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STREBLID BAT FLIES ON PHYLLOSTOMID BATS FROM AN ISLAND OFF THE COAST OF SÃO PAULO, BRAZIL

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ABSTRACT

Streblidae is the family of bloodsucking flies, mostly tropical and subtropical, that are obligate ectoparasites of bats. A high number of these fly species are found in the Atlantic Forest, but there is little information about their quantitative descriptors. In this paper, we describe the prevalence, mean intensity, and infracommunities of streblid bat flies on phyllostomid bats from the Parque Estadual da Ilha do Cardoso, São Paulo state, Brazil. Surveys were conducted from July 1990 to July 1991 in distinct places of the island, with a total of 454 flies of 30 species collected from 132 bats of 15 species. From those, we found 44 host-parasite associations and 31 infracommunities that suffered variations due to accidental associations or contaminations. With our results, the number of Streblidae species increased from 31 to 36 in São Paulo State.

KEY-WORDS: Infracommunity; Hippoboscoidea; Atlantic Forest.

INTRODUCTION

Streblidae is composed of blood-feeding flies, that are obligate ectoparasites of bats. This family is more specious in the New World, with a mostly tropical and subtropical range, and are most commonly associated with bats of the family Phyllostomidae (Dick & Miller, 2010). Streblidae comprises 237 valid species (Soares *et al.*, 2013), of which, nearly 81 have been recorded in Brazil. In Brazil, phyllostomid bats, the main host of streblid bat flies, are represented by 43 genera and 92 species (Nogueira *et al.*, 2014).

In the Brazilian Atlantic Forest, systematic surveys of streblid bat flies have been done in Pernam-

buco (Soares *et al.*, 2013), Minas Gerais (Azevedo & Linardi, 2002), Rio de Janeiro (Almeida *et al.*, 2011; França *et al.*, 2013; Lourenço *et al.*, 2014), Paraná (Graciolli & Bianconi, 2007; Silva & Ortêncio-Filho, 2011), and Rio Grande do Sul (Graciolli & Rui, 2001; Rui & Graciolli, 2005; Camilotti *et al.*, 2010). For São Paulo state, only Bertola *et al.* (2005) and Graciolli *et al.* (2006) described the streblid bat fly community in two kinds of forest, Altitudinal Atlantic and semidecíduos.

The objective of this paper was to study the host-parasite relationship, describing streblid bat flies infracommunities, as well as record prevalence and mean intensity of infestation from the Parque Estadual da Ilha do Cardoso.

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MATERIAL & METHODS

Parque Estadual da Ilha do Cardoso (25°11'S, 47°74'W) is located on the southern coast of São Paulo State, municipality of Cananéia, Brazil. The island is made up of approximately 22,500 ha of Atlantic Forest *sensu stricto*. The climate is superhumid megathermal, in Thornthwaite's classification, with no water deficit (Funari *et al.*, 1986).

The bats were sampled monthly by Fazzolari-Corrêa (1995) during her Ph. D. research from July 1990 to July 1991. Five mist-nets (6 × 2.6 m) were opened for 12 hours/night during two or three days of each field excursion, being reviewed each hour until 00:00 h, and then reviewed again at 06:00 h, totaling 58,032 h.m² of sampling effort (Straube & Bianconi, 2002). The captured bats were identified in the field and most of them were killed by hanging, individualized in paper bags, and taken to the field laboratory where ectoparasites were collected and stored in 70% ethanol. Bat flies were identified using generic and specific keys for Streblidae (Guerrero, 1993, 1994a, b, 1995a, b, 1996). The bats and bat flies were deposited at the MZUSP.

We followed Bush *et al.* (1997) for definitions of prevalence (P), mean intensity of infestation (MI) and infracommunity. Confidence intervals (CI) were calculated using Quantitative Parasitology 3.0 (Rózsa *et al.*, 2000). Bat species with less than 10 captured specimens were excluded in all analysis we made, in infracommunity description were removed the bats that all infracommunities were made by flies with mean intensity equating to one, without sufficient information for CI calculating.

Bat flies known to be associated with specific bat species, that were found on another bat species were considered to be accidental infestations when both bats were captured, principally if the main host was abundant.

