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Bat (Mammalia: Chiroptera) diversity in an area of mangrove forest in southern Pernambuco, Brazil, with a new species record and notes on ectoparasites (Diptera: Streblidae)

Fábio A.M. Soares[1,7]
Gustavo Graciolli[2]
Carlos E.B.P. Ribeiro[3]
Rafael S. Bandeira[4]
José A.T. Moreno[5]
Stephen F. Ferrari[6]

ABSTRACT

This study reports the occurrence of bat species and their ectoparasites to a mangrove area of the State of Pernambuco. The bats were captured for seven consecutive months in four mangrove areas. Sampling occurred for 12 consecutive hours each night collection where mist-nets were used. Eighty-three bats of 14 species were captured. Of these, only 53 Phyllostomidae family bats found themselves parasited. We identified seven species of flies of the family Streblidae parasitizing bats. The diversity of bats is H' = 2.19 for all areas sampled and the prevalence of streblid ranged from 8.3 to 66,6. The mean intensity ranged from one and five. It is reported for the first time the occurrence of Lophostoma brasiliense *to the mangrove ecosystem, besides two species of streblid to Pernambuco.*

Key-Words: Bats; Batflies; Ectoparasites; Mangrove; Pernambuco.

INTRODUCTION

Mangroves are wetland ecosystems located within the intertidal zone of tropical and subtropical coasts (Macintosh & Ashton, 2002), generally in sheltered estuaries. Mangrove forests vary considerably in their configuration depending on factors such as tidal amplitude, and whereas mangrove habitats may cover a coastal strip of only a few meters in southeastern Brazil, where tidal amplitudes are around one meter,

1. Universidade Federal da Bahia – UFBA, Programa de Pós-Graduação em Ecologia. Rua Barão de Jeremoabo, 147, Ondina, CEP 40170-115, Salvador, BA, Brasil.
2. Universidade Federal do Mato Grosso do Sul – UFMS, Centro de Ciências Biológicas e Saúde – CCBS, Departamento de Biologia. Avenida Costa e Silva, s/nº, Universitário, CEP 79070-900, Campo Grande, MS, Brasil.
3. Faculdade Frassinetti do Recife – FAFIRE. Avenida Conde da Boa Vista, 921, Boa Vista, CEP 50060-002, Recife, PE, Brasil.
4. Universidad Torcuatro Di Tella – UTDT, Av. Figueroa Alcorta 7350, Sáenz Valiente 101, Buenos Aires, Argentina.
5. Empresa de Projetos Biodinâmicos – EMPROBIO. Rua Major Nereu Guerra, 195, Casa Amarela, CEP 52070-300, Recife, PE, Brasil.
6. Universidade Federal de Sergipe – UFS, Laboratório de Biologia da Conservação. Avenida Marechal Rondon, s/nº, Jardim Rosa Elze, CEP 49100-000, São Cristóvão, SE, Brasil.
7. Email of corresponding author: fabiosoares9@gmail.com
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they may extend over kilometers on the macrotidal coast of northern Brazil (Lacerda *et al.,* 2006).

Mangrove ecosystems encompass heterogeneous habitats with an unique variety of animals and plants adapted to the environmental conditions of highly saline, regularly inundated habitats established on soft, anaerobic mud (Macintosh & Ashton, 2002). These systems provide important rest stops and feeding grounds for migratory birds, mammals, and fishes (Saenger *et al.,* 1983), and support the life cycles of many species of considerable economic and ecological importance.

Worldwide, 114 mammal species (belonging to 14 orders) are found in mangroves, representing 7.7% of the 1,470 vertebrate species known to occur in these systems (Fernandes, 2000; Andrade & Fernandes, 2005). However, scant data are available on the diversity of bats in mangroves, and there are few studies for Brazil (Costa *et al.,* 2008). These studies include inventories (Cruz *et al.,* 2007; Andrade *et al.,* 2008; Lourenço *et al.,* 2010b), and some more specific research on diet (Bordignon & França, 2002; Bordignon, 2006a), behavior (Bordignon, 2006b; Almeida *et al.,* 2007), and reproductive patterns (Bordignon & França, 2012). These studies have recorded the occurrence of 37 bat species in Brazilian mangroves (Lourenço *et al.,* 2010a), based on records from the state of Espírito Santo, Maranhão, Pará, Paraná, and Rio de Janeiro. Lourenço *et al.* (2010a) concluded that one of the principal reasons for this paucity of studies was inherent difficulties of conducting systematic studies in flooded habitats, especially those subject to a tidal regime.

