Neotropical Biology and Conservation
10(1):15-20, january-april 2015

Bat inventory in a Caatinga area in Northeastern Brazil, with a new occurrence in the state of Paraíba

Inventário de morcegos em uma área de Caatinga no Nordeste brasileiro, com uma nova ocorrência para o estado da Paraíba

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Abstract

The Caatinga is a semi-arid ecosystem with a long history of anthropic impacts and scientific negligence. Since bats are the second most diverse group of mammals and have wide ecological roles, a well-based comprehension of their diversity for an area is important for management and conservationist actions. The goal of this study is to provide a list of the bat species found in Private Reserve of Natural Heritage Fazenda Almas, Paraíba, Northeastern Brazil. By sampling with mist nets and exploring roosts, we captured 126 specimens and recorded 19 species from 5 families. The most abundant species were *Artibeus planirostris, Peropteryx macrotis, Myotis nigricans*, and *Carollia perspicillata*. We registered high diversity of Phyllostominae, as well as the occurrence of the genus *Histiotus* in the state for the first time. Our results indicate that Caatinga areas can maintain bat assemblages with levels of diversity similar to moist tropical areas, which highlights the need to expand the network of protected areas in this threatened ecosystem.

Keywords: *Chiroptera*, diversity, private reserve, semi-arid.

Resumo

A Caatinga é um ecossistema semiárido com longo histórico de impactos antrópicos e negligência científica. Os morcegos são o segundo grupo mais diverso de mamíferos, com grande espectro de papéis ecológicos, e conhecimento sólido sobre sua diversidade em uma determinada área é fundamental para ações de manejo e conservação. O presente trabalho foi realizado na Reserva Particular de Patrimônio Natural Fazenda Almas, Paraíba, Nordeste do Brasil. Coletando com redes de neblina e explorando abrigos, realizamos 126 capturas e registramos 19 espécies distribuídas em cinco famílias. As espécies mais abundantes foram *Artibeus planirostris, Peropteryx macrotis, Myotis nigricans* e *Carollia perspicillata* Registramos alta diversidade de Phyllostominae, indicadores de baixa degradação ambiental, assim como realizamos o primeiro registro do gênero *Histiotus* para o estado. Os resultados indicam que áreas de Caatinga podem manter comunidades de morcegos com níveis de diversidade similares aos de florestas tropicais úmidas, o que reforça a necessidade de expandir a rede de áreas protegidas nesse ecossistema ameaçado.

Palavras-chave: *Chiroptera*, diversidade, reserva privada, semiárido.

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Introduction

Caatinga is a Neotropical ecosystem characterized by its accentuated seasonal weather, with scarce and irregular rainfall and high temperatures (Leal *et al.*, 2005; Menezes *et al.*, 2012). The vegetation includes arboreal and scrub forests with low canopy and with many xerophytic adaptations (Magalhães *et al.*, 2013; Oliveira *et al.*, 2012). It is one of the less protected ecosystems in Brazil, and one of the most threatened due to hundreds of years under unsustainable exploitation of its natural resources, now facing a process of desertification (Andrade *et al.*, 2005; Velloso *et al.*, 2002). The deficit of studies on its biodiversity and natural history represent a problem that is aggravated due to its history of widespread anthropic impact (Cruz *et al.*, 2005). Recent studies show that the region is highly diverse with a considerable rate of endemic species (Sá-Neto and Marinho-Filho, 2013).

However, the region as a whole is deficient of studies when compared with other Neotropical ecosystems (Santos *et al.*, 2011). Regarding bats, inventories for the Caatinga are very scarce, and most of them were done more than five years ago (e.g.: Fabián, 2008; Sbragia and Cardoso, 2008; Gregorin *et al.*, 2008; Astúa and Guerra, 2008; Nogueira *et al.*, 2008; Rios *et al.*, 2008; Sá-Neto and Marinho-Filho, 2013). The discovery of the most recently described bat genus (*Xeronycteris*) on the Caatinga (Gregorin and Ditchfield, 2005; Nogueira *et al.*, 2014) might be a hint that there is a promising field for research on this Brazilian semi-arid ecosystem.

