

BATS (CHIROPTERA, MAMMALIA) IN BARN OWL (*TYTO ALBA*) PELLETS IN NORTHERN PANTANAL, MATO GROSSO, BRAZIL

Fabricio Escarlate-Tavares^{1,2} and Leila M. Pessôa¹

¹ Lab. Mastozoologia, sala A1-121, Instituto de Biologia, CCS, Universidade Federal do Rio de Janeiro, Av. Brigadeiro Trompowski s/n°, Ilha do Fundão, CEP: 21940-590, Rio de Janeiro, Brasil.

² PPG-Zoo, Museu Nacional, Quinta da Boa Vista, São Cristóvão, Rio de Janeiro, Brasil
<morcegoescarlate@ig.com.br>

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The Pantanal is the largest seasonally flooded interior wetland in the world, covering an area of 500 000 km² in the central portion of South America (**Fig. 1A**) (Godoi-Filho, 1986; Alho et al., 1988). Its bat fauna is still poorly studied and scarcely documented (Oliveira et al., 2002).

Inventories based on analysis of Barn Owl (*Tyto alba*, Tytonidae, Strigiformes) pellets contents may show significant differences in relation to those based on other sampling methods (Yom-Tov and Wool, 1997). The purpose here was to provide a complementary inventory of bats found in Barn Owl pellets from the largest private reserve in Brazil (Reserva Particular do Patrimônio Natural - RPPN), and to elaborate a description to each species on the basis of structures best preserved in pellets.

This reserve covers an area of approximately 108 000 ha between the rivers Cuiabá and São Lourenço, 145 km South from Cuiabá, Mato Grosso State, Brazil (**Fig. 1B**). Intact Barn Owl pellets and pellet debris were collected twice a year (dry and wet seasons) in 6 surveys (from August 1999 to October 2002) in 3 nests (**Fig. 1C**). A total of 161 pellets (124 collected in site 1, 31 in site 2, and 6 in site 3) were analyzed. The minimum number of individuals was estimated according to methods proposed in

González et al. (1995). Eighteen cranial measures were taken following Vizzoto and Taddei (1973) and López-González et al. (2001): greatest length of skull (GLS), length of maxillary tooth row (MAX), condylocanine length (CCL), condylobasal length (CBL), palatal length (PL), palatal breadth (PB), basal length (BL), zygomatic breadth (ZYG), interorbital constriction (INC), breadth across upper molars (BAM), breadth across upper canines (BAC), postorbital breadth (POB), breadth of braincase (BBC), mastoidal breadth (MAB), length of rostrum (LNR), occipital height (OH), length of mandibular toothrow (MTR), mandibular length (ML). Bat remains were identified at species level using identification keys, original descriptions, and revisions (Sanborn, 1932; Goodwin, 1942; Goodwin and Greenhall, 1961; Husson, 1962; Vizzoto and Taddei, 1973; Wilson and LaVal, 1974; Freeman, 1981; Hood and Pitoccheli, 1983; Dolan, 1989; Baud and Menu, 1993; Best et al., 1996; Anderson, 1997; López-González et al., 2001; Gregorin and Taddei, 2002), and by direct comparisons with specimens deposited in the collection of the Museu Nacional, Rio de Janeiro (MN), where the voucher were deposited.

Samples included 662 small mammals and 8 unidentified birds. Eleven specimens of bats were found, 10 of which were identi-

