Ectoparasites (Insecta and Acari) Associated With Bats in Southeastern Brazil

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ABSTRACT The result of a survey of ectoparasites infesting bats in southeastern Brazil is presented. Of 181 bats belonging to 16 species, 10 (34.1%) were infested by streblid flies (Streblidae), nine (33.5%) by spinturnicid mites (Spinturnicidae), and five (8.3%) by macronyssid mites (Macronyssidae). One species of the families Trombiculidae and Myobiidae was found. A total of 195 streblids, 178 spinturnicids, and 76 macronyssids was collected. *Paratrichobius longicrus* was the most abundant bat fly species (50 specimens). The spinturnicid mite *Periglischrus iheringi* was the most abundant ectoparasite species (159 specimens) and was recorded on three different bat species; *Radfordiella desmodi* was the most numerous macronyssid (69 specimens).

KEY WORDS ectoparasites, spinturnicids, macronyssids, bat flies, southeastern Brazil

Arthropods associated with bats belong to virtually all known groups of ectoparasites, including those classified in Acari and Insecta (except Phthiraptera) (Whitaker Jr. 1998). The composition of ectoparasite communities and the patterns of infestation are important factors to the understanding of the ecology of bat ectoparasitism. In this way, the knowledge of bat ectoparasites could offer important information with regard to the biological, systematic, and phylogenetic aspects of their hosts (Fritz 1983).

The South American bat ectoparasite fauna is relatively well studied through many taxonomic papers, such as those focused on spinturnicid mites (Herrin and Tipton 1975), macronyssid mites (Radovsky 1967), and streblid flies (Guerrero 1997). In Brazil, many faunistic surveys focused on bat flies (Graciolli and Bianconi 2007, Dias et al. 2009, Camilotti et al. 2010), and a few others dealing exclusively with bat mites (Gettinger and Gribel 1989, Azevedo et al. 2002, Dantas-Torres et al. 2009, Silva et al. 2009) have been published. However, there are no published results with these two important groups of ectoparasites together.

Thus, the goal of this study is to report for the first time association between bat ectoparasites (mites and flies) and their hosts in southeastern Brazil, presenting data on their prevalence and parasitic burden, and assess if there is interdependence between the different groups of ectoparasites on these bats.

Materials and Methods

Bats were collected from March 2006 to June 2008, at Colônia Juliano Moreira, in Parque Estadual da Pedra Branca (PEPB) (23°52′–23°04′S and 43°23′–43°32′W), Rio de Janeiro, southeastern Brazil. During one night per month, preferably at the last quarter or at the new moon phases, mist nets were placed across small streams and through trails, from 5:00 a.m. to 12:00 p.m. The mist nets were examined at intervals of 15 min, and the captured bats were kept in individualized and numbered cloth bags. These bags were used only once per day to avoid ectoparasite exchange among collected hosts. Despite no vouchers, specimens were kept; all bat species collected commonly occur in the area, making the host identification more reliable. They were examined alive and released afterward. Their ectoparasites were collected with fine forceps and placed in vials containing 70% ethanol, using a separate vial for each individual bat.

The identification of bat flies was made with the aid of a stereomicroscope, using the keys presented by Wenzel et al. (1966) and Graciolli and Carvalho (2001b). Due to their high mobility on the bats, all bat flies recovered out of their common hosts following the list by Guerrero (1997), and represented by single specimens were considered as contamination and/or straggling (Dick 2007) to avoid wrong host-parasite associations.

The mites were mounted on glass slides using lactophenol and Hoyer's medium (Flechtmann 1990). Their identification was carried out with the aid of a light microscope, according to Herrin and Tipton (1975) and Radovsky (1967) for Spinturnicidae and Macronyssidae, respectively.

For each ectoparasite species, the prevalence and mean intensity were calculated using the software Quantitative Parasitology 3.0 (Rózsa et al. 2000).

