Bat assemblage in savanna remnants of Sonora, central-western Brazil

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Abstract: The Cerrado (savanna) is a wide Neotropical formation, but the knowledge on the occurrence and distribution of bat species for this phytogeographic region is scarce, especially in the western portion. Here we address what are the bat species and their relative abundances in a western Cerrado site, municipality of Sonora, Mato Grosso do Sul, Brazil. Bats were mist-netted in eight non consecutive months over the course of two years. Sampled bats (n = 507) belonged to 18 species. The estimator Jackknife 1 estimated 22 species, and diversity (H') was 1.6. Richness and diversity of bats in Sonora were slightly higher than in the southern Cerrado, and similar to or lower than in the central Cerrado. Frugivorous species predominated, as expected, however richness and abundance of nectarivorous were unexpectedly high. *Carollia perspicillata* was the dominant species. The endemic bat *Lonchophylla dekeyseri* was highly abundant in Sonora, which enhances the importance of conserving the savanna remnants in this region.
Keywords: *Cerrado, Chiroptera, diversity of species, Lonchophylla dekeyseri, Mato Grosso do Sul, Tonatia bidens.*

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Resumo: O Cerrado (savana) é uma ampla formação neotropical, porém o conhecimento sobre a ocorrência e distribuição de espécies de morcegos é escasso para esta região fitogeográfica, principalmente na porção oeste. Estudamos aqui quais são as espécies de morcegos e suas abundâncias relativas em uma localidade da porção oeste do Cerrado, no município de Sonora, Mato Grosso do Sul, Brasil. Morcegos foram capturados em redes-de-neblina em oito meses não consecutivos ao longo de dois anos. Os morcegos amostrados (n = 507) pertenceram a 18 espécies. O estimador Jackknife 1 estimou 22 espécies, e a diversidade (H') foi 1,6. A riqueza e a diversidade de morcegos em Sonora foram pouco maiores que na porção sul do Cerrado, e semelhantes ou menores que no Cerrado central. Espécies frugívoras predominaram, como esperado, porém a riqueza e abundância de nectarívoras foram inesperadamente altas. *Carollia perspicillata* foi a espécie dominante. O morcego endêmico *Lonchophylla dekeyseri* foi muito abundante em Sonora, fato que aumenta a importância de conservar os remanescentes de savana dessa região.
Palavras-chave: *Cerrado, Chiroptera, diversidade de espécies, Lonchophylla dekeyseri, Mato Grosso do Sul, Tonatia bidens.*

Introduction

Brazil is the second richest country in bat species, roosting approximately 15% of the known species of bats in the world (Bernard et al. 2010). The Brazilian savanna (Cerrado) is among the widest phytogeographic formations in the Neotropics, covering approximately 2 million km² (Scariot et al. 2005). Nonetheless, the knowledge about bat species occurrence and distribution is still incipient in the Cerrado (Gregorin & Ditchfield 2005, Zortéa & Alho 2008, Santos et al. 2010), especially in the western portion which includes the states of Mato Grosso do Sul and Mato Grosso (Bernard et al. 2010). In spite of bats have been increasingly surveyed in Mato Grosso do Sul (e.g. Camargo & Fischer 2004, Bordignon 2006, Longo et al. 2007, Camargo et al. 2009, Cunha et al. 2009, Ferreira et al. 2010, Alho et al. 2011), there is a large gap of data in the northern Cerrado of this state (Bernard et al. 2010). This region urges for biological inventories and conservation initiatives, because natural areas have been rapidly transformed into cattle ranches, monocultures, hydroelectric dams, and sucroalcohol facilities (Bernard et al. 2010); (pers. obs.). Here, we asked what are the bat species and their relative abundances in savanna remnants in the municipality of Sonora, a northern region of Cerrado in Mato do Grosso do Sul.

