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Infracommunities of Streblidae and Nycteribiidae (Diptera) on bats in an ecotone area between Cerrado and Atlantic Forest in the state of Mato Grosso do Sul

Guilherme D. P. Dornelles, Gustavo Graciolli, Anderson Odon & Marcelo O. Bordignon

Laboratório de Zoologia, Instituto de Biociências, Programa de Pós-Graduação em Biologia Animal, Universidade Federal de Mato Grosso do Sul, Cidade Universitária, 79002-900 Campo Grande, MS, Brazil. (dornelles_d@hotmail.com)

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ABSTRACT. We described infracommunities, prevalence and mean intensity of infestation of ectoparasite flies (Nycteribiidae and Streblidae) on bats in an ecotone area of Cerrado as predominant vegetation, with influence of Atlantic Forest, in the southeast of Mato Grosso do Sul. In 36 sampling nights between April 2015 and August 2016 (23,328 m².h), we captured 17 bat species, of which ten were infested, and 14 species of fly. The most abundant bats were the phyllostomids *Artibeus planirostris* (Spix, 1823), *Glossophaga soricina* (Pallas, 1776) and *Carollia perspicillata* (Linnaeus, 1758) and the most abundant flies were the streblids *Trichobius longipes* (Rudow, 1871), *T. joblingi* Wenzel, 1966 and *Megistopoda aranea* (Coquillett, 1899). *Phyllostomus hastatus* (Pallas, 1767) was the bat species that presented the highest infestation rate. *Platyrrhinus lineatus* (É. Geoffroy, 1810) and *Desmodus rotundus* (É. Geoffroy, 1810) were not infested. Besides that, the frequency of bats that were infested by a single species of fly was higher than the frequency of bats infested for two or more, and it may be a pattern.

KEYWORDS. Parasitology, Hippoboscoidea, Midwest.

RESUMO. Infacomunidades de Streblidae e Nycteribiidae (Diptera) em morcegos em uma área de ecótono entre Cerrado e Mata Atlântica no estado do Mato Grosso do Sul. Descrevemos infracomunidades, prevalência e intensidade média de infestação de moscas ectoparasitas (Nycteribiidae e Streblidae) sobre morcegos numa área de Cerrado como vegetação predominante, com influência de Mata Atlântica, no sudeste de Mato Grosso do Sul. Após 36 noites de coleta entre abril de 2015 e agosto de 2016 (23.328 m².h), capturamos 17 espécies de morcegos, das quais dez estavam infestadas, e 14 espécies de moscas. Os morcegos mais abundantes foram os filostomídeos *Artibeus planirostris* (Spix, 1823), *Glossophaga soricina* (Pallas, 1776) e *Carollia perspicillata* (Linnaeus, 1758) e as moscas mais abundantes foram as estréblidas *Trichobius longipes* (Rudow, 1871), *T. joblingi* Wenzel, 1966 e *Megistopoda aranea* (Coquillett, 1899). *Phyllostomus hastatus* (Pallas, 1767) foi a espécie de morcego que apresentou as taxas de infestação mais elevadas. *Platyrrhinus lineatus* (É. Geoffroy, 1810) e *Desmodus rotundus* (É. Geoffroy, 1810) não estavam infestados. Além disso, a frequência em que os morcegos estavam infestados por apenas uma espécie de mosca foi superior à dos que estavam infestados por duas ou mais, o que pode ser um padrão.

PALAVRAS-CHAVE. Parasitologia, Hippoboscoidea, Centro-Oeste.

Among mammals, bats represent 178 species distributed in nine families in Brazil, with Phyllostomidae as the most specious, with 92 valid species (Nogueira *et al.*, 2014). They have great ecological importance as maintainers of the insect population balance, pollinators and seed dispersers. Usually the bats are infested by hematophagous flies adapted and highly specific, classified in two families, Streblidae and Nycteribiidae, both exclusive bat parasites.

Streblidae consists of macropterous, brachypterous and apterous Diptera (Wenzel & Peterson, 1987), while Nycteribiidae are all apterous (Peterson & Wenzel, 1987). Both families are cosmopolitan and their distribution correlates with their hosts (Wenzel *et al.*, 1966).

The streblid flies are divided into five subfamilies, Nycterophiliinae, Trichobiinae and Streblinae for the New World, and Brachytarsininae and Ascodipterinae for the Old World (Dick & Miller, 2010), and the Nycteribiidae are distributed in three, Archinycteribiinae and Cyclopodiinae exclusive to the Old World and Nycteribiinae cosmopolitan, with two genus in the New World, *Basilia* Miranda-Ribeiro, 1903 and *Hershkovitzia* Guimarães e D'Andretta, 1956 (Graciolli, 2010). For Brazil there are record of 80 Streblidae species (Graciolli, 2017a) and 26 Nycteribiidae species (Graciolli, 2017b).