The present study provides first data on the occurrence of bats in the mangroves of Brazilian state of Pernambuco. In addition to the inventory of bats, which includes the first record of the insectivorous species, *Lophostoma brasiliense* Peters, 1866, in mangrove, data are presented on the infestation of phyllostomid bats by ectoparasites of the order Diptera.

MATERIALS AND METHODS

The present study was conducted in the municipality of Sirinhaém (08°35'S, 35°06'E), located in the "Forest Zone" of the southern Pernambuco coast, in northeastern Brazil. Annual precipitation is approximately 2,050 mm, with an intense rainy season between March and August and a mean temperature of around 25°C.

The study site was a 3,000 hectare tract of mangrove, which constitutes an environmental protection area, located on the property of the Usina Trapiche S/A sugar mill, a sugarcane plantation. This region is classified as being of extreme biological importance in the Biodiversity Atlas of Pernambuco (Pernambuco, 2002).

Four study sites were established, with two points being sampled within each area, one of which was located in mangrove habitat (approximately 30 m from the border), and the other, in *terra firme* (unflooded) forest. Mist-netting was conducted over 10 nights in the mangrove, and 14 nights in the *terra firme* forest. The latter forests are formed by small fragments of vegetation on dry ground within the mangrove. In general, these areas were more degraded when compared to the mangrove, and some contained exotic fruit trees such as jackfruit (*Artocarpus heterophyllus*), mango (*Mangifera indica*) and jambo (*Eugenia* sp.) as well as cashew trees (*Anacardium occidentale*) and coconut (*Cocos nucifera*).

Fieldwork was conducted between August 2008 and February 2009, on two or three consecutive nights per month. During each capture session, four 12 × 3 m mist-nets were set at 17:00 h, and were left open until 05:00 h the following day. During this period, the nests were inspected at 30-minute intervals. The nets were set at ground level, and those in areas affected by tides were adjusted as the water level shifted.

Capture effort was calculated by multiplying the total area of the set of the mist-nets (length × width × number of nets) by sample time (session duration × number of nights of sampling). This is the standard protocol described by Straube & Bianconi (2002).

Bats captured were identified in the field with the aid of identification keys of Vizotto & Taddei (1973), Dias, D. & Peracchi (2008) and Jones & Hood (1993). Nomenclature followed Simmons (2005). Ecological diversity of the bats was estimated using the Shannon-Wiener index (H'), run in PAST (Hammer *et al.,* 2001).

All individuals were marked with colored plastic collars. Voucher specimens were fixed in 10% formalin and preserved in 70% ethanol, and subsequently deposited in the Zoological Collection of the Faculty Frassinetti at Recife, Pernambuco, Brazil (Appendix 1). All the specimens collected were processed according to the recommendations of the Animal Care and Use Committee (1998).

The ectoparasites were collected using tweezers, through the visual inspection of the fur of the specimens by the naked with the assistance of a hand lens. The ectoparasites collected were stored in containers with 70% alcohol, and the material was deposited in the reference collection of the Federal University of Mato Grosso do Sul in Campo Grande. The approach of Bush *et al.* (1997) was used to estimate the

TABLE 1: Bat species captured in an area of mangrove in the municipality of Sirinhaém, Pernambuco (Brazil). Ins = insectivore; Hem = hematophage; Nec = nectarivore; Fru = frugivore; Car = carnivore, and Psi = pscivore.

Taxon		Guild	Habitat[1]		Relative abundance	Total
			Mangrove	*Terra firme*		
Emballonuridae	*Rhynchonycteris naso* (Wied-Neuwied, 1820)	Ins	1	—	1.2%	1
Phyllostomidae	*Artibeus lituratus* (Olfers, 1818)	Fru	2	2	4.8%	4
	Artibeus planirostris Spix, 1823	Fru	8	10	21.6%	18
	Carollia perspicillata (Linnaeus, 1758)	Fru	8	10	21.6%	18
	Desmodus rotundus (E. Geoffroy, 1810)	Hem	6	3	10.8%	9
	Diphylla ecaudata Spix, 1823	Hem	—	2	2.4%	2
	Glossophaga soricina (Pallas, 1766)	Nec	—	12	14.5%	12
	Lophostoma brasiliense Peters, 1866	Ins	1	3	4.8%	4
	Phyllostomus discolor Wagner, 1843	Fru	4	3	8.4%	7
	Platyrrhinus lineatus (E. Geoffroy, 1810)	Fru	1	2	3.6%	3
	Sturnira lilium Gray, 1842	Fru	—	2	2.4%	2
	Trachops cirrhosus (Gray, 1847)	Car	—	1	1.2%	1
Noctilionidae	*Noctilio leporinus* Linnaeus, 1758	Psi	1	—	1.2%	1
Vespertilionidae	*Lasiurus blossevillii* (Lesson and Garnot, 1826)	Ins	1	—	1.2%	1
Total			**33**	**50**		**83**

[1] M = mangrove; TR = *terra firme.*

prevalence (number of infected hosts/number of hosts examined × 100) and the average intensity (number of parasites/number of parasitized hosts) of parasites.

