

# Do young *Carollia perspicillata* (Chiroptera: Phyllostomidae) present higher infestation rates of Streblidae (Diptera)?

Esbérard, CEL.<sup>a\*</sup>, Astúa, D.<sup>b</sup>, Geise, L.<sup>c</sup>, Costa, LM.<sup>a,d</sup> and Pereira, LG.<sup>e</sup>

<sup>a</sup>Laboratório de Diversidade de Morcegos, Instituto de Biologia, Universidade Federal Rural do Rio de Janeiro – UFRRJ, CP 74507, CEP 23890-000, Seropédica, RJ, Brazil

<sup>b</sup>Laboratório de Mastozoologia, Departamento de Zoologia, Universidade Federal de Pernambuco – UFPE, Av. Professor Moraes Rego, s/n, Cidade Universitária, CEP 50670-420, Recife, PE, Brazil

<sup>c</sup>Laboratório de Mastozoologia, Departamento de Zoologia, Instituto de Biologia – IB, Universidade do Estado do Rio de Janeiro – UERJ, Rua São Francisco Xavier, 524, CEP 20559-900, Rio de Janeiro, RJ, Brazil

<sup>d</sup>Programa de Pós-graduação em Ecologia e Evolução, Universidade do Estado do Rio de Janeiro – UERJ, RJ, Brazil

<sup>e</sup>Habtec Engenharia Sanitária e Ambiental Ltda, Av. Treze de maio, 13, Grupo 1508, Centro, CEP 20003-900, Rio de Janeiro, RJ, Brazil

\*e-mail: cesberard@superig.com.br

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(With 3 figures)

## Abstract

Ecological aspects related to parasitism are one of the less studied issues in parasitology research, and the scarce evidence available supports that younger specimens present higher infestation rates. The purpose of this work is to establish if higher infestation rates are observed in nursing females and their young captured inside their roost. Bats were captured inside a shelter located in RPPN Estação Veracel, Santa Cruz de Cabrália, Bahia state, Brazil. A total of 56 individuals of *Carollia perspicillata* were observed, 17 captured inside the roost during the day and 39 in trails at night. Captures of *C. perspicillata* during the day in a shelter yielded similar infestation rates to bats netted in trails and higher prevalence. The hypothesis that young were more infected was confirmed, based on the higher infestation of nursing females with neonates and on the significant inverse relation between body weight and number of parasites in young and subadults.

*Keywords:* parasite load, prevalence, roost, sampling, *Trichobius*.

## Jovens de *Carollia perspicillata* (Chiroptera: Phyllostomidae) apresentam maiores taxas de infestação de Streblidae (Diptera)?

## Resumo

Aspectos ecológicos relacionados ao parasitismo são uma das questões menos estudadas em parasitologia e poucas evidências sobre indivíduos jovens apresentando maiores taxas de infestações estão disponíveis. O objetivo deste trabalho é estabelecer se a taxa de infestação mais elevada é observada em fêmeas lactantes e jovens capturados dentro de seu refúgio. Os morcegos foram capturados dentro de um abrigo localizado na RPPN Estação Veracel, Santa Cruz de Cabrália-Bahia, Brasil. Um total de 56 indivíduos de *Carollia perspicillata* foi observado, sendo que 17 indivíduos foram capturados dentro do refúgio, durante o dia, e 39 foram capturados em trilhas, à noite. Indivíduos de *C. perspicillata* capturados durante o dia no abrigo apresentaram índices de infestação semelhantes aos morcegos capturados em trilhas e maior prevalência. A hipótese de que jovens eram mais infectados foi confirmada, com base na maior infestação de fêmeas com recém-nascidos e na relação inversa significativa entre o peso corporal e o número de parasitas em jovens e subadultos.

*Palavras-chave:* carga parasitária, prevalência, refúgio, amostragem, *Trichobius*.

