Bat assemblages from three Atlantic Forest fragments in Rio de Janeiro state, Southeastern Brazil

Roberto Leonan Morim Novaes[‡], Daniel Tavares Cassilhas Rosa[§], Davor Vrcibradic[|], Leonardo dos Santos Avilla[|]

‡ Fundação Oswaldo Cruz, Rio de Janeiro, Brazil
§ Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
| Universidade Federal do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Corresponding author:

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Abstract

Bat species richness in Neotropical localities is generally higher than that of any other group of mammals, and surveys of local bat assemblages may provide useful data for conservation management plans. Although the bat fauna of the Rio de Janeiro state is currently one of the best known in Brazil, there are several localities not adequately surveyed yet, and most of them are in the mountainous regions and in the northern portion of the state. From January 2008 to November 2009, we conducted surveys of bats in three localities in the state of Rio de Janeiro (municipalities of Varre-Sai, Sumidouro, and Cantagalo), and our fieldwork constitutes the first assessment of the bat assemblages of these localities. Surveys were conducted using mist nets in four different habitat types in each locality (forest interior, forest edge, riparian forest, and open areas [pastures]). We captured a total of 148 individuals in 17 species, 14 genera and 3 families. Among them, 11 species were recorded in Sumidouro, seven in Cantagalo, and nine in Varre-Sai. Although species richness was low compared with previous surveys in other close localities, we recorded species that have been rarely sampled in Southeastern Brazil (e.g., *Macrophyllum macrophyllum* [Phyllostomidae]). The results reinforce the importance of sampling different habitats in short surveys to improve the number of species registered.

Keywords

Atlantic Forest remnants, Chiroptera, Neotropical bats, species richness.

Introduction

The Brazilian Atlantic Forest is one of the most endangered biomes on Earth (Ribeiro et al. 2009), and due to its high biodiversity and rates of endemism it is considered one of the world's hotspots, and an area of high priority for conservation (Myers et al. 2000). Because of a historical process of exploiting the land for timber, cultivation of coffee, sugar cane, and, more recently, pastures for livestock (Galindo-Leal and Câmara 2005), the original vegetation was reduced to about 11%, and most of the remnant vegetation is currently diffused in small fragments of second-growth forests (Ribeiro et al. 2009). Biodiversity surveys in these remnants are necessary to subsidize conservation management plans for local faunas and floras. Also, the study of local faunas is essential for understanding the regional patterns of biological diversity, and allows better characterizations of the geographic distribution of specific taxa (Soulé and Wilcox 1980).

Bats represent the second most speciose mammalian order, and can make up more than half of the mammal species in some Neotropical communities (Tim 1994). Surveys of bat faunas can be important tools to evaluate the degree of habitat conservation in forest remnants (Medellín et al. 2000, Estrada and Coates-Estrada 2002). According to Esbérard (2003) the richness and diversity of bat species depends on the local availability of food and shelter, so there is a relationship between bat community composition and complexity of habitats available within a given site (Estrada et al. 1993, Sedlock et al. 2008). Thus, different habitats should be sampled to adequately survey local faunas (Kunz and Kurta 1988), including both human-modified and natural environments.

The state of Rio de Janeiro has one of the best studied bat faunas in Brazil (Bergallo et al. 2003, Esbérard and Bergallo 2005, Bernard et al. 2010). However, the mountainous region (i.e., slopes of Serra do Mar and Serra da Mantiqueira) and the northern portion of the state still represent gaps in the knowledge of the bat fauna, and surveys are highly required (Moratelli and Peracchi 2007, Modesto et al. 2008a, Modesto et al. 2008b, Esbérard et al. 2010, Peracchi and Nogueira 2010). Here, we present lists of bat species from three previously unsampled localities in the state of Rio de Janeiro (two in mountainous areas and one in the extreme north of the state), with comments on the importance of sampling in different habitats.

