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The bat communities (Chiroptera) of the Parque Estadual do Rio Doce, a large remnant of Atlantic Forest in southeastern Brazil

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Abstract
We surveyed the bat communities of a large Atlantic Forest reserve in the state of Minas Gerais, SE Brazil, the Parque Estadual do Rio Doce (PERD), over a period of ten months, collecting data on diet and reproduction of their bat species. We recorded bats using ground-level mist-nets erected in several environments within the park, and searched for bat roosts. Of a total of 33 species of bats recorded in the reserve to date, 24 bat species were recorded during this study,12 of which were first records for the park. Seeds of *Cecropia* predominated in the fecal samples of stenodermatine bats, and seeds of *Piper* were the main item in the fecal samples of *Carollia perspicillata*. We also got the first records of bats consuming fruits of *Vismia magnoliifolia*. Peaks of reproduction of bats in PERD occurred in the wet season, except for *Desmodus rotundus*, which was found reproductively active during the dry season. We suggest that the relative abundance of common species such as *D. rotundus* and *Artibeus lituratus* in the most disturbed areas within PERD may be correlated with distinct degrees of disturbance.

Keywords: Atlantic forest, Minas Gerais, frugivory, *Vismia magnoliifolia*, *Cecropia*, bat reproduction, bioindicator.

Introduction

Over 270 species of bat species are distributed through the Neotropical region, from which approximately 40% may be involved in complex ecological mechanisms, such as pollination and seed dispersal. Interactions between Neotropical fruit-eating bats and plants are widely known for their key roles in processes of natural succession and regeneration of forests (e.g. Charles-Dominique, 1986; Fenton et al., 1992; Whittaker & Jones, 1994). Unfortunately, studies on the ecological dynamics of the bat communities associated to the threatened Brazilian Atlantic Forest domain are scarce (e.g. Marinho-Filho, 1991; Müller & Reis, 1992; Faria, 1996; Pedro & Passos, 1995; Passos et al., 2003; Aguiar & Marinho-Filho, 2004).

In fact, the bat fauna of the Atlantic Forest has been insufficiently surveyed in terms of capture effort (Bergallo et al., 2003) and large areas remain completely unsampled, resulting in the current underestimated bat-diversity estimates for this biome. Among the southeastern Brazilian states (Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo), the bat fauna of Minas Gerais (MG) remains the poorest known. The Atlantic Forest of Minas Gerais historically suffered the most intensive destruction within SE Brazil as a consequence of several human activities through time (e.g. calcareous and iron mining, livestock, urbanization, timber) (see Fonseca, 1985).

In this study, we report on aspects of the bat assemblages associated to distinct environments of the Parque Estadual do Rio Doce (PERD). This reserve, currently the larger continuous remnant of Atlantic Forest in MG (ca. 35,794 ha.), is located in the fragmented Rio Doce Basin, in the eastern portion of the state. PERD has been considered of “extreme priority for conservation” (Costa et al., 1998). Some bat species have been previously recorded in sporadic surveys in PERD by Stallings et al. (1990), Tavares & Anciães (1998), Tavares & Taddei (2003), and Nogueira et al. (2003). Our data summarize the first systematic account of the PERD bat fauna and its interactions with the environments within the park. Additionally, we provide

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data on diet and reproduction of the bat species, and preliminary comparisons of bat faunal composition in different habitats within the park.

Material and Methods

The Parque Estadual do Rio Doce (PERD) (19°29' S - 19°48' S, 42°28' W - 42°38' W; 230 m to 515 m elevation), is bordered by the river Doce to the east and partially by the river Piracicaba to the west (Fig. 1). The regional climate is Tropical warm and semi-humid with well-defined dry winters and wet summers, with temperatures averaging 22°C, and average annual rainfall of 1478 mm. Rainfall averaged 1400 m and temperature 23ºC during this study, and the coldest and dry months were between May and August (Fig. 2).

The vegetation in PERD is a mosaic of relatively undisturbed forest, with the predominance of Tropical Low Semi-Deciduous Atlantic forest. PERD have a unique system of more than 40 lakes that occupy approximately 6% of its total area, most of them formed through natural processes. Fern assemblages called regionally "Samambaial" and lowland fields seasonally flooded and dominated by *Cecropia* are also typical formations of PERD. Pastures for cattle and plantations of *Eucalyptus* sp. dominate the surroundings.

Bats were surveyed in three different areas of PERD – a) "Campolina" (CPL), an area of continuous primary forest *(i.e.* relatively undisturbed), tall, mature and stratified, with 20-30 m-high superior stratum, with interconnected canopy with abundant epiphytes *(e.g. Vriesea carinata* Wawra, *Aechmea* sp. — Bromeliaceae), and understory dominated by shrubs such as many species of *Piper* spp. (Piperaceae — Tab. 1); b)"Vinhático" (VIN) is a mature secondary forest with bamboos, grasses and a developed herbaceous stratum, which superior stratum was relatively low (75% of canopy trees reaching 6-15 m), and a partially closed canopy with less expressive presence of epiphytes; c) "Campo de Pouso" (CPO) is an abandoned landing field bordered by a swamp and a pasture, with sparse short trees. The swampy area was covered with thin-trunk low trees of *Cecropia pachystachia* (Urticaceae). Grasses such as *Carex* sp. (Cyperaceae, "Capim navalha"), small shrubs, bushes and trees, composed the herbaceous stratum of CPO.

We conducted fieldwork for periods of four days from February to July, and in October and November 1997, and for six days in January 1997. Sampling in the three areas (CPL, VIN and CPO) was alternated (one to two nights at each area monthly) so that capture efforts resulted approximately equal. We used 6-m and 12-m mist-nets (20-36 mm mesh; 2.5 and 3.0 high, respectively) set at ground level, erecting between 58 m