Species inventories are important to support decision-making and planning on conservancy initiatives (Soulé and Kohm, 1989). In addition, a well-based comprehension specifically about bat fauna on a region is important for conservation and management actions, since bats are the second most diverse group of mammals, with over 160 species registered in Brazil (Reis *et al.*, 2007). Besides, they play important ecological roles, such as pollination, seed dispersal and population control for insects (Peracchi *et al.*, 2006). Bats are also considered excellent bioindicators, since they respond to many environmental changes, and have responses associated to other taxa (Meyer *et al.*, 2010).

Here we report results of the first bat survey conducted in the Private Reserve of Natural Heritage (RPPN) Fazenda Almas, located in the eastern Caatinga, in the state of Paraíba, northeastern Brazil. The region (Borborema geographical mesoregion) is under intense human occupation and traditional agribusiness exploitation (especially livestock), causing fast landscape modification and habitat loss, and making all efforts to study the regional biodiversity urgent.

Materials and methods

The present work was conducted in the Private Natural Heritage Reserve (RPPN) Fazenda Almas (7°28'19" S and 36°53'40" W), located between São José dos Cordeiros and Sumé (Barbosa *et al.,* 2007), at about 650 m a.s.l., in mid-eastern Paraíba, in the northeastern of Brazil. The RPPN Fazenda Almas has an area of approximately 3,505 hectares. The native vegetation is represented by areas of arboreal Caatinga (dense and sparse) and "lajedos" (lithic outcrops typical of the Caatinga physiognomy with peculiar flora). Rainfall ranges between 500 and 800 mm/year, some years reaching as low as 350 mm, and temperature ranging between 26°C and 30°C (Araújo *et al.*, 2011).

Data collection and analysis

We sampled at night during the months of September and November 2009 and during March and May 2010 using mist nets at ground level. The nets were placed in pre-existent trails considered to be flyways (Kunz and Kurta, 1988; Flaquer *et al.*, 2007), near trees bearing fruits and flowers, as well as water streams and structures (i.e., hollow trees, built structures) that are potential roosts. We did complementary samplings on roosts to capture species not commonly sampled using mist nets; roost-samplings took place during the day, using hand-nets. Sampling effort was calculated according to Straube and Bianconi (2002) as follows:

$$E_a = A_r.N_r.H_n.N_n$$

Where E_a represents the sample effort, A_m the mist net area, N_r the number of nets employed, H_n hours per night, and N_n the number of sampled nights. Collected bats were taken to the lab as voucher specimens. Taxonomical identification followed Gardner (2007), Gregorin and Taddei (2002), Vizotto and Taddei (1973). Specimens were preserved either in alcohol 70% after fixation by formalin 10% or taxidermied. We did the samplings under authorization n° 20321-2 (Ministério do Meio Ambiente). All specimens are deposited in Laboratório de Mamíferos' collection, at Federal University of Paraíba (UFPB 6013-6015 and UFPB 6111-6233).

The diversity estimator Chao 1 (Chao, 1984) was calculated using EstimateS (Colwell, 2009), using only mist net data. A randomized species accumulation curve, with 95% confidence was calculated, using 1,000 random samplings with no reposition.

Results

The sampling effort totalized 3,663.6 m²/h. We captured 126 individuals, belonging to 19 species of five families (Table 1): Phyllostomidae (11 species), Vespertilionidae (4), Molossidae (2), Emballonuridae (1), and Noctilionidae (1). *Artibeus planirostris* (Spix, 1823) was the most abundant species, with 43 individuals (34.1%), followed

Table 1. List of Species sampled at RPPN Fazenda Almas, in the northeastern of Brazil, from August 2009 to May 2010, discriminated between roost and mist net captures. Conservation status according to Chiarello *et al*. (2004), where DD stands for Data Deficient and NA stands for Not Available. Percentage of the species' contribution to all captures is discriminated between mist net captures, roost samplings and total samplings.