There are few studies that describe the streblids and nicteribiids communities on their hosts through parasitological indexes in the cerrado (Komeno & Linhares, 1999; Aguiar & Antonini, 2011; Eriksson *et al.*, 2011; Vasconcelos *et al.*, 2016), and even fewer describe the infracommunities (Santos *et al.*, 2013; Aguiar & Antonini, 2016; Barbier & Graciolli, 2016).

Seeking to contribute to the knowledge of possible patterns of parasitism between the ectoparasitic flies and their chiropteran hosts, the present study aimed to describe

quantitatively the population of these Diptera, prevalence and mean intensity, besides recording the infracommunities in the southeast of Mato Grosso do Sul.

MATERIAL AND METHODS

The study was performed in the legal reserve of Fazenda Dona Amélia, 905 ha, in the city of Nova Andradina, Mato Grosso do Sul (22°12'37.314"S 53°28'35.576"W). The local vegetation is predominantly cerrado, with influences of Atlantic rainforest. The climate is Aw of Köppen, tropical humid with well-defined seasons. Annual precipitation fluctuates from 1,400 to 1,700 mm, with mean temperature above 18°C in the coldest month (Oliveira *et al.*, 2000).

The bats were captured with mist nets, between April 2015 and August 2016, in spots distributed around the farm, aiming to capture the higher possible diversity. We used four 3 x 9 m nets in the first six hours of the night, with 36 nights total, sampling effort of 23,328 m².h (Tab. I) (Straube & Bianconi, 2002). The nets were visited every 15 minutes and the captured bats were placed in cotton bags to later screening. We inspected the bats with the naked eye and collected the flies with trousers and placed in Eppendorf tubes with 70% alcohol.

The bats identification was performed in the field, when possible, with help of specific identification keys (Charles-Dominique *et al.*, 2001; Gregorin & Taddei, 2002; Reis *et al.*, 2007; Miranda *et al.*, 2011; Reis *et al.*, 2013). A male and a female of each bat specie and the individuals that could not be identified in the field were killed by cervical dislocation and deposited in the Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul (ZUFMS) under authorization of the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) #5064201, and under protocol #728/2015 of the Comissão de Ética no Uso de Animais da Universidade Federal de Mato Grosso do Sul (CEUA/UFMS).

The flies were identified with a stereomicroscope in the Laboratório de Sistemática, Ecologia e Evolução (LSEE) of Universidade Federal de Mato Grosso do Sul. For Streblidae we used the genus key of Dick & Miller (2010) and the specific keys of Guerrero (1994a,b; 1995a,b; 1996; 1997), and for Nycteribiidae the key of Graciolli (2004). The flies are going to be deposited in the ZUFMS.

To calculate the prevalence (P), percentage of bats infested by certain fly species, and mean intensity of infestation (MI), average number of individuals of a given species of fly in each infested bat, we utilized the software Quantitative Parasitology 3.0 (Rózsa *et al.*, 2000), utilizing 95% confidence rate to the intervals. We considered as accidental infestation the non-primary infestations (P<5%) (Dick, 2007) when the primary host of the dipteran was captured in the same night.

The description of the infracommunities and infrapopulations was compiled in a table considering only the species composition, not abundance. We excluded the quantitative analysis and the description of the infracommunities of the bat species with captures below 10 (n<10) or that did not present ectoparasites.

RESULTS

We captured 452 bats of 17 species of four families, in order of abundance, Phyllostomidae (n=418), Vespertilionidae (n=18), Molossidae (n=14), and Noctilionidae (n=2). Of these, we collected 519 flies, being 513 of 13 species of Streblidae, ten of Trichobiinae and three of Streblinae, and six dipterans of *Basilia carteri* Scott, 1936 (Nycteribiidae), total of 14 fly species. The most abundant bat was the phillostomid *Artibeus planirostris* (Spix, 1823) (n=126), and the most abundant fly was *Trichobius longipes* (Rudow, 1871) (n=161) (Tab. II).

The total prevalence was 44.3% with mean intensity of infestation of 2.66 (Tab. II). *Phyllostomus hastatus* (Pallas, 1767) was the most infested bat species, as well as in prevalence as in intensity, associated to *T. longipes*, and *Glossophaga soricina* (Pallas, 1776) was the less infested species, associated to *T. dugesii* Townsend, 1891, when excluded accidental infestations.

A total of 18 compositions of fly species was found in the seven bat species analyzed (Tab. III). The bat species that presented the highest quantity of different parasites composition was *A. planirostris*, with three infracommunities that involved the three infrapopulations found. *Glossophaga soricina*, *Myotis nigricans* (Schinz, 1821) and *P. hastatus* showed only one infrapopulation composition.