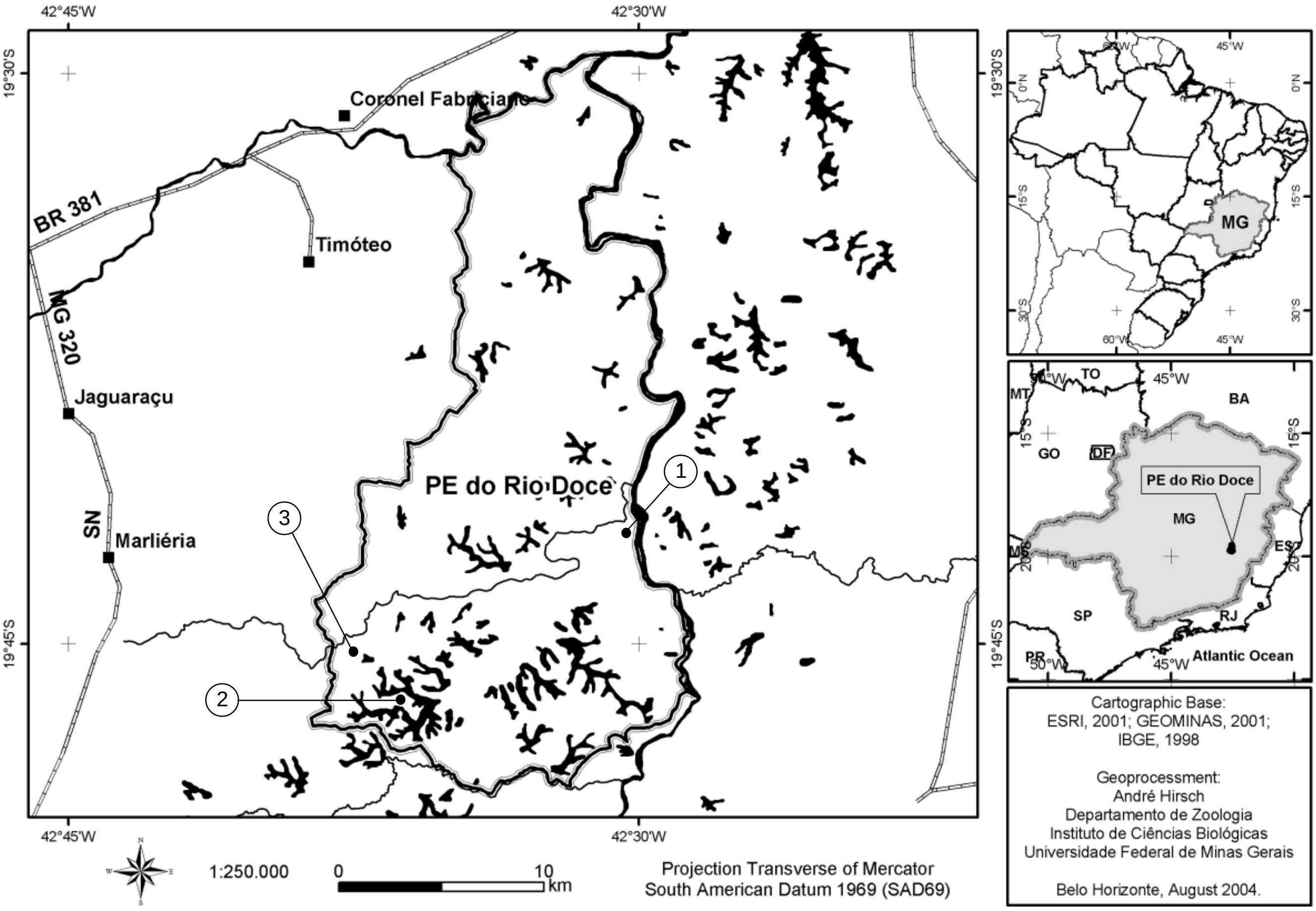

Figure 1 - Map showing the location of Parque Estadual do Rio Doce (PERD) within Minas Gerais state and Brazil, and the sampling sites (1. Campolina; 2. Vinhático and 3. Campo de Pouso)

and 72 m of nets at each night. In total, we erected 3,661 meters of ground-level mist-nets in 29 nights. Nets remained open for at least 8 hours/night. They were placed along and perpendicular to trails, inside cluttered forests and in gaps, and were inspected for bats every 20-30 min. Additionally, we sporadically searched for bats in natural roosts (fallen trunks, tree holes, palm leaves) and artificial roosts located inside and in the surroundings of the reserve (houses, bridges, tunnels, mines, iron pipes, inactive iron ovens).

All bats captured were placed in individually numbered cloth bags and left to defecate for at least 30 min. Fecal samples with insects were placed in alcohol 70% for further analysis, and samples with seeds were placed in Petry dishes, washed and left to dry over absorbent paper. Whenever there was enough seeds/individual, part of the samples was prepared to be kept in labeled glassine envelopes and further identified, and part was prepared to germinate. Most bats were released in their original capture sites after they were identified, measured, photographed, weighted, and marked with aluminum tags. Vouchers and specimens that we were unable to identify in the field are deposited in the collections of UNIDERP at Campo Grande, MS, and at the mammal collection of the Taxonomic Collections of the UFMG (currently at the Laboratório de Mastozoologia, Department of Zoology), MG, Brazil.

Bats were categorized by age (juveniles x adults) according to the ossifying degree of the epiphyses of forelimbs. The reproductive categories of females were defined as: pregnant, lactating, pregnant/lactating, post-lactating (with dark developed nipples not secreting milk), juveniles (with undeveloped nipples, and epiphyses incompletely ossified). Categories for males were set through the observation of testicles, whether they were contained in the scrotal sac (potentially active males) or not (potentially inactive males).

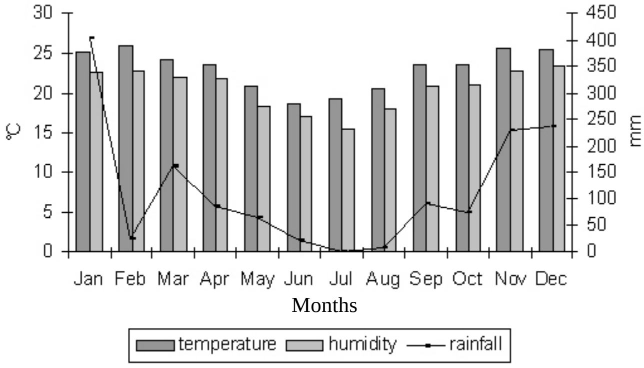

Figure 2 - Temperature (ºC) relative humidity (%) and rainfall (mm) for the year of 1997 in the Parque Estadual do Rio Doce (PERD). The rainfall data was provided by Instituto Estadual de Florestas (IEF).

Seeds were discriminated in a first pass by their external morphology under microscope, and further compared with a reference collection built during the study period. Whenever there was enough seeds, part of each sample (25 seeds) was arbitrarily taken and put to germinate to help in the identification of plants. Seeds for germination experiments were placed in closed Petri dishes filled with cotton soaked in antifungal substance (“nistatina”) at 25°C. Seedlings were transferred to soil pots when they reached the cap. We surveyed three pre-existing trails, one in each sampling area, for plants with chiropterochoric characters diagnosed through criteria as defined in the literature (e.g. Van der Pijl, 1957, 1972, Uieda and Vasconcellos-Neto, 1985, Marinho-Filho and Vasconcellos-

Table 1 - Chiropterochoric plants occuring in PERD, with their relative abundance in the three areas sampled, when applied. P = primary forest (CPL), S = secondary forest (VIN), D = highly disturbed area (CPO).

Plant species	Common name	Habitat	Relative abundance
Piperaceae			
Piper amalago L.	-	P	Abundant
Piper arboreum Aubl.	Jaborandi grande	P, S	Abundant
Piper ceruum Vell.	Capebão	P	Frequent
Piper molliconum Kunth	-	P	Abundant
Piper vicosanum Yuncker	-	P, S	Abundant
Pothomorphe umbellata (L.) Miq.	-	P	Frequent
Piper sp. 1	Jaborandi	P	-
Piper sp. 2	Jaborandi	P	-
Solanaceae			
Solanum sp. 1	-	D	-
Moraceae			
Ficus spp.	Figueira	P	Frequent
Cecropiaceae			
Cecropia glaziovi Snethl.	Embaúba vermelha	P	Rare
Cecropia hololeuca Miq.	Embaúba branca	S, D	Rare
Cecropia pachystachia Trécul	Embaúba do Brejo	S, D	Abundant
Clusiaceae			
Vismia magnoliifolia Schltdl. & Scham	Ruão	D	Abundant

Neto, 1994) and collection of reference seeds in the months of January and November: the CPL trail (1500 m), the VIN trail (1000 m), and the Carioca trail, in CPO (1000 m). Discrete observations of general aspects of the vegetation in the sampling sites included connectivity of canopy trees, presence of lianas, development of herbaceous strata, and presence of epiphytes as suggested by August (1983). Abundance of chiropterochoric plants was estimated through counts in every 200 m in transects, and categorized as follows: rare (less than five individuals); frequent (from five to ten); abundant (more than ten individuals) (Tab. 1).

We calculated the Shannon index *(H')* and evenness index *(E)* to estimate the diversity and homogeneity of the bat communities sampled. Additionally, the index of Levins *(BA)* was calculated to estimate degrees of diet specialization of bats, according to the equation $BA = 1/\sum pij^2 - 1/ n-1$, where *pj* is the proportion of individuals using the resource *I* and *n* is the maximum number of resources used by bats in this study. We built a niche matrix based on trophic categories and size classes for the bat communities of PERD using a factor of 2.0 (1.26^3) for weight classes as suggested by MacNab (1971).