Species	Number of individuals			Status	%		
	Mistnet	Roost	Total		Mistnet	Roost	Total
Emballonuridae							
Peropteryx macrotis (Wagner, 1843)	0	21	21	NA	0	80.8	16.7
Phyllostomidae							
Diphylla ecaudata (Spix, 1823)	1	0	1	DD	1	0	0.8
Glossophaga soricina (Pallas, 1766)	7	0	7	NA	7	0	5.6
Lonchophylla mordax (Tomas, 1903)	1	0	1	NA	1	0	0.8
Micronycteris megalotis (Gray, 1842)	2	1	3	NA	2	3.8	2.4
Micronycteris sanborni (Simmons, 1996)	1	0	1	DD	1	0	0.8
Mimon crenulatum (E. Geoffroy, 1810)	2	0	2	NA	2	0	1.6
Trachops cirrhosis (Spix, 1823)	2	1	3	NA	2	3.8	2.4
Carollia perspicillata (Linnaeus, 1758)	13	0	13	NA	13	0	10.3
Sturnira lilium (E. Geoffroy, 1810)	2	0	2	NA	2	0	1.6
Artibeus planirostris (Spix, 1823)	43	0	43	NA	43	0	34.1
Platyrrhinus lineatus (E. Geoffroy, 1810)	1	0	1	NA	1	0	0.8
Noctilionidae							
Noctilio albiventris (Desmarest, 1818)	1	0	1	NA	1	0	0.8
Molossidae							
Molossus molossus (Pallas, 1766)	0	1	1	NA	0	3.8	0.8
Molossops temminckii (Burmeister, 1854)	3	0	3	NA	3	0	2.4
Vespertilionidae							
Eptesicus furinalis (D'Orbigny, 1847)	2	0	2	NA	2	0	1.6
Histiotus sp.	0	2	2	NA	0	7.7	1.6
Myotis nigricans (Schinz, 1821)	17	0	17	NA	17	0	13.5
Rhogeesa io (Thomas, 1903)	2	0	2	NA	2	0	1.6
Total of individuals	100	26	126				
Total of species	16	5	19				

by *Peropteryx macrotis* (Wagner, 1843) (21 individuals, 16.7%), the most abundant species sampled on roosts. Only two (*Trachops cirrhosus* (Spix, 1823) and *Micronycteris megalotis* (Gray, 1842)) of the five species sampled on roosts had individuals sampled by mist nets. Individuals of *Myotis* were observed on the visited roosts, even though only captured by mist nets. None of the species captured is considered endangered (Chiarello *et al.,* 2004).

Although the species' accumulation curve did not stabilize, the estimator Chao 1 indicates that the estimated diversity reaches around 18 species. Based on the final Chao 1 estimation (17.43 species), the present work sampled 91% of the local diversity.

Discussion

This study represents the first bat inventory performed in the altitude of the dry region of Cariri, in the Paraíba State, northeastern Brazil. Comparing to other studies performed in the state, the RPPN Fazenda Almas has a richness similar to the study of Cruz *et al*. (2005), in another dry Caatinga area (20 species). However, bat diversity in the study area was higher than the ones by Percequillo *et al.* (2007) in an Atlantic forest area and Sousa *et al.* (2003) in a Caatinga enclave moist forest or "brejo de altitude" (13 species each). This support the thesis that the semi-arid Caatinga has a rich mammal fauna (Sá-Neto and Marinho-Filho, 2013). Considering that most of the areas studied on Caatinga are under-sampled, the distribution of sampled sites is inadequate, and there are extensive areas with no performed surveys, where a diversity even higher than the currently known one should be expected (Oliveira *et al.,* 2003; Feijó and Lannguth, 2011).

The bat fauna composition in the RPPN Fazenda Almas presents a typical tropical pattern, with the predominance of insectivorous, frugivorous and nectar-feeding species. This is commonly observed when the samplings are held using ground-level mist nets (Passos *et al.*, 2003). Mist nets are the main sampling method used to conduct surveys in Brazil (Bergallo *et al.*, 2003; Esbérard and Bergallo, 2005). The family Phyllos-