Tab. I. Sample effort of studies that described bat ectoparasites (Streblidae and Nycteribiidae) communities in the Cerrado, Brazil.

State	Fly species	Bats inspected (total species)	Sampling effort (m²h)	Reference
MG	12	205 (12)	#	Komeno & Linhares, 1999
DF	7	619 (3)	#	Aguiar & Antonini, 2011
MS	17	327 (13)	11289.60	Eriksson *et al.*, 2011
MA	25	487 (27)	129600	Santos *et al.*, 2013
MG	38	880 (33)	24300	Vasconcelos *et al.*, 2015
DF	24	892 (15)	#	Aguiar & Antonini, 2016
MS	22	708 (22)	28080	Barbier & Graciolli, 2016
MS	14	452 (17)	23328	Present study

Tab. II. Streblidae and Nycteribiidae fly species collected from bats in Fazenda Dona Amélia, Nova Andradina, state os Mato Grosso do Sul, Brazil ([a] Accidental infestation; [b] Insuficient data to calcule coinfidence intervals).

Host	n	Bat fly	n	P (95% CI)	MI (95% CI)
Molossidae					
Molossops temminckii (Burmeister, 1854)	14	-			
Noctilionidae					
Noctilio albiventris Desmarest, 1818	2	*Paradyschiria parvula* Falcoz, 1931	11		
Phyllostomidae					
Artibeus lituratus (Olfers, 1818)	43	*Aspidoptera phyllostomatis* (Perty, 1833)[a]	1	2,3 (0.05 - 12.29)	1[b]
		Paratrichobius longicrus (Ribeiro, 1907)	14	20.9 (10.04 - 36.05)	1.56 (1.11 - 2)
Artibeus planirostris (Spix, 1823)	126	*Aspidoptera phyllostomatis* (Perty, 1833)	42	19 (12.60 - 27.01)	1.63 (1.29 - 2.21)
		Megistopoda aranea (Coquillett, 1899)	93	34.9 (26.64 - 43.93)	2.09 (1.70 - 2.59)
		Metelasmus pseudopterus Coquillett, 1907	5	3.2 (0.87 - 7.93)	1.25 (1 - 1.50)
Carollia perspicillata (Linnaeus, 1758)	69	*Megistopoda aranea* (Coquillett, 1899)[a]	1	1,4 (0.03 - 7.82)	1[b]
		Strebla guajiro (Garcia & Casal, 1965)	10	11,6 (5.14 - 21.58)	1.25 (1- 1.75)
		Trichobius joblingi Wenzel, 1966	116	66,7 (54.28 - 77.57)	3.24 (2.63 - 3.89)
Chrotopterus auritus (Peters, 1856)	1	-			
Desmodus rotundus (É. Geoffroy, 1810)	16	-			
Glossophaga soricina (Pallas, 1776)	82	*Trichobius dugesii* Townsend, 1891	14	17.1 (9.66 - 26.99)	1[b]
Lophostoma brasiliense (Peters, 1866)	1	*Strebla tonatiae* (Kessel, 1924)	1		
Micronycteris megalotis (Gray, 1842)	4	-			
Phyllostomus discolor Wagner, 1843	1	*Trichobius costalimai* Guimarães, 1938	14		
Phyllostomus hastatus (Pallas, 1767)	42	*Trichobius longipes* (Rudow, 1871)	161	88.1 (74.36 - 96.02)	4.35 (3.41 - 6.43)
Platyrrhinus lineatus (É. Geoffroy, 1810)	8	-			
Sturnira lilium (É. Geoffroy, 1810)	25	*Aspidoptera falcata* Wenzel, 1976	21	36 (17.97 - 57.48)	2,33 (1.33 - 3.56)
		Megistopoda aranea (Coquillett, 1899)[a]	1	4 (0.1 - 20.36)	1[b]
		Megistopoda proxima (Séguy, 1926)	8	24 (9.35 - 45.13)	1.33 (1 - 1.67)
Vespertilionidae					
Lasiurus blossevillii (Lesson & Garnot, 1826)	1				
Myotis nigricans (Schinz, 1821)	15	*Basilia carteri* Scott, 1936	6	26.7 (7.78 - 55.11)	1.5 (1 - 2)
Eptesicus furinalis (d'Orbigny & Gervais, 1847)	2	-			
Total	452		519	44.3 (39.43 - 49.17)	2.66 (2.37 - 3.12)

Tab. III. Infrapopulations and infracommunities of flies on bats captured in Fazenda Dona Amélia, Nova Andradina, MS, Brazil.

Host (n)	Infracommunity/Infrapopulation	Frequency
Artibeus lituratus (10)	*Aspidoptera phyllostomatis*	1
	Paratrichobius longicrus	9
Artibeus planirostris (62)	*Aspidoptera phyllostomatis*	15
	Megistopoda aranea	34
	Metelasmus pseudopterus	2

Tab. III. Cont.