Results

Bat communities and chiropterochoric plants

We recorded 199 bats on the ground-level mist-nets (individuals recorded in front of or inside roosts excluded) (Tab. 2) resulting in a total of five families, 26 genera and 33 species recorded for PERD to date (including species recorded in the previous studies of Stallings et al., 1991; Tavares & Anciães, 1998; Tavares & Taddei, 2003 and Nogueira et al., 2003, see Tab. 3). Eighteen species were captured with mist-nets, four were recorded exclusively in their diurnal roosts, and one was caught inside a lodge at PERD's research center. Authorships for bat species mentioned below are given in Tab. 3. CPL was richer in species than VIN, but the relative species abundance at VIN was more evenly distributed than that of CPL (Tab. 2). CPO was the less diverse and even among all areas, although CPO was almost as rich as CPL (Tab. 2). In CPL and VIN, *A. lituratus* was the most frequently captured species (38% in both areas) followed by *Carollia perspicillata* (Fig. 2). In CPO, *Desmodus rotundus* was the most frequent species (45 %) followed by *Artibeus lituratus* (28%) (Fig. 3). A low percentage (2, 7%) of the total number of marked individuals was recaptured (namely, three *Carollia perspicillata* and one *Sturnira lilium*).

We found one large group (80-85 individuals), another medium-sized group (28-30 individuals) of *Rhynchonycteris naso*; one small group (6-8 individuals) and a medium sized group (46-48 individuals) of *Macrophyllum macrophyllum* sheltering in two houses, regionally called "palafitas" in the Lagoa da Barra. Bat roosts in "palafita" houses containing mixed species *(M. macrophyllum, R. naso and Myotis albescens)* have been previously reported for PERD by Tavares & Anciães (1998). We also found a group of six females of *Peropteryx macrotis*, four with youngsters, one pregnant, and one unreproductive female in an abandoned concrete pipe, and a colony with approximately 30 individuals of *Phyllostomus hastatus* roosting in an abandoned firewood stove, at a charcoal producing company (CAF) in the southern border of the park. A

Table 2 - Effort and success of capture, species richness, diversity and evenness of bats in distinct environments within PERD (see text for details), excluding those collected close to their previously known roost sites *(Histiotus velatus* and *Molossus molossus)* or inside their roosts (e.g. *Macrophyllum macrophyllum).*

Parameter	Area			
	Primary (CPL)	**Secondary (VIN)**	**Disturbed (CPO)**	**PERD***
Effort				
Number of nights	10	10	9	29
Nets open (hours)	72	72	68	212
Nets open (m)	1464	1179	1018	3661
Total effort (m X h)	105408	84888	69224	776132
Success				
N bats captured	62	67	70	199
N bat/meter-net	0.042	0.057	0.0688	0.054
N bat/hour-net	0.861	0.931	1.029	0.934
N bat/meter-hour	0.0007	0.0008	0.0011	0.0003
Richness and diversity				
Richness	11	8	10	-
Diversity	1,74	1,72	1,56	-
Evenness	0,72	0,82	0,68	-

* Total bat species richness of PERD is not represented here because we only considered captures made with mist-nets for our comparisons (for total richness see text).

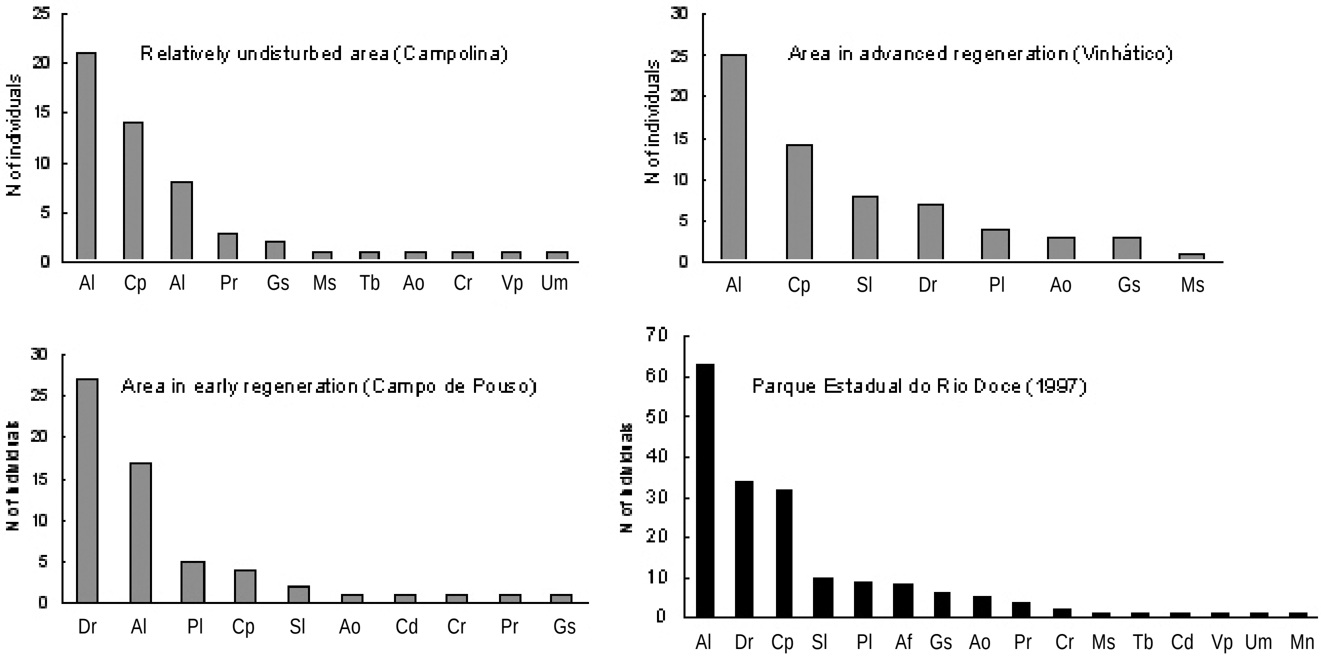

Figure 3 - Relative frequencies (absolute number of records per species) of bats in three areas sampled within Parque Estadual do Rio Doce, and total number of records per species sampled with ground-level mist-nets over the year 1997, excluding species captured in or close to their roosts. *Af = Artibeus fimbriatus, Ao = Artibeus obscurus, Al = Artibeus lituratus, Cp = Carollia perspicillata, Cd = Chiroderma doriae, Cv = Chiroderma villosum, Dr = Desmodus rotundus, Gs = Glossophaga soricina, Ms = Micronycteris schmidtorum, Mn = Myotis nigricans, Pl = Platyrrhinus lineatus, Pr = Platyrrhinus recifinus, Sl = Sturnira lilium, Tb = Tonatia bidens, Um = Uroderma magnirostrum, Vp = Vampyressa pusilla.*

single individual of *Trachops cirrhosus* was captured when flying inside a lodge for visiting researchers.

We found over 15 potentially-chiropterochoric plant species belonging in the families Piperaceae, Moraceae, Cecropiaceae and Clusiaceae in the three study sites (for species, see Tab. 1). All *Piper* species were distributed in the understory of the two forested areas surveyed. *Vismia magnoliifolia* was only recorded in the open area, and arboreal *Ficus* species composed the canopy in the primary area. We observed taller individuals of *Cecropia* spp. inside the forested areas, whereas shorter reproductively-active individuals of *C. pachystachia* were more frequent in borders, open, and swampy areas. On the other hand, *C. glaziovi* was relatively frequent in CPL, being absent in the other two areas.