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Table 1. Bat fly associations found in this study in Rio de Janeiro, Brazil

Hosts		Bat flies (Diptera, Streblidae)					
Species	*n* (np)	Species	Sex ratio (♂/♀)	Total *n*	Total %	P (%)	IM
Artibeus lituratus	106 (22)	*Paratrichobius longicrus*	0.9	46	96	19	2.1
		Trichobius tiptoni	1.0	1	2	<1	1.0
		Trichobius longipes	1.0	1	2	<1	1.0
Artibeus planirostirs	1 (1)	*Paratrichobius longicrus*	1.0	2	100	100	2.0
Artibeus obscurus	3 (1)	*Paratrichobius longicrus*	0.0	1	100	33	1.0
Carollia perspicillata	24 (14)	*Trichobius tiptoni*	0.9	21	73	42	2.1
		Trichobius joblingi	3.0	3	14	8	1.5
		Strebla alvarezi	3.0	3	10	8	1.5
		Paratrichobius longicrus	0.0	2	3	4	2.0
Desmodus rotundus	10 (6)	*Trichobius furmani*	0.9	21	57	40	5.2
		Trichobius joblingi	1.0	2	9	20	1.0
		Trichobius dugesioides	2.5	7	30	10	7.0
		Strebla mirabilis	1.0	1	4	10	1.0
Micronycteris megalotis	2 (2)	*Trichobius dugesioides*	1.0	2	67	50	2.0
		Strebla alvarezi	1.0	1	33	50	1.0
Mimon bennettii	1 (1)	*Paratrichobius longicrus*	0.0	2	100	100	2.0
Phyllostomus hastatus	16 (7)	*Trichobius longipes*	1.4	36	69	19	12.0
		Paratrichobius longicrus	0.5	3	6	12	1.5
		Trichobius joblingi	2.0	12	23	12	6.0
		Trichobius dugesioides	1.0	1	2	6	1.0
Tonatia bindens	1 (1)	*Strebla hertigi*	0.0	1	33	100	1.0
		Trichobius dugesioides	1.0	2	67	100	2.0
Noctilio leporinus	3 (2)	*Noctiliostrebla aitkeni*	1.2	33	100	67	16.5
Total	167 (57)		1.3	204		34	3.6

IM, average rate of parasitism; *n*, absolute number; np, number of hosts parasitized; P, prevalence.

Fisher test was used to calculate the interdependence of the groups of ectoparasites collected. Ectoparasite vouchers were deposited at Acarological Collection in Oswaldo Cruz Institute, Fiocruz (Rio de Janeiro, Brazil).

Results

A total of 181 bats belonging to two families, 14 genera, and 16 species was examined, as follows (number of specimens in parentheses): Phyllostomatidae, *Artibeus lituratus* (Olfers, 1818) (106), *Artibeus planirostris* (Spix, 1823) (1), *Artibeus obscurus* (Schinz, 1821) (3), *Anoura caudifer* (É. Geoffroy, 1818) (2), *Carollia perspicillata* (Linnaeus, 1758) (24), *Chiroderma doriae* Thomas, 1891 (1), *Desmodus rotundus* (E. Geoffroy, 1810) (10), *Diphylla ecaudata* Spix, 1823 (2), *Glossophaga soricina* (Pallas, 1766) (2), *Micronycteris megalotis* (Gray, 1842) (2), *Mimon bennettii* (Gray, 1838) (1), *Phyllostomus hastatus* (Pallas, 1767) (16), *Sturnira lilium* (E. Geoffroy, 1810) (4), *Tonatia bidens* (Spix, 1823) (2), *Vampyressa pusilla* (Wagner, 1843) (2); Noctilionidae, *Noctillio leporinus* (Linnaeus, 1758) (3). *Anoura caudifer*, *C. doriae*, *D. ecaudata*, *G. soricina*, and *V. pussila* were captured in relatively low numbers, and no ectoparasites were found on any individuals of these species. As a whole, 95.03% of bats were infested by at least one kind of ectoparasite, 34.1% by bat flies, 33.5% by spinturnicids, and 8.3% by macronyssids.

In total, 195 streblids were collected from all host species. Considering the bat species with at least 10 individuals collected, the most abundant species and with the highest prevalence rates were those of *Trichobius tiptoni* Wenzel on *C. perspicillata*, *Trichobius furmani* Wenzel on *D. rotundus*, and *Paratrichobius longicrus* (Miranda-Ribeiro) on *A. lituratus* (Table 1). Spinturnicids were represented by six species; *Periglischrus iheringi* Oudemans (89.4%) was the most abundant species, followed by *Periglischrus micronycteridis* Furman and *Periglischrus ojastii* Machado-Allison (2.8% for both). All different developmental stages of this family were found, and the adults were the most collected stage (Table 2). Twelve bats were parasitized by macronyssids; 78 samples were collected belonging to three genera, with only three species identified. Other two samples could not be identified to species level because of the poor condition of the few specimens examined. As shown in Table 3, except for *Radfordiella desmodi* Radovsky, no more than two specimens were recovered from each parasitized bat. Only three adult males were collected; this probably occurred because they do not ingurgitate blood and so are hardly found on their host (Radovsky 1967).