## 1. Introduction

Streblidae dipterans are bat parasites, and the vast majority of their species are associated with phyllostomid bats. Species of Streblidae are viviparous, retaining the eggs in the female abdomen. After their development, the larvae are laid on the wall of the roost, and become pupae that emerge after 22 to 24 days. The deposition of larvae occurs during the activity period of the bats (Marshall, 1981; Graciolli et al., 2008).

Some species of Streblidae are found parasiting *Carollia perspicillata* (Linnaeus, 1758), such as *Trichobius joblingi* Wenzel, 1966, *Trichobius anducei* Guerrero, 1988, *Strebla guajiro* (Garcia & Casal, 1965) and *Speiseria ambigua* Kessel, 1925 (Rui and Graciolli, 2005; Graciolli et al., 2008), and up to five species of streblids can be found at some localities (e.g. Eriksson et al., 2011). Two species are most frequently observed and present a higher prevalence with *C. perspicillata*: *T. joblingi* and *S. guajiro* (Komeno and Linhares, 1999, Rui and Graciolli, 2005). *Trichobius joblingi* is a specific parasite of *Carollia erspicillata* and it has been found throughout most of the geographic range of its host (Wenzel, 1976; Wenzel et al., 1966; Graciolli et al., 2008).

Factors influencing ectoparasite diversity include roost type, host behavior and interspecific interactions, and aspects such as sex, the reproductive condition and host size may also influence ectoparasite occurrence and abundance (Marshall, 1981). Factors influencing the variation of Streblidae infestation rates in bats are still unclear, as variations related to sex were found to be either absent (Rui and Graciolli, 2005), or, when present, restricted to certain host species, such as in *Sturnira lilium* (E. Geoffroy, 1810). Higher infestation rates in immature specimens of *S. lilium* were sometimes found (Rui and Graciolli, 2005), but such a relation has not been confirmed (Komeno and Linhares, 1999). In *Noctilio leporinus* (Linnaeus, 1758), sex and age class did not present any significant influence in Streblidae infestation rates, but these varied significantly between seasons (Moura et al., 2003). In all of these studies, the influence of these factors in Streblidae infestation rates were evaluated based almost strictly on specimens obtained from mist-net sampling on flying routes.

Younger specimens usually present higher infestation rates (Marshall, 1981). Several hypotheses have been proposed to explain these higher infestation rates in young: (i) they spend more time in shelters and are less motile than adults; (ii) the young have not acquired yet all autogrooming skills, and are thus more infected; or (iii) differences in the epidermis thickness between young and adults facilitate haematophagy by parasites (Marshall, 1981; Komeno and Linhares, 1999; Moura et al., 2003; Rui and Graciolli, 2005; Bertola et al., 2005). Higher infestation rates in young bats are important for the ectoparasites because they increase the probabilities of dispersal, as the young leave the roost after weaning or at the end of the reproductive season (Komeno and Linhares, 1999; Bertola et al., 2005).

*Carollia perspicillata* is one of the most abundant bat species in Brazil, with confirmed records in all biomes. They establish groups, usually divided in harems, which can use the same roost for four years or more (Reis et al., 2007). Birth numbers usually peak during the period between dry and rainy seasons (Trajano and Gimenez, 1998).

In contrast to mist-netted specimens, estimates of infestation rates in specimens obtained directly in the roost during the day have not yet been conducted. The purpose of this work is thus to evaluate if higher infestation rates can be observed in juveniles, when compared to adults, and in bats inside the roost, compared to bats netted in flying routes.

## 2. Material and Methods

Bats were captured inside a roost located in an indigenous construction replica, located in the Reserva Particular do Patrimônio Natural Estação Veracel, Santa Cruz de Cabrália, Bahia state, Brazil (16° 23' 18.8" S and 39° 10' 7.8" W, 90 m). The reserve is an important portion of the Atlantic Rain Forest from southern Bahia, and preserves lowland forest in a region largely deforested to *Eucalyptus* spp. plantation.

