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Diversidade, Espécies Ameaçadas e Sustentabilidade

Filling knowledge gaps for the State
of Paraná, Brazil: Bats (Mammalia, Chiroptera)
of Palotina municipality

Preenchendo lacunas para o Estado
do Paraná: Morcegos (Mammalia, Chiroptera)
do município de Palotina

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The order Chiroptera stands out by its species richness, as it comprises approximately one-fourth of all mammals in the world (REIS *ET AL.* 2013). Bats occupy a large diversity of trophic guilds, and, therefore, are fundamental in the formation and maintenance of ecosystems, playing important roles in seed dispersion (ARTEAGA *ET AL.*, 2006; MELLO *ET AL.*, 2008), insect control (Mayne & Boyles 2015), and pollination (SAZIMA *ET AL.* 1999; FLEMING *ET AL.*, 2009). This way, the group received greater attention in the past decades, which resulted in a considerable increase in the number of studies on bats in Brazil (MIRETZKI, 2003; BERNARD *ET AL.*, 2011).

Paraná reflects this situation. In 2003, there were 53 bat species known for the state; in 2007, the list increased to 56 species, and three years later, 64 species were recorded (MIRETZKI, 2003; PACHECO *ET AL.* 2007; PASSOS *ET AL.*, 2010). Although knowledge of the bat fauna advanced, it is still heterogeneous and punctual, and mostly concentrated in the eastern and northern regions of Paraná (MIRETZKI, 2003).

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The lack of inventories, and, therefore, the lack of data on the fauna in some regions result in underestimated geographic distributions and hinders the determination of species conservation status (COLE *ET AL.*, 1994). Knowing the diversity of a given site is the first step to establishing conservation and monitoring actions (LONGINO & COLWELL, 1997). In this sense, fauna inventories allow knowing which species exist and where they are distributed (SENNA *ET AL.*, 2013).

The western region of Paraná is within the Atlantic Forest biome, which is a semi-deciduous seasonal forest (VELOSO *ET AL.*, 1991). The region is considered a high-priority for bat inventories (MIRETZKI, 2003) and is characterized as being highly agricultural, as it was intensively deforested during its colonization, over 50 years ago. Currently, its landscape is composed mostly of small forest fragments dispersed in a large monoculture matrix, with intensive use of agricultural implements and technologies. Bats may be used as indicators of changes in environmental quality (FENTON *ET AL.*, 1992; LIM & ERGSTROM, 2001). Hence, the objective of the present study was to carry out a first inventory of the bats of Palotina, western Paraná.

MATERIAL AND METHODS

STUDY AREA

Palotina (24° 17' 02''S; 53° 50' 24''W) is located in western Paraná, southern Brazil (Fig. 1), and has an area of 651 km² and a population of approximately 30,000 inhabitants (IBGE, 2015). Only 3% of the municipality are covered by green areas, which are remnants of semi-deciduous seasonal forest (SOS Mata Atlântica/INPE, 2014). Those green areas include the São Camilo State Park, a protected area. Following the Köppen system, the regional climate is subtropical humid, with hot summers and no well-defined dry season. The average annual rainfall is 1,649 mm (IAP 2006).

Sampling was carried out in two areas of Palotina. The first site comprises the campus of the Federal University of Paraná (24°17'41''S; 53°50'29''W), within the urban perimeter. The campus has an altered forest of approximately 4 ha, and beside this forest, there is a small area where a forest restoration project has been carried out since 2012, with the species *Cecropia pachystachya* Trécul, *Luehea divaricata* Mart & Zucc., *Croton urucurana* Baill., *Eugenia uniflora* L., etc. Besides, close to the blocks of buildings and constructions, there are sparse trees of the species *Tabebuia* sp. and *Ficus* sp., among others.

