

Diversity and Ecology of *phyllostomid* Bat Species (Chiroptera: *Phyllostomidae*) in Caparaó National Park, Southeastern Brazil

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Abstract

Bats have varied feeding habits and have varied responses to habitat fragmentation and loss. In this study we analyzed the diversity and ecology of bat species in the understory of Parque Nacional do Caparaó, in the Atlantic Forest of Minas Gerais, southeastern Brazil. The captures were carried out from November 2011 to December 2013, with mist nets (9x3m), mounted at ground level, open at dusk and closed after six hours of exposure. A total of 288 individuals, six genera and seven species were captured. All species sampled belong to the Phyllostomidae family, in four subfamilies. Sternodematinae was the most abundant subfamily in the samples, representing 57% of the species and 76% of the specimens sampled. The composition of species diversity suggests that these disturbed fragments alter the dynamics of behavior and structure of these communities. Some bat species found in the PNC have an important association with the vertical stratum, making it evident that the structure and level of anthropization of the forest fragment is a factor that regulates the richness and abundance of bat species.

Keywords: Chiroptera; Atlantic forest; Species richness

Abbreviations: PNC-Caparao National Park; UEMG-State University of Minas Gerais

Introduction

The order Chiroptera is the most taxonomically diverse among mammals, with 1250 species, distributed in 20 families currently recognized in the world [1], representing 25% of mammals [2], with 15% of the total bat species having occurrence records for the national territory. Bats constitute a considerable part of the mammalian fauna in Neotropical environments and, frequently, have a higher species richness than the number of mammal species of other orders present in the same locality and region [3]. In Brazil, 180 species are recognized, with 98 occurring in the Atlantic Forest biome and 77 bat species recorded for the state of Minas Gerais [4-6]. Studies on the ecology of bats show that they are species responsible for interactions that are fundamental to the conservation and maintenance of ecosystems, controlling populations of invertebrates and vertebrates, dispersing seeds and pollinating flowers [7-9], in addition to being of public health interest [1]. According to Kalko [10], in an in-depth study of the ecology of Neotropical bats, found that there were species with strong specialization in diet and space use resulting from evolutionary adaptations in the morphology of their wings and in the frequency of echolocation, classifying them into ten different guilds [10]. As it is a very diverse group, each species uses the habitat according to its morphological, physiological and behavioral adaptations, with the phytophysiognomy of the place being a determining factor in its foraging area [11]. Many bat species inhabit similar environments, exhibiting similar foraging patterns, thus allowing them to be classified

into groups that use closed habitats such as forests, grasslands, and areas above the canopy [12]. With increasing changes in natural ecosystems, continuous forest formations disappeared through degradation or were replaced by cities, plantations and pastures [13,14], with these changes and the fragmentation of forests, fragments have been isolated and possible foraging sites, generally exploited by bat species in search of resources [15].

As a result of these changes in the environment, many species are able to replace their natural habitats with similar ones [16,17], however, some species are sensitive to fragmentation, having in their behavior varied responses to this process [18], as reported by Schulze [19], who demonstrated that the species *Sturnira lilium* and *Carollia perspicillata* present different patterns in their behavior, foraging in the edges of anthropized forests in search of secondary food sources, having an increase in their populations, in addition to being good indicators of altered environments. [18], reported that several species of bats occupy different vertical strata of a forest, adapting to specific conditions in their behavior, as the species *C. perspicillata*, which forages from the forest to the understory, presenting changes in its diet and in the structure of its community due to the levels of disturbance and fragmentation of its niche. In order to evaluate the diversity and ecology of bat species in the understory in several areas of the Caparaó National Park, with different states of conservation and human disturbance, the objective of this study was to relate the diversity of these species to their ecology and food guild.

Material and methods

Study area

Located in Serra do Caparaó, the Caparaó National Park (PNC) located between the parallels 20°19'S and 20°37'S and the meridians 41°43'W and 41°53'W [20], is located in Serra do Caparaó on the border between two states, Minas Gerais and Espírito Santo, in southeastern Brazil, being a Federal Conservation Unit, with 31.8 thousand hectares, with 80% of its area located in the state of

