Geographic variation in ectoparasitic mites diversity in *Tadarida brasiliensis* (Chiroptera, Molossidae)

Tatiana C. Pesenti¹, Sâmara N. Gomes¹, Ana M. Rui² & Gertrud Müller¹

1. Laboratório de Parasitologia de Animais Silvestres, Departamento de Microbiologia e Parasitologia, Instituto de Biologia, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brazil. (tatiana pesenti@yahoo.com.br)
2. Laboratório de Ecologia de Aves e Mamíferos, Departamento de Ecologia, Zoologia e Genética, Instituto de Biologia, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brazil.

**ABSTRACT.** *Tadarida brasiliensis* (Geoffroy, 1824), the Brazilian free-tailed bat, is an insectivorous bat that occurs from southern United States of America to southern South America. In this study we present the first data on diversity of ectoparasitic mites of *T. brasiliensis* in Brazil. A compilation and analysis of the studies of mite diversity conducted in different points the geographic distribution this bat species are provided. The mites were collected from March 2010 to November 2011 on 160 *T. brasiliensis* adult bats captured in southern Brazil. Four species of mites have been found: Chiroptonyssus robustipes (Ewing, 1925), Ewingana longa (Ewing, 1938), Ewingana inaequalis (Radford, 1948), and specimens of Cheyletidae. Chiroptonyssus robustipes was the most prevalent species (100%), followed by *E. longa* (20%), *E. inaequalis* (10%), and specimens of Cheyletidae (1.25%). The data currently available show that *C. robustipes* parasitizes *T. brasiliensis* throughout its region of occurrence, and this mite is highly prevalent and abundant. The two species of *Ewingana* accompany the geographical distribution of *T. brasiliensis*, but with much lower prevalence and abundance.

**KEYWORDS.** Brazilian free-tailed bat, Acari, Macronyssidae, Myobiidae, Cheyletidae.

**RESUMO.** Variação geográfica na diversidade de ácaros ectoparasitos em *Tadarida brasiliensis* (Chiroptera, Molossidae). *Tadarida brasiliensis* (Geoffroy, 1824) é um morcego insetívoro que ocorre desde o sul dos Estados Unidos até o sul da América do Sul. Neste estudo são apresentados os primeiros dados sobre diversidade de ectoparasitos de *T. brasiliensis* no Brasil e é disponibilizada uma compilação e análise dos estudos de diversidade de ácaros realizados nos diferentes pontos da distribuição geográfica desta espécie de morcego. Os ácaros foram coletados de 160 espécimes adultos de *T. brasiliensis* capturados no extremo sul do Brasil, entre março de 2010 e novembro de 2011. Quatro espécies de ácaros foram coletadas: *Chiroptonyssus robustipes* (Ewing, 1925), *Ewingana longa* (Ewing, 1938), *Ewingana inaequalis* (Radford, 1948) e espécimes de Cheyletidae. *Chiroptonyssus robustipes* foi a espécie mais prevalente (100%), seguido de *E. longa* (20%), *E. inaequalis* (10%) e exemplares de Cheyletidae (1,25%). Os dados disponíveis atualmente demonstram que *C. robustipes* parasitiza *T. brasiliensis* em toda sua região de ocorrência e que este ácaro é altamente prevalente e abundante. As duas espécies de *Ewingana* acompanham a distribuição geográfica de *T. brasiliensis*, porém com prevalências e abundâncias muito menores.

**PALAVRAS-CHAVE.** Morcego brasileiro da cauda livre, Acari, Macronyssidae, Myobiidae, Cheyletidae.

**Tadarida brasiliensis** (Geoffroy, 1824), the Brazilian free-tailed bat, is an insectivorous bat of the family Molossidae with a wide geographic distribution, occurring from Southern United States of America (USA), through Mexico, Central America, and western South America to about 45°S including Brazil, Uruguay, Chile, and Argentina. It also occurs in the Small and Great Antilles in the Caribbean (Wilkins, 1989; Simmonds, 2005). In Brazil, it occurs mainly in the southeast and south regions, where the temperatures are lower. *Tadarida brasiliensis* form colonies in several kinds of shelters including caves, sewers, attics, bridges, and tree hollows (Wilkins, 1989).

*Tadarida brasiliensis* was well studied in the USA, however there is little information on this species out of North America (Wilkins, 1989). Regarding acarine ectoparasites of *T. brasiliensis*, most studies were conducted in the southern USA; however, few contain information for a significant number of individuals. Among the studies conducted with a great number of hosts include: Durden et al. (1992) and Ritzi et al. (2001), in USA, with 133 and 96 specimens, respectively; Guzmán-Cornejo et al. (2003), in Mexico, with 98 specimens; and Muñoz et al. (2011), in Chile, with 195 specimens. Few studies were conducted in South America, and only two (Muñoz et al., 2003, 2011) are comprehensive studies of ectoparasites of *T. brasiliensis*; however, only Muñoz et al. (2003) report the parasitic indexes found. The other studies are records of occurrence of Acari species (Yunker & Radovsky, 1966; Saunders, 1975; Mauri, 1982). There is no information concerning mite parasites in *T. brasiliensis* from Brazil.

The knowledge of the ectoparasite fauna of bats can provide important information on behavior and biological aspects of its host (Fritz, 1983). In this study we present the first data on mite ectoparasites of *T. brasiliensis* in Brazil, and we include data on the species richness, and parameters of prevalence, mean abundance and mean intensity. We also provide a compilation of the studies on mite ectoparasites of *T. brasiliensis* throughout its geographic distribution to discuss the existence of geographic variation in diversity, to detect gaps in knowledge on the subject, and priority approaches for future studies.