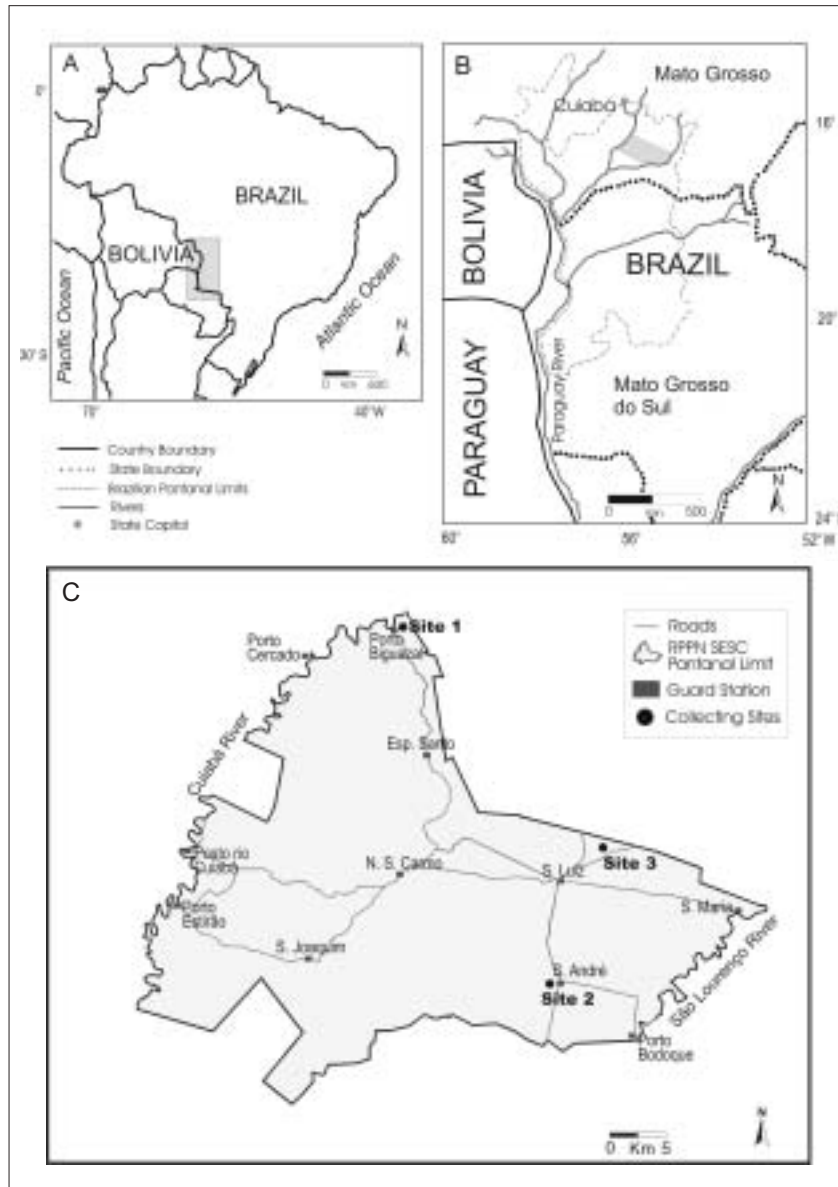


Fig. 1. Grayish area in A and B shows: A) region in South America where Pantanal is located; B) location of Reserva Particular do Patrimônio Natural - RPPN in Mato Grosso State (modified from Alho and Lacher, 1991); and C) shows the location of the sites in RPPN where *Tyto alba* pellets were collected.

fied at species level and 1 at family level (Table 1).

Skulls were the main bat remains found in pellets. Larger skulls were less damaged than smaller ones. Three regions of the skull were most frequently damaged: the anterior region of the premaxilla (lacking in two specimens),

the inferior region of the braincase (lacking in three specimens), and the auditory bulla (lacking in all specimens). The upper molar series were the best-preserved structures. Structures more often damaged in the bat skulls found in pellets were the same structures often damaged in bat fossils (Czaplewski and Cartelle, 1998).

Table 1

Relative frequency (%) considering the minimum number of individuals (n = 670) found in Barn Owl pellets in the three collecting sites in Reserva Particular do Patrimônio Natural RPPN.