RESULTS

We identified 454 streblid bat flies of 30 species, collected from 15 species of phyllostomid bats (Table 1). The most abundant flies were *Megistopoda proxima* (Séguy, 1926) (n = 75), *Trichobius dugesioides dugesioides* Wenzel, 1966 (n = 66) and *Strebla miriabilis* (Waterhouse, 1879) (n = 38)

The prevalence varied from 1.1 (0.02-5.2), *Aspidoptera phyllostomatis* (Perty, 1833) and *Megistopoda aranea* (Coquillett, 1899) on *Sturnira lilium* (É. Geoffroy, 1810), to 90.9 (58.7-99.7), *T. dugesioides dugesi-*

oides Wenzel, 1966 on *Tonatia bidens* (Spix, 1823), while the mean intensity varied from 1, all the single occurrences, to 6.60 (3.90-10.60), *T. dugesioides dugesioides* on *T. bidens* (Table 1).

We found 31 infracommunities on nine species of phyllostomids (Table 3). Excluding accidental associations or contaminations, the richness of infracommunities was 1 to 4. On *S. lilium*, the bat species with the most infested individuals, we mainly found a single bat fly species infracommunity, *M. aranea*, the same was noticed for *A. lituratus* (Olfers, 1818) infested by *Paratrichobius longicrus* (Miranda-Ribeiro, 1907).

DISCUSSION

The most associations between flies and bats found were previously recorded in the Atlantic Forest and the state of São Paulo (Bertola *et al.*, 2005; Graciolli *et al.*, 2008). The richness of streblid flies from Parque Estadual da Ilha do Cardoso was higher than in other works from the Atlantic Forest *sensu stricto* (Graciolli & Rui, 2001; Bertola *et al.*, 2005; Rui & Graciolli, 2005; Soares *et al.*, 2013; Lourenço *et al.*, 2014).

Five species of streblid bat flies are recorded for the first time in São Paulo state, they are *Neotrichobius delicatus* (Machado-Allison, 1966), *Trichobius diphyllae* Wenzel, 1966, *Paratrichobius salvini* Wenzel, 1966 *Srebla diphyllae* Wenzel, 1966 and *S. miriabilis*, increasing the number of registered Streblidae species for the state to 36.

For the first time in the Atlantic Forest *P. salvini* was registered on *P. lineatus*. *Paratrichobius* Costa Lima, 1921 is a genus usually associated with Stenodermatinae, a subfamily of Phyllostomidae (Dick & Miller, 2010), which includes bats of the genus *Platyrrhinus* Saussure, 1860. *Platyrrhinus aurarius* (Handley & Ferris, 1972), *P. brachycephalus* (Rouk & Carter, 1972), *P. dorsalis* (Thomas, 1900), *P. lineatus* and *P. vittatus* (Peters, 1860) have all been found infested by *Paratrichobius longicrus*, while *P. salvini* has only been found on *Platyrrhinus brachycephalus* and *P. helleri* (Peters, 1866) (Guerrero, 1994a).

According to Dick (2007), one-third of all batfly-bat associations were not considered primary (prevalence less than 5%). Of all the parasite-host relationships found (n = 44), we considered a quarter (n = 12) of those accidental infestations. Indeed, ten of the records we considered as contamination are also non-primary associations (P < 5%), and there is one association that was not considered contamination, *Trichobius phyllostomae* Kessel, 1925 on *S. lilium*, be-

TABLE 1: Streblidae fly species collected from bats in Parque Estadual da Ilha do Cardoso, municipality of Cananéia, São Paulo. ^a Accidental infestation; ^b new record of bat fly species for São Paulo state; ^c Insufficient data to calculate coincidence intervals.

