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Bat diversity in the western Brazilian Pantanal

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Abstract: Located in southwestern Brazil, the Pantanal is a Wetland of International Importance and Biosphere reserve. It is composed of several subregions, each with distinct vegetation, and hosts diverse bat fauna. The goal of this study was to compare the bat communities between different subregions of the Pantanal, especially poorly sampled areas. From February 2008 to November 2009, we surveyed bats using mist nets at five sites with different vegetation structure and hydrology, over an area of 30,000 km^2. Fecal samples were also collected. We captured 254 bats belonging to six families and 37 species: Phyllostomidae (19), Vespertilionidae (8), Molossidae (8), Noctilionidae (1), Emballonuridae (1) and Natalidae (1). The most abundant species was *Artibeus planirostris* (32%). The species reported in this study represent 60% of bat species recorded in Mato Grosso do Sul and 71% of species known from the Pantanal region of the state. We also highlight important records for the Pantanal, including *Eumops patagonicus*, *Eptesicus diminutus* and *Micronycteris sanborni*. The most common plant species in the feces of bats were from the genera *Cecropia* and *Ficus*. The community of bats in the Pantanal proved rich and diverse, with differences among subregions, possibly reflecting their complex landscape and different habitats.

Keywords: *Artibeus obscurus*; Corumbá; frugivory; Paraguai River; Phyllostomidae.

Introduction

The Pantanal is located in central-west of Brazil and is part of the Upper Paraguay River Basin at the confluence of three phytogeographic regions of South America: the Amazonian forest, the Cerrado and the Chaco. It is subject to seasonal floods, which begin in the north and east and then drain to the south and west (Penatti et al. 2015). The largest portion of the Pantanal is located in Brazil and is considered a Biosphere Reserve and Wetland of International Importance (Harris et al. 2005). These wetlands also extend into Bolivia in the west and Paraguay in the south. The area faces many anthropogenic threats, such as deforestation and river damming that threaten its ecological functions and biodiversity (Roque et al. 2016).

According to Fischer et al. (2015), 74 species of bats have been recorded in the state of Mato Grosso do Sul, representing 44% of the 169 species that occur in Brazil (Peracchi et al. 2011). Inventories and studies in recent years have added important records to the bat fauna of this region, expanding the limits of the geographic distributions for several species, such as *Vampyrum spectrum* (Silveira et al. 2011), *Artibeus obscurus* (Bordignon and Santos 2010), *Eumops patagonicus* (Bordignon et al. 2011) and *Eumops dabbenei* (Fischer et al. 2015). Although a number of studies of bat communities in the Pantanal have been developed in recent years, they covered only small territorial areas (e.g. Bordignon 2005, Camargo and Fischer 2005, Longo et al. 2007, Bordignon and França 2009, Bordignon et al. 2011, Silveira et al. 2011). There are still large gaps in our knowledge of the bat community in this wetland, especially in areas that are difficult to access. Less than half of the Pantanal has been surveyed for bats and only 12% has been minimally surveyed (Bernard et al. 2011).

Bats can occupy a wide variety of dietary niches in large part because of their wide range of morphological modifications for different feeding habits, including body size, wing morphology, cranial morphology and bite force (Stockwell 2001, Dumont et al. 2011, Saldaña-Vázquez 2014). Phyllostomid bats in particular display a diverse diet (Giannini and Kalko 2004). Further, the seasonal variations in rainfall and flooding (Penatti et al. 2015) create periods of stress for bat species and force them to adapt, especially in regard to their diet, in order to survive (Alho et al. 2011, Munin et al. 2012). This niche breadth often leads to a complex relationship between different bat species and their habitat (Fenton et al. 1992, Pedro et al. 1995, Reis et al. 2008, Peracchi et al. 2011). In addition, certain species of bats are highly sensitive to habitat changes and disturbance and therefore may be considered indicators of environmental quality within the boundaries of their geographical distribution (Fenton et al. 1992, Peracchi et al. 2011).

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In the present study, we aimed to (1) record the richness and abundance of the bat community in the different regions of the Pantanal, especially in poorly sampled sites, (2) determine the variation in the bat community composition among the subregions sampled and (3) assess the diet of common frugivorous species.