Most seeds/Petri-dish of in our germination experiments were viable (ca 90%).

Diet and trophic niches

Phyllostomid bats consumed fruits of at least three species of Piperaceae, three of *Cecropia,* at least two of Moraceae *(Ficus),* and one of Clusiaceae (Tab. 4). *Cecropia* fruits were the main item consumed by phyllostomids in PERD — 53% of the fecal samples of stenodermatine bats (n = 49) contained seeds of plants in this genus and 37% of them contained *Ficus* seeds.

Artibeus lituratus had the broadest diet range, followed by *Carollia perspicillata*. *Artibeus lituratus* consumed mostly fruits of *Cecropia* (52,6%) and of *Ficus* (42,1%). Of the seed samples of *Cecropia* from feces of *A. lituratus,* 70% belonged to *C. pachystachia*. *Artibeus fimbriatus* also fed on fruits of *C. pachystachia*, while *Carollia perspicillata* fed mainly on fruits of *Piper* spp. *Carollia perspicillata* (n = 3), *Artibeus lituratus* (n = 2) and *S. lilium* (n = 1) also fed on fruits of *Vismia magnoliifolia*. Insects were occasionally consumed by six species of phyllostomid bats (e.g. *Glossophaga soricina).* Unindentified pollen grains were found in the feces of *G. soricina* and *A. lituratus.*

Small to medium-sized species of bats predominate in the trophic-size niche matrix (Tab. 5), many species of small-sized insectivorous and medium to large-sized frugivorous bats occupied the same cells, and nearly half of the cells of the trophic-size niche matrix were unoccupied.

Reproduction

We captured a large number of pregnant and lactant females of *A. lituratus* between October and January, and juveniles of this species were frequently captured in October and April (Fig. 4). Most of the reproductive bat females recorded for PERD were captured in the wettest months of the year of 1997, with the

Table 3 – List of bats from Parque Estadual do Rio Doce, including method of recording, relative frequencies per site of capture, habitat, and sources of information. Capture sites of records gathered from Stallings et al. (1991) are discriminated in the "habitat" column, and follow their habitat classification: "native forest", "dirty field", and "anthropogenic". CPL = Campolina; VIN = Vinhático; CPO = Campo de Pouso.

TAXON	METHOD[1]	ABUNDANCE PER SITE[2]			HABITAT	SOURCE
		CPL	VIN	CPO		
EMBALLONURIDAE						
Peropteryx macrotis (Wagner, 1843)	R	–	–	–	Anthropogenic	this study
Rhynchonycteris naso (Wied-Neuwied, 1820)	R	–	–	–	Anthropogenic	this study, Stallings et al. 1991, Tavares and Anciães 1998
NOCTILIONIDAE						
Noctilio leporinus (Linnaeus, 1758)	MN	–	–	–	Anthropogenic	Stallings et al. 1991, and see appendix
PHYLLOSTOMIDAE						
DESMODONTINAE						
Desmodus rotundus (É. Geoffroy, 1810)	MN	–	7 (10,8)	27 (45)	Secondary and highly disturbed	this study
GLOSSOPHAGINAE						
Anoura caudifer (É. Geoffroy, 1818)	MN	–	–	–	Anthropogenic	Stallings et al. 1991
Anoura geoffroyi Gray, 1838	MN	–	–	–	Anthropogenic	Stallings et al. 1991
Glossophaga soricina (Pallas, 1766)	MN	2 (3,7)	3 (4,6)	1 (1,7)	Primary, secondary, highly disturbed, and anthropogenic	this study, Stallings et al. 1991
PHYLLOSTOMINAE						
Chrotopterus auritus (Peters, 1856)	MN	–	–	–	Native forest	Stallings et al. 1991
Macrophyllum macrophyllum (Schinz, 1821)	R	–	–	–	Secondary forest	this study, Tavares and Anciães 1998
Micronycteris schmidtorum Sanborn, 1935	MN	1 (1,85)	–	–	Primary forest	Tavares and Taddei 2003
Phyllostomus hastatus (Pallas, 1767)	R	–	–	–	Native forest	this study, Stallings et al. 1991
Tonatia bidens (Spix, 1823)	MN	1 (1,85)	–	–	Primary forest	this study
Trachops cirrhosus (Spix, 1823)	A	–	–	–	Anthropogenic	this study
CAROLLIINAE						
Carollia perspicillata (Linnaeus, 1758)	MN	14 (25,9)	14 (21,6)	4 (6,7)	All	this study, Stallings et al. 1991

Continued...

Table 3 - continued.

TAXON	METHOD[1]	ABUNDANCE PER SITE[2]			HABITAT	SOURCE
		CPL	VIN	CPO		
Carollia perspicillata (Linnaeus, 1758)	MN	14 (25,9)	14 (21,6)	4 (6,7)	All	this study, Stallings et al. 1991
STENODERMATINAE						
Sturnira lilium (É. Geoffroy, 1810)	MN	–	8 (12,3)	2 (3,3)	Highly disturbed areas, and native forest	this study, Stallings et al. 1991
Artibeus fimbriatus Gray, 1838	MN	8 (14,8)	–	–	Primary forest	this study
Artibeus planirostris (Spix, 1823)	MN	–	–	–	Native forest	Stallings et al. 1991
Artibeus lituratus (Olfers, 1818)	MN	21 (38,9)	25 (38,5)	17 (28,3)	All	this study, Stallings et al. 1991
Artibeus obscurus Schinz, 1821	MN	1 (1,8)	3 (4,6)	1 (1,7)	All	this study, Stallings et al. 1991
Chiroderma doriae Thomas, 1891	MN	–	–	1 (1,7)	Highly disturbed area	this study
Chiroderma villosum Peters, 1860	MN	1 (1,8)	–	1 (1,7)	Primary and highly disturbed area	this study
Platyrrhinus lineatus (É. Geoffroy, 1810)	MN	–	4 (6,1)	5 (8,3)	Secondary and highly disturbed area, dirty fields, anthropogenic	this study, Stallings et al. 1991
Platyrrhinus recifinus (Thomas,1901)	MN	3 (5,6)	–	1 (1,7)	Primary forest and highly disturbed area	this study
Pygoderma bilabiatum (Wagner, 1843).	–	–	–	–	Unknown	see appendix
Uroderma magnirostrum Davis, 1968	MN	1 (1,8)	–	–	Primary forest	Nogueira et al. 2003
Vampyressa pusilla (Wagner, 1843)	MN	1 (1,8)	–	–	Primary forest	this study
MOLOSSIDAE						
Molossus molossus (Pallas 1766)	R	–	–	–	Secondary	this study
VESPERTILIONIDAE						
Eptesicus brasiliensis (Desmarest 1819)	–	–	–	–	Unknown	see appendix
Histiotus velatus (I. Geoffroy, 1824)	R	–	–	–	Secondary	this study
Lasiurus ega (Gervais 1855)	–	–	–	–	Unknown	see appendix
Myotis albescens (E. Geoffroy 1806)	R	–	–	–	Roost	Tavares and Anciães, 1998
Myotis nigricans (Schinz 1821)	MN	–	1 (1,5)	–	Secondary forest	this study
Rhogessa hussoni Genoways & Baker 1996	–	–	–	–	Unknown	see appendix

[1] Mist netting (MN), roost searching (R), unknown (-), or accidental (A; for this category see text).
[2] Number of individuals captured with mist-nets at each site and relative frequency (%) of each species/site in parentheses.

