The chiggerflea *Hectopsylla pulex* (Siphonaptera: Tungidae) as an ectoparasite of free-tailed bats (Chiroptera: Molossidae)

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In the present study, we investigated the prevalence and intensity of Hectopsylla pulex *infection in* Molossus rufus *and* Molossus molossus*, the parasite's choice of attachment site, and whether this host-parasite system varies with host size. Twenty-four bats were captured by hand from the roof of a house in Southeastern Brazil.* M. rufus *exhibited a prevalence of 71.4% and the mean intensity averaged 5 ectoparasites per bat.* M. molossus *exhibited a prevalence of 90%, and the average mean intensity was 2.11 ectoparasites. The attachment sites were: ear, tragus, shoulder blade and tibia, anus, wing, axilla, mouth and dactylopatagium. A positive correlation was observed between the bats' weight and the number of fleas.*

Key-words: body mass - infestation - prevalence - chiggerflea

Hectopsylla pulex (Haller, 1880) (= *Rhynchopsyllus pulex* Haller, 1880) (Méndez 1977, Hastriter & Méndez 2000, Graciolli et al. 2008) is a burrowing chigger flea species (Siphonaptera: Tungidae). This species is an obligatory parasite of bats (Mammalia: Chiroptera). Females are usually found attached to the host in order to mature their eggs (Linardi & Guimarães 2000), while males abandon their host after feeding. Hastriter and Méndez (2000) captured females of *H. pulex* from bats, while males were only found associated with the guano of *Molossus* spp. (Molossidae), in Colombia and Panama.

Linardi and Guimarães (2000) reported the occurrence of this insect in Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Peru and Venezuela. Twelve species of bats have already been reported to be infested by *H. pulex* (Tipton & Machado-Allison 1972, Autino & Claps 2000, Linardi & Guimarães 2000, Esbérard 2001, Monteiro et al. 2005). Among bat species, there is a preference for Molossidae, since the parasite was only observed in specimens of *Molossus molossus* among a total of 66 individuals representing three families and seven species of different genera captured in artificial roosts in the municipality of Juiz de Fora, state of Minas Gerais (MG), Southeastern Brazil (Pallas 1766) (Netto 2001 *apud* Graciolli et al. 2008).

Esbérard (2001) is currently the only study to have analysed the prevalence and intensity of *H. pulex* in bats. Among 356 individuals of *M. molossus* captured from the roof of a house in the state of Rio de Janeiro (RJ), Southeastern Brazil, Esbérard (2001) collected 65 fleas from 29 bats and determined a prevalence of 8.14% with fleas attached preferably to the bats' heads. Parasite intensity sorted by host gender was 1.57 in males and 2.87 in females, with a maximum number of six fleas on males and nine on females. Despite the existence of 176 other chiropterans belonging to four other species (including *Molossus rufus* E. Geoffroy, 1805) found in the same roost, the presence of this parasite was only observed in *M. molossus*.

Hosts that are vulnerable to parasitism are likely to be in a poor nutritional state. Alternatively, parasites may favour the exploitation of high-quality hosts, which would provide better single meals. Christe et al. (2003) demonstrated that parasite density was significantly higher on individual hosts in good nutritional condition when compared with poorly fed hosts.

Thus, the objectives of the present study were to investigate the prevalence and intensity of *H. pulex* in *M. rufus* and *M. molossus*, to determine the parasite's choice of attachment site and to determine whether this host-parasite system varies with bat condition.

MATERIALS AND METHODS

Since 2007, efforts have been made to characterise the biota of Praia das Neves (Southeastern Brazil) to support the Management Plan of "Lagartixa da Praia" (*Liolaemus lutzae* Mertens, 1938), and a campaign was carried out to analyse the local bat fauna. Located on the shore of the Itabapoana river, at the boundary of the states of Espírito Santo and RJ, Praia das Neves, Presidente Kenedy municipality (21°05'56"S 41°02'48"W) still exhibits remnants of *restinga* (costal shrub land) and other typical vegetation of the Atlantic Forest ecoregion.

A mixed colony of *M. molossus* and *M. rufus* was found in a ceiling cavity of approximately 6 m^2 in one of the houses in Praia das Neves. Bats of both species were roosting between the cistern and the wall, in a space that varies from 2-10 cm. Both bat species had constant contact.

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From an estimated total of 30 individuals on 10 May 2008, 24 bats were captured by hand. Ectoparasites were removed with forceps and fixed in 92.4% alcohol. Bats were measured, weighed, marked with plastic bead necklaces with colored cylinders, and released at the same place. Bats were analysed to determine parasite prevalence, intensity (Margolis et al. 1982) and flea attachment site. Attachment sites were divided into nine categories: ear, tragus, shoulder blade, tibia, anus, wing, axilla, mouth and dactylopatagium. In order to calculate the mean intensity, non-infested individuals were not considered.