Material and methods

Study areas

The study was conducted in the municipalities of Varre-Sai, Sumidouro, and Cantagalo (Fig. 1). The three areas are highly fragmented due to the historical process of land use for agriculture and cattle ranching, and they represent gaps in the knowledge of occurrence of mammals, in general, and bats, in particular, for the state of Rio de Janeiro (Bergallo et al. 2009).

Varre-Sai is in the extreme north of the state of Rio de Janeiro, bordering the state of Espírito Santo. The locality sampled is situated at the Serra da Sapucaia (20°55'50"S, 41°53'54"W; altitude ca. 800 m), an extension of the Serra do Caparaó, in the Mantiqueira range. Sampling was carried out in fragments of seasonal semideciduous forest surrounded by matrix of pastures, agricultural fields and coffee plantations.

Sumidouro is in the mountains of the central region of Rio de Janeiro, at the continental border of the Serra do Mar. Fieldwork was carried out in a small fragment of dense ombrophilous forest on top of an inselberg-type rock formation named Pedra de Santa Rita (22°07'38"S, 42°41'00"W; altitude ca. 900–1000 m), an area with several natural caves.

Cantagalo is also in the mountains of the central region of the state of Rio de Janeiro, in the north of the continental border of Serra do Mar. Samplings were carried out in the Novo Tempo cave and surrounding areas (21°48'53"S, 42°11'57"W; altitude ca. 400 m), in a region of dense ombrophilous forest. The Novo Tempo cave is one of the largest caves in the state of Rio de Janeiro, and is located in a region formed by a mosaic of secondary forest fragments of various sizes, agricultural fields and open areas (pastures).

Data collecting and analysis

Bat surveys were conducted from January 2008 to November 2009, with one sampling in the dry season and other in the rainy season in each locality. Each sampling was carried out from two to five nights. Bats were collected using mist nets (9x3 m, 25 mm-dash) placed on trails inside forested areas, at the edges of forest fragments, at the margins or over water bodies, and at the entrances or inside natural cavities that bats were using as roosts (Kunz and Kurta 1988). We used four to eight mist nets from sunset to sunrise. Sampling effort was calculated following Straube and Bianconi (2002), and resulted in a total of 6,480m²/h for Varre-Sai (five nights), 8,100m²/h for Sumidouro (seven nights) and 4,860m²/h for Cantagalo (four nights), with an almost equal effort for the four different habitats types (ca. 3,760m²/h). The following habitats were sampled: (1) forest, with mist n ets placed inside three forest fragments of 54, 91 and 122 ha; (2) edges of these same fragments; (3) riparian forest, with mist nets placed in the margin or perpendicular to watercourses; and (4) open areas, with mist-nets placed in the pastures, which were 50 to 80 m far from the fragments. These four habitat types were present in the three sampled localities.

Bats captured were measured, sexed and identified in the field. Identifications followed Vizotto and Taddei (1973), Simmons and Voss (1998),Dias et al. (2002) and Dias and Peracchi (2008). Voucher specimens of all species per locality were collected and deposited in the collection of mammals of the Museu Nacional, Rio de Janeiro (MN), and collection of bats of the Universidade Federal Rural do Rio de Janeiro (LDM [see Data resources]).

Assemblages were compared by locality and habitat using the diversity index of Shannon-Wiener, and equitability and dominant species index (Magurran 1998). A rarefaction curve

(95% confidence) was produced using the PAST software (Hammer et al. 2001), and the capture efficiency was calculated dividing the total captures by the sampling effort.

Data resources

Voucher specimens were deposited at the mammal collection of Museu Nacional, Rio de Janeiro (MN) and at the bat collection of Laboratório de Diversidade de Morcegos (LDM), Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro.