Table 4 - Number of fecal samples containing alimentary items consumed by bats in PERD, during 1997 and diet breadth index (BA) for some species. *Af: Artibeus fimbriatus, Ao: Artibeus obscurus, Al: Artibeus lituratus, Cp: Carollia perspicillata,Cd: Chiroderma doriae, Gs: Glossophaga soricina, Hv: Histiotus velatus, Mm: Molossus molossus, Pl: Platyrrhinus lineatus, Pr: Platyrrhinus recifinus, Sl: Sturnira lilium, Tb: Tonatia bidens.*

PLANTS/OTHER FOOD ITEMS	BAT SPECIES											
	Af	*Ao*	*Al*	*Cp*	*Cd*	*Gs*	*Hv*	*Mm*	*Pl*	*Pr*	*Sl*	*Tb*[1]
CECROPIACEAE												
Cecropia glaziovi Snethl.	–	–	3	–	–	–	–	–	–	–	–	–
Cecropia hololeuca Miq.	–	–	3	–	–	–	–	–	–	–	–	–
Cecropia pachystachia Trécul	4	–	14	–	–	–	–	–	3	–	–	–
MORACEAE												
Ficus spp.	–	–	16	–	1	–	–	–	–	1	–	–
PIPERACEAE												
Piper arboreum Aubl.	–	–	–	2	–	–	–	–	–	–	–	–
Piper sp.1	1	–	–	7	–	–	–	–	–	–	1	–
Piper sp.2	–	–	–	3	–	–	–	–	–	–	–	–
SOLANACEAE												
Solanum spp.	–	–	–	–	–	–	–	–	–	–	1	–
CLUSIACEAE												
Vismia magnoliifolia Schltdl & Cham.	–	–	2	3	–	–	–	–	–	–	1	–
Insects	–	–	1	3	–	2	1	1	–	–	–	1[1]
Polen	–	–	1	–	–	2	–	–	–	–	–	–
Fruit pulp	1	1	3	4	–	–	–	–	–	2	–	–
Samples with seeds (n)	5	–	38	15	1	–			3	1	3	–
Total samples analyzed (n)	8	5	63	35	1	4	2	1	9	4	11	1
Dietary breadth (BA)	0,04	–	0,17	0,12	–	–	–	–	–	–	–	–

[1] *Tonatia bidens* consumed insects belonging in the orders Coleoptera and Lepidoptera.

exception of *D. rotundus*. In the wet season (January), we captured pregnant females of *S. lilium* (1), *P. lineatus* (3), and *D. rotundus* (1), and a lactating *S. lilium*; in March, a lactating *C. perspicillata*, and a post-lactating *S. lilium*, and in October a post-lactating *P. lineatus*. In the dry season, we recorded two pregnant *D. rotundus* (one in April, and one in July), a lactating *V. pusilla*, two post-lactating females of *A. fimbriatus*, two post-lactating females of *C. perspicillata*, three lactating females of *A. fimbriatus*, and one of *C. doriae* (all in May). The capture of a pregnant female of *U. magnirostrum* in PERD in October 1997, was recently reported by Nogueira et al. (2003).

Discussion

Bat communities

In other studies conducted with similar methodology and at similar latitudes, bat richness varied from 10 to 37 species, and the number of individuals captured averaged ~250 (e.g. Trajano, 1985; Pedro & Taddei, 1997; Passos et al., 2003). Our results conform to those from previous works, except for the fact that we captured a lower overall number of individuals on the ground level nets, and a higher number of species. In all the studies mentioned above, as well as in other Neotropical sites in the Amazonian forest domain, with larger number of bats sampled and employing mixed sampling techniques (Kalko et al., 1996b; Simmons & Voss, 1998; Bernard 2001a, b; Bernard & Fenton, 2002), phyllostomid bats predominated.

On the other hand, adequate samples of aerial insectivorous bat species are limited by the ground-level mist-netting sampling method (Kalko et al., 1996a, b), since those bats usually flight high and have the ability to locate nets due to their refined echolocation system (Kalko, 1997; Kalko et al., 1996b). Further attempts to make exhaustive inventories of bats in PERD, thus, would benefit from the use of high nets (Handley, 1967; Bernard, 2001b; Lim & Engstrom, 2001) and from the monitoring of echolocation signals (e.g. Kalko et al., 1996a; Kalko, 1997). Nonetheless, our sample was apparently improved by erecting nets in a variety of microhabitats within each area and by roost searching — *M. macrophyllum* and *R. naso* were tightly associated to water in PERD and were only captured close to lakes; *M. schmidtorum* was captured in a net set in the cluttered inner forest and away from trails (Tavares & Taddei, 2003); *P. macrotis*, *H. velatus* and *M. molossus* were exclusively captured close to, or inside their roosts. Therefore efforts to improve inventories in PERD (and by extension in SE Brazil) should minimally include roost-searching and enhanced sampling effort with mist-nets, particularly when there are

Tabela 5 - Niche matrix based on bat body-mass classes and diet from PERD, built according to parameters of McNab (1971).

Feeding guilds	Body-mass classes (g)				
	< 6	6 - 12	12 - 24	24 - 48	> 48
Insectivores	2	6		2	
Nectarivores	1	1	1		
Frugivores		1	4	4	3
Sanguivores				1	
Carnivores					
Piscivores					2
Omnivores					1

limitations to the use of other sampling techniques (e.g. echolocation monitoring). Nevertheless, in the absence of complete inventorying tools, conclusions on the diversity of bats from Atlantic Forest areas must be taken with caution.

Diet and bat trophic-niches

As we observed in our study, species of *Artibeus* have been reported to feed mainly on fruits of Moraceae and Urticaceae (= Cecropiaceae) in Costa Rica (Heithaus et al., 1975; Fleming et al., 1977), and in SE Brazil (Zortéa & Chiarello, 1994; Faria, 1996; Pedro & Taddei, 1997; Passos et al., 2003). *Artibeus* fed mostly on fruits of *C. obtusa* in French Guiana (Charles-Dominique, 1986) and of *Ficus* at Barro Colorado, Panama (Gianinni & Kalko, 2004). In the Atlantic Forest of southeastern Brazil, *Cecropia* is a largely abundant food resource for bats, and seems to be a core resource for phytophagous phyllostomid bats, its fruits being as frequently consumed as those of *Ficus* and the fecal samples containing them often outnumber those with seeds of *Ficus*.

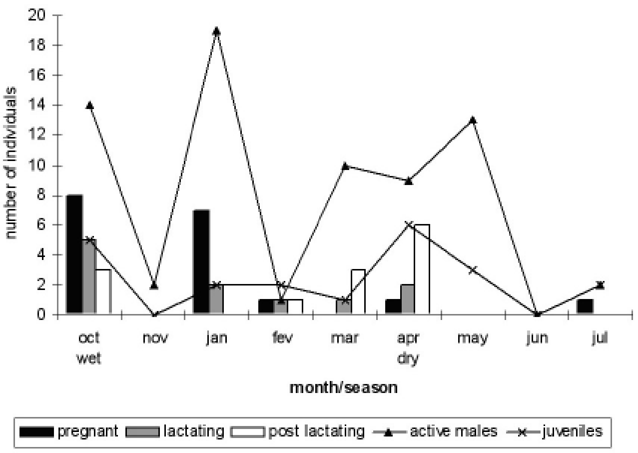

Figure 4 - Reproductive pattern of *Artibeus lituratus* in PERD over the year of 1997 as demonstrated by reproductive status of captured individuals.

The predominance of *Piper* in the diet of *Carollia perspicillata*, as detected in our study, has been previously demonstrated for other study sites in SE Brazil (e.g. Marinho-Filho, 1991; Passos et al., 2003) and several other Neotropical regions (e.g. Heithaus et al., 1975; Palmeirim et al., 1989; Fleming, 1991; Thies et al., 1998; Gianinni & Kalko, 2004; Thies & Kalko, 2004).