A Pearson correlation was used to test whether the variation of the body size and the number of ectoparasites were correlated, considering both bat species. For this analysis, we considered all individuals, including the non-infested ones. Statistical tests were performed using Systat 8.0 software.

RESULTS

Fourteen individuals of *M. rufus* (2 males and 12 females) exhibited a prevalence of 71.4% and an average mean intensity of 5 ectoparasites, with a total of 50 individuals of *H. pulex* (Table I). The number of fleas varied from 1-12 in females and from 6-7 in males.

Ten individuals of *M. molossus* (4 males and 6 females) exhibited a prevalence of 90% and an average mean intensity of 2.11 ectoparasites per bat, with a total of 19 *H. pulex* (Table I). The number of fleas varied from 1-2 in females and from 1-6 in males.

In both bat species, fleas were attached preferentially to the ear and tragus. Seven attachment sites were observed in *M. rufus* and four in *M. molossus*. Attachment sites were chosen in the following order of preference: ear, tragus, shoulder blade and tibia, anus, wing, axilla, mouth and dactylopatagium (Table II).

A significant positive correlation was observed between bat weight and the number of fleas found when both bat species were considered together ($r = 0.406$, $N = 24$, $p = 0.049$).

TABLE I

Total of captures, number of bats infested, mean intensity and prevalence for both bat species captured in Praia das Neves

	Host species	
	Molossus rufus	*Molossus molossus*
Total of captures	14	10
Bats infested	10	9
Number of ectoparasites	50	19
Mean intensity	5	2.11
Prevalence (%)	71.43	90

TABLE II

Number of individuals of *Hectopsylla pulex* on different attachment sites on *Molossus molossus* and *Molossus rufus* in Praia das Neves

Attachment sites	*M. rufus*	*M. molossus*
Ear	26	12
Tragus	15	5
Shoulder blade	3	0
Tibia	3	0
Anus	1	0
Wing	0	1
Axilla	1	0
Mouth	0	1
Dactylopatagium	1	0
TOTAL	50	19

DISCUSSION

Most studies of *H. pulex* report only on its occurrence (Alarcón 2000, Autino & Claps 2000, Monteiro et al. 2005). Only Esbérard (2001) has examined the prevalence and intensity in this host-parasite system, finding values much lower than those reported in the present study. The small number of individuals captured in Praia das Neves prevents further analysis; however, it is important to emphasise the high rate of prevalence and intensity found in this colony. Although our observations were based on a sole colony, the conditions observed here are unusual. The cohabitation between the two species is not typical and the inter-specific contact is even rarer. Our study likely represents the first report to find both species heavily parasitised with *H. pulex*.

Contrary to what was observed in RJ (Esbérard 2001) and MG (Netto 2001 *apud* Graciolli et al. 2008), we report a mixed bat colony where *M. molossus* is not the only infested species. A possible explanation is the higher bat density observed in the present study (5.0 bats/m^2 of roost) compared to other previously reported densities [0.3 bats/m^2 - considering the average number of bat captures and a roost with 150 m^2 - Esbérard (2001) and unpublished observations]. This higher bat density may facilitate transmission between individual bats. A negative relationship between parasitism rate and roost area has already been described by Esbérard et al. (2005) in *M. rufus* infested by *Hesperoctenes fumarius* (Westwood, 1874).

As previously described, the parasites preferentially attach to the bat's head (ear and tragus). The attachment sites chosen by ectoparasites exhibit a thinner epidermis than other body parts, which probably makes the attachment easier (Marshall 1991). Alternatively, the ectoparasites may be more protected from bat grooming at those sites (Graciolli et al. 2008).

Although levels of parasitism can vary greatly among bats, little is known about how the characteristics of the hosts affect this variation. Two strategies of host choice are described in the literature and may occur in nature. These are the preference for a vulnerable host and the preference for a well-fed host (Zhang 1991, Criste et al. 2003, Presley 2004, Hawlena et al. 2005).

Ectoparasites did not respond consistently to host body size and the effect of host body size is still unknown. Pearce and O'Shea (2007) found that large adult brown bats had more ectoparasites than volant juveniles

for most of the species analysed. Mite load and the condition of the bats were negatively correlated in a study by Lourenço and Palmeirim (2007) and the information available suggests that this may be due to an effect of parasitism. Heavier infestations of Streblidae parasites can be found in juvenile bats (Komeno & Linares 1999, Bertola et al. 2005). Although usually attributed to a dispersal strategy due to the less frequent grooming activity performed by young bats, this effect may also be related to the smaller mass.

Patterson et al. (2008) did not find a relationship between prevalence and mean intensity with host body mass, distribution, or abundance, but the number of fly species was correlated with host body mass.

This study suggests that parasite density was significantly higher in larger bats. The circumstances under which the observations were made possibly favour the well-fed host strategy. Since that assumption is based on a sole colony, a larger sampling may be desirable to confirm our findings.

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