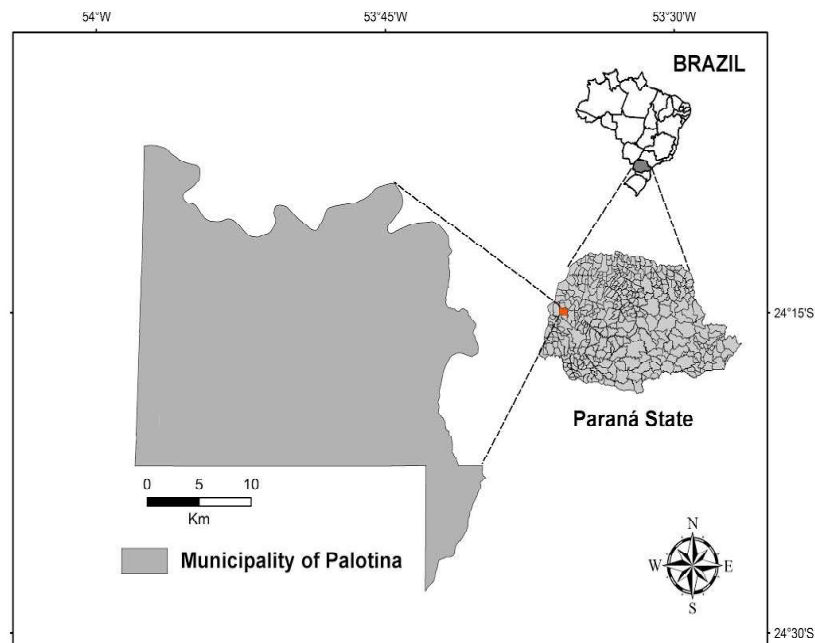


Fig. 1. Location of the municipality of Palotina, western Paraná State, southern Brazil.

The second site is a forest fragment located on a rural property ($24^{\circ}09'47''S$; $53^{\circ}52'87''W$) in the border between the municipalities of Palotina and Francisco Alves. The small fragment comprises a fully protected area (APP) surrounding a streamlet, which is part of the Piquiri River Basin. A road cuts the fragment. At one side of the road, there is a small dammed lake. The vegetation is composed of species of *Cecropiaceae*, *Solanaceae*, *Moraceae*, and *Piperaceae*, among others.

PROCEDURES

Data collection was carried out from January to May 2015. For the inventory of bat species, we used two methods. First, we set mist nets in the two sampling areas. We used from two to five mist nets, measuring 9 m in length and 2.5 m in height, set up from 0.5 to 1 m above ground. These nets were distributed among several parts of the University campus and rural property. We opened the nets after sunset for a period from 3 to 5 h, and checked them every 20 min, to avoid damaging the nets and injuring the bats. Sampling sessions were carried out regardless of moon cycle and without regular periodicity. We identified all individual bats captured, marked them with a hole in the dactylopatagium (punch-

marking), and released them. At least one individual of each species were collect and individuals with difficult to identify (collect license number 43560/2014). The calculation of the sampling effort followed Straube & Bianconi (2002) and resulted in 5,865 m².h. Second, we collected bats found fallen in houses and constructions within the urban perimeter of Palotina. There was no active search, the individuals were collected casually and we identified them in the laboratory.

Species identification was made using the keys by GREGORIN & TADDEI (2002) AND MIRANDA *ET AL.* (2011). Voucher specimens were deposited in the Capão da Imbuia Natural History Museum, in Curitiba (Appendix 1).

RESULTS

We captured a total of 94 individual bats of three families, eight genera, and 12 species: *Molossus molossus* (Pallas, 1766), *Molossus rufus* E. Geoffroy, 1805, *Eumops glaucinus* (Wagner, 1843), and *Eumops aripendulus* (Shaw, 1800) of the family Molossidae; *Esptesicus furinalis* (d'Orbigny & Gervais, 1847), *Lasiurus blossevillii* (Lesson & Garnot, 1826), and *Myotis nigricans* (Schinz, 1821) of the family Vespertilionidae; and *Artibeus lituratus* (Olfers, 1818), *Artibeus fimbriatus* Gray, 1838, *Artibeus planirostris* (Spix, 1823), *Platyrrhinus lineatus* (E. Geoffroy, 1810), and *Stunira lilium* (E. Geoffroy, 1810) of the family Phyllostomidae.

We collected 87% of all bats (six species) on the University campus, 7% (five species) in houses and constructions and 5% (four species) on the rural property (Table 1). Those differences reflect the sampling effort used in each area, as on the rural property the sampling effort was only 135 m².h and there was no active search for roosts in houses and constructions in the urban perimeter.