Methods

The study was carried out in savanna remnants (17° 32' 19.80" S and 54° 26' 2.91" W) inserted in a matrix of pastures and plantations of soybean, sorghum and sugar cane, close to the Correntes river, municipality of Sonora, Mato Grosso do Sul, Brazil. Segments of rock cliffs from karstic formation occur along the riverbanks. The climate is Aw of Koppen, the mean annual temperature and rainfall are approximately 22 ºC and 1500 mm, respectively (Instituto... 1992). The savanna remnants consist of "cerradão" (dense forests with shaded understory), "cerrado *stricto sensu*" (marked presence of shrubs and trees interspaced with open fields), "vereda" (marshlands with *Mauritia flexuosa* palm trees), and riparian forests (Instituto... 1992).

Bats were mist-netted in May (three nights), June (four nights), September (four nights), and November (four nights) of 2008, and February (two nights), June (four nights), August (four nights), and November (four nights) of 2010. In each sampling night, four to six mist-nets of 12 × 3 m and two of 9 × 3 m were set at ground level, opened at dusk and closed after 4-9 hours, depending on rainfall. Total sampling effort was 42,282 h.m² (cf. Straube & Bianconi 2002); and month efforts were 7,182 h.m² in May, 7,074 h.m² in June, 7,371 h.m² in September and 7,056 h.m² in November of 2008; 2,160 h.m² in February, 4,788 h.m² in May, 5,796 h.m² in August, and 3,420 h.m² in November of 2010.

Identifications of bat species were based on literature (Vizotto & Taddei 1973, Taddei et al. 1983, Taddei 1996, Gregorin & Taddei 2002); nomenclature follows Simmons (2005), except *Artibeus planirostris* (Larsen et al. 2007). To help identifications, bats' forearm length and mass were measured with caliper (±1 mm) and dynamometer (±1 g), respectively. They were marked with nontoxic ink for identifying recaptures in a same night, and then released in the site of capture. Twenty two specimens were collected and deposited as voucher in the zoological collection of the Universidade Federal de Mato Grosso do Sul (ZUFMS-M): *Anoura caudifer* (E. Geoffroy 1818) – 292 e 293, *Anoura geoffroyi* Gray 1838 - 246, *Artibeus cinereus* (Gervais 1856) - 389, *Carollia perspicillata* (Linnaeus 1758) – 242; *Glossophaga soricina* (Pallas 1766) - 247; *Lonchophylla dekeyseri* Taddei, Vizotto & Sazima 1983 – 280, 522 e 523; *Molossops temminckii* (Burmeister 1854) – 294 e 390; *Natalus stramineus* Gray 1838 - 295; *Phyllostomus discolor* (Wagner 1843) – 235, 236 e 467, *Platyrrhinus helleri* (Peters 1866) - 241, *P. lineatus* (E. Geoffroy 1810) – 239 e 240, *Pteronotus parnellii* (Gray 1843) - 233, *Tonatia bidens* (Spix 1823) - 237, *Trachops cirrhosus* (Spix, 1823) - 524.

We evaluated sufficiency of sampling using rarefaction curves based on the cumulative quantity of captured individuals, and estimated total expected richness with Jackknife 1 estimator (1000 randomizations) based on sampling nights. Shannon's diversity index (H'), using neperian logarithm and the 95% CI (bootstrap, 1000 randomizations), were calculated for the bat assemblage. Analyses were done in the Vegan package (Oksanen et al. 2010), R program (R Development Core Team 2010).

Results

We captured 507 individuals belonging to four families, 14 genera and 18 species (Table 1). The rarefaction curve (Figure 1) showed that capture effort was sufficient to include most of the species at the study site. The Jackknife 1 estimated 22 ± 1.9 (mean ± SD) species of bats, thus our observed richness (n = 18) included approximately 82% of the bat species which could be captured in mist-nets. The diversity (H') was 1.6, with 95% CI between 1.4 and 1.7. Phyllostomidae was the richest and commonest family (15 species, 97% of the captures); other families presented one species only. Frugivorous species were more common (n = 6) than nectarivorous (n = 4), insectivorous (n = 4), carnivorous (n = 2), omnivorous (n = 1), and hematophagous (n = 1) (Table 1). *Carollia perspicillata* was the dominant species; its relative abundance was one order of magnitude higher than that of the other common bat species – *L. dekeyseri* (Figure 2a), *G. soricina*, *P. lineatus*, *D. rotundus,* and *A. planirostris*. Thirteen additional species were relatively rare as they accounted for less than 10 individuals captured; only one individual of *A. cinereus* (Figure 2b), *C. auritus*, and *N. stramineus* was captured.

