

Bat assemblage in remnants of Atlantic Forest in Minas Gerais State, southeastern Brazil

Taxocenose de morcegos em remanescentes de Floresta Atlântica em Minas Gerais, sudeste do Brasil

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Abstract

The process of habitat fragmentation has been intensified by human action, and therefore becomes increasingly more important to establish protected areas for conservation of native species, including with the participation of private entities. Wildlife surveys are essential to understanding the regional patterns of biological diversity, allowing a better characterization of the geographic distribution of specific taxa, supporting an adequate planning for nature conservation. We conducted an inventory of bats in a fragmented area of Atlantic Forest at Private Reserve of Natural Heritage Fazenda Lagoa, Minas Gerais, southeastern Brazil. With 110 captures, we recorded 16 species of bats belonging to four families, with dominance of generalist frugivorous species. Seven of the 10 trophic guilds categorized for Neotropical bats were recorded at the study area. This study adds important information about a region that represents a gap in the knowledge of Brazilian chiropterofauna, subsidizing possible conservation plans in the future.

Keywords: Chiroptera, conservation, private reserve, survey, trophic guild.

Resumo

O processo de fragmentação de habitat tem sido intensificado pela ação humana. Por isso torna-se cada vez mais importante o estabelecimento de áreas protegidas para conservação das espécies nativas, inclusive com a participação do setor privado. Levantamentos de fauna são essenciais para se compreender os padrões regionais de diversidade biológica, permitindo uma melhor caracterização da distribuição geográfica de táxons específicos, subsidiando planejamentos adequados para a conservação da natureza. Assim, realizamos um inventário de morcegos em área de Floresta Atlântica intensamente fragmentada na Reserva Particular do Patrimônio Natural Fazenda Lagoa, sul de Minas Gerais, sudeste do Brasil. Foram realizadas 110 capturas e registradas 16 espécies de morcegos distribuídas em quatro famílias, havendo acentuada dominância de espécies frugívoras generalistas. Sete das 10 guildas tróficas reconhecidas para morcegos neotrópicos foram registradas na área de estudo. Este estudo adiciona importantes informações sobre uma região que representa uma lacuna no conhecimento da quiropterofauna brasileira, subsidiando possíveis planos de conservação no futuro.

Palavras-chave: Chiroptera, conservação, levantamento, reserva privada, guilda trófica.

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Introduction

The process of habitat fragmentation occurs naturally due to several factors such as climatic fluctuations and the dynamics of hydrogeological processes (Constantino *et al.*, 2003). However, habitat fragmentation has been exacerbated by human activity and in the Atlantic Forest it typically occurred in a large spatial scale over a short period of time (Cerqueira *et al.*, 2003). Factors, such as distance, degree of isolation, size and shape of the remnants, type of surrounding matrix and edge effects modify the landscape altering ecological processes and community structure (Medellín *et al.*, 2000; Cerqueira *et al.*, 2003). Direct consequences of the fragmentation process, such as habitat loss and decreased landscape connectivity, can result in a reduction of the effective population size of susceptible species living in the fragments, restricting the genetic variability of these populations and, in the extreme scenarios, local extinctions (Terborgh, 1992).

Due to habitat loss and fragmentation, the establishment of protected areas for the conservation of native species becomes urgent. However, the limitations of the public system to establish protected areas increase the importance of the participation of the private sector in the conservation strategy of the Brazilian biodiversity, particularly through the creation of Private Natural Heritage Reserves - RPPN (Pinto *et al.*, 2004).

The RPPN is a special type of conservation unit recognized by Brazilian environmental government agencies, at the federal or state ambit, in which the landowner is responsible for its preservation (Ferreira *et al.*, 2004). However, biodiversity studies are crucial to formally create this class of conservation unit (Esbérard, 2003). In addition, biodiversity studies are essential for understanding the regional patterns of biological diversity and to allow a better characterization of the

geographic distribution of specific taxa (Soulé and Wilcox, 1980). These studies are an important tool for the conservation of native remnants, especially in the conservation units (Esbérard, 2003), subsidizing the creation of more effective programs to protect native species.