All phyllostomid species were recorded exclusively in nets, whereas molossid species were recorded only in houses and constructions within the urban perimeter. Vespertilionids were recorded with both methods.

Phyllostomidae was the family with the largest number of species (42 %), followed by Molossidae (33 %), and Vespertilionidae (25 %). In terms of abundance, phyllostomids dominated the sample, with 89 % of all captures, followed by molossids (6 %) and vespertilionids (4 %).

The most frequent species was *Stunira lilium* (32 %), followed by *Artibeus lituratus* (28 %), and *Platyrrhinus lineatus* (22 %), which together represented 82 % of the sample. The other nine species showed low frequency, with one to five individuals captured.

The feeding habits of the captured species comprised only insectivory and frugivory. Frugivores were the most abundant (90%), comprising all

Table 1. List of the bat species recorded in Palotina, state of Paraná, Southern Brazil, with their respective observed frequencies (FO), capture method, site of capture, and feeding habit (A, mist nets; B, collected fallen on the ground; 1, UFPR; 2, rural property; 3, houses and constructions in the urban perimeter; Fr, frugivore; In, Insectivore).

	FO	Capture method	Area	Feeding habit
Phyllostomidae				
<i>Artibeus lituratus</i> (Olfers, 1818)	28 %	A	1	Fr
<i>Artibeus fimbriatus</i> Gray, 1838	4 %	A	1, 2	Fr
<i>Artibeus planirostris</i> (Spix, 1823)	3 %	A	1	Fr
<i>Platyrrhinus lineatus</i> (E. Geoffroy, 1810)	22 %	A	1	Fr
<i>Sturnira lilium</i> (E. Geoffroy, 1810)	32 %	A	1, 2	Fr
Vespertilionidae				
<i>Eptesicus furinalis</i> (d'Orbigny & Gervais, 1847)	2 %	A	1, 2	In
<i>Lasiurus blossevillii</i> (Lesson & Garnot, 1826)	1 %	B	3	In
<i>Myotis nigricans</i> (Schinz, 1821)	1 %	A	2	In
Molossidae				
<i>Eumops auripendulus</i> (Shaw, 1800)	1 %	B	3	In
<i>Eumops glaucinus</i> (Wagner, 1843)	1 %	B	3	In
<i>Molossus molossus</i> (Pallas, 1766)	2 %	B	3	In
<i>Molossus rufus</i> E. Geoffroy, 1805	2 %	B	3	In

members of the family Phyllostomidae and subfamily Stenodermatinae. Insectivores were represented by molossids and vespertilionids (10 %). However, regarding richness, insectivores (58 %) prevailed over frugivores (42 %).

DISCUSSION

The number of bat species recorded represented 19 % of the species listed for the state of Paraná (PASSOS *ET AL.*, 2010) and 31 % of the species expected for semi-deciduous seasonal forests (MIRETZKI, 2003). Considering the sampling effort applied, which was small, the richness obtained was satisfactory. Studies in fragments of semi-deciduous seasonal forests or urban areas in other municipalities of Paraná have obtained similar or higher number of species, but using a much higher sampling effort (REIS *ET AL.*, 1993; SEKIAMA *ET AL.*, 2001; BIANCONI *ET AL.* 2004; ORTÊNCIO-FILHO *ET AL.*, 2005; ORTÊNCIO-FILHO & REIS, 2009).

The small sample obtained in the forest fragment of the rural property does not represent well the local bats community, a higher sampling effort

is needed to know the real richness of the site. The forest fragment and the area under a restoration process are important for the University campus, as only two species, *Eptesicus furinalis* and *Artibeus lituratus*, were recorded in nets dispersed over the campus and close to constructions. Forest fragments, even small ones, are valuable for the maintenance of bat species, either as roosting areas or stepping stones (ESTRADA & COATES-ESTRADA, 2002; BIANCONI ET AL. 2006), as they provide food and shelter for bats (AGUIRRE, 2002).

Molossids were recorded exclusively through capture by hand in houses and constructions. The use of mist nets is considered a selective method, it captures mainly phyllostomids, as molossids fly above the canopy and insectivorous species have a better echolocation system and detect nets more easily (REIS ET AL., 2003; ROSA, 2004; ORTÊNCIO-FILHO & REIS 2009). This highlights the importance of using different sampling methods for more complete inventories (REIS ET AL., 2006).