Discussion

The richness of bat species (n = 18) in savanna remnants in Sonora is slightly higher than that found in sites of southern Cerrado (10 and 13 species; respectively Cunha et al. 2009, Camargo et al. 2009), but it is similar to or less than richness (16-28 species) found in

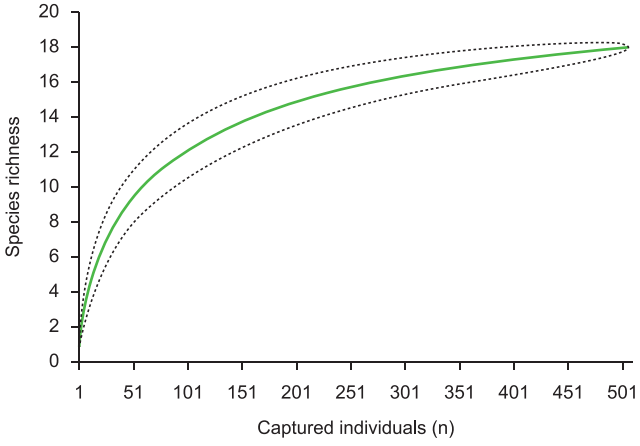

Figure 1. Rarefaction curve of bat species on cumulative number of captured individuals in Sonora, Mato Grosso do Sul (dotted line = 95% confidence interval).

Figura 1. Curva de rarefação de espécies de morcegos em relação ao número cumulativo de indivíduos capturados em Sonora, Mato Grosso do Sul (linha pontilhada = intervalo de confiança de 95%).

Table 1. Number of captured individuals of 18 species of bats in Sonora, Mato Grosso do Sul.

Tabela 1. Número de indivíduos capturados de 18 espécies de morcegos em Sonora, Mato Grosso do Sul.

Families/Species	Guild[a]	Females						Males				Σ
		Y	A	P	L	PoL	Σ	Y	AT	ET	Σ	
Phyllostomidae												
Carollia perspicillata	Frug	12	82	31	48	-	173	5	38	90	133	306
Lonchophylla dekeyseri	Nect	4	11	3	3	1	22	1	2	16	19	41
Glossophaga soricina	Nect	3	8	1	4	1	17	-	2	13	15	32
Platyrrhinus lineatus	Frug	1	12	2	3	-	18	1	10	3	14	32
Desmodus rotundus	Hema	1	8	10	2	-	21	1	3	6	10	31
Artibeus planirostris	Frug	-	1	8	4	-	13	-	3	4	7	20
Tonatia bidens	Insec	-	1	-	2	-	3	-	2	2	4	7
Phyllostomus discolor	Omni	-	1	-	1[b]	-	2	-	1	2	3	5
Anoura caudifer	Nect	1	-	-	-	-	1	-	-	3	3	4
Artibeus lituratus	Frug	-	-	1	-	-	1	-	-	3	3	4
Platyrrhinus helleri	Frug	-	-	-	-	-	-	-	3	1	4	4
Anoura geoffroyi	Nect	-	-	-	-	-	-	-	1	1	2	2
Trachops cirrhosus	Carn	-	-	-	1	-	1	-	1	-	1	2
Artibeus cinereus	Frug	-	-	-	1	-	1	-	-	-	-	1
Chrotopterus auritus	Carn	-	-	-	-	-	-	-	-	1	1	1
Molossidae		-	-	-	-	-	-	-	-	-	-	-
Molossops temminckii	Insec	-	-	3	1	-	4	-	1	3	4	8
Mormoopidae		-	-	-	-	-	-	-	-	-	-	-
Pteronotus parnellii	Insec	-	1	1	-	-	2	-	3	1	4	6
Natalidae		-	-	-	-	-	-	-	-	-	-	-
Natalus stramineus	Insec	-	-	-	1	-	1	-	-	-	-	1

[a]Frug: Frugivorous, Nect: Nectarivorous, Hema: Hematophagous, Insec: Insectivorous, Omni: Omnivorous, Carn: Carnivorous. [b]It was additionally pregnant.

