Bats (Mammalia, Chiroptera) from an area of Caatinga in southwestern Bahia, Brazil

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Morcegos (Mammalia, Chiroptera) de uma área de Caatinga do sudoeste da Bahia, Brasil

Resumo: O presente estudo fornece um inventário das espécies de morcegos capturados no município de Caetité, no sudoeste da Bahia, Brasil. No total, foram capturados 68 indivíduos de morcegos, pertencentes a nove espécies e três famílias. A riqueza de espécies estimada para a área através do estimador Jackknife 1, foi 9,9. Os morcegos filostomídeos foram os mais abundantes, e a espécie Carollia perspicillata (Linnaeus, 1758) foi a dominante. Nossos resultados são consistentes com estudos anteriores realizados na Bahia e no bioma Caatinga, fornecendo dados sobre a estrutura local da comunidade de morcegos. Além disso, destaca a importância de inventários rápidos para compreender a diversidade e distribuição da fauna de morcegos.

Palavras chave: Assembléia de morcegos, Caatinga, Caetité, inventário rápido.

Abstract: The present study provides an inventory of the bat species recorded in the municipality of Caetité, in southwestern Bahia, Brazil. Sixty-eight individuals were captured, belonging to nine species and three families. The Jackknife 1 procedure estimated a species richness of 9.9. The phyllostomid bats were the most abundant, and Carollia perspicillata (Linnaeus, 1758) was captured most frequently. Our results are consistent with previous studies conducted in Bahia and the Caatinga, providing data on the local bat community structure. It also highlights the importance of rapid inventories for the understanding of the diversity and distribution of the bat fauna.

Key words: Bat assemblage, Caatinga, Caetité, rapid inventories.

Introduction

The Brazilian Caatinga biome is formed predominantly by a seasonal, dense arboreal scrub composed of small trees and shrubs, without a continuous canopy, dominated by spiny, small-leaved plants and succulents (Cardoso & Queiroz 2007). The Caatinga extends over a total
area of 735,000 km², including part of nine Brazilian states (Leal et al. 2005). The climate of the Caatinga is characterized by long dry seasons and irregular rains (Andrade-Lima 1981).

A total of 153 species of mammal are known to occur in the Caatinga, of which approximately half (82) are bats (Paglia et al. 2012; Moratelli & Dias 2015; Feijó et al. 2015a,b; Rocha et al. 2015, 2018). Chiroptera is the second largest mammalian order, with 182 species known to occur in Brazil, representing nine families (Nogueira et al. 2014; Feijó et al. 2015a; Moratelli & Dias 2015; Rocha et al. 2015, 2018; Gregorin et al. 2016). In addition to their high taxonomic diversity (Simmons 2005), bats have an exceptionally wide range of diets and ecological niches (Kalko 1998), and play a vital role in the ecosystem and the maintenance of natural environments (Peracchi et al. 2011).

A number of studies have focused on the bat fauna of the Brazilian state of Bahia (Falcão et al. 2005; Faria 2006; Faria et al. 2006; Faria & Baumgarten 2007; Rios et al. 2008; Sá-Neto & Marinho-Filho 2013), including both Atlantic Forest and Caatinga biomes. To date, 78 species have been identified, representing 50 genera and eight families (Faria et al. 2006). Bahia includes some areas, in particular in the south of the state, that Bernard et al. (2011) consider to be relatively well-sampled, but with a total area of 565,000 km², much of which is poorly accessible, there are considerable gaps, especially in the Caatinga biome. The present study provides a new inventory from a poorly-studied region of Caatinga scrubland in southwestern Bahia.

Material and Methods

Study site

Bats were surveyed in the Fazenda do Engenho Cachoeira (13°50'34.07“ S, 42°15'22“ W), a ranch in the municipality of Caetité, in southwestern Bahia (Figure 1). The property is owned by Indústrias Nucleares do Brasil (INB), and contains 172 hectares of seasonal Caatinga. The region’s climate is semi-arid, with a rainy season typically between November and April, mean annual precipitation of 600 mm and mean annual temperature of 26°C (INMET 2014).