Materials and methods

Study site

The Pantanal covers an area of 140,000 km^2, mostly in the Brazilian state of Mato Grosso do Sul as well as Mato Grosso and extends into Paraguay and Bolivia. This region has marked climatic seasonality and flat topography, resulting in a great diversity of habitats, combining aspects of mesic and xeric environments (Prance and Schaller 1982, Silva et al. 2000). There is a dry season from April to September and a wet season from October to March. Annual rainfall is between 800 and 1400 mm (Damasceno Jr et al. 2005). The heaviest rainfall usually falls in the north and east Pantanal as well as in the surrounding plateaus and then gradually flows and drains into the south and west. Water typically reaches its highest level in the southern and western Pantanal several months after the north and east (Penatti et al. 2015). The average temperature ranges from 20°C in the dry season to 27°C in the wet season. This landscape includes many types of vegetation, often composed of monotypic formations dominated by a single species, such as acurizais (*Attalea phaleratta*), cambarazais (*Vochysia divergens*) and carandazais (*Copernicia alba*), and codominant elements of semi-deciduous forest formations (Pott et al. 2011). In addition to the seasonal flooding pulse and climate stress, this wetland is also influenced by fires that usually occur in the dry season (April–September) (Oliveira et al. 2014). These factors influence the composition and distribution of fauna in this ecosystem.

Sampling was distributed among five subregions of the Pantanal (Figure 1). Because of climatic and hydrological seasonality, as well as geomorphology, these regions are covered by various types of vegetation, as follows: (1) Abobral subregion (19° 34′ S, 57° 01′ W), which consists of woods, grasslands and ponds, with sandy soils (Allem and Valls 1987); (2) Nabileque subregion (19° 54′ S, 57° 47′ W), characterized by dry fields, flooded fields, paratudais and carandazais (Silva et al. 2000); (3) Nhecolândia subregion (18° 59′ S, 56° 37′ W), characterized by a mosaic of small ponds (fresh and salt water), ridges and sandy soil

Figure 1: Map showing locations of bat surveys in the western Pantanal of Mato Grosso do Sul: Abobral (ABO); Nabileque (NAB); Nhecolândia (NHE); Paraguay River (PAR); Porto Murtinho (PMUR).

(Embrapa Pantanal 2009); (4) Paraguay River subregion (19° 13′ S, 57° 29′ W), characterized by flooded fields, swamps, gallery forests and formations of hills bordered by the Urucum Massif (Bordignon and França 2009); (5) Porto Murtinho subregion (22° 01′ S, 57° 54′ W), characterized by vegetation adapted to drier environments (xerophilous), usually with thorns and shrubs, caraguata (*Bromelia balansae* Mez), caranda palm trees (*Copernicia australis* Becc) and deciduous seasonal forest, showing the influence of the Paraguayan Chaco (Straube et al. 2006).

Bat capture

Between February 2008 and November 2009, 40 capture nights were carried out, equally divided between the dry season (April–September) and the wet season (October–March). Sampling took place for eight nights in each of the Pantanal subregions during the new or waning moon phases, again equally divided between the dry and the wet seasons. Each night, four mist nets of 14 × 3 m were deployed in forests and monotypic formations. Nets were inspected at 15-m intervals. Sampling began at sunset and continued for 6–8 h, depending on weather conditions. Captured bats were placed individually in cloth bags and maintained for approximately 2 h for the deposition of stool (Willig 1985). Feces deposited in cloth bags were packed in individual plastic tubes containing glycerin for subsequent identification of the seeds in laboratory, through the comparison with reference material, obtained during the study. Bat species were identified according to Vizotto and Taddei (1973), Tejedor (2006), Gardner (2007) and Reis et al. (2007). Subsequently, bats were released at the end of the night. Specimens that are difficult to identify in the field were collected for identification and deposited in the Zoological Collection of the Universidade Federal de Mato Grosso do Sul (ZUFMS). All procedures were authorized (license no. 10303-1/2007) and followed recommendations by the Chico Mendes Institute for Biodiversity Conservation (ICMBio).