Trombiculidae and Myobiidae were the lesser frequent mite families found. Five larvae of chiggers were collected, identified as *Perissopalla ipeani* (Brennan), around the ears of one specimen of *T. bidens*. The family Myobiidae was represented by one nymph not identified and belonging to the genus *Eudubasbekia*, found on *P. hastatus*.

Some of the ectoparasites were found associated with each other on the same individual host, and ≈54% of these associations were in *A. lituratus*. Probably this occurred because of the fact this was the most commonly collected host. The Fisher test allowed to evaluate that there is no interdependence between the different groups of ectoparasites. Ectoparasite associ-

Table 2. Spinturnicid mite associations found in this study in Rio de Janeiro, Brazil

Hosts		Spinturnicid mites (Mesostigmata, Spinturnicidae)												
Species	*n* (np)	Species	♂		♀		Deuto ♂		Deuto ♀		Prot		Total	P(%)	IM
			n	%	*n*	%	*n*	%	*n*	%	*n*	%			
Artibeus lituratus	106 (48)	*Periglischrus iheringi*	63	55	18	15	5	4	11	10	18	16	115	45	2.4
Artibeus planirostris	1 (1)	*Periglischrus iheringi*	2	67	0	–	0	–	0	–	1	33	3	100	3.0
Artibeus obscurus	3 (1)	*Periglischrus iheringi*	0	–	1	100	0	–	0	–	0	–	1	33	1.0
Carollia perspicillata	24 (5)	*Periglischrus iheringi*	7	17	25	61	0	–	3	7	6	15	41	21	8.2
Desmodus rotundus	10 (2)	*Periglischrus herreai*	2	50	0	–	0	–	1	25	1	25	4	20	2.0
Micronycteris megalotis	2 (1)	*Periglischrus micronycteridis*	4	80	0	–	0	–	1	2	0	–	5	5	5.0
Mimon bennettii	1 (1)	*Periglischrus acutisternus*	1	100	0	–	0	–	0	–	0	–	1	100	1.0
Phyllostomus hastatus	16 (3)	*Periglischrus torrealbai*	1	25	2	50	0	–	0	–	1	25	4	19	1.3
Sturnira lilium	4 (2)	*Periglischrus ojastii*	1	20	1	20	0	–	0	–	3	60	5	25	5.0
		Periglischrus iheringi	1	100	0	–	0	–	0	–	0	–	1	25	1.0
Total	167 (64)		82	45	47	26	5	3	16	9	30	17	180	38	2.8

♂, males; ♀, females; Deuto ♂, male deutonymphs; Deuto ♀, female deutonymphs; IM, average rate of parasitism; *n*, absolute number; np, number of hosts parasitized; P, prevalence; Prot, protonymphs.

ation that occurred with more frequency was between the families Streblidae and Spinturnicidae (Table 4).

Discussion

The mites infesting Chiroptera have scarcely been studied in Brazil, and very little is known about their distribution and host associations (Azevedo et al. 2002, Dantas-Torres et al. 2009, Silva et al. 2009). Conversely, bat flies have been relatively well studied in some regions of Brazil, despite the fact that this scenario reveals a deficiency on the faunal surveys for bat ectoparasites in southeastern states. This study represents the first inquiry for these arthropods in that region.

Bat Flies (Streblidae). This group of ectoparasites appeared more alone than in association with other groups of parasites. The association of bat flies and spinturnicids revealed the strongest one between the groups of ectoparasites analyzed according to Fisher exact test, but such association occurs still independently (Table 4). *A. lituratus* was the bat that had the greatest number of association St + Spin, whereas *A. planirostris*, *D. rotundus*, and *M. bennetti* were less infected when they only had streblids as parasites. The weak association between St + Macro was probably because of the low number of bats infected by macronyssids.