Approximately 50 individuals of *C. perspicillata* were observed inside the roost, forming at least three groups. A mist-net (9 × 2.5 m, 36 mm of mesh) was set inside the roost, from 3:00 PM to 5:00 PM on March 26<sup>th</sup>, 2008, and animals were captured as moving without disturbing. Bats were kept in individual cloth bags, except from lactating females, which were kept together with their young. In order to compare Streblidae infestation rates in the roost with specimens from outside it, 52 specimens were captured with mist-nets set on existing trails up to 1,200 m away from the shelter. These were collected during four consecutive nights following the roost sampling.

Parasites were collected manually using tweezers, fixed in 95% ethyl alcohol and stored in labeled individual vials with each host number, for posterior identification. Bats were weighed with a digital precision scale (0.1 g) and measured with a digital caliper (0.01 mm). All collected parasite specimens are housed in the Laboratório de Diversidade de Morcegos reference collection, presently located at the Universidade Federal Rural do Rio de Janeiro (IBAMA process 1755/89). Voucher specimens for bats are also housed in the reference collection of Laboratório de Diversidade de Morcegos, in Universidade Federal Rural do Rio de Janeiro.

Two indices were used for the analysis of Streblidae infestation in *C. perspicillata*: prevalence ( $n^\circ$  of infested hosts /  $n^\circ$  of examined hosts × 100) and average intensity ( $n^\circ$  of parasites /  $n^\circ$  of infected hosts) (Bush et al., 1997). To test differences between the samples captured inside and outside the roost, between the sexes and between the reproductive conditions the Student T test was used assuming the significant level as  $p < 0.05$  (Zar, 1999).

The relationship between the host age and number of ectoparasites was assessed with a simple linear regression

(Zar, 1999), using body weight as a surrogate for age. The number of parasites in newborns was estimated as 50% of the total number of parasites counted in the mother.

### 3. Results

*Carollia perspicillata* is usually the host of several species of streblid flies (e.g. Wenzel, 1976; Wenzel et al., 1966), but only three parasite taxa were found in the specimens of *Carollia perspicillata* sampled: *Trichobius joblingi*, *Strebla guajiro*, and unidentified individuals of *Speiseria*.

In these specimens (N = 56), the body weight was significantly and positively correlated to the forearm length ( $r = 0.58$ ,  $F = 24.278$ ,  $p < 0.001$ ), and independent subadult specimens usually weighed smaller than 10.0 g, and had forearms smaller than 37.00 mm.

A total of 17 specimens of *C. perspicillata* were captured inside the roost. Four were subadults (two males, two females), nine adults (two pregnant females, four lactating females with their young, and two males with abdominal testicles) and four were newborn (Table 1).

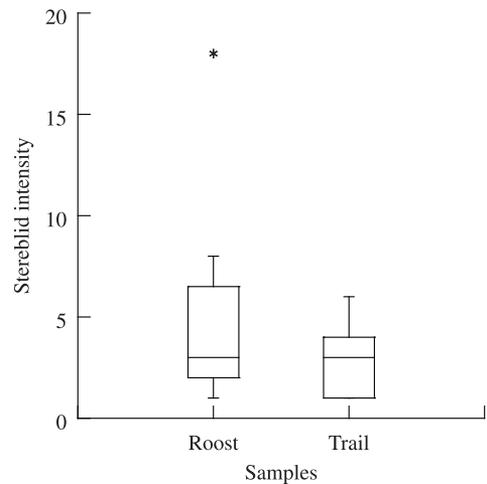
Since *T. joblingi* comprises 80.4% of the 148 flies encountered in this sampling and none of the flies of *S. guajiro* and *Speiseria* sp. were found infesting alone in any bat in this sampling, we opted to consider all data of streblid together. Average Streblidae infestation of all roost specimens was  $5.81 \pm 6.21$  parasites per infected bat (varying from zero to 18) and prevalence was 85.7% (N = 4 males positives, 80% of prevalence and N = 7 female positives, 87.5% of prevalence). In 39 bats captured in the trails, the mean infestation was  $2.62 \pm 1.36$  (ranging from 1 to 6 ectoparasites) and prevalence was 57.70%. In males (N = 15 parasited, 53.57% of prevalence) a total of 35 streblid was found ( $2.33 \pm 1.05$  parasites) and in females (N = 15 parasited, 62.50% of prevalence) a total of 41 parasites was observed in females ( $2.73 \pm 1.67$  parasites). Intensity was not significantly different between samples, using the Student *t*-test ( $t = 0.878$ ,  $p = 0.386$ ) (Figure 1).