Data analysis

The capture effort ($m^2 \cdot h$) was calculated by multiplying the net area (m^2) by the total time (h) of net exposure (Straube and Bianconi 2002). Sampling effort totaled 56,448 $m^2 \cdot h$. We calculated the Shannon's diversity index H′ for each subregion. We also constructed a diversity profile with 95% confidence interval to compare the biodiversity of all five regions together (Tóthmérész 1995). A Whittaker's diagram (dominance) was made, ordering the species in decreasing order of abundance for each subregion (Smith and Wilson 1996). We used a Kruskall-Wallis to compare the abundance of species between both the dry and the wet seasons and the different subregions. Each night of capture was used as the replicate unit. To compare the similarity of bat communities across subregions, we used the Morisita index with cluster analysis of presence-absence of species in the subregions. All statistical analyses were carried out in the program PAST (Hammer et al. 2001).

Results

Bat community

We captured 254 individuals of 38 species of bats distributed in six families (Table 1): Phyllostomidae (19 species), Vespertilionidae (8 species), Molossidae (8 species), Noctilionidae (1 species), Emballonuridae (1 species) and Natalidae (1 species). Phyllostomids were the most abundant with 198 individuals, representing 78% of the bats captured (Table 1). *Artibeus planirostris* (Spix 1823) was the most abundant species, accounting for 32% of all captures. The second most captured species was *Glossophaga soricina*, which represented 13% of captures. *Artibeus planirostris* was present in all five subregions, while *G. soricina* was present in four. The second most abundant family was Vespertilionidae, with 20 individuals belonging to eight species. *Myotis nigricans* (Schinz 1821) occurred in all subregions, totaling 13 individuals (5%). Molossidae was the third most abundant family with 15 individuals of eight species. There were differences in species richness and abundance between feeding guilds: insectivorous bats showed the highest species richness (n = 19) (Figure 2); however, frugivores were the most abundant (52%).

Bat communities of subregions

Species richness and biodiversity was highest in the Nabileque subregion (n = 18; H′ = 2.21), followed by the Paraguay River (n = 16; H = 2.15), Abobral (n = 10; H′ = 1.89), Nhecolândia (n = 10; H′ = 1.57) and Porto Murtinho (n = 7; H′ = 1.39) subregions. Despite this variation in species richness and biodiversity, diversity profiles of all five subregions together showed overlap between the 95%

Table 1: Bats captured in five Pantanal subregions in western Mato Grosso do Sul, Brazil.

Family/species	Guild	Abobral	Nabileque	Nhecolândia	Paraguay River	Porto Murtinho	Total
Emballonuridae							
Peropteryx macrotis	Ins		6				6
Phyllostomidae							
Desmodus rotundus	Hem	1	7		8		16
Diaemus youngii	Hem				1		1
Glossophaga soricina	Nec		6	22	3	1	32
Crotopterus auritus	Car				1		1
Lophostoma silvicolum	Omn	1	6			1	8
Micronycteris minuta	Omn				1		1
Micronycteris sanborni	Omn		2				2
Phyllostomus discolor	Omn		1	2			3
Phyllostomus elongatus	Omn				1		1
Phyllostomus hastatus	Omn				1		1
Carollia perspicillata	Fru		1		15		16
Artibeus lituratus	Fru	1			3		4
Artibeus obscurus	Fru					2	2
Artibeus planirostris	Fru	13	26	5	22	14	80
Chiroderma doriae	Fru				8		8
Platyrrhinus helleri	Fru	1					1
Platyrrhinus lineatus	Fru	5	1		1		7
Sturnira lilium	Fru			1	12		13
Vampyrodes caraccioli	Fru		1				1
Noctilionidae							
Noctilio albiventris	Ins	5	8		1		14
Natalidae							
Natallus espiritosantensis	Ins		1				1
Molossidae							
Cynomops abrasus	Ins			2			2
Eumops auripendulus	Ins		1				1
Eumops patagonicus	Ins					2	2
Molossops temminckii	Ins			1			1
Molossus currentium	Ins			2			2
Molossus molossus	Ins					3	3
Molossus pretiosus	Ins		1				1
Molossus rufus	Ins	3					3
Vespertilionidae							
Eptesicus brasiliensis	Ins		1				1
Eptesicus diminutus	Ins		1				1
Eptesicus furinalis	Ins			1			1
Lasiurus blossevillii	Ins				1		1
Lasiurus ega	Ins	1					1
Myotis albescens	Ins			1			1
Myotis nigricans	Ins	8	1	2	1	1	13
Myotis riparius	Ins		1				1
Total and percent of individuals (%)		39 (15.35)	72 (28.35)	39 (15.35)	80 (31.5)	24 (9.45)	254
Richness		10	18	10	16	7	38