Figure 1. Location of the Fazenda do Engenho Cachoeira in the municipality of Caetité, southwestern Bahia, Brazil.
The forest at the study site (Figure 2) has a continuous canopy of approximately 20 m or more in some places, with varying levels of anthropogenic disturbance. Domestic stock (cattle and sheep) were observed in some areas. Other large tracts of mature Caatinga can be found in the surrounding area, including a private natural heritage reserve (RPPN), also owned by the INB. The principal plant families found in the study area are the Anacardiaceae, Bignoniaceae, Cactaceae, Fabaceae, Moraceae, Myrtaceae and Rhamnaceae.

Figure 2. Area of Caatinga sampled in the municipality of Caetité during the dry (A) and rainy (B) seasons.

Data collection

Two field campaigns were conducted in 2014, one in the dry season, in August, and the other in the rainy season, in December, each lasting 10 days (total sample of 20 days). Five points were sampled within and around the Fazenda do Engenho Cachoeira, each point sampled during two days in each campaign. The mist-nets were set along pre-existing trails, and adjacent to reservoirs and mango orchards.

Bats were captured using 10 mist-nets (12 x 3 m) set at ground level, continuously between 18:00 p.m. and 00:00 h. Active searches for bats were also conducted at specific sites (tree hollows, abandoned houses, storm drains, and termite nests) in the surrounding area, as well as households in the village of Maniaçu, approximately 28 km from Caetité.

Captured bats were placed in cotton bags for identification, the confirmation of the reproductive condition of the specimen (males: active or inactive; females: pregnant, lactating or post-lactation), and the collection of biometric data.

The species were identified based on Simmons & Voss (1998), Gregorin & Taddei (2002) and Gardner (2007), and nomenclature followed Simmons (2005). The voucher specimens were deposited in the Mammalian Zoology Collection of the Natural History Museum at the Federal University of Alagoas (Appendix 1).

Data analysis

The data from the active searches were not included in the analyses. The relative abundance of each species was calculated by the percentage of individuals captured in comparison with the total number of specimens. Sampling effort was determined using the index of Straube & Bianconi (2002). Species richness was estimated in the software EstimateS, with 1000 randomizations.

Results

A total sampling effort of 43.200 m².h (mist-nets) together with the active searches in roosts resulted in the capture of 68 individuals representing nine species in three families (Table 1). The family Molossidae, represented by Molossus molossus (Pallas, 1766), was captured only in roosts. The Jackknife 1 procedure estimated species richness of 9.9 (Figure 3), which indicates that 91% of the species expected for the area were collected during the present study.
Table 1. List of the bat species captured at Fazenda do Engenho Cachoeira, Caetité (Bahia). Guilds: FR – frugivorous, NE – nectarivorous, HE – hematophagous, IN – insectivorous.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number of specimens collected in:</th>
<th>Guild</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mist-nets</td>
<td>Roosts</td>
</tr>
<tr>
<td><strong>Phyllostomidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desmodontinae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desmodus rotundus</td>
<td>05</td>
<td>-</td>
</tr>
<tr>
<td>Glossophaginae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anoura geoffroyi</td>
<td>01</td>
<td>-</td>
</tr>
<tr>
<td>Glossophaga soricina</td>
<td>04</td>
<td>-</td>
</tr>
<tr>
<td>Carolliinae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carollia perspicillata</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>Stenodermatinae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artibeus planirostris</td>
<td>02</td>
<td>-</td>
</tr>
<tr>
<td>Platyrhinus lineatus</td>
<td>03</td>
<td>01</td>
</tr>
<tr>
<td>Sturnira lilium</td>
<td>04</td>
<td>-</td>
</tr>
<tr>
<td>Molossidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molossus molossus</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>Vespertilionidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myotis lavali</td>
<td>12</td>
<td>01</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>49</td>
<td>19</td>
</tr>
</tbody>
</table>

Figure 3. Cumulative bat species richness and the species richness estimated by Jackknife 1, based on the standardized samples collected at Fazenda do Engenho Cachoeira, Caetité (Bahia).

