

Species list of bats (Mammalia, Chiroptera) of Santarém area, Pará State, Brazil

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ABSTRACT. Despite its enormous area, diversity of habitat, and bat species, studies in the Brazilian Amazon represent just a small portion of the bat research in the South America. Consequently, the distribution of the major part of the bat species in the Brazilian Amazon remains incompletely documented. Conservation strategies involving bat species in the Brazilian Amazon may be difficult without more information about geographic distribution, status, roost, food preferences, and reproduction of the species. Here is presented an updated list of species of bats of Alter do Chão, and complete this list with data from the nearby Amazon National Park, providing a list of bats in the Santarém area. This list includes at least 55 species of bats, representing 34 genera, and 7 families. The higher taxonomic composition of bat fauna of Santarém area is similar to other areas sampled in the Brazilian Amazon, with a high proportion of frugivores, but the number of aerial insectivores is lower, probably due the use of mist nets as the principal sampling method.

KEY-WORDS. Chiroptera, species list, Amazon forest, bats, biodiversity, Tapajós river, Santarém, Brazil

The mammal fauna of the Neotropics is probably the most species-rich in the world (JANSON & EMMONS 1990; TIMM 1994; HUTTERER *et al.* 1995; VOSS & EMMONS 1996; EMMONS 1997), and bats are a large component of this species richness (*e.g.* HANDLEY 1966; FLEMING *et al.* 1972; HANDLEY 1976; MOK *et al.* 1982; BROSSET & CHARLES-DOMINIQUE 1990; SIMMONS & VOSS 1998). Although bats are being studied throughout the Neotropics, the most studied sites are in the Central America (VOSS & EMMONS 1996; but see BROSSET & CHARLES-DOMINIQUE 1990; SIMMONS & VOSS 1998).

In South America, the Amazon forest is the dominant biome (AB'SABER 1977), and more than 60% of its area is within Brazil's territory. Despite this enormous area (approx. 3,9 millions of km²), its diversity of habitats, and bat species, studies in the Brazilian Amazon represent a small portion of the bat research in the continent (*e.g.* HANDLEY 1967; PICCININI 1974; TADDEI & REIS 1980; MOK *et al.* 1982; REIS 1984; UIEDA & VASCONCELLOS-NETO 1985; MARQUES 1986; REIS & PERACCHI 1987; GRIBEL & TADDEI 1989; BERNARD 2001). Consequently, the distribution of bats in the Brazilian Amazon remains incompletely documented (reviewed in KOOPMAN 1993; MARINHO-FILHO & SAZIMA 1998). Conservation strategies involving bat species in the Brazilian Amazon may be difficult without more information about geographic distribution, status, roost, food preferences, and reproduction of the species.

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As a step toward filling gaps in species distribution in the Brazilian Amazon, here is presented an updated list of species of bats of Alter do Chão, and complete this list with data from the nearby Amazon National Park, providing a list of bats in the Santarém area.

MATERIAL AND METHODS

Area of Study and Methodology

This paper presents data collected at two localities, Alter do Chão, and the Amazon National Park (PNA), both near Santarém, Pará State, Brazil (Fig. 1). Santarém (2°24'52"S, 54°42'36"W) is at the right bank of the Tapajós river, 35 meters above the sea level, at the confluence with the Amazon River. The average annual temperature is between 24 and 27°C, and the rainfall is about 2000 mm (MIRANDA 1993). During the dry season, from July to November, the area receive 25% of the annual rainfall. Different types of vegetation are present in the area, but the predominant are tropical forest and Amazonian savannas (PIRES & PRANCE 1985; SANAIOTTI & MAGNUSSON 1995).

Alter do Chão is about 30 km south of Santarém, in a relatively dry area dominated by Amazonian savannas. The savanna vegetation in this region is dominated by grasses, with sparse clumps of shrubs, composed mainly of species from the Myrtaceae and Melastomataceae families (MIRANDA 1993). Small patches of forest, ranging from 0.2 to 125 ha, also occur within the savannas. Amazonian savannas, as cerrado in central Brazil, have limited distributions and may shelter endemic species of birds (CAVALCANTI 1988), and the area around Alter do Chão has been suggested for designation as a faunal sanctuary (RYLANDS & PINTO 1998).

The PNA is on the left bank of the Tapajós river, about 250 km southwest of Santarém, and cover an area of 993.500 ha (REIS & SCHUBART 1979; GEORGE *et al.* 1988). The Park is accessible from the Transamazon Highway, and is 54 km south of Itaituba, the nearest city. The main vegetation is tropical non-flooded forest, with high canopy (15-30 meters), but spots of small forest and flooded forest also occur along the river banks. The fauna of the PNA is relatively known, including at least 101 species of mammals (GEORGE *et al.* 1988), seven considered as endangered in Brazil. Data about bats in the PNA followed a preliminary check-list (REIS & SCHUBART 1979), and a complementary list (MARQUES 1985). In both studies, sampling methods included the use of mist nets and searches for roosts.