In adult bats, no differences were observed between the roosting bats and bats netted during the night in the

intensity of each species of streblid separately, using the Student *t*-test (*T. joblingi* -  $t = 0.261$ ,  $p = 0.796$ , *P. guajiro* -  $t = 1.078$ ,  $p = 0.289$  and *Strebla* sp. -  $t = -0.444$ ,  $p = 0.660$ ).

Considering all bats together, the intensity of streblid differs between sexes ( $t = 2.081$ ,  $p = 0.045$ ). Differences were also observed between pregnant and inactive females ( $t = -2.109$ ,  $p = 0.055$ ), pregnant and lactating females ( $t = -3.179$ ,  $p = 0.019$ ) and lactating and inactive females ( $t = -5.528$ ,  $p < 0.001$ ) (Figure 2).

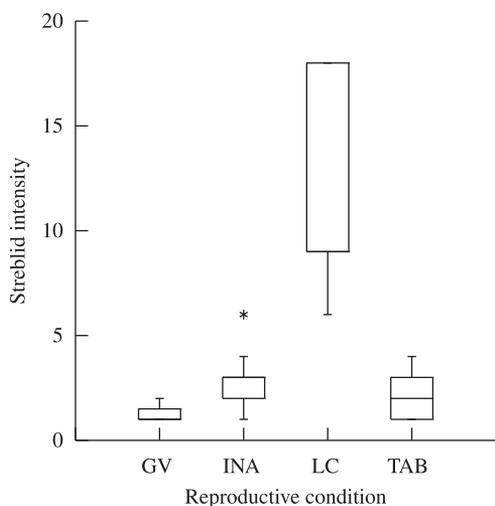
A negative and significant relation was observed between the weight of bats and streblid intensity if we consider the intensity for the four young still lactating (weights varying from 4.5 to 9.0 g) as half of that of their nursing mothers ( $\text{Streblid} = -0.457 \cdot \text{g} + 9.163$ ,  $r^2 = 0.25$ ,  $F = 12.648$ ,  $p = 0.001$ ) (Figure 3).



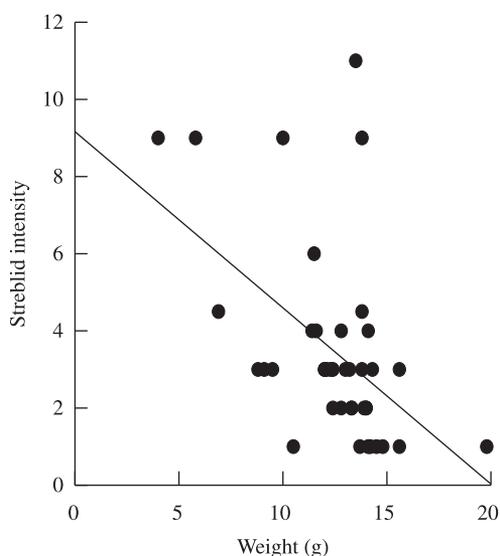
**Figure 1.** Intensity between samples in RPPN Estação Veracel, Santa Cruz de Cabrália, southern Bahia state, Brazil. Roost = captured inside roost during the day and Trail = netted in trails during night. No neonates were considered.

**Table 1.** Prevalence and mean infestation intensity by Streblidae dipterans in bats by sex and age/reproductive condition netted inside a roost and sampled with nets in forest areas in the RPPN Estação Veracel, Santa Cruz de Cabrália, Bahia state.