Guilds refer to feeding guilds: frugivores (Fru), nectarivores (Nec), omnivores (Omn), insectivores (Ins), sanguivores (Hem) and carnivores (Car).

confidence intervals, indicating these differences in biodiversity are not significant (Figure 3).

Bat abundance also varied among some of the subregions. Porto Murtinho had a lower abundance than both Nabileque ($H = 4.47$, $p = 0.01$) and Paraguay River ($H = 3.18$, $p = 0.03$). Abundance did not differ significantly between any other pairs of subregions. Abundance was higher in the dry season than the wet ($H = 3.69$, $p = 0.05$). The dry season contributed 61% of the total number of individual bats; with *Artibeus planirostris* being the most captured

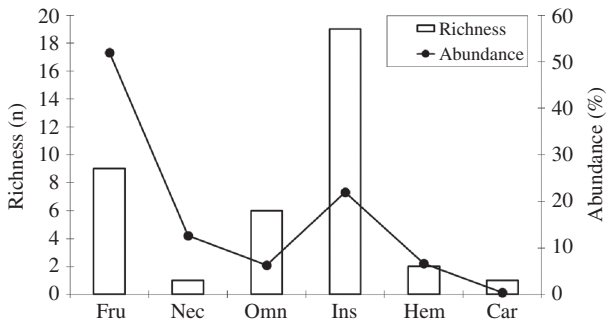

Figure 2: Richness and abundance of bats captured in western Pantanal of Mato Grosso do Sul, Brazil, according to different feeding guilds: frugivores (Fru), nectarivores (Nec), omnivores (Omn), insectivores (Ins), sanguivores (Hem) and carnivores (Car).

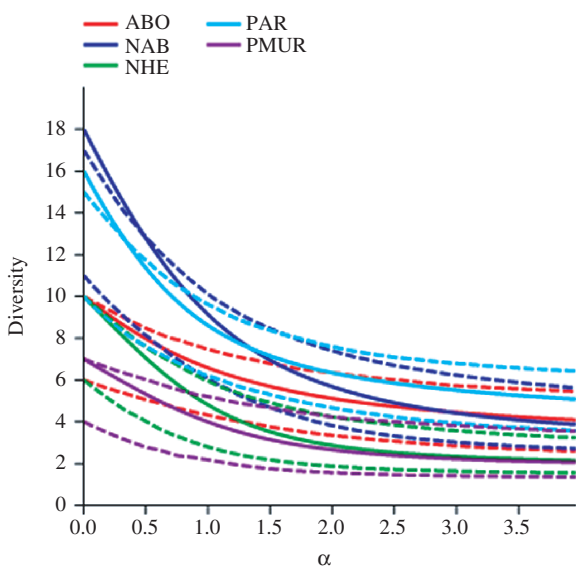

Figure 3: Diversity profiles of the five subregions of the Pantanal of Mato Grosso do Sul sampled in this study: Abobral (ABO), Nabileque (NAB), Nhecolândia (NHE), Paraguay River (PAR) and Porto Murtinho (PMUR). Diversities are shown in solid lines, with 95% confidence intervals as dashed lines.