In Alter do Chão, between April and May 1988, it was sampled in 25 forest fragments (from 0.75 to 125 ha), and four forest sites, using 8-12 mist nets set at ground level. All nets were 12 x 2.5 m, with four shelves. Mist nets were opened at 18:00 and closed at 24:00, and checked at intervals of 20 to 40 minutes. Captured animals were placed in cloth bags, identified and weighed. The identification of all species captured was based on a identification key for Amazonian bats (C.O. Handley pers. comm.). Voucher specimens of some species, and all those bats that died during the capture/measuring process, were fixed in 10% formalin solution, and are deposited in the Mammals Collections Sector of the Brazilian National Institute for Research in the Amazon (INPA 2593 to 2610 and 2660 to 2667).



Fig. 1. Map of the study locations, near Santarém, Pará State, Brazil. (Alter) Alter do Chão, (PNA) Amazon National Park.

RESULTS

In Alter do Chão, 29 nights of sampling amounted to a total effort of 2019 mistnet-hours (mnh), 1737 mnh in forest fragments and 282 mnh in non-fragmented forest areas. 622 bats, belonging to 41 species, 23 genera, and four families were captured (Tab. I). Phyllostomidae was the most abundant family, both in number of species (34) and individuals (593). The family Emballonuridae was represented by five species and 27 captures, the Mormoopidae and Thyropteridae each by one species and one capture.

Among the Phyllostomidae, the sub-family Phyllostominae was the species richest (17 species), followed by Stenodermatinae (10), Carollinae (4), Glossophaginae (2) and Lonchophyllinae (1). In numbers of captures, Stenodermatinae (248 captures) and the Carollinae (215) were more abundant than Phyllostominae (115 captures).

One very abundant species, *Carollia perspicillata* (Linnaeus, 1758), accounted for almost 28% of the captures (174/622), and three common species, *Artibeus jamaicensis* Leach, 1821, *A. cinereus* (Gervais, 1856), and *A. obscurus* (Schinz, 1821), respectively 13.2, 12.3, and 8.5% of the captures. Ten species were represented by just one capture (Tab. I).

Species accumulation curve of bats in Alter do Chão (Fig. 2) reveals 13 species for the first two nights of sample (effort of 144 mnh), 30 species for 10 nights (684 mnh), 37 species for 20 nights (1401 mnh), and finally, 41 species at the end of 29 nights (2019 mnh). The last species registered (*Phyllostomus discolor* Wagner, 1843) was captured in the 25th night.

In the PNA, REIS & SCHUBART (1979) reported 17 species of bats (Tab. I) after an effort of 279 mnh of captures and 3 hours of roost searching. Later, MARQUES (1985) reported 31 species with an effort of 408 mnh, elevating to 36 the number of bat species reported in the Park (Tab. I).

Table I. Species of bats captured in Alter do Chão and Amazon National Park, near Santarém, Pará State, Brazil. Species were grouped into six guilds (see text). (AI) Aerial insectivores, (FR) frugivores, (SA) sanguivores, (NE) nectarivores, (GA) gleaning animalivores, (OM) omnivores.