Taxon	Number of individuals	Relative frequency (%)
BIRDS	8	1.19
MAMMALS	662	98.81
Rodentia	581	86.71
<i>Holochilus sciureus</i>	450	67.16
<i>Calomys</i> aff. <i>callidus</i>	1	0.15
<i>Oligoryzomys</i> sp.	1	0.15
<i>Necromys lasiurus</i>	1	0.15
<i>Oecomys</i> sp.	1	0.15
<i>Cavia aperea</i>	1	0.15
unidentified rodents	126	18.8
Didelphimorphia	70	10.44
Chiroptera	11	1.64
unidentified Phyllostomidae	1	0.15
<i>N. albiventris</i>	3	0.44
<i>P. discolor</i>	1	0.15
<i>L. brasiliense</i>	1	0.15
<i>M. nigricans</i>	1	0.15
<i>M. molossus</i>	2	0.29
<i>E. perotis</i>	2	0.29

Structures damaged in rodents and marsupials were different from those of bats. Thus, it seems that there might be trends or patterns in breakage, as extensively discussed by Andrews (1990), and might be related to structural properties of the prey skulls, or to behavioral or forestomach anatomical-physiological properties of the owls.

Four species of bats, *Noctilio albiventris*, *Phyllostomus discolor*, *Lophostoma brasiliense* and *Eumops perotis* are reported here for the first time for the diet of *T. alba*. The most frequent bat in pellets, *N. albiventris* (0.44%), was also very abundant in mist-net sampling in RPPN (Escarlate-Tavares and Pessôa, in prep.). Moreover, hundreds of *N. albiventris* have been observed foraging along the Cuiabá River, especially during the wet season. The other 5 species of bats were poorly represented in mist-net-sampling and *L. brasiliense* was not captured on mist-nets.

The frequency of bats in the Barn Owl's diet is usually low, ranging from 13% to 35% (Vaughan and McCoy, 1982). In RPPN, bat's frequency was lower than that observed in other countries such as Bolivia and Mexico (Ramírez-Pulido and Sánchez-Hernández, 1972; Vargas et al., 2002), and higher than in Uruguay and Argentina (e.g., Tiranti, 1992; González et al., 1995; Pardiñas and Cirignoli, 2002). The composition also was different from those found in Argentina and Uruguay, and only one species (*Molossus molossus*) and one genus (*Myotis*) were coincident in Bolivia (Tiranti, 1992; González et al., 1995; Vargas et al., 2002). Geographic variation on the diet of the Barn Owl had been related to variations in habitat and prey availability (Glue, 1971; Campbell et al., 1987; Yom-Tov and Wool, 1997).

It is often assumed that mist-netting and other usual inventory methods are biased, sampling only a fraction of a local bat fauna. Some bat

species are rarely captured using mist-nets, and others usually fly above the canopy (Handley, 1967) where they cannot be netted. Moreover, some insectivorous bats such as molossids and vespertilionids are difficult to capture with mist-nets (Handley, 1967; Reis and Muller, 1995).

Some authors argue that the Barn Owl hunts randomly (Marti, 1987; Yom-Tov and Wool, 1997). If this is true, it should be expected that sampling Barn Owl pellets should be more homogeneous and less biased than mist netting, and also that the owls' probability of capturing an insectivorous bat should be similar to the probability of capturing bats with other feeding habits. However, prey selection is strong in the Barn Owl and may reflect the prey abundance, size or accessibility/vulnerability (Steyn, 1983; Bellocoq and Kravetz, 1994).

All species collected in pellets in RPPN except *P. discolor* are considered exclusively insectivorous or mainly insectivorous (Gardner, 1977; Nowak, 1993). Insectivorous bats usually occur in higher frequencies in open areas where *T. alba* preferentially hunts (Colvin and McLean, 1986; Reis and Muller, 1995).

It is possible to conclude that the exclusive use of Barn Owl pellets to inventory a local bat fauna can also add bias because of the differential abundance and susceptibility of capture of different bat species. However, the use of Barn Owl pellets to complement mist-net sampling should be strongly recommended since some species are rarely captured using this method, mainly insectivorous species, can be sampled by the Barn Owl.

Family Noctilionidae

Noctilio albiventris (Desmarest, 1818)

Specimens examined — MN 64793, MN 64794, MN 64795.