Source	Sex	Condition	Prevalence %	Mean intensity
Roost	Male	Subadult (2)	100	3.0
		Adult (3)	66.7	1.0
		<b>Total (N = 5)</b>	<b>80.0</b>	<b>2.0</b>
	Female	Subadult (3)	100	3.0
		Pregnant (2)	50	1.0
		Lactating (4)	100	12.25
		<b>Total (N = 9)</b>	<b>87.5</b>	<b>8.0</b>
In trails	Females	Pregnant (4)	80.0	1.75
		Lactating (2)	100	3.5
		<b>Total (n = 24)</b>	<b>62.5</b>	<b>2.73</b>
	Males	Males (15)	53.6	2.33
		<b>Total (N = 39)</b>	<b>57.7</b>	<b>2.53</b>



**Figure 2.** Variation of the streblid intensity between females and males of *Carollia perspicillata* in RPPN Estação Veracel, Santa Cruz de Cabrália, southern Bahia.



**Figure 3.** Variation of the streblid intensity in *Carollia perspicillata* in RPPN Estação Veracel, Santa Cruz de Cabrália, southern Bahia. All bats were included in the analysis; neonates were considered as presenting half of the intensity observed in their mother.

#### 4. Discussion

Specimens of *Carollia perspicillata* captured during the day in a shelter yielded similar intensity to those obtained from mist-nests set on trails or forest edges, but with higher prevalence, mainly subadults and lactating females and their young. Dittmar et al. (2011) observed a ratio of 4.9 *Trichobius frequens* Peterson & Hürka, 1974 flies per roosting bat and 3.15 flies in *Erophylla sezekorni* Gundlach, 1860 emerging to forage. Low prevalence and

reduced mean intensity are usually found in bats captured at night (e.g. Komeno and Linhares, 1999; Moura et al., 2003; Rui and Gracioli, 2005; Bertola et al., 2005; Anderson and Hortêncio Filho, 2006). Such a phenomenon is expected, as Streblidae are active during inactive periods of the hosts (Marshall, 1981), and probably leave them before they leave the roost.

Patterson et al. (2007) stated that prevalence, parasite load and richness attain higher levels in bat species that use permanent structures, such as caves and shelters. The structure used as a shelter from where the specimens for this analysis were obtained has been used as such for more than three years, but no analysis was performed to discriminate which species uses that roost (personal communication from the staff of the RPPN Estação Veracel). The fidelity of *C. perspicillata* to this shelter may represent a success factor for survival of *Trichobius* (see Reckardt and Kerth, 2006).

The hypothesis that young are more heavily infected was confirmed, based on the higher infestation of females with newborns and on the significant inverse correlation between body weight and number of parasites in all bats, including the neonates. Higher levels of infestation in younger animals have already been reported in samples captured during active periods (e.g. Komeno and Linhares, 1999; Moura et al., 2003; Rui and Gracioli 2005; Bertola et al., 2005). Higher infestation rates are expected in younger individuals, as they present little autogrooming activity (Marshall, 1981), although Hofstede and Fenton (2005) estimated grooming frequency in bats where parasites had been removed and found no significant difference with their control group, thus suggesting that grooming frequency does not increase in frequency with the presence of Streblidae parasites.

The correlation between size (and thus age) and infestation rate proves that Streblidae seek preferentially lactating females with newborns (and probably individual young as well) during the day, and three hypotheses can be formulated for this preference: (i) the young remain 24 hours in the shelter until they develop full flight capacity, and are carried by the mother if necessary; (ii) they have thinner epidermis, thus facilitating haematophagy (Marshall, 1981) or (iii) after weaning, part of these young must disperse, mainly males, thus favoring Streblidae colonization in other shelters (Bertola et al., 2005). As a result, lactating females may also present higher infestation rates than sexually inactive or pregnant females, as observed in our results, with subadults males and females having 3.0 streblid and 100% of prevalence.

It is thus important that further research focuses on infestation rates in different periods of the day inside roosts in order to determine at which moment the Streblidae are on the hosts and when they move to the substrate. Although only considering a sole roost, these data are important as they demonstrate similar infestation rates in bats captured inside and outside the roost, as well as the preference of Streblid for younger bats and their nursing mothers.

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