The family Phyllostomidae (N = 37) dominated the sample, with 77.5% of the specimens captured. Carollia perspicillata was the most abundant species (N = 18) (Figure 4D), followed by Myotis lavali Moratelli, Peracchi, Dias & de Oliveira, 2011 (N = 12) (Figure 4I). Only C. perspicillata was classified as common, with all the other species being classified as rare. The frugivorous guild was the most common (N = 28), followed by the insectivorous guild (N = 12), whereas nectarivorous and hematophagous bats were collected only during the rainy season (Table 2).
Bats were observed in a reproductive condition only during the rainy season. Two pregnant females of *Carollia perspicillata* and one of *Platyrrhinus lineatus* (E. Geoffroy, 1810) and *Myotis lavali* were captured. Lactating and post-lactating females of *Desmodus rotundus* (E. Geoffroy, 1810), *Artibeus planirostris* Spix, 1823, *C. perspicillata*, *Sturnira lilium* (E. Geoffroy, 1810) and *Glossophaga soricina* (Pallas, 1766) were also captured (Figure 4).

**Table 2** List of the bat species captured in mist-nets at Fazenda do Engenho Cachoeira, Caetité (Bahia) during the dry and rainy seasons.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of individuals collected during the:</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry season</td>
<td>Rainy season</td>
</tr>
<tr>
<td><em>Anoura geoffroyi</em></td>
<td>-</td>
<td>01</td>
</tr>
<tr>
<td><em>Artibeus planirostris</em></td>
<td>-</td>
<td>02</td>
</tr>
<tr>
<td><em>Carollia perspicillata</em></td>
<td>06</td>
<td>12</td>
</tr>
<tr>
<td><em>Desmodus rotundus</em></td>
<td>-</td>
<td>05</td>
</tr>
<tr>
<td><em>Glossophaga soricina</em></td>
<td>-</td>
<td>04</td>
</tr>
<tr>
<td><em>Platyrrhinus lineatus</em></td>
<td>-</td>
<td>03</td>
</tr>
<tr>
<td><em>Sturnira lilium</em></td>
<td>-</td>
<td>04</td>
</tr>
<tr>
<td><em>Myotis lavali</em></td>
<td>01</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>07</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

**Figure 4.** Bat species captured at Fazenda do Engenho Cachoeira, Caetité (Bahia): A. *Desmodus rotundus*, B. *Anoura geoffroyi*, C. *Glossophaga soricina*, D. *Carollia perspicillata*, E. *Artibeus planirostris*, F. *Platyrrhinus lineatus*, G. *Sturnira lilium*, H. *Molossus molossus*, I. *Myotis lavali*.
Discussion

All the species recorded in the present study (Figure 4) had been recorded previously in the Brazilian state of Bahia. The species composition and abundance patterns are consistent with the results of Falcão et al. (2005), and the predominance of phyllostomids is typical of the Neotropical region in general (Humphrey & Bonaccorso 1979; Fenton et al. 1992; Kalko 1998), and of the Caatinga biome, in particular, where more than half the species are members of this family (Silva & Nascimento 2008; Carvalho-Neto et al. 2016).

It is important to remember, however, that the mist-netting technique adopted in the present study strongly favors the capture of phyllostomids over other families (Findley 1993), given that they tend to fly low down in the forest (Sampaio et al. 2003). Consequently, they are typically the most abundant group captured in studies of this type. To obtain a more reliable inventory of bats in areas of Caatinga, complementary techniques should be employed (Silva & Bernard 2017). In particular, acoustic monitoring can increase the inventory of species not captured by mist nets, especially insectivorous bats, which typically fly above the canopy (MacSwiney et al. 2008; Silva & Bernard 2017). Nearly half of the Caatinga bat species are insectivores that forage in open spaces, flying high above nets, or species able to detect and avoid the nets (Paglia et al. 2012; Nogueira et al. 2014).