Sample — three skulls relatively well preserved, 1 with mandible. The entire sample came from pellet debris. MN 64795 had the anterior region of the rostrum broken, lacking the premaxilla. Measurements in **Table 2**.

Description — Skull short (GLS: 18.8 to 20.5 mm); braincase high, dorsal margin

slightly flattened; postorbital region very constricted (INC: 7.5 to 7.9 mm); lambdoidal and sagittal crests greatly developed; supraorbital rims elevated, converging posteriorly; coronoid process and mandibular condyle aligned in parallel with the dentary; apical margins of the upper incisors divergent, I2 located diagonally behind I1; upper canines long with a very conspicuous external cingulum; large P4, triangular in occlusal view; p1 smaller than half the size of p2; molar ectolophs W-shaped; M3 broader than long, half the size of M2.

Family Phyllostomidae

Unidentified Phyllostomidae

Specimens examined — MN 64801.

Sample — One incomplete postcranial skeleton (1 humerus, 2 broken radii, 1 femur, the pelvis, carpal and metacarpal bones, some ribs and vertebrae and some phalanges) found in intact pellet. The allocation to the family Phyllostomidae was due to the presence of three completely ossified phalanges on digit III.

Lophostoma brasiliense (Peters, 1867)

Specimens examined — MN 64799.

Sample — A well-preserved skull without mandible found in pellet debris. Only 1 internal upper incisor was present, the other teeth were lost. Measurements in **Table 2**.

Description — Skull long (GSL: 19.9 mm) and narrow; lambdoidal and sagittal crests poorly developed; braincase rounded and narrow (BBC: 8.2 mm); mastoid processes poorly developed (MAB: 9.6 mm); rostrum long and narrow; postorbital region constricted, measuring about 3.4 mm; internal margin of the upper internal incisors united from the bases to the apices; two upper premolars, P3 alveolus smaller than P4; M3 alveolus much smaller than the M1 and M2.

Phyllostomus discolor Wagner, 1843

Specimen examined — MN 64798.

Sample — A very well preserved skull with mandible found in pellet debris. Measurements in **Table 2**.

Description — Skull long (GLS: 27.7 mm); rostrum narrow, relatively short (LNR 11.6

Table 2
Cranial measurements (in mm) of bat specimens found in Barn Owl pellets in Reserva Particular do Patrimônio Natural RPPN. Acronyms are listed in text.

Taxon	Specimen	CRANIAL MEASUREMENTS																		
		GLS	MAX	CCL	CBL	PL	PB	BL	ZYG	INC	BAM	BAC	POB	BBC	MAB	LNR	OH	MTR	ML	
<i>N. albiventris</i>																				
	MN 64793	20.5	7.4	17.5	18.6	8.8	-	15.3	15.2	7.9	-	6.6	5.8	11.2	13.8	7.1	8.3	6.8	12.2	
	MN 64794	18.8	6.8	16.3	17.3	7.3	5.1	14	14.3	7.8	9.3	6.6	5.4	10.75	13.3	7.0	7.3	-	-	
	MN 64795	-	6.3	16.2	-	7.7	5.2	14.1	14.2	7.5	9.2	-	5.4	10.9	13.2	-	7.0	-	-	
<i>P. discolor</i>																				
	MN 64798	27.7	8.5	23.8	25	12.2	4.9	21.1	15.1	6.3	9.1	6.4	6.0	11.6	13.9	11.6	6.9	10.6	18.2	
<i>L. brasiliense</i>																				
	MN 64799	19.9	6.6	17.2	17.5	8.3	3.3	14.6	9.9	4.3	6.6	3.5	3.4	8.2	9.6	8.1	6.6	-	-	
<i>M. nigricans</i>																				
	MN 64800	13.8	5.0	-	-	6.7	3.0	-	8.4	4.2	5.1	3.4	3.6	6.6	-	5.6	-	5.8	9.7	
<i>M. molossus</i>																				
	MN 64796	17.1	5.8	-	-	4.8	4.3	-	-	4.5	8.0	4.6	3.7	-	-	6.7	-	-	-	
	MN 64797	16.3	5.5	-	-	4.9	4.3	-	10.7	4.1	7.8	4.4	3.6	8.7	10.3	6.7	-	-	-	
<i>E. perotis</i>																				
	MN 64803	31.2	12.6	29.6	30.6	12.8	5.7	27.25	19.1	8.1	12.8	8.3	5.3	12.7	15.7	13.6	9.5	14	24.2	
	MN 64802	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.35	24.25