Paratrichobius longicrus was collected on *A. lituratus*, *A. planirostris*, *A. obscurus*, and *P. hastatus* (Table 1). The prevalence of infestation by this species reported in this study, regardless of host species, was lower than that found in others Brazilian states. In Brazil, *P. longicrus* has been reported on the bat families Phyllostomidae (Dias et al. 2009) and Vespertilionidae (Bertola et al. 2005).

Five species of the genus *Trichobius* were found on six bat species (Table 1). *T. tiptoni* Wenzel was collected mostly on *C. perspicillata*, and the specimen from *A. lituratus* is regarded in this study as a contamination. The prevalence of *T. tiptoni* on *C. perspicillata* (41.67%) was lower than that found in São Paulo (65%) (Bertola et al. 2005). Its prevalence on *D. rotundus* (20%) found in the current study was slightly higher than that (i.e., 6%) in São Paulo (Bertola et al. 2005).

Trichobius furmani Wenzel has been found on *S. lilium* in São Paulo (Bertola et al. 2005) and on *D. rotundus* and *D. ecaudata* in Central Brazil (Coimbra et al. 1984). *Trichobius dugesioides* Wenzel was collected in PEPB on

Table 3. Macronyssid mite associations found in this study in Rio de Janeiro, Brazil

Hosts		Macronyssid mites (Mesostigmata, Macronyssidae)							
Species	*n* (np)	Species	P (%)	♂		♀		Prot		Total
				n	%	*n*	%	*n*	%	
Artibeus lituratus	106 (4)	*Macronyssoides kochi*	2	0	–	2	100	0	–	4
		Radfordiella sp.	<1	1	33	0	–	2	67	3
		Parichoronyssus sp.	<1	1	100	0	–	0	–	1
Artibeus planirostris	1 (1)	*Macronyssoides kochi*	100	0	–	1	100	0	–	1
Carollia perspicillata	24 (1)	*Radfordiella desmodi*	4	0	–	24	36	43	64	67
Desmodus rotundus	10 (5)	*Radfordiella* sp.	50	0	–	0	–	1	100	1
Sturnira lilium	4 (1)	*Parichoronyssus euthysternum*	25	1	100	0	–	0	–	1
Total	145 (12)		8	3	4	29	36	46	60	78

♂, males; ♀, females; *n*, absolute number; np, number of hosts parasitized; P, prevalence; Prot, protonymphs.

Table 4. Parasitic associations found in this study in Rio de Janeiro, Brazil

Hosts	*n*	Parasitic associations						
		Str	Spi	Mac	Str + Spi*	Str + Mac*	Spi + Mac*	Str + Spi + Mac*
Artibeus lituratus	106	10	34	3	11	0	2	1
Artibeus planirostris	1	0	0	0	0	0	0	1
Carollia perspicillata	24	10	2	0	3	1	0	0
Desmodus rotundus	10	3	0	1	0	2	1	1
Mimom bennetti	1	0	0	0	1	0	0	0
Phyllostomus hastatus	16	5	1	0	2	0	0	0
Total	158	28	37	4	17	3	3	3

n, Absolute number of sampled bats. Total of host parasitized by: Mac, Macronyssidae; Spi, Spinturnicidae; Str, Streblidae. *, Number dependence between the parasitism among different families of ectoparasites (Fisher's exact test, $P > 0.05$).

D. rotundus, *M. megalotis*, *P. hastatus*, and *T. bidens*. It has been reported in Brazil on species of subfamilies Desmodontinae and Phyllostominae (Bertola et al. 2005).

Three species of the genus *Strebla* were found. *Strebla guajiro* was reported in Brazil on *C. perspicillata* (Dias et al. 2009), *T. bidens* (Guerrero 1997), *Strebla hertigi* on *Phyllostomus discolor* (Wagner), *P. hastatus* e *D. rotundus* (Wenzel et al. 1966), and *Strebla alvarezi* Wenzel on *M. megalotis* (Guerrero 1997).

In Brazil, *Noctiliostrebla aitkeni* has been recorded on *Noctilio leporinus* (L.) (Moura et al. 2003). The prevalence found in the current study (66.67%) was very similar to those reported by those authors (75%) in Brazil.