Sumirouro, Rio de Janeiro, Brazil: *Anoura caudifer* (MN 77690-77695, 77710, 77711-77713, 77715, 77716, 77718-77720); *Artibeus lituratus* (MN 77696, 77700, 77701); *Artibeus obscurus* (MN 77698, 77717); *Carollia perspicillata* (MN 77699, 77702, 77706, 77714, 77732); *Chiroderma doriae* (LDM 5266, 5267); *Chrotopterus auritus* (MN 77726, 77729, 77730); *Desmodus rotundus* (MN 77697, 77708, 77727, 77731, 77733); *Diphylla ecaudata* (MN 77728); *Macrophyllum macrophyllum* (MN 77735); *Platyrrhinus lineatus* (MN 77703); *Platyrrhinus recifinus* (MN 77705, 77709); *Vampyressa pusilla* (MN 77704, 77707). Varre-Sai, Rio de Janeiro, Brazil: *Artibeus fimbriatus* (MN 77725); *Carollia perspicillata* (MN 77722, 77723); *Myotis nigricans* (MN 77724); *Platyrrhinus lineatus* (MN 77734); *Sturnira lilium* (MN 77721). Cantagalo, Rio de Janeiro, Brazil: *Carollia perspicillata* (MN 77738, 77746, 77749); *Desmodus rotundus* (MN 77739-41, 77743, 77745); *Diphylla ecaudata* (MN 77747, 77748); *Glossophaga soricina* (MN 77736); *Peropteryx macrotis* (MN 77737, 77742, 77744, 77750-77752).

Results and Discussion

We captured a total of 148 bats of 17 species for the three localities together (Sumidouro = 82 individuals of 11 species; Cantagalo = 25 individuals of seven species; Varre-Sai = 41 individuals of nine species). *Carollia perspicillata* was the most frequent species in the three areas, representing more than 50% of all bats recorded at Varre-Sai and more than 35% of the records from the other two areas (Table 1). *Carollia perspicillata* seems to be the dominant species in most Atlantic Forest localities in Rio de Janeiro (see Esbérard et al. 2006, Dias et al. 2008, Luz et al. 2011, Delciellos et al. 2012), and one of the most common in the Neotropics.

Individuals of frugivorous bats accounted for most of the captures in the three areas, and in the four habitats sampled as well. The dominance of frugivorous species typical of forest edge, such as *C. perspicillata*, is common in secondary forest fragments and agricultural areas (Heithaus and Fleming 1978, Faria 2006, Rocha et al. 2010, Novaes et al. 2014), since these species are benefited by the presence of pioneer vegetation and by high fruit production (Herrera et al. 1994, Murcia 1995, Guariguata and Sáenz 2002, Asbjornsen et al. 2004). The use of mist-nets may biased the low sampling of insectivorous bats, becuase it is more efficient for sampling representatives of phytophagous species

(such as stenodermatines and carolliines) than animalivorous species, which can detect mist-nets easily (Portfors et al. 2000, Gorresen et al. 2008).

The three areas sampled had similar values for species diversity, equitability and dominance (Table 1). However, there were significant differences between these indices when compared by habitat. The forest interior showed higher species richness and species diversity (H'=2.27) than the other habitats, but there were no dominance (D'=0.12) (Table 2), indicating that the forest interior is subject to less environmental stress than the other habitats. The forest interior also had a high evenness of species composition (J'=0.91), and a greater number of exclusive species (five) when compared with the other habitats.

The higher species richness within the forested areas was expected, since these environments have more heterogeneous habitats, allowing coexistence of more species from different trophic guilds than other habitats, including those species with more specialized feeding habits (Kalko et al. 1996). Nevertheless, five species were recorded neither in the interior nor at the edge of forests, among them: *Peropteryx macrotis* and *Glossophaga soricina* were collected only in open areas; *Macrophyllum macrophyllum* and *Platyrrhinus lineatus* were collected only near or over water bodies in riparian forest; and *Myotis nigricans* was collected both in open areas and riparian forest. These observations reinforce the importance of sampling different habitats during short-term species surveys.