Marinho-Filho & Vasconcellos-Neto (1994) observed bats consuming fruits of *Vismia cayennensis* in the Brazilian Amazon and suggested that other species of *Vismia* could potentially be dispersed by bats due to their chiropterochoric morphology. Indeed, fruits of *Vismia magnoliifolia*, to the best of our knowledge firstly reported here to be eaten by bats, are similar in morphology to fruits of other *Vismia* species already recorded being dispersed by bats (e.g. *V. guianensis*, *V. sessifolia* and *V. latifolia* in French Guiana — Charles-Dominique, 1986; *V. cayanensis* in the Brazilian Amazonia — Marinho-Filho & Vasconcellos-Neto, 1994).

Small and medium-sized bats predominated in both community matrixes as usually predicted for bat communities (Findley, 1993) and further records may increase the number of occupied cells (e.g., all missing size-categories of insectivorous bats). However, part of the many empty cells in our matrix was an expected result (e.g., there are no small-sized carnivorous or hematophagous bats). Overall, the trophic-size matrix coarsely mixed species with distinct diet and habitat preferences in the same cells. Other parameters, such as constraints related to foraging strategies and roost requirements, will further be studied and eventually added to the matrix for a better understanding of mechanisms of resource partitioning within PERD (V. Tavares, unpublished).

Reproduction

Seasonality of reproduction events of frugivorous bats usually correlate to rainfall regimes, coinciding with periods of great resource availability. Mello et al. (2004), for example, demonstrated that *Carollia perspicillata* synchronizes its reproduction with peaks of *Piper* fruit production in Reserva Biológica de Poços das Antas, a fragment of Atlantic Forest in the state of Rio de Janeiro. Phyllostomid species have been considered either seasonal polyestrous, or aseasonal polyestrous

(Wilson, 1973; Taddei, 1976; Wilson, 1979). Although our results were constrained by the lack of information on the bat-plant phenology the peaks of reproductive activity of phytophagous bats coincided with the rainy season at PERD. In contrast, reproduction of the hematophagous species, *Desmodus rotundus,* appears not to be related to seasonal constraints, maybe because food is abundant for this species throughout the year. According to some authors (e.g. Wimsatt & Trapido, 1952), *D. rotundus* has continuous reproduction, and has been usually considered aseasonal polyestrous (Wilson, 1979).

Conservation

Bat capture rates may help the diagnosis of the conservational state of Atlantic Forest areas. It has been noticed for other Neotropical sites that undisturbed habitats usually have a higher species accumulation rate than disturbed ones, which, in contrast, tend to have higher capture rates (e.g. Simmons & Voss, 1998; Simmons et al., 2000). Although our sampling was not exhaustive, these patterns can already be noticed in our results. Several authors (Fenton et al., 1992; Wilson et al., 1996; and Medellin et al., 2000) have suggested that bats may serve to diagnose the health of an environment by the observation of diversity values, absolute richness, and total numbers of rare species plus relative frequencies of the most common ones.

We suggest that bats may be appropriate as bioindicators even in the undersampled SE Brazil if — 1) capture efforts are taken into consideration for analyses of relative abundance, and 2) richness and relative abundance are treated separately, and allied to information on the biology of the species. Medellin et al. (2000), for example, found that relative abundance of the most abundant bat in Selva Lacandona (Mexico) was negatively correlated with vegetation complexity, a clear pattern observed in our study.

Aspects of the biology of *D. rotundus* also aid characterizing low environmental quality. Sheltering options are independent from habitat disruption to a certain point for *D. rotundus*, particularly in Minas Gerais, as this species uses both artificial and natural roosts (e.g. the state is rich in karstic areas with caves), and food availability is positively correlated with disturbance in the state. This is due to the extensive, ever-growing livestock industry in the state, which was established centuries ago. These two elements, abundant and easily accessible food (blood from livestock), and sheltering plasticity, contributed to the abnormal increase of populations of *D. rotundus* in the state. In fact, Goodwin & Greenhall (1961) already predicted a forthcoming situation similar to that we just described for the Neotropical region in general. Therefore, deforestation has favored the growing of populations of *D. rotundus*, which are often associated to habitat disruption, when markedly predominant numerically over other species.

In the highly degraded area of CPO, *A. lituratus* was almost as frequent as *D. rotundus*, a determinant factor to affect the equitability and diversity in this area. *Artibeus lituratus* is a very common bat throughout the forests of SE Brazil and a customary city-dweller (e.g. Taddei, 1969; Müller & Reis, 1992; Sazima et al., 1994; Bredt & Uieda, 1996; Perini et al., 2003). Its relative abundance appears to be another suitable aspect to diagnose the empoverishment of an environment. However, *A. lituratus* needs foliage to roost and fruits to eat, even being, to a certain point, a flexible opportunistic fruit bat. All considerations taken, we still suggest that exceptionally higher frequencies of *A. lituratus* in relation to those of other frugivorous bat-species may be informative to compare among forested areas in southeastern Brazil, when methodologically robust, high capture efforts are employed. It is worthy to comment that this situation appears not to be valid for *A. lituratus* in other regions (e.g., in a well preserved area of western Pará, *A. obscurus* appears to be the most abundant *Artibeus* species, while *A. lituratus* is relatively less frequent — V. Tavares, pers. obs.).

Wilson et al. (1996) regarded carolliine bats as indicators of disrupted habitats. Thus, in SE Brazil, *Carollia perspicillata* is also frequently captured, but requires forested habitats. In our study, *C. perspicillata* has apparently been favored by the secondary forest in PERD, plenty of its favorite food *(Piper)*, and was relatively uncommon in the highly disturbed area, where *Piper* was scarce.

Relative rarity of phyllostomine bats in inventories in the Atlantic Forest domain may be partially related to the intense destruction that this biome has been suffering, since many phyllostomine bats have specialized diets (predominantly carnivorous and insect-gleaners) and special roosting requirements (Fenton et al., 1992). The simple presence of phyllostomine species in inventories conducted within SE Brazilian forests may be taken into account in assessments of the preservation status of Atlantic Forest sites, independently of species number and relative abundance, with the exception of two species, *Phyllostomus hastatus*, and *P. discolor*. These two species have broad diets and are frequently found in artificial roosts and in urban environments of SE Brazil (e.g. Perini et al., 2003) but, on the other hand, they are not usually abundant: their relative sensitivity to the environment is then confusing to assess with the data currently available. Wilson et al. (1996) also disregarded *P. hastatus* as a useful bioindicator.

Aside from considerations on the usefulness of bats as bioindicators for the Atlantic Forest domain, phyllostomid species contribute to spread populations of pioneer plants such as *Cecropia* and consequently to the regeneration of fragmented areas in the Atlantic Forest domain to a yet unmeasured extent. Studies analyzing the influence of chiropterochory on the regeneration of Atlantic Forest fragments are largely missing and may be of special interest from a conservational point of view. Further investigations may include monitoring bats to quantifying the amount of fruits consumed, dispersal ranges of seeds carried by bats, and the role of bats in the regeneration of fragmented areas within the Atlantic forest, in areas such as PERD. Such studies can only be performed with the establishment of long-term studies of the bat communities in the Atlantic forest, which have not been attempted to date.

Intensive threats to the Park of Rio Doce (PERD) and to the Rio Doce Basin are related to the uncontrolled industrial and urban expansion in the region (Costa et al., 1998) and to the hunting of medium and large-sized mammals. Fires are also an alarming threat to the forested areas in the region, and the risk of fires increases with anthropogenic expansion. Cattle rising in the immediate surroundings should be fast controlled to limit food availability for *D. rotundus* and due to serious consequences of their populational increase coupled with the hazardous circulation of rabies virus. The importance of artificial roosts is also remarkable for the bat communities of PERD and surroundings, such as "palafita" houses, where roosting associations of up to three bat species from three different families have been found (Tavares & Anciães, 1998). Environmental education should prevent local people, such as fishermen, to eliminate the roosting bats, which is the general predisposition as we understood by interviewing riverside people.