mm); braincase narrow (BBC: 11.6 mm), poorly elevated; mastoid processes very developed (MAB: 13.9 mm); sagittal crest poorly developed; postorbital region poorly constricted (INC: 6 mm); zygomatic arch narrow (ZYG: 15 mm); incisors 2/2, internal upper incisors larger than the external, different in shape; premolars 2/2, P3 separated from P4 by a short diastema; molars 3/3, ectoloph W-shaped.

Family Vespertilionidae

Myotis nigricans (Schinz, 1821)

Specimens examined — MN 64800.

Sample — An incomplete skeleton (radii, tibiae, 1 scapula, phalanges, humerus, femur, pelvis, fragmented ribs, and some vertebrae) with skull and mandible found in an intact pellet. The inferior region of the braincase was completely missing. Only molar series were preserved. Cranial measurements in **Table 2**.

Description — Skull small (GLS: 13.8 mm) and delicate; braincase narrow (BBC: 6.6 mm) and elevated in lateral view; rostrum short (LNR: 5.6 mm); postorbital region depressed; sagittal and lambdoidal crests poorly developed; premaxillae completely separated; upper incisors and canines separated by a short diastema; upper canines with a well developed external cingulum; P2 and P3 united and separated from P4 by a short diastema; P3 alveoli less than P2 and smaller than half the size of P4; P4 antero-posteriorly expanded; molars ectoloph W-shaped; M2 larger than M1 and M3; premolars forming a continuous row from the canine to the molar.

Family Molossidae

Molossus molossus (Pallas, 1766)

Specimens examined — MN 64796, MN 64797.

Sample — Two damaged skulls lacking the mandibles and the inferior region of the braincase. MN 64796 also lacked half of the braincase, and MN 64797 lacked half premaxilla. Measurements in **Table 2**.

Description — Skull short (GLS: 16.3 to 17.1 mm); braincase laterally expanded (BBC: 8.7 mm); rostrum short (LNR: 6.7 mm), robust and heavy; postorbital region very constricted (INC: 4.1 to 4.5 mm); mastoidal processes

pointed (MAB: 10.3 mm); well developed sagittal crest, extending from the posterior end of the nasals to the lambdoidal crest, being highest in the region of the postorbital constriction; upper incisors completely fill the space between the canines; canines with external cingulum very developed; P4 broad, in occlusal view almost as broad as M1; molars broad, ectoloph of M1 and M2 W-shaped; M3 smaller than the M1 and M2, with the talon very reduced, having a V-shape.

Eumops perotis (Schinz, 1821)

Specimens examined — MN 64802, MN 64803.

Sample — A well-preserved semi-complete skeleton with skull and mandible found in intact pellet (MN 64803) and 1 mandible found on pellet debris (MN 64802). Cranial measurements in **Table 2**.

Description — Skull large (GLS: 31.2 mm) and robust; rostrum long (LNR: 9.5 mm), robust and heavy; postorbital region very constricted (INC: 8.1 mm); sagittal crest poorly developed; lambdoidal crest well developed; mastoidal processes broad (MAB: 15.7 mm); incisors 1/2, upper incisors in contact at the bases and divergent at the apices, with a well developed internal cingulum; apical margin of the lower incisors bilobed, i2 covered by the cingulum of the canines in occlusal view; canines with external cingulum very developed; premolars 2/2, P3 very small, located at the base of the canine; molars dilambdodont, M3 half the size of the formers, ectoloph in occlusal view form an incomplete “W”; talonid of M3 and m3 reduced.

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