RESULTS

Bat Diversity

A total of 15 nights of sampling were conducted during the seven months of the study period, with a total capture effort of 28,080 m².h. A total of 83 bats were captured, representing 14 different species from four families (Table 1). All but three of these species were phyllostomids, with the other families – Emballonuridae, Noctilionidae, and Vespertilionidae – each being represented by a single individual of a single species. The four most abundant species included two frugivores, one nectarivore, and one hematophage. Species diversity was H' = 2.19 for the study area as a whole, H' = 1.87 in the mangrove, and H' = 2.14 in the *terra firme* forest.

Frugivores predominated in terms of the number of species (six) and abundance of individuals (53 of the 83 specimens, or 63.9%). The next most diverse guilds was that of the insectivores (three species), but with very few individuals (six).

Nine bats species (33 individuals) were captured in the mangrove samples, including two (*N. leporinus* and *R. naso*) that were exclusive to this habitat. A larger number of individuals (50) were captured in the *terra firme* forest, although the difference was approximately proportionate to that in sampling effort (14 *vs.* 10 nights). Species richness was also proportionately higher (12 species), including five exclusive species, of which *G. soricina* was the most abundant, occurring only in the *terra firme.*

Ectoparasites

Ectoparasites were observed on fourteen of the phyllostomid specimens examined representing seven bat species (Table 2). Individual bats hosted as many as 13 ectoparasites, and eight bats (representing three species) hosted two different species of parasites. A total of 37 parasites were collected, belonging to seven different species, all representing the dipteran family Streblidae.

While no infestation was recorded in some bat species, at least half the specimens of *L. brasiliense* and *P. lituratus* were infested, although it seems likely that this high prevalence was related to the small number of specimens collected rather than any specific factor affecting the vulnerability of any given species to infestation. The most abundant streblid species was *Trichobius joblingi,* which was found on seven different bats belonging to two species, and represented approximately 27% of the ectoparasites collected.

DISCUSSION

The bat species recorded in this study represent just under a fifth of the total number (71) known to

TABLE 2: Ectoparasite species (Streblidae) found on the bat specimens captured in an area of mangrove in the municipality of Sirinhaém, Pernambuco (Brazil).

Bat species	NB	Ectoparasite	NE	PSI (%)	Mean intensity
Artibeus lituratus	1	*Paratrichobius longicrus*	1	25.0	1.0
Carollia perspicillata	5	*Trichobius joblingi*	13	27.7	2.6
		Speiseria ambigua	1	27.7	0.2
Desmodus rotundus	2	*Strebla wiedemanni*	5	22.2	2.5
Glossophaga soricina	1	*Trichobius uniformis*	2	8.3	2.0
		Trichobius costalimai	5	8.3	5.0
Lophostoma brasiliense	2	*Mastoptera minuta*	4	50.0	2.0
Phyllostomus discolor	1	*T. costalimai*	1	14.2	1.0
Platyrrhinus lineatus	2	*P. longicrus*	3	66.6	1.5
		T. joblingi	2	66.6	1.0

occur in Pernambuco (Guerra, 2007; Lira *et al.,* 2009; Silva & Marinho-Filho, 2010). All but one of these species are included in the 37 taxa known to occur in Brazilian mangroves (Lourenço *et al.,* 2010a). The species *L. brasiliense* had not previously been recorded in mangrove habitats.

A similar set of species was recorded in mangroves in Maranhão by Cruz *et al.* (2007) and Dias, P.A.T. *et al.* (2007), although the ecological diversity recorded in the present study was higher than that recorded in Maranhão (*H'* = 1.85) by Cruz *et al.* (2007). While the diversity of the mangrove forest is limited, being composed basically of *Rhizophora mangle,* and offers few resources for bats (Fernandes, 2000), it may sustain a relatively rich bat fauna, especially in marginal areas, where fruit trees are commonly found, as in the present study. Mangrove may thus be a marginal, rather than the principal habitat for most, if not all of the bat species observed in this environment, and in many cases, it may represent a transit area, rather than a foraging site (Hutchings & Saeger, 1987; Lourenço *et al.,* 2010b).