The predominance of phyllostomids is common in other inventory studies in Neotropical bat communities (BIANCONI ET AL., 2004; ROSA, 2004; MARTINS ET AL., 2006; ESBÉRARD ET AL., 2010), due to the high richness of the family in the region, with 92 species recorded in Brazil (NOGUEIRA ET AL., 2014).

The five phyllostomid species captured belong to the subfamily Stenodermatinae, which is more abundant in disturbed areas (FENTON ET AL., 1992). *Sturnira lilium*, *A. lituratus*, and *P. lineatus* are species with high dietary plasticity and high tolerance to altered habitats (REIS ET AL., 2006; NOVAES E NOBRE, 2009; PRONE ET AL., 2012; GAZARINI & PEDRO, 2013). Other studies carried out in forest remnants also had some of those species dominating the bat community (REIS ET AL., 2003; BIANCONI ET AL., 2004; ORTÊNCIO-FILHO ET AL., 2005; BARROS ET AL., 2006; ZANON & REIS, 2007; ROCHA ET AL., 2010; BERNARDI ET AL., 2012; PEREIRA 2013). *Artibeus fimbriatus* and *A. planirostris* were not as frequent as in other studies in fragments of semi-deciduous seasonal forest in the state of Paraná (BIANCONI ET AL., 2004; ORTÊNCIO-FILHO ET AL., 2005; REIS ET AL. 2006).

The vespertilionid species captured are found in primary and secondary forests and constructions and tolerate altered habitats (REIS ET AL., 2013). In Brazil, *M. nigricans* is among the most frequent insectivorous species sampled in inventories carried out in southern and southeastern regions of Brazil (SEKIAMA ET AL., 2001; DIAS ET AL., 2002; ESBÉRARD 2003; COSTA ET AL., 2012). *Eptesicus furinalis* and *Lasiurus blossevilli* have already been recorded in several regions of the state of Paraná (Reis & Muller 1995, Sekiama et al. 2001, Bianconi et al. 2004, Arnone & Passos 2007,

Graciolli & Bianconi 2007, Ortêncio-Filho & Reis 2009, Gazarini & Pedro 2013).

Among molossids, the two *Molossus* species collected are among the most common in urban areas in Brazil (Pacheco *et al.* 2010, Costa *et al.* 2012). The *Eumops* species captured can also roost in constructions and urban areas (Ramos *et al.* 2013). *Eumops auripendulus* have already been recorded in several regions of Paraná (Miretzki 2003, Zanon & Reis 2007), but *E. glaucinus* was recorded only in the northern region of the state (Miretzki 2003, Reis *et al.* 2006). Therefore, the present study presents the first record of this species for the western part of the state.

A higher richness of insectivorous than frugivorous species reflects the reality of urban environments (Lima 2008, Pacheco *et al.* 2010): high food availability due to high densities of insects attracted to artificial lights and high availability of roosts in constructions, roof linings, and other human-made structures (Rydell 1992, Gaisler *et al.* 1998, Pacheco *et al.* 2010).

The number of species recorded in Palotina is low when compared to that of other cities in Paraná, within the same biome (Reis *et al.* 2006), but we presume that the real richness of the municipality remains to be estimated. Hence, it is necessary to increase the sampling effort and use complementary methods, such as active roost search, as well as sampling of large and well-preserved forest fragments, such as São Camilo State Park (385.34 ha). The present study suggests that the bat fauna of the region may be rich and should be better studied.

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SUMMARY

The number of bat studies in Brazil has increased in the past decades, but knowledge is heterogeneous and punctual. In Paraná, bat studies have been concentrated mainly in the northern and eastern regions of the state. Hence, we aimed at making an inventory of the bat fauna of the municipality of Palotina, western Paraná. We sampled two sites: the campus of the Federal University of Paraná, within the urban perimeter, and a forest fragment on a rural property. We used mist nets, in a sampling effort of 5,865 m²/h. We also captured specimens fallen in houses and constructions within the urban perimeter; those individuals were collected

manually. We captured a total of 94 individual bats of 12 species, eight genera, and three families. *Sturnira lilium*, *Artibeus lituratus*, and *Platyrrhinus lineatus* were the most abundant species and corresponded to 82% of all individuals captured. The Vespertilionidae species captured are frequently sampled in other regions of the state, similarly as the Molossidae species, except for *Eumops glaucinus*, which was recorded only in northern Paraná. Therefore, this is the first recorded of this species for western Paraná. Sampling in larger and better-preserved forest fragments, a higher sampling effort, and active search in roosts are needed to estimate the bat richness of Palotina, and the present study took the first step.