Bats are an important group of studies in tropical forests, which may represent up to 50% of the mammal community of a locality (Timm, 1994). Due to its great diversity of food habits and abundance, bats are considered vital to the maintenance of forest ecosystems, performing ecological services such as seed dispersal, pollination and control populations of herbivorous arthropods (Kalka *et al.*, 2008; Garibaldi *et al.*, 2011; Mello *et al.*, 2011). Kalko *et al.* (1996) classify Neotropical bats in 10 trophic guilds, considering their feeding habits and foraging space. Due to their alimentary specificity and occurrence in particular habitats, some guilds are more susceptible to extinction than others in case of disturbances (Kalko *et al.*, 1996).

Some studies have demonstrated that bat communities in fragmented areas have undergone changes in species composition, and may have alterations in abundance and species richness (Medellín *et al.*, 2000; Estrada and Coates-Estrada, 2002; Faria, 2006). Thus, species with limited distribution and that are more sensitive to habitat fragmentation may be more susceptible to environmental changes in local and regional scales, declining and disappearing in response to rapid environmental modifications (Brosset *et al.*, 1996; Grajon *et al.*, 1996; Cosson *et al.*, 1999).

Bernard *et al.* (2010) indicated that about 60% of the entire Brazilian territory does not have a single formal record of bat species and that our knowledge on Brazilian Chiroptera has large gaps. The authors commented that this problem is even more critical, since several of these gaps overlap with deforestation frontiers and

advancing agribusiness. Although the Atlantic Forest is the best sampled Brazilian biome for the bat fauna, most surveys were conducted in areas of evergreen rainforest. Few surveys were conducted in semi-deciduous forest or ecotonal areas between the Atlantic Forest and Cerrado like the southern region of the state of Minas Gerais (Bernard *et al.*, 2012).

We report on the first bat survey in remnants of Atlantic Forest in the Private Reserve of Natural Heritage (RPPN) Fazenda Lagoa, southeastern Brazil. This region not only presents a knowledge gap of Brazilian bats, but it also suffers intense anthropogenic pressures due to expansion of agricultural properties, which emphasizes the importance of studying the local biodiversity.

Material and methods

Study area

The Private Reserve of Natural Heritage (RPPN) Fazenda Lagoa (21°24'41.89''S and 46°15'54.09''W; elevation ca. 850m) is located in Monte Belo, southern Minas Gerais, Brazil (Figure 1). The RPPN Fazenda Lagoa has an area of 350 hectares divided into three fragments of semi-deciduous forest that is part of the Atlantic Forest biome. They are surrounded by a matrix composed of sugar cane fields, coffee plantations, and pastures (Figure 2). The fragments comprising the RPPN Fazenda Lagoa are formed by secondary forest resulting from reforestation process that started over 80 years ago. Today, the fragments exhibit characteristics of mature forest in their interior, with intense shading, canopy 15m tall, and high abundance of epiphytic bromeliads (Morellato and Haddad, 2000). There are also several other forest fragments surrounding the RPPN, forming an important mosaic of agricultural areas and remnants of Atlantic Forest.

Data collection and analysis

Between July 2010 and November 2011 we conducted 14 bat-sampling expeditions during the night using mist nets, which were placed on trails, clearings, and waterways. We used five to ten mist nets (Zootech® 9x3m, 20mm) set at ground level and left opened for six hours each night (from 6 h to 12 h). Captured bats were taxonomically identified in the field, according to Vizotto and Taddei (1973), Simmons and Voss (1998), Dias *et al.* (2002), Reis *et al.* (2007), Dias and Peracchi (2008), and Gardner (2008). Bats were marked with numbered bands and released at the capture site. The research was authorized by the SISBIO/IBAMA (3173-1). All ethic guidelines in manipulating animals were followed using recommendations by Sikes *et al.* (2011).

Sampling was carried out in four different sites: (1) interior of the fragments, (2) edges of forest fragments, (3) secondary forest in the initial process of regeneration, known as *capoeira*, and (4) riparian forest. The sampling effort was calculated according to Straube and Bianconi (2002) and capture efficiency was calculated by dividing the total number of captures by the sampling effort. We used the estimator of species richness index Chao-1 (see Chao, 1984), and performed the species accumulation curve with rarefaction (95% confidence) using the software PAST® (Hammer *et al.*, 2001). Bats were classified into trophic guilds as suggested by Kalko *et al.* (1996).