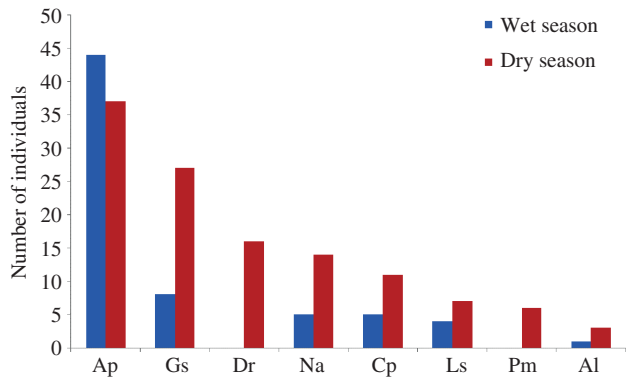

Figure 4: Abundance of individuals of the species caught in the dry season (April to September) and the wet season (October to March) in the western Pantanal, Mato Grosso do Sul: *Artibeus planirostris* (Ap); *Glossophaga soricina* (Gs); *Desmodus rotundus* (Dr); *Noctilio albiventris* (Na); *Carollia perspicillata* (Cp); *Lophostoma silvicolum* (Ls); *Peropteryx macrotis* (Pm); *Artibeus lituratus* (Al).

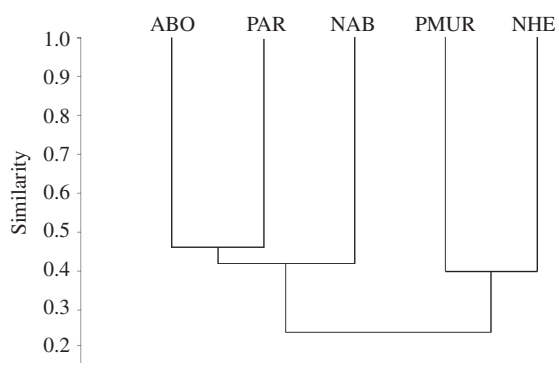

Figure 5: Morisita's similarity by cluster's analysis to the communities of bats in the five subregions of the western Pantanal of Mato Grosso do Sul: Abobral (ABO), Nabileque (NAB), Nhecolândia (NHE), Paraguay River (PAR) and Porto Murtinho (PMUR).

species (23%). The vampire bat *Desmodus rotundus* (E. Geoffroy 1810) and the insectivorous *Peropteryx macrotis* (Wagner 1843) were captured only in the dry season. In the wet season, *A. planirostris* was even more dominant, representing 49% of captures among 13 species recorded (Figure 4).

Similarity analysis showed two distinct clades, one including the subregions of Nhecolândia and Porto Murtinho, and another composed of the other three subregions (Figure 5). Similarity between the clade of Abobral-Paraguay River-Nabileque and the clade of Porto Murtinho-Nhecolândia was 21%. The greatest similarity between the communities was between the subregion of Paraguay River and Abobral (46%).

Rarefaction curves for each subregion indicate that Nabileque and Paraguay had the most equitability, while Porto Murtinho had the least (Figure 6). In all subregions, the communities were characterized by the dominance of a few species, and these dominant species were always Phyllostomids. *Artibeus planirostris* accounted for most of the captures in all the subregions, except in the Nhecolândia subregion, in which *Glossophaga soricina* was the most captured species (Table 1).

Diet of frugivorous bats

We found seeds in 44 fecal samples from seven phyllostomid species. Seeds of *Cecropia pachystachya* occurred