KEYWORDS: bats; western Paraná; inventory

SUMÁRIO

O número de estudos com quirópteros no Brasil tem aumentado nas últimas décadas, entretanto esse conhecimento é heterogêneo e pontual. Para o Estado do Paraná esses estudos se concentram principalmente na região norte e leste do Estado. Assim este estudo teve por objetivo inventariar a quiropterofauna do município de Palotina, região oeste do Paraná. Foram amostrados dois diferentes locais, o campus da Universidade Federal do Paraná, dentro do perímetro urbano, e um fragmento florestal em uma propriedade rural nos limites geográficos do município. Para esses locais foram utilizadas redes de neblina, resultando em um esforço amostral de 5.865 m².h. Um segundo método utilizado foi a captura de espécimes caídos em casas e construções dentro do perímetro urbano, os indivíduos foram coletados manualmente utilizando luvas. Foi capturado um total de 94 indivíduos distribuídos em 12 espécies de oito gêneros e três famílias. *Sturnira lilium*, *Artibeus lituratus* e *Platyrrhinus lineatus* foram as espécies mais abundantes, correspondendo a 82 % dos indivíduos capturados. As espécies de Vespertilionidae capturadas são frequentemente amostradas em outras regiões do estado, assim como as espécies de Molossidae, com exceção de *Eumops glaucinus* que foi registrado apenas na porção norte do Estado do Paraná, sendo este o primeiro registro para a porção oeste. A amostragem em fragmentos maiores e mais conservados, um maior esforço amostral e a busca ativa em refúgios são necessários para se estimar a real riqueza dos morcegos de Palotina, entretanto esse estudo representa um primeiro passo para o conhecimento da quiropterofauna local.

PALAVRAS-CHAVE: quirópteros; Oeste do Paraná; inventário

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APPENDIX 1

Bats collected in Palotina, state of Paraná, southern Brazil, and Deposited in the Capão da Imbuia Natural History Museum in Curitiba.

Species	Voucher Number	Geographic Coordinates
<i>Myotis nigricans</i> (Schinz, 1821)	MNHCI 6668	24°09'47''S; 53°52'87''W
<i>Eptesicus furinalis</i> (d'Orbigny & Gervais, 1847)	MNHCI 6669	24°09'47''S; 53°52'87''W
<i>Lasiurus blossevilli</i> (Lesson & Garnot, 1826)	MNHCI 6670	24°17'41''S; 53°50'29''W
<i>Eumops glaucinus</i> (Wagner, 1843)	MNHCI 6671	24°17'35''S; 53°50'47''W
<i>Eumops auripendulus</i> (Shaw, 1800)	MNHCI 6672	24°17'24''S; 53°50'40''W
<i>Molossus rufus</i> E. Geoffroy, 1805	MNHCI 6673	24°16'48''S; 53°49'32''W
<i>Molossus molossus</i> (Pallas, 1766)	MNHCI 6674	24°17'57''S; 53°50'25''W
<i>Artibeus lituratus</i> (Olfers, 1818)	MNHCI 6675	24°17'41''S; 53°50'29''W
<i>Artibeus planirostris</i> (Spix, 1823)	MNHCI 6676	24°17'41''S; 53°50'29''W
<i>Artibeus fimbriatus</i> Gray, 1838	MNHCI 6677	24°09'47''S; 53°52'87''W
<i>Platyrrhinus lineatus</i> (E. Geoffroy, 1810)	MNHCI 6678	24°17'41''S; 53°50'29''W
<i>Platyrrhinus lineatus</i>	MNHCI 6679	24°17'41''S; 53°50'29''W
<i>Sturnira lilium</i> (E. Geoffroy, 1810)	MNHCI 6680	24°17'41''S; 53°50'29''W
<i>Sturnira lilium</i>	MNHCI 6681	24°17'41''S; 53°50'29''W

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