Host	n	Bat fly	n	P (95% CI)	MI (95% CI)
<i>Anoura caudifer</i> (É. Geoffroy, 1818)	4	<i>Paratrichobius longicrus</i> (Ribeiro, 1907) ^a	1	—	—
		<i>Trichobius tiptoni</i> Wenzel, 1976	6	—	—
<i>Anoura geoffroyi</i> Gray, 1838	1	<i>Anastrebla modestini</i> Wenzel, 1966	1	—	—
		<i>Exastinion clovisi</i> (Pessôa & Guimaraes, 1937)	3	—	—
<i>Artibeus fimbriatus</i> Gray, 1838	32	<i>Aspidoptera phyllostomatis</i> (Perty, 1833)	13	25 (11.4-43.4)	1.63 (1-3)
		<i>Megistopoda aranea</i> (Coquillett, 1899)	15	21.9 (9.2-40)	2.14 (1.29-2.86)
		<i>Metelasmus pseudopterus</i> Coquillett, 1907	9	21.9 (9.2-40)	1.29 (1-1.57)
		<i>Trichobius tiptoni</i> Wenzel, 1976 ^a	1	3.1 (0.07-16,2)	1 ^c
<i>Artibeus lituratus</i> (Olfers, 1818)	58	<i>Aspidoptera falcata</i> Wenzel, 1976 ^a	1	1.7 (0.04-9.2)	1 ^c
		<i>Megistopoda aranea</i> (Coquillett, 1899) ^a	1	1.7 (0.04-9.2)	1 ^c
		<i>Megistopoda proxima</i> (Séguy, 1926) ^a	2	3.4 (0.04-11.9)	1 ^c
		<i>Paratrichobius longicrus</i> (Ribeiro, 1907)	35	32.8 (21.0-46.3)	1.84 (1.47-2.21)
		<i>Trichobius</i> sp. <i>dugesii</i> group ^a	2	1.7 (0.04-9.2)	2 ^c
<i>Artibeus obscurus</i> (Schinz, 1821)	93	<i>Paratrichobius longicrus</i> (Ribeiro, 1907) ^a	1	1.1 (0.02-5.9)	1 ^c
		<i>Trichobius dugesii</i> Townsend, 1891	1	1.1 (0.02-5.9)	1 ^c
<i>Carollia perspicillata</i> (Linnaeus, 1758)	17	<i>Strebla guajiro</i> (Garcia & Casal, 1965)	4	17.6 (3.7-43.4)	1.33 (1.00-1.67)
		<i>Strebla</i> sp.1	1	5.9 (0.14-28.7)	1 ^c
		<i>Trichobius anducei</i> Guerreiro, 1998	1	5.9 (0.14-28.7)	1 ^c
		<i>Trichobius joblingi</i> Wenzel, 1966	18	47.1 (22.9-72.1)	2.25 (1.50-2.88)
<i>Chiroderma doriae</i> (Thomas, 1891)	1				
<i>Dermanura cinerea</i> Gervais, 1856	20	<i>Neotrichobius delicatus</i> (Machado-Allison, 1966) ^b	1	5 (0.1-24.8)	1 ^c
		<i>Strebla</i> sp.2	1	5 (0.1-24.8)	1 ^c
<i>Desmodus rotundus</i> (É. Geoffroy, 1810)	7	<i>Strebla hertigi</i> Wenzel, 1966 ^a	3	—	—
		<i>Strebla wiedemanni</i> Kolenati, 1856	30	—	—
		<i>Trichobius dugesioides dugesioides</i> Wenzel, 1966	10	—	—
		<i>Trichobius furmani</i> Wenzel, 1966	14	—	—
<i>Diphylla ecaudata</i> Spix, 1823	1	<i>Strebla diphyllae</i> Wenzel, 1966 ^b	5	—	—
		<i>Trichobius diphyllae</i> Wenzel, 1966 ^b	6	—	—
<i>Glossophaga soricina</i> (Pallas, 1776)	1				
<i>Lamproncyteris brachyotis</i> (Dobson, 1879)	1				
<i>Platyrrhinus lineatus</i> (É. Geoffroy, 1810)	19	<i>Paratrichobius longicrus</i> (Ribeiro, 1907)	2	5.3 (0.26-22.6)	2 ^c
		<i>Paratrichobius salvini</i> Wenzel, 1966 ^b	4	21.1 (6.05-45.7)	1 ^c
<i>Pygoderma bilabiatum</i> (Wagner, 1834)	2				
<i>Sturnina lilium</i> (É. Geoffroy, 1810)	89	<i>Aspidoptera falcata</i> Wenzel, 1976	15	11.2 (5.5-19.7)	1.50 (1.10-1.90)
		<i>Aspidoptera phyllostomatis</i> (Perty, 1833) ^a	1	1.1 (0.02-5.2)	1 ^c
		<i>Megistopoda aranea</i> (Coquillett, 1899) ^a	1	1.1 (0.02-5.2)	1 ^c
		<i>Megistopoda proxima</i> (Séguy, 1926)	75	42.7 (32.2-53.6)	1.97 (1.61-2.37)
		<i>Trichobius phyllostomae</i> Kessel, 1925	2	2.2 (0.2-7.9)	1 ^c
		<i>Trichobius</i> sp. <i>parasiticus</i> complex ^a	3	3.4 (0.7-9.5)	1 ^c
<i>Sturnina tildae</i> de la Torre, 1959	16	<i>Megistopoda proxima</i> (Séguy, 1926)	17	56.3 (29.9-80.2)	1.89 (1.11-3.78)
		<i>Trichobius</i> sp. <i>parasiticus</i> complex	1	6.3 (0.15-30.24)	1 ^c
<i>Tonatia bidens</i> (Spix, 1823)	11	<i>Strebla mirabilis</i> (Waterhouse, 1879) ^b	38	72.7 (39.0-94.0)	4.75 (2.75-7.38)
		<i>Trichobius dugesioides dugesioides</i> Wenzel, 1966	66	90.9 (58.7-99.7)	6.60 (3.90-10.60)
		<i>Trichobius</i> sp.	2	9.1 (0.47-40.4)	2 ^c
<i>Trachops cirrhosus</i> (Spix, 1823)	5	<i>Strebla mirabilis</i> (Waterhouse, 1879) ^b	17	—	—
		<i>Trichobius dugesioides dugesioides</i> Wenzel, 1966	22	—	—
<i>Vampyressa pusilla</i> (Wagner, 1843)	2	<i>Neotrichobius</i> sp.	1	—	—
		<i>Trichobius</i> sp. <i>dugesii</i> complex	1	—	—