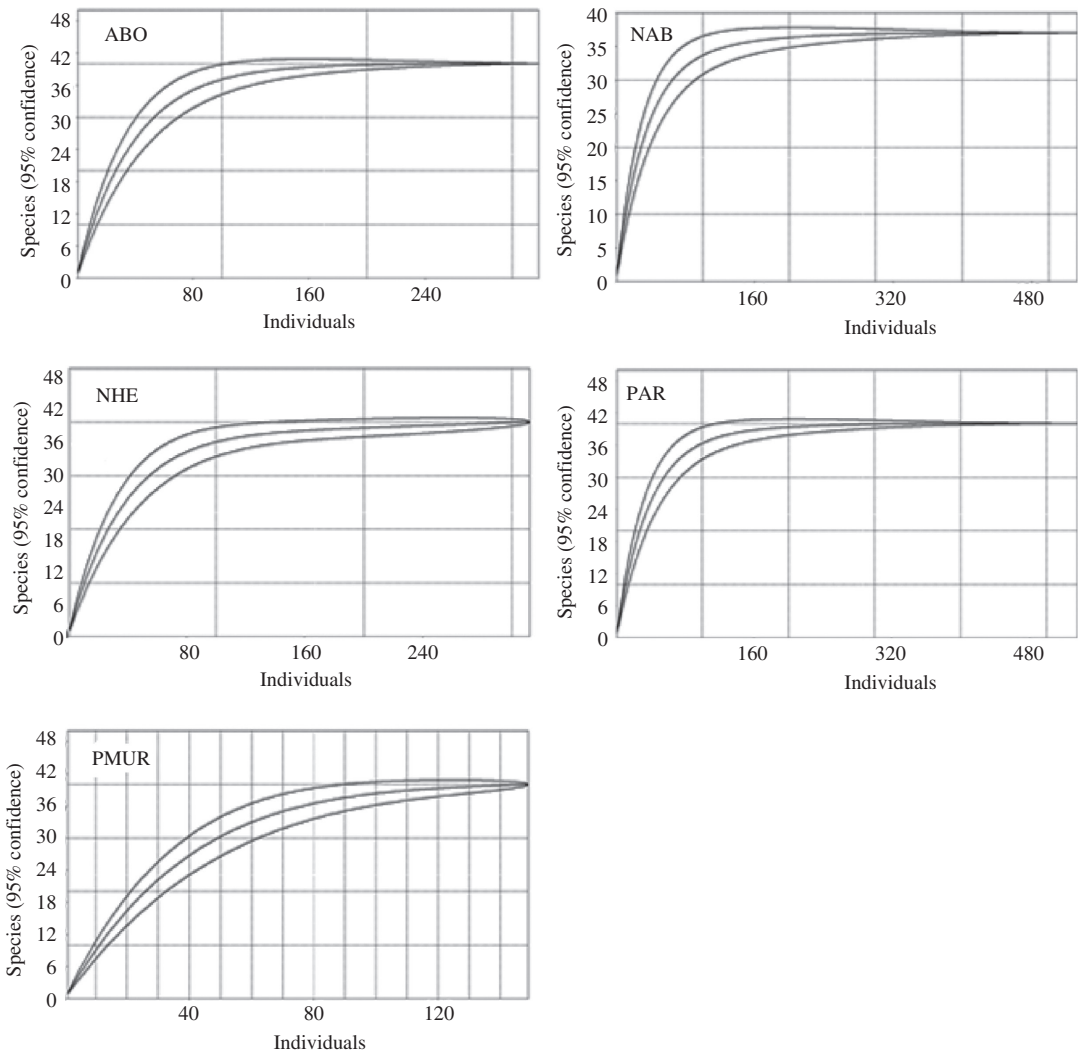

Figure 6: Cumulative number of bat species and relative abundance among the five subregions of the western Pantanal, Mato Grosso do Sul: Abobral (ABO), Nabileque (NAB), Nhecolândia (NHE), Paraguay River (PAR) and Porto Murtinho (PMUR). The number of individuals is on the x-axis and number of species on the y-axis.

in feces of *Artibeus planirostris* (n = 9) and *Platyrrhinus lineatus* (n = 3); *Ficus* spp. in feces of *A. planirostris* (n = 6), *Sturnira lilium* (n = 2), *Glossophaga soricina* (n = 2), *C. perspicillata* (n = 1) and *P. lineatus* (n = 1); *Piper arboreum* seeds were only found in fecal samples of *A. planirostris* (n = 5). There was 50% similarity of plant species consumed by bats between the Nabileque and the Paraguay, Abobral and Nhecolândia subregions. The lowest similarity (22%) was found between the Paraguay River subregions with the Abobral and Nhecolândia.

Discussion

The species recorded in this study represent 60% of all bat species reported in the state and 71% of wetland Mato Grosso do Sul bat species (Cáceres et al. 2008, Fischer et al. 2015). The majority of individuals captured were frugivorous bats (52%), while insectivorous bats accounted for 22%. This pattern has been found in other studies in the Pantanal (Alho et al. 2011, Oliveira et al. 2012), as well as in other biomes in Brazil (e.g. Bernard 2001, Bernard and Fenton 2007, Zortéa and Alho 2008, Ortêncio-Filho et al. 2014, Novaes et al. 2017, Soares et al. 2017). The greater abundance of frugivores is likely at least partially related to the capture method, as mist nets are more selective for these bats, which fly at lower altitudes in the understory (Moreno and Halffter 2001, Bergallo et al. 2003, Castro-Luna et al. 2007). The majority of insectivorous species in our study were recorded during roost searches and netting by known or suspected roosts, strategies which are generally more

effective for surveying these species (Cunto and Bernard 2012).