Spinturnicid and Macronyssid Mites (Spinturnicidae and Macronyssidae). These families were better represented when they were isolated. According to Fisher test, the association between Spin + Macro was at random, and its occurrence was in ≈12% of the associations. On some host species, the spinturnicids (on *A. planirostris*, *D. rotundus*, and *M. bennetti*) and the macronyssids (on *A. planirostris*, *C. perspicillata*, *M. bennetti*, and *P. hastatus*) occurred only in association with other groups of ectoparasites. In the same way, *A. lituratus*, *A. planirostris*, and *D. rotundus* associated with the three groups of parasites found in this study.

P. iheringi is commonly found on species of the genera *Artibeus*, *Vampyrops*, *Uroderma*, and other dozen of scattered species belonging to various other genera, including *S. lilium* (Herrin and Tipton 1975). This spinturnicid species has already been reported in Brazil on the family Phyllostomidae (Gettinger and Gribel 1989, Azevedo et al. 2002, Dantas-Torres et al. 2009, Silva et al. 2009). In PEPB, *P. iheringi* was collected on three *Artibeus* species (*A. lituratus*, *A. obscurus*, and *A. planirostris*), on *C. perspicillata*, and on *S. lilium* (see Table 2). Although the single male collected on the latter bat species could be considered as a case of contamination, the infestation by *P. iheringi* on *S. lilium* has sporadically been reported in Mexico, Venezuela, Paraguay, and Brazil (Herrin and Tipton 1975, Azevedo et al. 2002). The prevalence of *P. iheringi* infestation (37.73%) was slightly higher than that found in Pernambuco (Dantas-Torres et al. 2009) (27.8%).

According to Herin and Tipton (1975), *Periglischrus acutisternus* is primarily associated with bats of the genus *Phyllostomus*. In Brazil, this spinturnicid species has been collected on one individual of *P. discolor* captured in Federal District (Gettinger and Gribel 1989) and in Pernambuco (Dantas-Torres et al. 2009). In PEPB, this mite was found on *M. bennettii* probably as result of contamination.

P. torrealbai is primary found on *P. hastatus* (Herrin and Tipton 1975). In Brazil, this mite species has been found on *P. discolor* in Brasília so far (Gettinger and Gribel 1989).

P. micronycteridis is a mite almost restricted to bats of the genus *Micronycteris*, and it has been found in Venezuela on *M. megalotis* and *M. minuta* (Herrin and Tipton 1975).

P. ojastii is primarily associated with bats of the genus *Sturnira* (Machado-Allison 1967). This species has already been reported on *C. perspicillata* in Pernambuco (Dantas-Torres et al. 2009) and on *S. lilium* in Minas Gerais (Azevedo et al. 2002) with 100% of prevalence, against only 25% found in this study.

Periglischrus herrerai is a parasite of *D. rotundus* (Machado-Allison 1967), and this association has only been reported in Brasília by Gettinger and Gribel (1989) with 50% of prevalence, higher than reported in PEPB (20%).

On the macronyssid mites, the low number of specimens collected makes it difficult to compare prevalence data. However, two identified species, *Macronyssoides kochi* (Fonseca) and *Radfordiella desmodi* (Radovsky), were found on their type host species (Fonseca 1948, Radovsky 1967). *Macronyssoides kochi* has been collected in São Paulo (Fonseca 1948) and Minas Gerais (Azevedo et al. 2002), whereas the only Brazilian record for *R. desmodi* is from Minas Gerais (Azevedo et al. 2002). The third species identified, *Parichoronyssus euthysternum* Radovsky, was collected on *S. lilium*. By now, this species has been exclusively associated with *Sturnira ludovici* (Anthony) (Morales-Malacara and Guerrero 2007). Although the finding of *P. euthysternum* on *S. lilium* could be considered as a new host record, further collections are desirable to confirm this parasite-host relationship.

Chigger and Myobiid Mites (Trombiculidae and Myobiidae). The only species of chigger found in the current study was *P. ipeani* on *T. bidens*. Despite the fact that this species has been described on *C. perspicillata* in Pará, Brazil (Brennan 1969), it has been found on its type host and also on *A. lituratus* and *D.*

ecaudata in neighboring areas of the PEPB (J.C.A., unpublished data).

The Phyllostomidae are infested by three genera of Myobiidae (Lukoschus et al. 1981). In PEPB, a single nymph of *Eudubasbekia* sp. was collected on *P. hastatus.* In Brazil, *Eudusbabekia* sp. has been found in Minas Gerais (Azevedo et al. 2002) on *A. lituratus.*

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