Host (n)	Infracommunity/Infrapopulation	Frequency
	A. phyllostomatis + *M. aranea*	9
	M. aranea + *M. pseudopterus*	1
	A. phyllostomatis + *M. pseudopterus*	1
Carolia perspicilata (43)	*M. aranea* + *T. joblingi*	1
	Trichobius joblingi	34
	Strebla guajiro	2
	S. guajiro + *T. joblingi*	6
Glossophaga soricina (14)	*Trichobius dugesii*	14
Myotis nigricans (4)	*Basilia carteri*	4
Phyllostomus hastatus (37)	*Trichobius longipes*	37
Sturnira lilium (15)	*Aspidoptera falcata*	8
	Megistopoda proxima	6
	A. falcata + *M. aranea*	1

DISCUSSION

The number of fly species collected at the present study (14) was lower than in other studies in the same state, within the area of cerrado. Eriksson *et al.* (2011), even with about half of our sampling effort, found 17 fly species. Barbier & Graciolli (2016), with sampling effort a little bigger (28,080 m².h), collected 22 species. In disagree with the works above-mentioned, the *Desmodus rotundus* (É. Geoffroy, 1810) and *Platyrrhinus lineatus* (É. Geoffroy, 1810) that we captured did not show infestation. In cerrado, *D. rotundus* is known for being host to *Strebla wiedemanni* Kolenati, 1856, *Trichobius furmani* Wenzel, 1966 and *T. parasiticus* Gervais, 1844 and *P. lineatus* host of *Paratrichobius* **aff.** *longicrus* (Miranda Ribeiro, 1907), *P. sanchezi* Wenzel, 1966 and *T.* **cf.** *angulatus*Wenzel, 1976 (Graciolli *et al.*, 2010; Eriksson *et al.*, 2011; Barbier & Graciolli, 2016; Vasconcelos *et al.*, 2016).

Artibeus lituratus (Olfers, 1818) was infested by *P. longicrus*, differently of what other works found out in the Cerrado (Komeno & Linhares, 1999; Graciolli *et al.*, 2010; Eriksson *et al.*, 2011; Santos *et al.*, 2013; Figueiredo *et al.*, 2015; Barbier & Graciolli, 2016), with exception of works in Goiás and Distrito Federal (Coimbra *et al.*, 1983). In this domain, *P. longicrus* is usually associated to *P. lineatus*, being probably a different species from what occurs on *Artibeus planirostris* and *A. lituratus* (Graciolli *et al.*, 2010). It is presumed that we captured *A. lituratus* infested by *P. longicrus* due to the study area being in an ecotone of Cerrado and Atlantic rainforest, domain where this association is more common.

Noctilio albiventris Desmarest, 1818 was infested only by *Paradyschiria parvula* Falcoz, 1931, however, the number of captured bats was low for greater inferences. In Brazil, *N. albiventris* is a primary host to *P. parvula*, *Noctiliostrebla maai* Wenzel, 1966 and *Xenotrichobius noctilionis* (Guerrero, 1995b).

The high prevalence (P>50%) of *Trichobius joblingi* Wenzel, 1966 on *Carollia perspicillata* (Linnaeus, 1758) and of *T. longipes* on *Phyllostomus hastatus*, as well as the low values (P<5%) of *Metelasmus pseudopterus* Coquillett, 1907 in *Artibeus planirostris*, may be a pattern to cerrado (Komeno & Linhares, 1999; Eriksson *et al.*, 2011; Santos *et al.*, 2013; Barbier & Graciolli, 2016; Vasconcelos *et al.*, 2016).

Overall, very close values of all prevalence found in the present work has already been recorded in others in this dominion, except *P. longicrus* in *A. lituratus*, we found higher values, and *B. carteri* in *M. nigricans*, with no previous records of prevalence and mean intensity of this association.

The mean intensity of infestation that we registered of *T. longipes* on *P. hastatus* and *P. longicrus* on *A. lituratus* are the highest, until now, to Cerrado. Close values to the other intensities already registered in the previously-mentioned works.

We found higher frequencies of infrapopulations (n=166) than infracommunities (n=19) on the individuals hosts, setting a possible association pattern (Barbier & Graciolli, 2016). *Artibeus planirostris* presented the highest number of composition of different parasite species (n=6), without accidental infestations, differently from the other works in the Cerrado (Santos *et al.*, 2013; Barbier & Graciolli, 2016).

From the 18 compositions of association recorded, three originated from possible contaminations. Accidental associations can highly increase the number of infracommunities, not reflecting the nature of the data, what emphasizes greater care in the parasites collection.

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