Results

The sampling effort totalized 15876 m².h, recording 16 bat species belonging to four families (Table 1). One hundred ten individuals of 16 species were netted and the most abundant species was *Carollia perspicillata* (Linnaeus, 1758), representing 27.2% of the total number of captures, followed by *Desmodus rotundus*

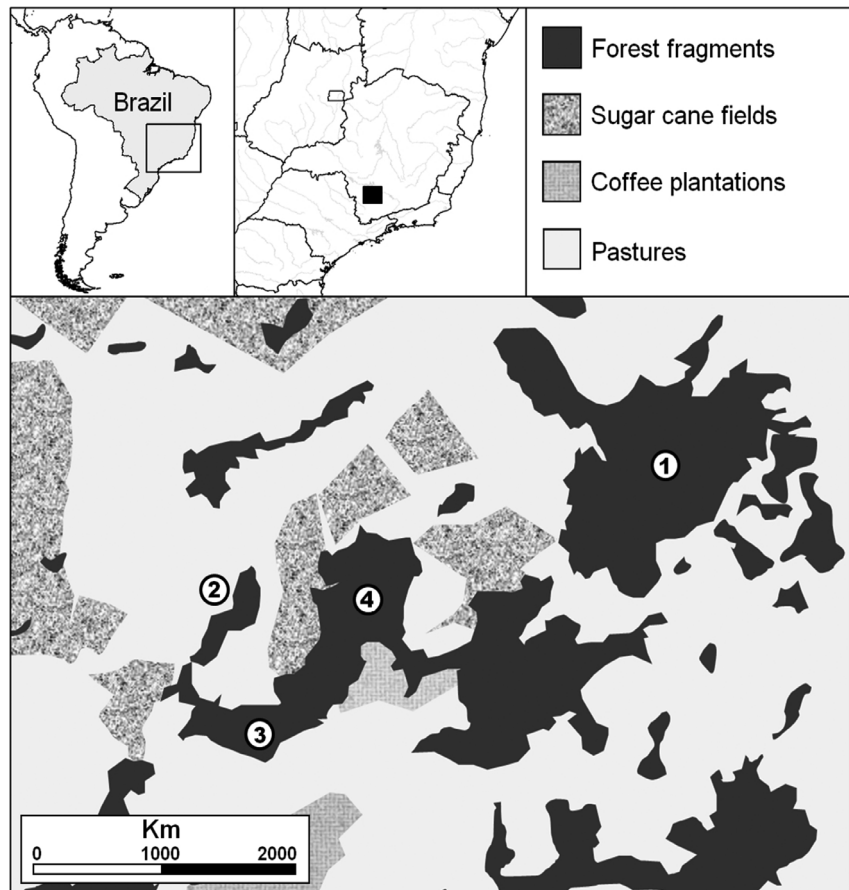


Figure 1. Study area in the Private Reserve of Natural Heritage Fazenda Lagoa, southeastern Brazil. Sites of captures: (1) interior of the fragment, (2) edges of forest fragments, (3) secondary forest in an initial process of regeneration (*capoeira*), and (4) margin of watercourse.

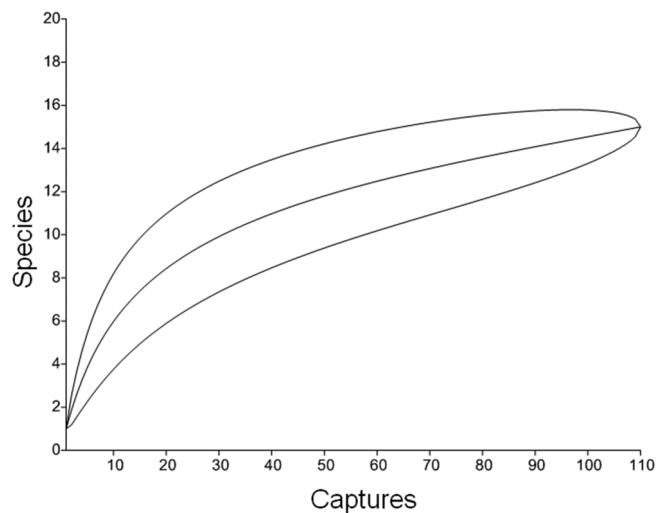


Figure 2. Curve of accumulation of species of bats in the Private Reserve of Natural Heritage Fazenda Lagoa, southeastern Brazil.