The two species captured in all five sites, *Artibeus planirostris* and *Myotis nigricans*, are generalists and were very common in other studies in the region (Alho et al. 2011, Oliveira et al. 2012). According to Martins et al. (2014) *A. planirostris* has great plasticity in its diet, feeding on both native and exotic plants, which allows it to occupy environments with even very high levels of disturbance and modification of vegetation. In the Pantanal, this species exhibits high levels of dietary flexibility and has been recorded consuming insects, leaves and pollen in addition to the more typical diet of seeds and fruit pulp (Teixeira et al. 2009). *Myotis nigricans* is an insectivore and was the most abundant species of this feeding guild. It can often be found in anthropogenically disturbed areas (Oliveira et al. 2012, Bader et al. 2015) and appears to have a wide diet, feeding on insects from a variety of families and orders (Aguiar and Antonini 2008). *Glossophaga soricina*, which was the second most abundant species and found in four out of the five subregions, is also a dietary generalist (Bredt et al. 2002, Fabián et al. 2008). This species consumes different floral resources in the Pantanal, such as nectar and pollen. All three of these generalist species seem to be adapted to environments altered by human activities, such as pastures, deforested areas and cattle raising, both in the Pantanal and in other regions of Brazil (Alho et al. 2011, Oliveira et al. 2011, 2012, Bader et al. 2015). They appear to be abundant and widespread throughout the Pantanal of Mato Grosso do Sul (Bordignon and França 2009, Teixeira et al. 2009, Fischer et al. 2015).

Among notable species, we captured two individuals of *Eumops patagonicus* (Thomas 1924) from an artificial shelter in the Porto Murtinho subregion, one male *Eptesicus diminutus* (Osgood 1915) and two *Micronycteris sanborni* (Simmons 1996) in forest habitats in the Nabileque subregion. Some animal-eating bats such as *M. sanborni*, *Micronycteris minuta* and *Lophostoma silvicolum* captured in our study are uncommon in highly altered environments (Brosset et al. 1996, Simmons and Voss 1998), and Kalko et al. (1999) considered *L. silvicolum* a good indicator species for habitat quality and level of forest disturbance. Our records of *M. sanborni* represent the first occurrence of this species in the Pantanal of Mato Grosso do Sul. A previous record made by Santos et al. (2010) occurred in the doline (sinkhole) known as "Buraco das Araras" located in the municipality of Jardim, approximately 200 km from the border of wetland floodplain. Very little is known about this species, which tends to favor more open and dry areas (Santos et al. 2010). The records of these species may suggest that despite the landscape changes brought about by anthropogenic disturbance in the Pantanal (Roque et al. 2016), several areas, particularly Nabileque, may still maintain adequate conditions to support a diverse community of bats.

We also highlight the records for the Pantanal of two specimens of *Artibeus obscurus* (see Bordignon and Santos 2010), captured in riparian environments. The record of *A. obscurus* expands the distribution estimated by Gardner (2007). Our results also indicate that this species may also be found in Paraguay because it was captured at the border of the marsh with Paraguayan Chaco. Thus, it likely occurs in sympatry with two other species in the genus *Artibeus*, *Artibeus lituratus* and *Artibeus planirostris* (Willig et al. 2000).

Eptesicus diminutus, which was captured within gallery forest at Fort Coimbra in the Nabileque subregion, is the smallest species of the genus, among the five extant species present in Brazil (Miranda et al. 2006). This is a species of the canopy and subcanopy, whose capture in nets at the level of the ground is considered rare and incidental (Carvalho et al. 2013).