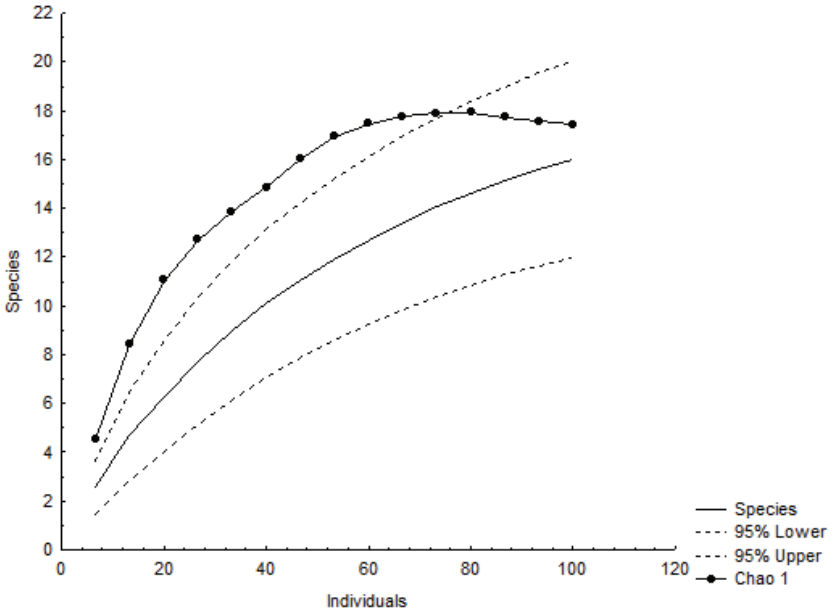

Figure 1. Species' accumulation curve of bat species sampled using mist nets at RPPN Fazenda Almas, northeastern Brazil, from August 2009 to May 2010, with the results of Chao 1 estimator. Full line represents the average observed number of species, and dotted lines represent the upper and lower 95% confidence interval.

tomidae is frequently the most representative in studies conducted this way, since a considerable number of species occur in sympatry and the family is the most diverse in the Neotropical region (Simmons, 2005; Wetterer *et al.*, 2000; Gardner, 2007).

The species richness of the subfamily Phyllostominae registered in the study area is unusually high comparing to other surveys conducted in Caatinga (Cruz *et al.*, 2005). This high species richness might be related to areas with low degree of environmental degradation, as the Phyllostominae are considered highly sensitive to vegetation covering alterations (Medellín *et al.*, 2000), although the use of Neotropical bats as environmental indicator must follow a series of precautions (Cunto and Bernard, 2012). This information shows the importance and effectiveness of conservationist actions on the Caatinga biome, as well as reinforces the importance of the private party participation on the efforts, as the RPPN proves to be an effective alternative to increase the number of protected areas.

The dominance of *Artibeus planirostris* (34.1% of total captures) is unusual for Caatinga inventories, contrasting sharply to data from Sbragia and Cardoso (2008), Silva *et al.* (2001) and Silva *et al.* (2004) who registered low abundance of this species in sites at Ceará. Gregorin *et al.* (2008) observed high capture rate and dominance of this species, sampling different points with different physiognomic variations of the Caatinga, whereas Sá-Neto and Marinho-Filho (2013) registered dominance of the genus *Artibeus*, sampling different areas in Bahia, with *A. obscurus* (Schinz, 1821) representing 35.48% of the captures, and *A. planirostris* 10.29%. We detected a high capture rate for *Peropteryx macrotis* during the work; this phenomenon was expected according to Gregorin *et al.* (2008), as the family Emballonuridae (especially the genera *Rhynchonycteris* and *Peropteryx*) is much common in the Brazilian Northeastern region, and known for being highly abundant in roosts.

The individuals of *Micronycteris megalotis* had morphological traits that fit in *M. microtis* Miller, 1898 description as well. The diagnostic trait proposed by Simmons (1996) upon the species description is the length of the hairs from the inner edge of the ear (3 mm for *M. microtis*, 7-8 mm for *M. megalotis*). Siles *et al.* (2013) points the taxonomic problems between the two species of *Micronycteris*, as well as problems setting the boundaries between other species within the genus. The validity of *Micronycteris microtis* can be questioned due to conflicting data (Porter *et al.*, 2007). The incongruence between the field data and the literature, and the superposition of diagnostic traits might indicate the necessity of a revision of the genus (Ecsobedo-Cabrera *et al.*, 2006; Ribas *et al.*, 2013). We support the adoption of *M. megalotis* as it is also the taxon recognized for the longest time (Alonso-Mejía and Medellín, 1991). The captured individuals of *Histiotus* sp. were similar to *Histiotus velatus* (I. Geoffroy, 1824). However, the specimens registered in the study area present unique ear morphology with light dorsal hair that distinguishes them from the typical *H. velatus*.

The present work has also first registered the occurrence of the genus *Histiotus* to the state, extending the genus distribution by 195 km northeast. The distance from the nearest record and the study area indicates a still deficient knowledge, and points out the importance of more extensive surveys and biogeography studies both as a gap-closing effort and as a way to unveil the genus' distribution on the Brazilian semi-arid regions.

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Submitted on July 11, 2014
Accepted on December 12, 2014