Carollia perspicillata, the species most captured in the present study, is generally the dominant species at Caatinga sites (Mares et al. 1981; Gregorin et al. 2008; Novaes & Laurindo 2014). This species is widely distributed in Brazil, occurring in all its biomes (Peracchi et al. 2011). The predominance of one or a few common species is typical of Brazilian bat communities (Pedro & Taddei 2007).

A predominance of insectivorous bats in the Caatinga has been observed in the states of Piauí (Gregorin et al. 2008; Novaes et al. 2015), Ceará (Willig & Mares 1989; Novaes & Laurindo 2014) and Paraíba (Zeppelini et al. 2017). In the present study, the insectivorous guild was abundant in the diurnal roosts, although no Molossus molossus were captured in the mist nets. The vespertilionid Myotis lavali was captured mainly in the nets set at the margins of small bodies of water, an ideal location for the capture of insectivorous bats (Lourenço et al. 2010; Costa et al. 2012; Novaes et al. 2015).

While observed bat species richness was close to that expected by the Jackknife 1 estimator, a relatively small number of species was recorded overall. The cumulative species curve did not reach the asymptote, indicating that additional species should be found. A number of species recorded commonly in the Caatinga were not encountered during the present study, including Artibeus lituratus (Olfers 1818), Dermanura cinerea Gervais, 1856, Lonchophylla mordax Thomas, 1903, and Phyllostomus discolor Wagner, 1843) (e.g., Mares et al. 1981; Willig 1983; Silva 2007; Novaes & Laurindo 2014; Rocha et al. 2015, 2017). Therefore, more systematic sampling with a greater capture effort may be necessary to obtain more reliable inventories of the bat fauna.

The number of species and the capture rates recorded at Caetité were much lower than those observed at other Caatinga sites. Even so, a reduced abundance of bats appears to be typical of the Caatinga biome (Silva et al. 2004; Gregorin et al. 2008; Novaes & Laurindo 2014; Beltrão et al. 2015; Novaes et al. 2015; Rocha et al. 2017; Zeppelini et al. 2017), where richness may typically be between 15 and 25 species (Novaes & Laurindo 2014). Surveys conducted at other sites in Bahia have also resulted in the capture of small numbers of bats. In Contendas do Sincorá, approximately 200 km from the present study area, for example, Rios et al. (2008) captured 14 bats belonging to seven species, while in Vitória da Conquista, 240 km from the present study, Falcão et al. (2005) recorded 13 bat species.

During the rainy season we recorded a greater abundance and species richness of bats at Fazenda do Engenho Cachoeira. In addition, actively reproductive bats were only observed during the rainy season. In the Caatinga, the highest abundance and diversity of bats is recorded during the rainy season (Rocha et al. 2017), a period is characterized by a greater abundance of resources such as insects (Vasconcellos et al. 2010) and fruit (Amorim et al. 2009). Rapid surveys
are important for the understanding of the diversity and distribution of the bat fauna, given the potential structure of local communities. In addition to providing primary data, they access the diversity of a given location directly, and provide important insights for the managers of protected areas and other public agents (Silveira et al. 2010). The understanding of local diversity is fundamental to the development of effective conservation measures (Brooks & Helgen 2010). In the specific case of the present study, the occurrence of additional, rare species may be confirmed through the collection of complementary data, through bio-acoustic studies, for example. The results of the present study nevertheless constitute an important contribution to the understanding of the bat diversity of the seasonal Caatinga of the Brazilian state of Bahia.

Appendix

Vouchers deposited in the Museu de História Natural da Universidade Federal de Alagoas (MHNUFAL): Carollia perspicillata ♀ MHNUFAL 106, Platyrhinus lineatus ♀ MHNUFAL 107, Sturnira lilium ♀ MHNUFAL 141, Myotis lavali ♀ MHNUFAL 142, Artibeus planirostris ♀ MHNUFAL 143, Desmodus rotundus ♀ MHNUFAL 144, Anoura geoffroyi ♀ MHNUFAL 145, Glossophaga soricina ♂ MHNUFAL 146, Molossus molossus ♀ MHNUFAL 147.

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References

Bats from an area of Caatinga


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