Species	GUILD	REIS & SCHUBART (1979)	MARQUES (1985)	Present study
Emballonuridae				
<i>Cormura brevirostris</i> (Wagner, 1843)	AI			2
<i>Peropteryx leucoptera</i> Peters, 1867	AI			19
<i>Rhynchonycteris naso</i> (Wied, 1820)	AI	6	3	4
<i>Saccopteryx bilineata</i> (Temminck, 1838)	AI			1
<i>Saccopteryx canescens</i> Thomas, 1901	AI			1
<i>Saccopteryx leptura</i> Thomas, 1901	AI	1		
Thyropteridae				
<i>Thyroptera tricolor</i> Spix, 1823	AI	6		1
Mormoopidae				
<i>Pteronotus parnellii</i> (Gray, 1843)	AI	3	6	1
<i>Pteronotus personatus</i> (Wagner, 1843)	AI		2	
Noctilionidae				
<i>Noctilio albiventris</i> Desmarest, 1818	AI	34	11	
Phyllostomidae				
<i>Carollia brevicauda</i> (Schinz, 1821)	FR	40		4
<i>Carollia perspicillata</i> (Linnaeus, 1758)	FR		169	174
<i>Rhinophylla fischeræ</i> Carter, 1966	FR	1	1	26
<i>Rhinophylla pumilio</i> Peters, 1865	FR		1	11
Desmodontinae				
<i>Desmodus rotundus</i> (E. Geoffroy, 1810)	SA	2	5	
Glossophaginae				
<i>Choeroniscus minor</i> (Peters, 1868)	NE	5		6
<i>Glossophaga soricina</i> (Pallas, 1766)	NE	4	28	5
<i>Lichonycteris obscura</i> Thomas, 1895	NE		1	
Lonchophyllinae				
<i>Lonchophylla thomasi</i> J. A. Allen, 1904	NE		2	4
Phyllostominae				
Carollinae				
<i>Chrotopterus auritus</i> (Peters, 1856)	GA			6
<i>Lamproncycteris brachyotis</i> (Dobson, 1879)	OM			6
<i>Lonchorhina aurita</i> Tomes, 1863	GA		2	
<i>Macrophyllum macrophyllum</i> (Schinz, 1821)	GA	1	2	
<i>Microncycteris megalotis</i> (Gray, 1842)	GA			2
<i>Microncycteris minuta</i> (Gervais, 1856)	GA			1
<i>Microncycteris schmidtorum</i> Sanborn, 1935	GA			1
<i>Microncycteris</i> sp.	GA			1
<i>Mimon crenulatum</i> (E. Geoffroy, 1810)	GA	1		8
<i>Phylloiderma stenops</i> Peters, 1865	OM		1	
<i>Phyllostomus discolor</i> Wagner, 1843	OM			1
<i>Phyllostomus elongatus</i> (E. Geoffroy, 1810)	GA		7	19
<i>Phyllostomus hastatus</i> (Pallas, 1767)	OM		37	4
<i>Tonatia brasiliense</i> (Peters, 1867)	GA			2
<i>Tonatia carrikeri</i> (J. A. Allen, 1910)	GA			3
<i>Tonatia saurophila</i> Koopman & Williams, 1951	GA			17
<i>Tonatia silvicola</i> (d'Orbigny, 1836)	GA			28
<i>Trachops cirrhosus</i> (Spix, 1823)	GA		11	11
<i>Trinycteris nicefori</i> (Sanborn, 1949)	GA			4
<i>Vampyrum spectrum</i> (Linnaeus, 1758)	GA			1
Stenodermatinae				
<i>Ametrida centurio</i> Gray, 1847	FR	7	2	1
<i>Artibeus cinereus</i> (Gervais, 1856)	FR			77
<i>Artibeus concolor</i> Peters, 1865	FR	3	4	13
<i>Artibeus jamaicensis</i> Leach, 1821	FR		13	82
<i>Artibeus lituratus</i> (Olfers, 1818)	FR	7	9	10
<i>Artibeus obscurus</i> (Schinz, 1821)	FR			53
<i>Chiroderma villosum</i> Peters, 1860	FR		3	

Continue

Table I. Continued.

Species	GUILD	REIS & SCHUBART (1979)	MARQUES (1985)	Present study
<i>Platyrrhinus helleri</i> (Peters, 1866)	FR		1	3
<i>Sturnira lilium</i> (E. Geoffroy, 1810)	FR	10	16	
<i>Sturnira tildae</i> de la Torre, 1959	FR		4	
<i>Uroderma bilobatum</i> Peters, 1866	FR		30	2
<i>Uroderma magnirostrum</i> Davis, 1968	FR	2	4	2
<i>Vampyressa bidens</i> (Dobson, 1878)	FR		1	5
Molossidae				
<i>Molossus ater</i> E. Geoffroy, 1805	AI		1	
<i>Nyctinomops laticaudatus</i> (E. Geoffroy, 1805)	AI		1	
Vespertilionidae				
<i>Myotis nigricans</i> (Schinz, 1821)	AI		2	
Total	55	6	133	622

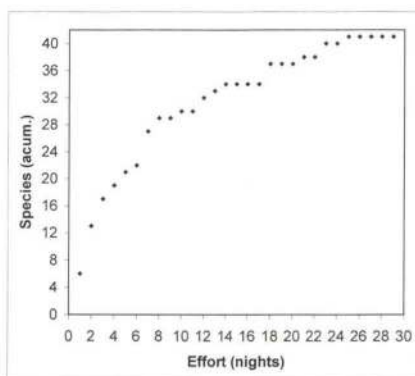


Fig. 2. Species accumulation curve of bats at Alter do Chão, Santarém, Pará State, Brazil (not included data from PNA). After 29 nights of effort using mist-nets, 41 species of bats were captured.

DISCUSSION

Once the sites sampled are close located, the species registered in the PNA and in Alter do Chão may be grouped in a first list of bats for the Santarém area. This list includes at least 55 species of bats, representing 34 genera, and seven families (Tab. I). The higher taxonomic composition of bat fauna of Santarém area is similar to other areas sampled in the Brazilian Amazon (HANDLEY 1967; REIS 1984; BERNARD 2001). Seven of the nine families present in the Amazon Basin are included: Emballonuridae, Phyllostomidae, Molossidae, Mormoopidae, Thyropteridae and Vespertilionidae. The other two families, Furipteridae and Natalidae, can be rare, and they may yet be recorded in Santarém.