Table 1. Bats richness and abundance of Private Reserve of Natural Heritage Fazenda Lagoa, southeastern Brazil, following Kalko's trophic guild classification. BAI = Background cluttered space/aerial insectivores, CAR = Highly cluttered space/gleaning carnivores, FRU = Highly cluttered space/gleaning frugivores, NEC = Highly cluttered space/gleaning nectarivores, PIS = Highly cluttered space/gleaning piscivore, SAN = Highly cluttered space/gleaning sanguivores, UAI = Uncluttered space/aerial insectivores. Sites of captures: (1) interior of the fragment, (2) edges of forest fragments, (3) secondary forest in an initial process of regeneration (capoeira), and (4) riparian vegetation. *Recorded by direct observation without capture.

Order chiroptera	Trophic guild	Landscapes				N	%
		1	2	3	4		
PHYLLOSTOMIDAE							
Glossophaginae							
<i>Anoura caudifer</i> (E. Geoffroy, 1818)	NEC	1	4	1	0	6	5.45
<i>Anoura geoffroyi</i> Gray, 1838	NEC	0	1	0	0	1	0.90
<i>Glossophaga soricina</i> (Pallas, 1766)	NEC	2	10	1	1	14	12.7
Desmodontinae							
<i>Desmodus rotundus</i> (E. Geoffroy, 1810)	HEM	0	9	10	0	19	17.2
Carollinae							
<i>Carollia perspicillata</i> (Linnaeus, 1758)	FRU	19	6	3	2	30	27.2
Phyllostominae							
<i>Chrotopterus auritus</i> (Peters, 1856)	CAR	1	0	0	0	1	0.90
Stenodermatinae							
<i>Artibeus fimbriatus</i> Gray, 1838	FRU	2	1	1	0	4	3.63
<i>Artibeus lituratus</i> (Olfers, 1818)	FRU	1	3	6	2	12	10.9
<i>Artibeus obscurus</i> (Schinz, 1821)	FRU	0	0	1	0	1	0.90
<i>Platyrrhinus lineatus</i> (E. Geoffroy, 1810)	FRU	0	5	0	0	5	4.54
<i>Platyrrhinus recifinus</i> (Thomas, 1901)	FRU	0	1	0	0	1	0.90
<i>Sturnira lilium</i> (E. Geoffroy, 1810)	FRU	5	1	2	1	9	8.18
NOCTILIONIDAE							
<i>Noctilio leporinus</i> (Linnaeus, 1758)	PIS	0	0	0	*	-	-
MOLOSSIDAE							
<i>Molossus molossus</i> (Pallas, 1766)	IAB	0	0	0	3	3	2.72
VESPERTILIONIDAE							
<i>Myotis nigricans</i> (Schinz, 1821)	ISB	0	0	1	2	3	2.72
<i>Myotis riparius</i> Handley, 1960	ISB	0	0	0	1	1	0.90
TOTAL		7	31	41	26	110	100

(E. Geoffroy, 1810) (17.2%) and *Artibeus lituratus* (Olfers, 1818) (12.7%) (Table 1). The capture efficiency was 0.0069 bats/m².h. *Noctilio leporinus* (Linnaeus, 1758) was recorded by direct observation, but no captures of species was done by mist nets, resulting in the exclusion of this species in our quantitative analysis.

The Chao-1 index estimated a maximum richness of 25 species. Thus, the observed richness corresponds to 64% of the estimated richness. Furthermore, the species accumulation curve with rarefaction showed no stabilization, indicating that new species should be recorded in the

study area with the increase of sample size.

We recorded seven of the ten trophic guilds known for Neotropical bats. The guild of gleaning frugivorous bats showed the largest number of species (S = 7), and it was the most abundant guild, representing 56.3% of all captures.

