño, E.; Carbone, L. G. & Miller, D. 1994. Arboreal and Terrestrial Mammal Trapping on Gigante Peninsula, Barro Colorado Nature Monument, Panama. *Biotropica*, 26(2): 208-213.
- Marques, S. A. 1985. Espécies associadas e algumas características físicas influenciando na presença de *Carollia perspicillata* em bueiros na região de Manaus, AM (Mammalia, Chiroptera: Phyllostomidae). *Acta Amazônica*, 15(1-2): 243-248.
- MMA, 2014. Lista das espécies brasileiras ameaçada de extinção. Portarias nº 444/2014. <http://www.icmbio.gov.br/portal/biodiversidade/fauna-brasileira/lista-de-especies.html>. Acessado em 08/03/2015.
- Nogueira, M. R.; Lima, I. P.; Moratelli, R.; Tavares, V. C.; Gregorin, R. & Peracchi, A.L. 2014. Checklist of Brazilian bats, with comments on original records. *Check List*, 10(4): 808–821.
- Nowak, R. M. & Paradiso, J. L. 1983. *Walker's Mammals of the World*. 4th Ed. Johns Hopkins University Press, Baltimore. 11510 p.
- O'Brien, S. J. & Koepfli, K. P. 2013. Evolution: A New Cat Species Emerges. *Current Biology*, 23(24): R1103-R1105.
- Olmos, F. 1991. Observations on the behavior and population Dynamics of some Brazilian Atlantic forest rodents. *Mammalia*, 55(4): 555-565.
- Paglia, A. P., Fonseca, G. A. B.; Rylands, A. B.; Herrmann, G.; Aguiar, L. M. S.; Chiarello, A. G.; Leite, Y. L. R.; Costa, L. P.; Siciliano, S.; Kierulff, M. C.; Mendes, S. L.; Tavares, V. C.; Mittermeier, R. A. & Patton, J. L. 2012. Lista Anotada dos Mamíferos do Brasil / Annotated Checklist of Brazilian Mammals. *Occasional Papers in Conservation Biology*, 6: 1-76.
- Palma, A. R. T. 1996. Separação de nichos entre pequenos mamíferos de Mata Atlântica. Dissertação de mestrado. Universidade Estadual de Campinas, São Paulo.
- Pardini, R. 2004. Effects of forest fragmentation on small mammals in an Atlantic Forest landscape. *Biodiversity and Conservation*, 13: 2567-2586.
- Pardini, R. & Umetsu, F. 2006. Pequenos mamíferos não-voadores da Reserva Florestal do Morro Grande - distribuição das espécies e da diversidade em uma área de Mata Atlântica. *Biota Neotropica*, 6(2): 1-22. Electronic

Database accessible at <http://www.biotaneotropica.org.br/v6n2>. (18/12/2008).

- Paresque, R.; Souza, W. P.; Mendes, S. L. & Fagundes, V. 2004. Composição cariotípica da fauna de roedores e marsupiais de duas áreas de Mata Atlântica do Espírito Santo, Brasil. *Boletim do Museu de Biologia Mello Leitão (Nova Série)*, 17: 5-33.
- Passamani, M. 1995. Vertical stratification of small mammals in Atlantic hill forest. *Mammalia*, 59(2): 276-279.
- Passamani, M. 2000. Análise da comunidade de marsupiais em Mata Atlântica de Santa Teresa, Espírito Santo. *Boletim do Museu de Biologia Mello Leitão (Nova Série)*, 11/12: 215-228.
- Passamani, M., Mendes, S. L. & Chiarello, A. G. 2000. Non-volant mammals of the Estação Biológica de Santa Lúcia and adjacent areas of Santa Teresa, Espírito Santo, Brazil. *Boletim do Museu de Biologia Mello Leitão (Nova Série)*, 11/12: 201-214.
- Passamani, M. & Fernandez, F. A. S. 2011. Abundance and richness of small mammals in fragmented Atlantic Forest of southeastern Brazil. *Journal of Natural History*, 45(9-10): 553-565.
- Pessoa, F. S.; Carvalho, T. M.; Albuquerque, H. G.; Attias, N. & Bergallo, H. G. 2009. Non-volant mammals, Reserva Particular do Patrimônio Natural (RPPN) Rio das Pedras, Mangaratiba Municipality, Rio de Janeiro State, Brazil. *Check List*, 5: 577-586.
- Ribeiro, M. C., Metzger, J. P.; Martensen, A. C.; Ponzoni, F. J. & Hirota, M. M. 2009. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. *Biological Conservation*, 142: 1141-1153.
- Rizzini, C. T. 1979. Tratado de fitogeografia do Brasil: Aspectos sociológicos e florísticos. Volume II. Hucitec and EDUSP, São Paulo.
- Ruschi, A. 1953a. Morcegos do Estado do Espírito Santo. Família Phyllostomidae. Chaves analíticas para sub-famílias, gêneros e espécies representadas no E. Santo. Descrição das espécies: *Trachops cirrhosus* e *Tonatia brasiliense*, com algumas observações a respeito. *Boletim do Museu de Biologia Professor Mello Leitão (Série Zoologia)*, 13: 1-18.
- Ruschi, A. 1953b. Morcegos do Estado do Espírito Santo. Família Phyllostomidae. Descrição das espécies: *Lonchophylla mordax* e *Hemiderma perspicilatum*, com algumas observações biológicas a respeito. *Boletim do Museu de Biologia Professor Mello Leitão (Série Zoologia)*, 19: 1-12.
- Santos-Filho, M.; Silva, D. J. & Sanaiotti, T. M. 2008. Variação sazonal na riqueza e na abundância de pequenos mamíferos, na estrutura da