A predominance of phyllostomid bats is typical of coastal areas in Brazil (Fogaça, 2003; Oprea, 2007; Cruz *et al.,* 2007; Dias, P.A.T. *et al.,* 2007; Carvalho *et al.,* 2009), although this is at least partly related to the selectivity of the mist-nets, which favor the capture of bats that fly at low levels in the forest (Straube & Bianconi, 2002). A predominance of frugivores was also observed by Cruz *et al.* (2007), Lourenço *et al.* (2010a, b), and Andrade *et al.* (2008). Insectivorous bats may be more vulnerable to mist-nets set over water (Kunz & Kurta, 1988; Bowles *et al.,* 1990; Lourenço *et al.,* 2010b), although in the present study, these species were captured more frequently in the interior of the mangrove forest, rather than on the borders.

The study also provided new insights into the parasitism of Neotropical bats by streblid flies, although there was no clear pattern of infestation. The seven species recorded here represent 27% of the total ectoparasitic dipteran fauna known to occur in Pernambuco (Guimarães, 1938; Soares *et al.,* 2013), and two of the species – *Trichobius uniformis* and *Strebla wiedemanni* – had not previously been registered in the state.

The intensity of infestation was generally very low, similar to the pattern observed in the southern extreme of Brazil by Rui & Graciolli (2005) and Camilotti *et al.* (2010). *Trichobius joblingi* was the most common species in the present study, as it was at other sites in Pernambuco (Soares *et al.,* 2013) and Brazil (Bertola *et al.,* 2005; Eriksson *et al.,* 2011). While *T. joblingi* was recorded in one other bat species, its overall abundance was related to that of *C. perspicillata,* which was not only by far the most abundant bat in the sample – which is typical of most sites in Brazil (Peracchi *et al.,* 2011) – but also had more than a third of the individuals infested with parasites.

Two of the streblids – *T. uniformis* and *S. wiedemanni* – were recorded in Pernambuco for the first time. However, the host-parasite interaction between these species had been recorded in previous studies (Guerrero & Morales-Malacara, 1996; Komeno & Linhares, 1999).

Brazil has extensive areas of mangroves along its coast, however, there are few researches developed in this ecosystem with regard to chiropterofauna. It is necessary that long-term studies will be developed in these environments, since most of these areas remains totally unknown. In addition, mangroves provide resources for several guilds, as registered in this study, and shelters, including to unusual species in inventories.

Knowledge of chiropterofauna in mangrove area in Brazil can be considered embryonic when compared to other ecosystems (*e.g.,* Atlantic Forest, Amazon and Cerrado), may be lost before even

known, since the coastal areas suffer intensive degradation caused by man. Greater attention should be given to this important coastal ecosystem in order to know ecological aspects of the species that live there. Furthermore, we report the first record of the species *L. brasiliense* to the mangrove, beyond the first list of bats ectoparasites captured in this ecosystem.

RESUMO

O presente artigo reporta a ocorrência de espécies de morcegos e seus ectoparasitos associados em uma área de manguezal do Estado de Pernambuco. Os morcegos foram capturados por sete meses consecutivos em quatro áreas. As capturas ocorreram por 12 horas em cada noite com auxílio de redes de neblinas. Foram capturados 83 espécimes de morcegos de 14 espécies. Destes, 53 indivíduos da família Phyllostomidae estavam parasitados. Nós identificamos sete espécies de moscas da família Streblidae parasitando morcegos. A diversidade de morcegos foi H' = 2.19 para todas as áreas amostradas e a prevalência de estrebídeos variou de 8.3 a 66.6. A intensidade média variou de um a cinco ectoparasitos. É reportada pela primeira vez a ocorrência de Lophostoma brasiliense *para o ecossistema manguezal, além de duas espécies de estrebídeos para Pernambuco.*

Palavras-Chave: Ectoparasitos; Manguezal; Morcegos; Moscas ectoparasitas; Pernambuco.

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APPENDIX 1

Voucher specimens deposited in the zoological collection of the Frassinetti Faculty in Recife, Pernambuco, Brazil (code: CCVM). *Desmodus rotundus* CCVM 11,12 ♀; *Noctilio leporinus* 13 ♂; *Rhynchonycteris naso* 14 ♂; *Diphylla ecaudata* 15 ♀, 16 ♂; *Glossophaga soricina* 17 ♂; *Lophostoma brasiliense* 18 ♂, 19 ♀; *Platyrrhinus lineatus* 20 ♂; *Artibeus planirostris* 21 ♂; *Phyllostomus discolor* 22 ♂, 23 ♀; *Artibeus lituratus* 24 ♂.

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