Espírito Santo (Figure 1). The region where the PNC is located has a mountain range that rises to 2800 m above sea level, forming the Caparaó Massif [21]. The climate according to Köppen is of the Cwb type: with dry winters and mild summers, being also characterized as altitude tropical, where the relief directly influences the temperature differences. The average annual temperature varies between 19 °C and 22 °C, with a maximum reaching 36 °C, and a minimum of -4 °C at the highest peaks. Average rainfall varies between 1,200 and 1,300mm per year [22] reaching 1,750mm in the northern region of the park [20]. The region was totally covered by Atlantic Forest Biome vegetation, with predominance of animal species adapted to the deformation of stony soils, intense cold, frost and formation of ice crusts [20]. With the increasing devastation and the loss of the forest for agriculture and livestock, much of its forests were destroyed, leaving the fauna small animals-such as opossum (*Didelphis aurita* Wied-Neuwied, 1826), cuíca (*Philander opossum* Linnaeus, 1758), paca (*Cuniculus paca* Linnaeus, 1766), tapeti (*Sylvilagus brasiliensis* Linnaeus, 1758), and caxinguelê (*Guerlinguetus brasiliensis* Thomas, 1901), and some predators such as the crab-eating fox (*Cerdocyon thous* Linnaeus, 1766), tayra (*Eira barbara* Linnaeus, 1758), raccoon (*Procyon lotor* Linnaeus, 1758) and a species of wildcat (*Leopardus tigrinus* Schreber, 1775); species threatened by fragmentation and hunting in the region [22]. Currently, it is possible to observe several plant formations in the Park, such as evergreen hygrophilous forests, seasonal subdeciduous forest, riparian forests, high altitude fields and rupestrian fields. This differentiation of vegetation formations was characterized by several factors such as climate variation, water courses, altitude, soil types, human interventions, deforestation and the introduction of exotic species [20,21]. The forest areas of the fragments surrounding the park are of secondary formation, altered by the action of fire, wood extraction and deforestation, leaving few preserved areas. The canopy of the forests varies between 20 and 30m, and plant species such as embaúbas (*Cecropia spp.*), quaresmeiras (*Tibouchina spp.*, *Miconia spp.*), adragos (*Croton spp.* (*Piptadenia spp.*) [21].

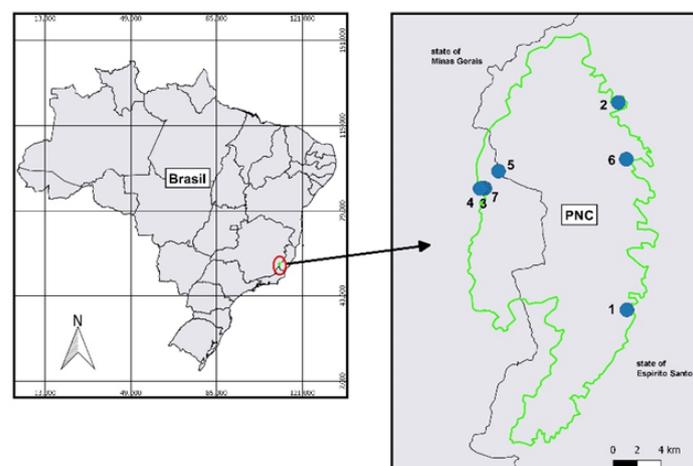


Figure 1: Location of the Caparaó National Park, on the border of the states of Minas Gerais and Espírito Santo. Blue circles indicate the sampling points of bats from 2011 to 2013: 1- Santa Marta, 2- Pedra Roxa, 3- Vale Verde, 4- Estrada da Tronqueira, 5- Cachoeira Bonita, 6- Ponto do Cachorro, 7-Casa do Waldomiro.

Animal capture

Captures were carried out in seven areas of the Caparaó National Park, in different seasonal periods, from November 2011 to October 2013, with five nights in each area (Table 1). The sampling effort was calculated according to [23]. All captures took place in the new and crescent phases of the moon, with temperatures ranging from 8.6 °C to 20.4 °C. Eight mist nets (9x3m) were used to capture bats, installed close to food sources, water bodies and flight routes, as well as existing trails in the forest and roads [24]. The nets were opened at dusk, reviewed at 15-minute intervals and closed after six hours of exposure [25]. The animals removed from the net were placed in cotton bags and taken to a field base for later identification of the species, biometrics, age class, sex and reproductive status. The age group was identified, following [26], by the ossification of

the epiphyses of the metacarpals and phalanges of the forelimbs, with individuals classified as adults, juveniles and infants. On each sampling night, abiotic data (temperature, relative humidity and luminosity) were obtained and recorded at the sampling site. After screening, the bats were released at the same location. Species identification was based on [27], and taxonomic classification followed [28]. Sampling was carried out in accordance with the license issued by the Chico Mendes Institute for Biodiversity Conservation: SisBio 31547 (Chiroptera)-Alessandro Brinati. All specimens were handled following capture, handling and collection protocols defined by the American Society of Mammalogists [29]. The specimens are deposited at the Newton Baidão de Azevedo Museum of Zoology at the Carangola Unit of the State University of Minas Gerais-UEMG.

Table 1: Sampling points, capture nights, sampling effort and number of individuals captured for bats in the Caparaó National Park from 2011 to 2013.