- floresta e na disponibilidade de artrópodes em fragmentos florestais no Mato Grosso, Brasil. *Biota Neotropica*, 8(1): 115-121. <http://www.biotaneotropica.org.br/v8n1/pt/abstract?article+bn02508012008>.
- Stallings, J. R. 1989. Small mammal inventories in an eastern Brazilian Park. *Bulletin of Florida State Museum, Biological Sciences*, 34: 153-200.
- Straube, F. C. & Bianconi, G. V. 2002. Sobre a grandeza e a unidade utilizada para estimar esforço de captura com utilização de redes-de-neblina. *Chiroptera Neotropical*, 8(1-2): 150-152.
- Tonini, J. F. R.; Carão, L. M.; Pinto, I. S.; Gasparini, J. L.; Leite, Y. L. R. & Costa, L. P. 2010. Non-volant tetrapods from Reserva Biológica de Duas Bocas, State of Espírito Santo, Southeastern Brazil. *Biota Neotropica*. 10(3): Database accessible at <http://www.biotaneotropica.org.br/v10n3/en/abstract?inventory+bn02710032010>.
- Trajano, E. 1984. Ecologia de populações de morcegos cavernícolas em uma região cárstica do Sudeste do Brasil. *Revista Brasileira de Zoologia*, 2(5): 255-320.
- Uchôa, T. 2006. Comunidades dos pequenos mamíferos em dois estágios sucessionais de floresta Atlântica e suas implicações à ecologia e conservação. Dissertação de mestrado. Universidade Federal do Paraná. Curitiba.
- Voltolini, J. C. 1997. Estratificação vertical de marsupiais e roedores na floresta Atlântica do sul do Brasil. Dissertação de mestrado. Universidade de São Paulo, São Paulo.
- Zortéa, M. 1995. Observations on tent-using in the Carolline bat *Rhinophylla pumilio* in Southeastern Brazil. *Chiroptera Neotropical*, 1(1): 2-4.
- Zortéa, M. 2007. Subfamília Stenodermatinae, p. 107-127. *In*: Reis, N. R.; Peracchi, A. L.; Pedro, W. A. & Lima, I. P. (eds.). *Morcegos do Brasil*. Londrina. 253 p.
- Zortéa, M. & Brito, B. F. A. 2000. Tents used by *Vampyressa pusilla* (Chiroptera: Phyllostomidae) in southeastern Brazil. *Journal of Tropical Ecology*, 16(3): 475-480.

Appendix 1. Voucher list.

Non-volant small mammals: The small mammal collection of Museu de Biologia Prof. Mello Leitão (MBML).

Marmosops incanus (54, 93, 95, 98, 111, 112); *Metachirus nudicaudatus* (103, 125, 164, 2063); *Marmosa murina* (97, 99, 119); *Gracilinanus microtarsus* (82); *Didelphis aurita* (81, 132, 152); *Philander frenatus* (79, 122);

Euryoryzomys russatus (50, 51, 88, 91, 138); *Trinomys paratus* (65, 66, 67, 68, 114, 127, 137); *Nectomys squamipes* (84, 85, 90, 106); *Guerlinguetus ingrami* (78, 104); *Phyllomys pattoni* (226); *Oxymycterus* sp (117).

Bats: The Chiroptera collection of Museu de Biologia Prof. Mello Leitão (MBML).

Mimon bennettii: (1643); *Carollia perspicillata*: (1674, 1675, 1678, 1720, 1729, 1735); *Artibeus lituratus*: (1740, 1741, 1743, 1744, 2769); *Anoura caudifer*: (1652, 1654, 2765, 2766, 2767); *Trachops cirrhosus* (2768); *Lonchorhina aurita* (2770, 2771); *Myotis nigricans* (1667, 1668, 1669, 1670, 1673); *Vampyressa pusilla* (1764, 1765); *Phyllostomus discolor* (1763); *Rhinophylla pumilio* (1680, 1681, 1682, 1683); *Desmodus rotundus* (1632).