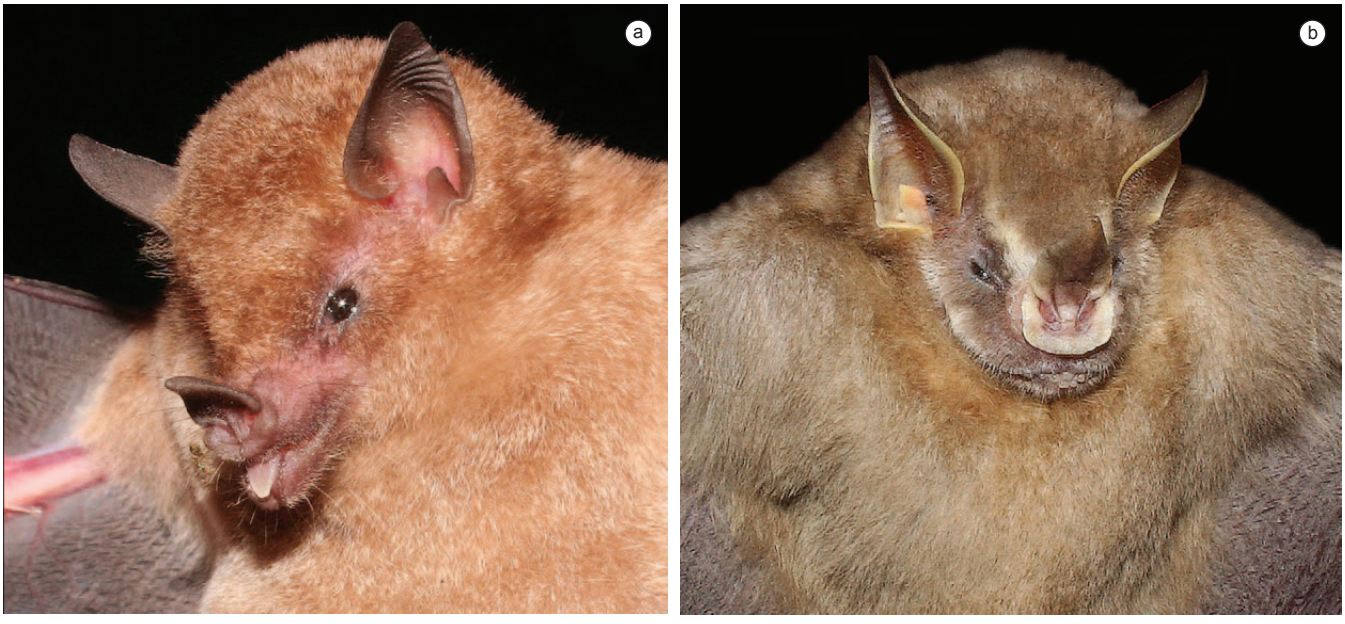

Figure 2. a) *Lonchophylla dekeyseri* and b) *Artibeus cinereus* recorded in Sonora, Mato Grosso do Sul (photos: N. L. Cunha).

Figure 2. a) *Lonchophylla dekeyseri* e b) *Artibeus cinereus* registrados em Sonora, Mato Grosso do Sul (fotos: N. L. Cunha).

central region of Cerrado (Marinho-Filho et al. 1998, Rodrigues et al. 2002, Bordignon 2006, Zortéa & Alho 2008, Zortéa et al. 2010). Likewise, diversity of bat species in Sonora (H = 1.6) is comparable to that in southern Cerrado sites (H' = 1.5-1.8) (Camargo et al. 2009, Cunha et al. 2009, Ferreira et al. 2010) but lower than in central Cerrado (H' = 2.2) (Zortéa & Alho 2008). Therefore, available data roughly indicate that richness and diversity of bats increase toward northern (or central region; based on Zortéa & Alho 2008) of Cerrado, a possibility that deserves studies. Overall, the increasing of diversity with decreasing of latitude is expected (Stevens 2004, Willig & Bloch 2006).