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References

Aguiar, L. M. S. & Marinho-Filho, J. S. 2004. Activity patterns of nine Phyllostomid bat species in a fragment of the Atlantic Forest in Southeastern Brazil. **Revista Brasileira de Zoologia, 21**: 385-390.

August, P. V. 1983. The role of habitat complexity and heterogeneity in structuring tropical mammal communities. **Ecology, 64**: 1495-1507.

Bergallo, H. G.; Esberard, C. E.; Ribeiro de Mello, M. A.; Lins, V.; Mangolin, R.; Melo, G. G. S.; & Baptista, M. 2003. Bat species richness in Atlantic Forest: What is the minimum sampling effort? **Biotropica, 35**: 278-288.

Bernard, E. 2001a. Species list of bats (Mammalia, Chiroptera) of Santarém area, Pará State, Brazil. **Revista Brasileira de Zoologia, 18**: 455-463.

Bernard, E. 2001b.Vertical stratification of bat communities in primary forests of Central Amazon, Brazil. **Journal of Tropical Ecology, 17**: 115-126.

Bernard, E. & Fenton, M.B. 2002. Species diversity of bats (Mammalia: Chiroptera) in forest fragments, primary forests, and savannas in central Amazonia, Brazil. **Canadian Journal of Zoology, 80**: 1124-1140.

Bredt, A., & Uieda, W. 1996. Bats from urban and rural environments of the Distrito Federal, mid-western Brazil. **Chiroptera Neotropical, 2**: 54-57.

Charles-Dominique, P. 1986. Inter-relations between frugivorous vertebrates and pioneer plants: *Cecropia*, birds and bats in French Guyana. In: Estrada, A. & Fleming, T. H. (Ed.) **Frugivorous and Seed Dispersal.** The Hague, W. Junk Publishers, pp. 119-136.

Costa, C.M.R.; Herrmann, G.; Martins, C.S.; Lins, L.V. & Lamas, I.R. 1998. **Biodiversidade em Minas Gerais: um atlas para sua conservação.** Belo Horizonte, Fundação Biodiversitas, 94pp.

Faria, D.M. 1996. Food resource utilization by a Phyllostomidae phytophagous bat guild at the Santa Genebra Reserve, Campinas, SP, Brazil. **Chiroptera Neotropical, 2**: 43.

Fenton, M. B.; Acharya, L.; Audet, D.; Hickey, M. B. C.; Merriman, C.; Obrist, M.K.; Syme, D.M.. 1992. Phyllostomid bats as indicators of habitat disruption in the neotropics. **Biotropica, 24**: 440-446.

Findley, J. S. 1993. **Bats: a Community Perspective**. Cambridge, Cambridge University Press, 167pp.

Fleming, T. H. 1991. The relationship between body size, diet, and habitat use in frugivorous bats, genus *Carollia* Phyllostomidae). **Journal of Mammalogy, 72**: 493–501.

Fleming, T. H.; Heithaus, E. R. & Sawyer, W. B. 1977. An experimental analysis of food location of frugivorous bats. **Ecology, 58**: 619-627.

Fonseca, G. A. B. 1985. The vanishing Brazilian Atlantic Forest. **Biological Conservation, 34**: 17-34.

Gianinni, N. & Kalko, E. K. V. 2004. Trophic structure in a large assemblage of phyllostomid bats in Panama. **Oikos, 105**: 209-220.

Goodwin, G. G. & Greenhall, A. M. 1961. A review of the bats of Trinidad and Tobago. **Bulletin of the American Museum of Natural History, 122**: 187-302.

Handley Jr., C. O. 1967. Bats of canopy of an Amazonian forest. In: Lent, H. (Ed.). **Atas Simpósio Biota Amazônica**. Manaus, Conselho Nacional de Pesquisas. V. 5, pp. 211-215

Heithaus, E. R.; Fleming, T. H.; Opler, P. A. 1975. Foraging patterns and resource utilization in seven species of bats in a seasonal tropical forest. **Ecology**, 56: 841-854.

Kalko, E. K. V. 1997. Diversity in tropical bats. In: Ulrich, H. (Ed.) **Tropical diversity and systematics**, Proceedings of the International Symposium on Biodiversity and Systematics in Tropical Ecossystems, Bonn, Zool. Forschungsinst Mus. Alexander Koenig, pp. 13-43.

Kalko, E. K. V, Herre, E. A. & Handley, C. O., Jr. 1996a. Relation of fig fruit characteristics to fruit-eating bats in the New and Old World tropics. **Journal of Biogeography, 23**: 565-576.

Kalko, E. K. V.; Handley, C. O., Jr. & Handley, D. 1996b. Organization, Diversity, and LongTerm Dynamics of a Neotropical Bat Community. In: Cody, M. & Smallwood, J. (Ed.), **Long-Term Studies of Vertebrate Communities**, Los Angeles, Academic Press, Inc., pp. 503-552.

Lim, B. & Engstrom, M. D. 2001. Bat community structure at Iwokrama forest, Guyana. **Journal of Tropical Ecology, 17**: 647-665.

MacNab, B. K. 1971. The structure of tropical bat faunas. **Ecology, 52**: 352-358.

Marinho-Filho, J. S. 1991. The coexistence of two frugivorous bat species and the phenology of their food plants in Brazil. **Journal of Tropical Ecology, 7**: 59-67.

Marinho-Filho, J. S. & Vasconcellos-Neto, J. 1994. Dispersão de sementes de *Vismia cayenensis* (Jacq.) Pers. (Guttiferae) por morcegos na região de Manaus, Amazonas. **Acta Botânica Brasiliensis, 8**: 88-96.

Medellín, R. A.; Equihua, M. & Amin, M. A. 2000. Bat diversity and abundance as indicators of disturbance in Neotropical rainforests. **Conservation Biology, 14**: 1666-1675.

Mello, M. A. R., Schittini, G., Selig, P., Bergallo, H.G. 2004. A test of the effects of climate and fruiting of *Piper* species (Piperaceae) on reproductive patterns of the bat *Carollia perspicillata* (Phyllostomidae). **Acta Chiropterologica, 6**: 309–318.

Morrison, D. W. 1978. Foraging ecology and energetics of the frugivorous bat *Artibeus jamaicensis*. **Ecology, 59**. 716-723.

Müller, M. F. & dos Reis, N. R. 1992. Partição de recursos alimentares entre quatro espécies de morcegos frugívoros (Chiroptera: Phyllostomidae). **Revista Brasileira de Zoologia, 9**: 345-355.

Nogueira, M. R., Tavares, V. C. & Peracchi, A. L. 2003. New records of *Uroderma magnirostrum* Davis (Mammalia, Chiroptera) from southeastern Brazil, with comments on its natural history. **Revista Brasileira de Zoologia, 20**: 691 - 697.

Palmeirim. J. M.; Gorchov, D. L. & Stoleson, S. 1989. Trophic structure of a Neotropical frugivore community: is there competition between birds and bats? **Oecologia, 79**: 403-411.

Passos, F. C.; Silva, W. R.; Pedro, W. A. & Bonin, M. 2003. Frugivory in bats (Mammalia, Chiroptera) at the Intervales State Park, Southeastern Brazil. **Revista Brasileira de Zoologia, 20**: 511-517.

Pedro, W. A. & Passos, F. C. 1995. Occurence and food habits of some bat species from the Linhares Forest Reserve, Espírito Santo, Brazil. **Bat Research News, 36**: 1-2.