The three regions sampled showed low richness and diversity of species compared to other studies carried out in mountainous areas and other close localities (e.g., Esbérard 2007, Moratelli and Peracchi 2007, Dias et al. 2008, Esbérard et al. 2010). This may be due to the low sampling effort employed in the present study, when compared with the aforementioned studies, or even due to the characteristics of the landscape, since most of the previous studies conducted in mountainous regions of Rio de Janeiro were concentrated in areas of continuous forest, which support higher species richness (Medellín et al. 2000). Therefore, it is possible that the high degree of human-induced disturbance and habitat fragmentation in these areas have resulted in the loss of more sensitive species.

Even considering the low species richness, the areas sampled in the present study yielded some interesting records. An individual of *Macrophyllum macrophyllum*, a species considered rare in the state of Rio de Janeiro, was captured in a mist-net placed over water bodies, in Sumidouro. According to Weinbeer et al. (2005), this species has a strong association with habitats with collections of water, since it forages close to the water, catching aerial insects or "fishing" semi-aquatic insects from the water surface (Meyer et al. 2005).

We known very little about bats inhabiting caves in Southeastern Brazil. Captures with mist-netsset up inside the Novo Tempo cave revealed colonies of *Peropteryx macrotis*, *Desmodus rotundus*, *Diphylla ecaudata*, *Carollia perspicillata* and *Artibeus obscurus*.

Considering the three areas combined, the list of species obtained here is still very preliminary, with the species accumulation curve did not reaching an asymptote (Fig. 2).

However, the results of this study indicate that sampling different habitats within a given locality increase the efficiency of bat inventories, in particular, during short surveys.

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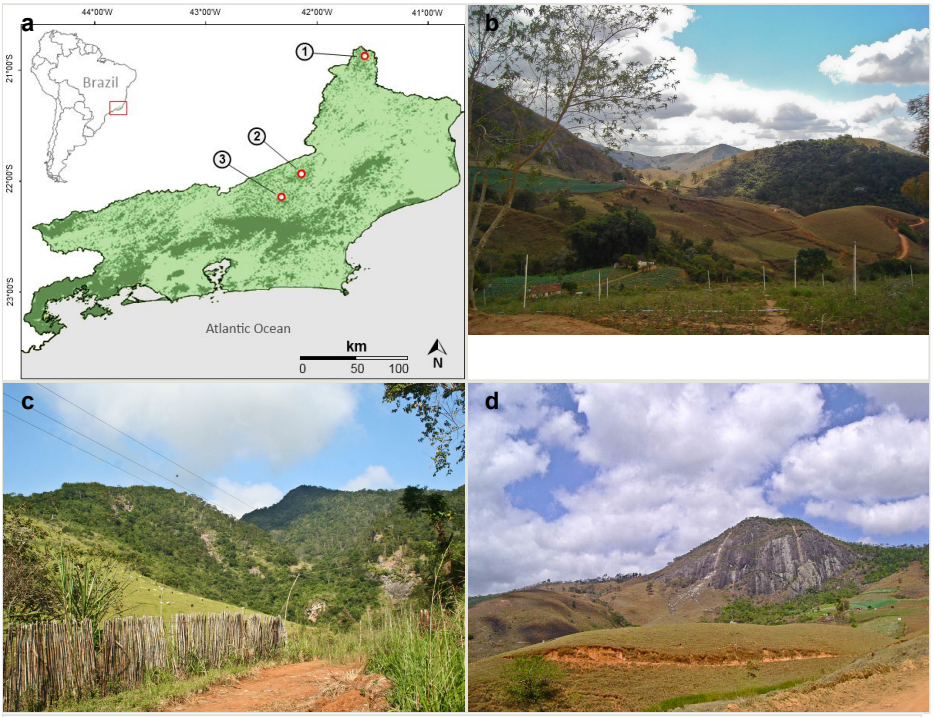

Figure 1.

Location and landscape of the studied areas in the Atlantic Forest of Rio de Janeiro, Southeastern Brazil.

a: Remnants of Atlantic Forest in the state of Rio de Janeiro (dark green), and location of the three surveyed areas in the municipalities of Varre-Sai (1), Cantagalo (2) and Sumidouro (3).

b: Sampled area in Varre-Sai.
c: Sampled area in Cantagalo.
d: Sampled area in Sumidouro.