Sampling Points	Capture Nights	Sampling Effort	Number of Catches
Santa Marta	5	6.480m ² . h	27
Pedra Roxa	5	6.480m ² . h	26
Vale-Verde	5	6.480m ² . h	86
Estrada-Tronqueira	5	6.480m ² . h	81
Cachoeira Bonita	5	6.480m ² . h	21
Ponto do Cachorro	5	6.480m ² . h	25
Casa do Waldomiro	5	6.480m ² . h	22
Total	35	45.360m ² . h	288

Result

A total of 288 specimens were sampled, distributed in seven species, six genera, one family, in 35 nights of campaigns, with a sampling effort of 45.360m².h of net (Tables 1 & 2). All species sampled belong to the Phyllostomidae family, in four subfamilies. Sternodematinae was the most abundant subfamily in the samples,

representing 57% of the species and 76% of the specimens sampled (Table 2). The species *C. perspicillata* was the most abundant, presenting a capture frequency of 58% in the samplings, being sampled at all points. Three trophic guilds were sampled, being a hematophagous species, a nectanivorous species and five frugivorous species. The predominance was of frugivorous bats, represented by 72% of the species (Table 2).

Table 2: Family, bat species, trophic guild, sex of individuals and total number of bats sampled in the Parque Nacional do Caparaó from 2011 to 2013.

Taxon	Trophic Guild	Sex		Total
		Female	Male	
Família Phyllostomidae Gray, 1825				
Subfamília Desmodontinae Wagner, 1840				
<i>Desmodus rotundus</i> (E. Geoffroy, 1810)	Hematophagous	11	23	34
Subfamília Glossophaginae Bonaparte, 1845				
<i>Anoura caudifer</i> (E. Geoffroy, 1818)	Nectanivorous	8	6	14
Subfamília Caroliinae Miller, 1824				
<i>Carollia perspicillata</i> (Linnaeus, 1758)	Frugivorous	14	6	20
Subfamília Sternodematinae Gervais, 1856				
<i>Artibeus fimbriatus</i> (Gray, 1838)	Frugivorous	8	17	25
<i>Artibeus lituratus</i> (Olfers, 1818)	Frugivorous	4	10	14
<i>Platyrrhinus lineatus</i> (E. Geoffroy, 1810)	Frugivorous	6	8	14
<i>Sturnira lilium</i> (E. Geoffroy, 1810)	Frugivorous	87	80	167
Total		138	150	288

Discussion

Our results showed 7% of the species recognized for the Atlantic Forest and 7% for the bat species registered for the state of Minas Gerais, these findings show an exclusive abundance of phyllostomid bats (Chiroptera: Phyllostomidae) for the PNC and all sampling sites, with a predominance of the *S.lillium* species with 58% of the individuals sampled. [30], relatam a plasticidade dessas espécies no uso e forrageio do ambiente, como a dominância nas comunidades de morcegos em áreas antropizadas e fragmentadas. *A. fimbriatus*, *S. lillium* and *C. perspicillata* showed a frequency of 73% in the samplings, being sampled at all points. The abundance of these species is directly related to the environmental history of the study area, because species that are more resistant to anthropization and that have plasticity in their diet are able to maintain larger populations compared to species that are sensitive to anthropization and environmental fragmentation, their diet being restricted and specialist [31]. Furthermore, they are common species for many AM fragments both in the state of MG and other states of MA [32-38]. The composition of catch diversity recorded in this work demonstrates a pattern of species richness and diversity compared to other studies carried out in preserved areas in Brazil, as seen in [39,40]. The high rate of specimens of the Stenodermatinae subfamily (*A. lituratus*, *A. fimbriatus*, *P. lineatus*, *S. lillium*) can be explained by the methodology used (gill nets in the understory), These animals are canopy and understory frugivores, with low foraging habits and are easily captured by the mist net, as observed in [15,41,42]. The abundance of the species *S. lillium* sampled in this study (58%), compared to other studies, shows that the species has a high frequency of capture in the understory, as observed by [39], who demonstrated that the fragmentation and disturbance of the environment directly affects the behavior of this species, and these responses are observed in its use and foraging in the environment. [43], related this behavior to the feeding guild of the species *S. lillium*, with the fruits consumed from low trees, such as *Solanum crinitum*, in relation to the forest canopy. [42], report that areas of fragmented and close vegetation on the plains help bats during their movement, forming great connections between the forest blocks of a forest [44], serving as a reference to locate themselves spatially when necessary, and protect themselves from predators and weather conditions [45,46].

Conclusion

The composition of the species diversity found in this study suggests that disturbed fragments alter the dynamics and structure of bat communities present in the locality [18,19]. Some bat species found in the PNC have an important association with floral composition, making it evident that the structure and level of anthropization of the forest fragment is a factor that regulates the richness and abundance of bat species.

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