Pedro, W. A. & Taddei, V. A. 1997. Taxonomic assemblage of bats from Panga reserve, southeastern Brazil: abundance patterns and trophic relations in the Phyllostomidae (Chiroptera). **Boletim do Museu de Biologia Mello Leitão (N. Sér.), 6**: 3-21.

Perini, F. A.; Tavares, V. C. & Nascimento, C. M. D. 2003. Bats from the city of Belo Horizonte, Minas Gerais, southeastern Brazil. **Chiroptera Neotropical, 9**: 169-173.

Sazima, I.; Fischer, W. A.; Sazima, M. & Fischer, E. A. 1994. The fruit bat *Artibeus lituratus* as a forest and city dweller. **Ciência e Cultura, 46**: 164-168.

Simmons, N. B. & Voss, R. S. 1998. The Mammals of Paracou, French Guiana: a Neotropical Lowland Rainforest Fauna - Part I. Bats. **Bulletin of the American Museum of Natural History, 237**: 1- 219.

Simmons, N. B.; Voss, R. S. & Peckham, H. C. 2000. The bat fauna of the Saül region, French Guiana. **Acta Chiropterologica, 2**: 23-36.

Souza, M. A.; Langguth, A.; Gimenez, E. A. 2004. Mamíferos dos brejos de altitude Paraíba e Pernambuco. In: Pôrto, K. C.; Cabral, J. J. P.; Tabarelle, M. (Ed.). **Brejos de altitude em Pernambuco e Paraíba, História Natural, Ecologia e Conservação**. Brasília, Ministério do Meio Ambiente, Série Biodiversidade, pp 229-249.

Stallings, J.R.; Fonseca, G. A. B.; Pinto, L. P.; Aguiar, L. M. S. & Sábato, E. L. 1990. Mamíferos do Parque Florestal do Rio Doce, Minas Gerais, Brasil. **Revista Brasileira de Zoologia, 7**: 663-677.

Taddei, V. A. 1969. Aspectos da biologia de *Artibeus lituratus lituratus* (Lichtenstein 1823) (Chiroptera: Phyllostomidae). **Ciência e Cultura, 21**: 451-452.

Taddei, V. A. 1976. The reproduction of some Phyllostomidae (Chiroptera) from the Northwestern region of the state of São Paulo. **Boletim de Zoologia da Universidade de São Paulo, 1**: 313-330.

Tavares V.C. & Anciães, M. 1998. Artificial roosts and diet of some insectivorous bats in the Parque Estadual do Rio Doce, Brazil. **Bat Research News, 39**:142.

Tavares, V. C. & Taddei, V. A. 2003. Range extension of *Micronycteris schmidtorum* Sanborn 1935 (Chiroptera: Phyllostomidae) to the Brazilian Atlantic forest, with comments on taxonomy. **Mammalia, 67**:463-467.

Tavares, V.C; Gregorin, R; Peracchi, A. L. **A Diversidade de Morcegos no Brasil**. In: Pacheco, S. M., Marques, R.V.; Esbérard, C. E. L. (Org). Morcegos do Brasil: *Biologia, Sistemática, Ecologia e Conservação*. Pelotas: USEB. In press.

Thies, W.; Kalko, E. K. V. & Schnitzler, H.-U. 1998. The roles of echolocation and olfaction in two Neotropical fruit-eating bats, *Carollia perspicillata* and *C. castanea*, feeding on *Piper*. **Behavioral Ecology and Sociobiology, 42**: 397-409.

Thies, W. & Kalko, E. K. V. 2004. Phenology of neotropical pepper plants (Piperaceae) and their association with their main dispersers, two short-tailed fruit bats, *Carollia perspicillata* and *C. castanea* (Phyllostomidae).**Oikos, 104**: 362-376.

Trajano, E. 1985. Ecologia de populações de morcegos cavernícolas em uma região cárstica de sudeste do Brasil. **Revista Brasileira de Zoologia, 2**: 225-320.

Uieda, W., and Vasconcellos-Neto, J. 1985. Dispersão de *Solanum* spp. (Solanaceae) por morcegos, na região de Manaus, Amazônia, Brasil. **Revista Brasileira de Zoologia, 2**: 449-458.

Van der Pijl, L. 1957. The dispersal of plants by bats

(Chiropterocory). **Acta botanica Neerlandica, 6**: 291-315.

Van der Pijl, L. 1972. **Principles of Dispersal in Higher Plants** (2nd edition). New York Springer-Verlag, 160 pp.

Whittaker, R. J. & Jones, S. H. 1994. The role of frugivorous bats and birds in the rebuilding of a tropical forest ecosystem, Krakatau, Indonesia. **Journal of Biogeography, 21**: 245–258.

Wilson, D.E. 1973. Reproduction in Neotropical bats. **Periodical Biology, 75**: 215-217.

Wilson, D. E. 1979. Reproductive patterns. In: Baker, R. J.; Knox-Jones, J., Jr. & Carter, D. C. (Ed). **Biology of bats of the New World Family Phyllostomatidae -Part III**, Special Publications, Lubbock, The Museum Texas Tech University, pp. 318-378.

Wilson, D. E.; Ascorra, C. F. & Solari, S. S. 1996. Bats as indicators of habitat disturbance. In: Wilson, D. E. & Sandoval, A. (Ed.). **Manu – The biodiversity of Southeastern Peru (La Biodiversidad del Sudeste del Perú)**, U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C., and Editorial Horizonte, Lima, Peru. pp. 613-625.

Wimsatt, W. A. & Trapido, H. 1952. Reproduction and the female reproductive cycle in the tropical American vampire bat, *Desmodus rotundus murinus*. **American Journal of Anatomy, 91**: 415-45.

Zortéa, M. & Chiarello, A. G. 1994. Observations on the big fruit-eating bat, *Artibeus lituratus*, in an urban reserve os southeast Brazil. **Mammalia**, **58**: 665-670.

Appendix I

Specimens from previous inventories in PERD studied in museum collections.

Museum acronyms: Royal Ontario Museum, Toronto, Canada (ROM); United States National Museum, Smithsonian Institute, Washington, DC, USA (USNM) e Museu de Zoologia da USP, São Paulo, SP (MZUSP).

Rhynchonycteris naso
Parque Estadual do Rio Doce (19º31'/ 42º32') [labeled at ROM as Coronel Fabriciano, Parque Estadual, Rio Doce]. ROM 91158.

Noctilio leporinus
Parque Estadual do Rio Doce (19º31'/ 42º32'). ROM 70939, 78017, 91162 [labeled as Coronel Fabriciano, Parque Estadual, Rio doce]. USNM 541448 [labeled as Coronel Fabriciano, Parque Estadual do Rio doce], USNM 341449-50.

Platyrrhinus lineatus
Parque Estadual do Rio Doce (19º31'/ 42º32') [labeled at ROM as Coronel Fabriciano, Parque Estadual, Rio doce]. ROM 70919-24.

Pygoderma bilabiatum
Parque Estadual do Rio Doce (19º31'/ 42º32') [labeled at ROM as Coronel Fabriciano, Parque Estadual, Rio Doce]. ROM 70910.

Eptesicus brasiliensis
Parque Estadual do Rio Doce (19º31'/ 42º32'0), baixo Piracicaba. MUZUSP 5831.

Lasiurus ega
Parque Estadual do Rio Doce (19º31'/ 42º32'), [labeled at ROM as Coronel Fabriciano, Parque Estadual, Rio Doce]. ROM 78240.

Roghessa "tumida" (= cf. *hussoni*)
Parque Estadual do Rio Doce (Baixo Piracicaba) (19º31'/ 42º32'). MZUSP 24045.