TABLE 2: Infracommunity description of streblid bat flies found parasitizing phyllostomid bats from Parque Estadual da Ilha do Cardoso, São Paulo. ^a Infracommunity with accidental fly.

Host (n)	Infracommunity	Frequency
<i>Artibeus fimbriatus</i> (15)	<i>Megistopoda aranea</i>	4
	<i>Aspidoptera phyllostomatis</i>	3
	<i>Metelasmus pseudopterus</i>	3
	<i>A. phyllostomatis</i> + <i>M. aranea</i>	1
	<i>A. phyllostomatis</i> + <i>M. pseudopterus</i>	1
	<i>A. phyllostomatis</i> + <i>M. aranea</i> + <i>M. pseudopterus</i>	2
	<i>A. phyllostomatis</i> + <i>M. pseudopterus</i> + <i>Trichobius tiptoni</i> ^a	1
<i>Artibeus lituratus</i> (22)	<i>Paratrichobius longicrus</i>	18
	<i>Megistopoda proxima</i> ^a	1
	<i>Trichobius</i> sp. (<i>dugesii</i> group) ^a	1
	<i>P. longicrus</i> + <i>Megistopoda aranea</i> ^a	1
	<i>Aspidoptera falcata</i> + <i>M. proxima</i> ^a	1
<i>Carollia perspicillata</i> (8)	<i>Trichobius joblingi</i>	5
	<i>T. joblingi</i> + <i>Strebla guajiro</i>	2
	<i>T. joblingi</i> + <i>Trichobius anducei</i> + <i>S. guajiro</i> + <i>Strebla</i> sp.1	1
<i>Platyrrhinus lineatus</i> (5)	<i>Paratrichobius salvini</i>	4
	<i>Paratrichobius longicrus</i>	1
<i>Sturnira lilium</i> (46)	<i>Megistopoda próxima</i>	31
	<i>Aspidoptera falcata</i>	4
	<i>Trichobius</i> sp. (<i>parasiticus</i> complex) ^a	1
	<i>A. falcata</i> + <i>M. proxima</i>	3
	<i>A. falcata</i> + <i>Trichobius phyllostomae</i>	2
	<i>A. falcata</i> + <i>Trichobius</i> sp. (<i>parasiticus</i> complex) ^a	1
	<i>M. proxima</i> + <i>Trichobius</i> sp. (<i>parasiticus</i> complex) ^a	2
	<i>M. proxima</i> + <i>P. longicrus</i> ^a	1
	<i>A. falcata</i> + <i>A. phyllostomatis</i> + <i>M. aranea</i> + <i>M. proxima</i> ^a	1
<i>Sturnira tildae</i> (9)	<i>Megistopoda próxima</i>	8
	<i>M. proxima</i> + <i>Trichobius</i> sp. (<i>parasiticus</i> complex) ^a	1
<i>Tonatia bidens</i> (10)	<i>Trichobius dugesioides dugesioides</i>	1
	<i>T. dugesioides dugesioides</i> + <i>Strebla miriabilis</i>	8
	<i>T. dugesioides dugesioides</i> + <i>Trichobius</i> sp.	1