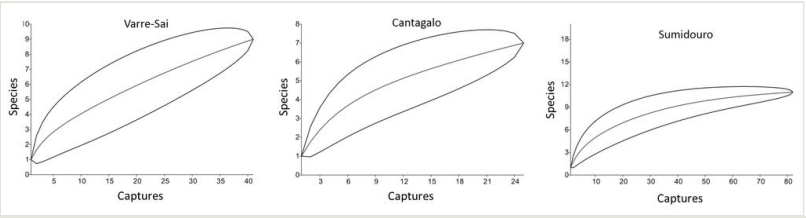

Figure 2.

Species rarefaction curve for the three bat assemblages in Rio de Janeiro, southeastern Brazil (see Suppl. material 1).

Table 1.

Absolute and relative abundances (%) of bat species, and parameters of the bat community (species richness, dominance, equitability, and diversity) for the three localities studied here.

Taxa	Trophic guild	Captures	
		Sumidouro	Cantagalo
Emballonuridae			
Peropteryx macrotis	Insectivore	0	5
Phyllostomidae			
Desmodontinae			
Desmodus rotundus	Sanguivore	10	5
Diphylla ecaudata	Sanguivore	1	2
Glossophaginae			
Anoura caudifer	Nectarivore	21	1
Glossophaga soricina	Nectarivore	0	1
Carolliinae			
Carollia perspicillata	Frugivore	30	10
Phyllostominae			
Chrotopterus auritus	Carnivore	3	0
Macrophyllum macrophyllum	Insectivore	1	0
Stenodermatinae			
Artibeus fimbriatus	Frugivore	0	0
Artibeus lituratus	Frugivore	5	0
Artibeus obscurus	Frugivore	3	0
Chiroderma doriae	Frugivore	3	0
Platyrrhinus lineatus	Frugivore	0	0
Platyrrhinus recifinus	Frugivore	3	0
Sturnira lilium	Frugivore	0	0

Vampyressa pusilla	Frugivore	2	0
Vespertilionidae			
Myotis nigricans	Insectivore	0	1
Total		**82**	**25**
Species richness		11	7
Capture efficiency (m².h)		0.010	0.005
Dominance (D')		0.224	0.251
Equitability (J')		0.761	0.821
Shannon-Wiener index (H')		1.826	1.599

Table 2.

Bat species richness by habitat, considering the three areas combined.

Species	**Habitats**			
	Forest	**Edge**	**Riparian**	**Open areas**
Peropteryx macrotis	0	0	0	5
Anoura caudifer	7	2	1	14
Artibeus fimbriaus	2	0	0	0
Artibeus lituratus	5	1	0	0
Artibeus obscurus	3	0	0	0
Carollia perspicilata	7	13	19	23
Chiroderma doriae	3	0	0	0
Chrotopterus auritus	3	0	0	0
Desmodus rotundus	10	0	0	5
Diphylla ecaudata	1	1	0	2
Glossophaga soricina	0	0	0	1
Macrophyllum macrophyllum	0	0	1	0
Platyrrhinus lineatus	0	0	1	0
Platyrrhinus recifinus	3	0	0	0
Sturnira lilium	1	8	1	0
Vampyressa pusilla	2	1	0	0
Myotis nigricans	0	0	1	1
Total of captures	**47**	**26**	**24**	**51**
Species richness	12	6	6	7
Capture efficiency (m².h)	0.012	0.006	0.006	0.013
Dominance (D')	0.121	0.355	0.635	0.300
Equitability (J')	0.913	0.715	0.472	0.745
Shannon-Wiener index (H')	2.270	1.282	0.847	1.451

Supplementary material

Suppl. material 1: Data of rarefaction curve

Authors: Roberto Leonan Morim Novaes
Data type: table
Filename: rarefaction_curve_data.csv - Download file (3.04 kb)