Discussion

The reported species richness of bats in the study area was similar to those recorded in other surveys done in remnants of Atlantic Forest in Minas Gerais (Barros *et al.*, 2006; Silva *et*

al., 2005; Nobre *et al.*, 2009), as well as in a remnant in the transition between the Atlantic Forest and the Cerrado (Paglia *et al.*, 2012). However, the bat richness found in Fazenda Lagoa proved to be far lower than the one found in large remnants of continuous Atlantic Forest (Tavares *et al.*, 2007; Dias *et al.*, 2008; Souza, 2013). According to Estrada and Coates-Estrada (2002), the species richness in small fragments tends to be lower than in large forest remnants. However, many areas with forest fragments, even small-sized ones, can be important sites for the maintenance of native biota, including bats (Zimmerman and Bierregaard, 1986; Reis *et al.*, 2003; Souza, 2013).

The bat abundance reported in this paper presented similar values within the sampling effort (15.876m².h) compared to other bat surveys conducted with similar sampling efforts in other areas of fragmented Atlantic Forest and Cerrado in Minas Gerais (e.g. Grelle *et al.*, 1997; Silva *et al.*, 2005; Barros *et al.*, 2006; Nobre *et al.*, 2009). The prevalence of Phyllostomidae in the sampling result was expected, since this family is the most speciose of the Neotropical region, containing 51% of the 174 bat species that occur in Brazil (Paglia *et al.*, 2012). Moreover, phyllostomid bats are among the most abundant in surveys throughout Brazil (e.g. Pedro and Taddei, 1997; Bernard and Fenton, 2002; Esbérard, 2003; Faria, 2006; Dias *et al.*, 2008; Gallo *et al.*, 2008; Bernardi and Passos, 2012). In addition the sampling method used in most of those studies (mist nets at ground level) is very selective and not appropriate to capture aerial insectivore bats, especially the families Emballonuridae and Molossidae, and some Vespertilionidae (Freeman, 1981; Portfors *et al.*, 2000).

The outstanding abundance of fruit bats, such as *C. perspicillata* and *A. lituratus*, was also recorded in the majority of inventories in fragmented or continuous Atlantic Forest areas (Dias *et al.*, 2002; Esbérard, 2003; Gallo

et al., 2008; Souza, 2013). However, Medellín *et al.* (2000) indicate that the remarkable dominance of generalist fruit bats, such as *Artibeus* spp., is an indicator of disturbed areas, since these species have a high adaptive potential because they can consume a wide variety of fruits, both native and exotic. Thus, they can occupy different habitat types and are able to disperse over long distances (Zortéa, 2007; Menezes Jr. *et al.*, 2008; Novaes and Nobre, 2009). The high abundance of *C. perspicillata* and *Artibeus* spp. at Fazenda Lagoa can also be associated with the feeding habits of these species that have a preference for the consumption of fruits of *Piper* L. (Piperaceae), *Cecropia* L. (Cecropiaceae), and *Ficus* L. (Moraceae) (Passos *et al.*, 2003; Mello *et al.*, 2004). These plants are commonly found in secondary forests and areas undergoing regeneration (Murcia, 1995). The low number of species in this study can be considered an artifact of insufficient sampling effort in the area, since the species accumulation curve did not reach an asymptote, indicating the possibility of recording new species. According to Townsend *et al.* (2006), only a portion of organisms present in an area can be sampled. Thus, species that are easier to capture are found in the first registers while rare species or others that are hard to capture will be added to the list as the sample number increases. This highlights the importance of continuing bat inventories in Fazenda Lagoa, not only with the objective to record more species but also to conduct ecological studies aiming to understand the use of different environments and resources. Such studies are essential to the long-term conservation of ecological communities (Medellín *et al.*, 2000). Although the state of Minas Gerais has one of the richest bat-faunas in Brazil, with 77 species (Tavares *et al.*, 2010), there are still many areas, such as the southern part of the state, that have little or no knowledge of their bat fauna

due to a lack of inventories (Bernard *et al.*, 2010). Most forest remnants in Minas Gerais are under constant environmental pressures, suffering massive deforestation by agribusiness (Drummond *et al.*, 2005). Thus, the enhancement of wildlife inventories and conduction of ecological studies are necessary to provide the necessary tools for conservation in this region, allowing mitigating actions for species conservation.

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