cause all species of the *Trichobius phyllostomae* group tend to show high specificity and occur with low prevalence (less than 8%) (Wenzel *et al.* 1966, Wenzel 1976, Bertola *et al.*, 2005, Rui & Graciolli, 2005).

Considering primary associations, the prevalence and mean intensity of bat flies found on *S. lilium*, *Artibeus lituratus* (Olfers, 1818) and *Artibeus fimbriatus* Gray, 1838 were like those found by Lourenço *et al.* (2014), except for *Aspidoptera falcata* Wenzel, 1976 on *S. lilium*, whose prevalence was higher than our results. Prevalence of *Trichobius joblingi* Wenzel, 1966 infesting *Carollia perspicillata* (Linnaeus, 1758) was higher than in works by França *et al.* (2013) and similar to other works (Bertola *et al.*, 2005; Lourenço *et al.*, 2014). *Trichobius dugesioides dugesioides* and *S. miriabilis* on *T. bidens* had the highest prevalence and mean intensity.

A high number of infracommunities (n = 31) were described, but almost one third were due to acci-

dental infestation, which emphasizes the importance of reducing contamination by using careful collection methods when working with these mobile ectoparasites. Apart from *T. bidens*, all others infracommunities found on bat species were made predominantly by a single species of fly, this may be a pattern, but there are not many works that we can compare our finding with. Moras *et al.* (2013) described the infracommunities on bats in Minas Gerais state, counting the bat flies and mites, but the number of bats infested was not high enough to see a pattern.

CONCLUSION

The present paper studied the host-parasite associations between streblid bat flies and bats from an island of Atlantic Forest in São Paulo state, with the goal of contributing to progress of quantitative de-

scriptors (P and MI) and infracommunity knowledge of these parasites for the region. The species of bat flies for São Paulo state has increased to 36 with this study. For a better understanding of interactions among bat flies on the same bat hosts, more papers quantitatively describing the infracommunities are necessary.

RESUMO

Streblidae é uma família de moscas hematófagas, encontradas em maior riqueza em regiões tropicais e subtropicais, ectoparasitas obrigatórias de morcegos. Um grande número de espécies é encontrado na Mata Atlântica, no entanto, não há muita informação a respeito de seus descritores quantitativos. Neste trabalho nós descrevemos a prevalência, intensidade média e as infracomunidades de moscas estrebliadas em morcegos filostomídeos do Parque Estadual da Ilha do Cardoso, estado de São Paulo, Brasil. Capturas foram realizadas de julho de 1990 até julho de 1991 em diferentes localidades da ilha, de forma que 454 moscas de 30 espécies foram coletadas de 132 morcegos de 15 espécies. Com isso, encontramos 44 associações parasito-hospedeiro e 31 infracomunidades que sofreram variação em virtude de associações acidentais ou contaminações. Com os nossos resultados o número de espécies de Streblidae para o estado de São Paulo aumentou de 31 para 36.

PALAVRAS-CHAVE: Infracomunidade; Hippoboscoidea; Mata Atlântica.

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