The predominance of fruit-eating bats at the study site is comparable to other regions of Cerrado, however, the richness and relative abundance of nectar-feeding bats is apparently high in Sonora (Gonçalves & Gregorin 2004, Bordignon 2006, Camargo et al. 2009, Cunha et al. 2009, Zortéa & Alho 2008). This result can partially be due to the high availability of chiropterophilous flowers (*Bauhinia ungulata*, *Calliandra* sp., *Caryocar brasiliense*, *Hymenaea stigonocarpa,* and *Lafoensia* sp.) and of roosts in rock cavities at the Correntes riverbanks (per. obs.). The four nectarivore species registered in Sonora are common users of caves as day roosts, which seems to be especially important for *L. dekeyseri* and *A. geoffroyi* (Baumgarten & Vieira 1994, Coelho & Marinho-Filho 2002, Esbérard et al. 2005). Insectivorous bats in Sonora are represented by few species when compared to sites in southern Cerrado or in savannas in Bolivia and Paraguay, where insectivorous bats predominate (Cunha et al. 2009, Aguirre 2002, Willig et al. 2000, Alho et al. 2011, Zortéa & Alho 2008). Only one Phyllostominae insectivorous species occurred in Sonora, *T. bidens*. However, additional insectivorous species of this subfamily would be expected, based on the occurrences reported for southern Cerrado and Pantanal (Cunha et al. 2009, Alho et al. 2011). On the other hand, the proportion of captured individuals of *T. bidens* at the study site (n = 7/507) was markedly higher than that recorded in sites in southern Cerrado and Pantanal (n = 5/9037) (Alho et al. 2011).

Carollia perspicillata has commonly been recorded as the dominant species in different vegetation formations, regenerating areas, rocky outcrops and caves (Bredt et al. 1999, Esbérard et al. 2005, Bordignon 2006, Bernard & Fenton 2007, Castro-Arellano et al. 2007). However, *C. perspicillata* is generally less abundant than *A. planirostris*, *P. lineatus* and *S. lillium* in the southern Cerrado (Camargo et al. 2009, Cunha et al. 2009, Alho et al. 2011). The relative abundance of this species in local assemblages, therefore, appears to increase towards the north or the center of Cerrado (Zortéa et al. 2010, Zortéa & Alho 2008, Bernard & Fenton 2007, this study). The opposite occurs for *A. planirostris*, a relatively less common species in Sonora and other sites in central and northern Cerrado than in the southern Cerrado and Pantanal (Pulchério-Leite et al. 1999, Bordignon 2006, Camargo et al. 2009, Cunha et al. 2009, Teixeira et al. 2009, Zortéa et al. 2010, Alho et al. 2011).

Lonchophylla dekeyseri is unusually abundant at the study site. It is endemic of Cerrado and globally classified as "near threatened" (International... 2010), which highlights the importance of conserving the savanna remnants in Sonora. Only six populations of this species are known, all associated with karstic regions (Aguiar et al. 2010). The high abundance of *L. dekeyseri* indicates that Sonora is close to the core region of population "B" (cf. Aguiar et al. 2010) and expands the distribution of this population to the west. *Lonchophylla dekeyseri* and *A. cinereus* were only found in northern Cerrado of Mato Grosso do Sul (Coelho 2005, this study), and were not included in bat species compilation for the state (Cáceres et al. 2008). *Trachops cirrhosus* was also recently recorded for the first time in Mato Grosso do Sul (Alho et al. 2011); our record in Sonora is the second for this state. Considering *L. dekeyseri*, *A. cinereus*, *T. cirrhosus* and two other recently reported species (Santos et al. 2010, Silveira et al. 2011), the updated known fauna of bats in Mato Grosso do Sul reaches 70 species.

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