A number of species captured in this study rely heavily on caves, mines and karst areas. *Peropteryx macrotis* recorded at Nabileque was captured near a cave used for tourist visits. This species also occurs in the Paraguay River subregion occupying limestone caves and abandoned mines in the Urucum Massif near Corumbá (Bordignon 2005). *Natalus espiritosantensis*, another species captured at Nabileque, is also found in the Urucum Massif (Bordignon and França 2009) as well as in the savannah regions (Taddei and Uieda 2001) of central Brazil. The presence of this species depends on the availability of shelter in cave areas, as is the case of the Paraguay River and Nabileque subregions where there are many limestone caves.

Hematophagous bats like *Desmodus rotundus* are common in the Pantanal. Although they can occupy different types of shelters such as hollow trees and human constructions (bridges, roofs), the existence of colonies with many individuals only occurs in cave sites (Trajano 1996, Tejedor 2006, 2011). Although most of the wetland is occupied by a broad, periodically floodable plain, there are mountain formations in many locations with the potential to provide roosts for this bat. Although food resources for many species decline during the dry season in the Pantanal (Munin et al. 2012), vampire bats were caught only during this season. This may be explained by the higher concentration of cattle herds in high lands protected from seasonal floods from April to September (Silva et al. 2000). Although the expansion in cattle raising could increase

the population of this species, vampire bat populations are controlled by government actions to eradicate human rabies (Sodré et al. 2010).

We found differences in bat abundance between subregions, but no significant differences in biodiversity. Although there was a wide range of species richness between the subregions, the lack of significant differences in biodiversity can be at least partially attributed to the wide confidence intervals in the diversity profiles (Figure 3). Additional sampling could further elucidate differences in biodiversity between the subregions of the Pantanal.

The subregions of Nabileque, Paraguay River and Abobral were most similar to each other (Figure 5) and had higher species richness and abundance of bats than Nhecolândia or Porto Murtinho. This may reflect the greater complexity of the landscape found in these places, especially in the subregion of the Paraguay River, where the Urucum Mountains have a greater diversity of vegetation relative to the more homogenous plains (Damasceno Jr et al. 2005). This heterogeneity may provide a greater variety of habitats for the bat communities in these subregions. In addition, Nhecolândia and Porto Murtinho (Figure 5) are drier than other regions of the Pantanal (Seidel and Moraes 2000, Pott et al. 2011), which may explain the lower bat species richness and more similar communities. The Chaco in particular is known for a higher dominance of high-flying molossids and lower diversity of phyllostomid fruit bats, which dominated the other subregions (Willig et al. 2000).

Although it was not significantly more diverse than other subregions, Nabileque had the most even community and the highest abundance of bats. The areas sampled in this subregion were based on the posting of Fort Coimbra, which belongs to the Brazilian Army. The high species richness and abundance as well as the evenness of the community in this region may be partially explained by the lower level of human occupation, which is limited to the resident families of soldiers and a small fishing village.

The fruits of *Cecropia pachystachya* and *Ficus* spp. seem to be a key resource for bats in the areas we sampled, as it was found in the feces of several generalist species, such as *Artibeus planirostris*, *Platyrrhinus lineatus* and *Glossophaga soricina*. Although *G. soricina* is generally considered nectivorous, largely consuming pollen and nectar, Melastomastaceae and Solanaceae seeds have also been recorded in their diet in savanna areas (Bredt et al. 2002) and up to 41% of the diet of this species' diet may be composed of fruit (Fabián et al. 2008). Frugivorous bats may be important seed dispersers for *Cecropia* and *Ficus* species, which are widespread pioneer species (Oliveira and Lemes 2010). However, *A. planirostris*, *P. lineatus* and *G. soricina* are all known to consume pollen and arthropods, in addition to fruit, especially in the Pantanal, where food resources are less available than other parts of their distribution (Munin et al. 2012). Therefore, our results only encompass a portion of these bats' diet.

Our study shows that the Pantanal has a great variety of species of bats and their communities may vary between subregions. The occurrence of recent records of *Artibeus obscurus* and *Eumops patagonicus* in the Pantanal (Bordignon and Santos 2010, Bordignon et al. 2011, present study) demonstrates the need for both continued surveys and conservation efforts, especially in the face of the many threats to this important wetland (Roque et al. 2016).

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