Following the dietary habits presented in the literature (FLEMING *et al.* 1972; GARDNER 1977; BONACCORSO 1979; HUMPHREY *et al.* 1983; KALKO *et al.* 1996; BERNARD 2001), the species present in the Santarém list can be broadly classified as: (1) aerial insectivores (all non-phylllostomids); (2) frugivores (carollines and stenodermatines); (3) gleaning animalivores (all phyllostomines, except *Lam-*

pronycteris brachyotis (Dobson, 1879), *Phylloderma stenops* Peters, 1865, *Phyllostomus discolor*, *P. hastatus* (Pallas, 1767); (4) nectarivores (glossophagines and lonchophyllines); (5) omnivores (*M. brachyotis*, *P. stenops*, *P. discolor*, *P. hastatus*); and (6) sanguinivores (*D. rotundus* (E. Geoffroy, 1810). Frugivores are the most speciose feeding guild in Santarém (17 species), followed by gleaning animalivores (16 species), aerial insectivores (13 species), omnivores (four species), nectarivores (four species), and sanguinivores (one species).

The dominance of frugivorous bats in terms of number of individuals, with *Carollia perspicillata* the most abundant species, followed a similar pattern observed in other sites in the Amazon Basin (e.g. HANDLEY 1967; REIS 1984; BROSSET & CHARLES-DOMINIQUE 1990; BERNARD 2001; SIMMONS & VOSS 1998). Also, the high proportion of frugivores in relation to the total number of species is consistent with other short term studies using mist nets in the Amazon (see SIMMONS & VOSS 1998), but the number of aerial insectivores is lower. However, the sites that presented the higher proportion of aerial insectivores were those with long term surveys, or complementary collecting techniques such as elevated mistnetting, regular roost searching, or others. Thus, species of the families Emballonuridae, Vespertilionidae, and Molossididae may be more abundant at Santarém, but were underestimated by the ground-level mistnetting. The proportion of nectarivores, and species considered as omnivores is similar to other studies in the Amazon, as well as the number of sanguivores.

Gleaning animalivore species were more diverse (29% of the species registered) than other sites in the Amazon, where this proportion was 16-28% (SIMMONS & VOSS 1998). Two genera, *Micronycteris* and *Tonatia*, strongly contributed to the high proportion of gleaning animalivores in Santarém, accounting for 9 of the 16 species registered. Curiously, most of those species were captured exclusively at the forest fragments sampled in Alter do Chão, and an analysis of the bat species composition there (not included the species of the PNA) and Manaus and Belém indicated that both the relative abundance and the presence/absence of species in Alter is different from the other two localities, and the species captured at the forest fragments may be the most important factor contributing to this difference (BERNARD *et al.* in press).

The Santarém area is included in the geographical distribution of other species (KOOPMAN 1993), and the cumulative species curve for Alter do Chão do not show evidence that the bat fauna was totally inventoried. Following the Chao's estimator of the species richness (CHAO 1984), represented by the equation:

$$S^* = Sobs + (a^2/2b)$$

where S^* is the expected number of species, $Sobs$ is the observed number of species, a is the number of species observed exactly once (singletons), and b the number of species observed exactly twice (doubletons), the number of expected species of bats for Santarém is 67. This number may be a little underestimate because it is based on the number of species observed, and the low incidence of aerial insectivores in Santarém, as discussed before, was abnormal, and may reflect a sample bias. In fact,

other species that were not captured, such as *Noctilio albiventris* Desmarest, 1818, can be easily observed flying near water bodies, and molossids may be seen starting their activity at the sunset. Also, one species of *Diclidurus*, probably *D. albus* Wied-Newwied, 1820, was observed entangled in one net, but escaped before captured.

Other techniques such as the monitoring of echolocation signals (FENTON 1988; KALKO 1995), elevated mistnets (HANDLEY 1967; BERNARD 2001) and searching for roosts (SIMMONS & VOSS 1998), will provide new species for the Santarém area list. In Panamá, some species were never captured with mistnets but are considered as common species based on echolocation recording (KALKO *et al.* 1996). In primary forests near Manaus, almost 30% of the species (15 in 51) were captured only in elevated nets (BERNARD 2001). And in French Guiana, 5 of the 78 species found were exclusively captured at roost and never by other method (SIMMONS & VOSS 1998). So, future studies involving other methodologies are important and necessary in the way to better understand the species composition and distribution of bats in the Brazilian Amazon.

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