**MATERIAL AND METHODS**

From March 2010 to November 2011, 160 adult specimens (80 males and 80 females) of *T. brasiliensis*...
from a colony housed in the attic of a one-story masonry building in the Municipality of Capão do Leão (31°48′03″S; 52°24′29″W), state of Rio Grande do Sul, Brazil, were captured in a harp trap.

Bats were anesthetized with ketamine hydrochloride by injection intramuscular (considering the weight and volume) and after euthanized in CO₂ chamber (licenced by ICMBio). Then were individually packed in plastic bags, and maintained under refrigeration for a few days in the laboratory until the time of analyses. Three different procedures were performed for collecting the ectoparasites: the body surfaces of the bats were examined under a stereomicroscope, the pelage was brushed on a tray with white background, and the bats were washed for thirty minutes in a vessel containing approximately 400 mL of water and 3 mL of detergent. The material that remained in the tray and water resulting from washing were examined under a stereomicroscope to obtain the ectoparasites. All mites were clarified in lacto phenol and mounted on slides for counting and identification. Some of these specimens were mounted on permanent slides in Hoyers’ Solution.

Mite identification was made according to keys of Ewing (1938), Fonseca (1948), Dusbabek (1968), and Krantz (1978). Parameters of prevalence (frequency of parasitized hosts in a sample), mean abundance (mean of the number of individuals of a particular parasite species per host examined) and mean intensity (mean of the number of individuals of a particular parasite species per infested host in a sample) of the mites were calculated according to Busk et al. (1997). The specimens were deposited in the Arthropod Collection of the Laboratory of Wild Animals Parasitology, Institute of Biology, Universidade Federal de Pelotas (UFPe), Pelotas (RS), Brazil.

We performed an extensive literature review to exhaust the location of new articles. The following information was summarized: study site, number of hosts analyzed, species found, species richness, and parasitic index.

RESULTS AND DISCUSSION

A total of 4,837 mites of four species were collected from 160 specimens of T. brasiliensis: 4,751 Chiroptonyssus robustipes (Ewing, 1925) (Macronyssidae) (Figs 1, 2), 63 Ewingana longa (Ewing, 1938) (Myobiidae) (Figs 3, 4), 21 Ewingana inaequalis (Radford, 1948) (Myobiidae) (Fig. 5), and two specimens of Cheyletidae (Fig. 6) (Tab. I).

| Mites                  | No. collected | Infestation range | Prevalence (%) | Mean Intensity ± SD | Mean Abundance ± SD |
|------------------------|---------------|-------------------|----------------|---------------------|---------------------|
| Chiroptonyssus robustipes | 4751          | 1-204             | 100            | 29.69 ± 24.67       | 29.69 ± 24.67        |
| Ewingana longa          | 63            | 0-8               | 20             | 1.96 ± 1.75         | 0.39 ± 1.1          |
| Ewingana inaequalis     | 21            | 0-2               | 10             | 1.31 ± 0.47         | 0.13 ± 0.42         |
| Cheyletidae             | 2             | 0-1               | 1.25           | 1                   | 0.012 ± 0.11        |

Tab. I. Parameter of infestation by mites in Tadarida brasiliensis (Geoffroy, 1824) captured from 2010 to 2011 in Rio Grande do Sul State, Brazil (n=160).

Two species of Ewingana were found in this study. Ewingana longa had a prevalence of 20% (Tab. I). In USA, low prevalence in T. brasiliensis was reported by Durden et al. (1992), Foster & Mertins (1996), and Ritz et al. (2001), of 1%, 3.5% and 11.46%, respectively. However, Guzmán-Cornejo et al. (2003), in Mexico, recorded high prevalences (42%, 50%, 63%, and 68%) (Tab. II).
Figs 1-6, ectoparasitic mites of *Tadarida brasiliensis* (Geoffroy, 1824). *Chyroptonyssus robustipes* (Ewing, 1925): 1, dorsal view; 2, ventral view. *Ewingana longa* (Ewing, 1938), dorsal view: 3, female; 4, male. 5, *Ewingana inaequalis* (Radford, 1948), dorsal view of female. 6, dorsal view of Cheyletidae.
Tab. II. Studies on mites ectoparasites of *Tadarida brasiliensis* (Geoffroy, 1824) at different regions. List of species collected and their parasitic indexes [P (%)*, prevalence; MI*, mean intensity; MA*, mean abundance; NA, not available].

| Reference                  | No bats examined | Location               | Mites                                         | Parasitic Index |
|----------------------------|------------------|------------------------|-----------------------------------------------|-----------------|
| Bradshaw & Ross, 1961      | NA               | Arizona (EUA)          | *Chiroptonyssus robustipes*                   |                 |
|                            |                  |                        | *Steatonyssus sp.*                           |                 |
| Durden *et al.*, 1992      | 133              | Alabama (EUA)          | *Chiroptonyssus robustipes*                   | 86.8            |
|                            |                  |                        | *Steatonyssus ceratognathus* (Ewing, 1923)    | 6               |
|                            |                  |                        | *Steatonyssus occidentalis* (Ewing, 1933)     | 2               |
|                            |                  |                        | *Ewingana longa*                              | 1               |
|                            |                  |                        | *Androlaelaps casalis* (Berlee, 1887)         | 1               |
| Spearrs *et al.*, 1999     | 45               | Georgia (EUA)          | *Chiroptonyssus robustipes*                   | 98              |
|                            |                  |                        | *Steatonyssus ceratognathus*                  |                 |
|                            |                  |                        | *Cheletonella vespertilionis* (Womersley, 1941)|                 |
| McAllister *et al.*, 2006  | 10               | Arkansas (EUA)         | *Chiroptonyssus robustipes*                   | 100             |
| Jameson, 1959              | 55               | Texas (EUA)            | *Chiroptonyssus robustipes*                   |                 |
|                            |                  |                        | *Ewingana longa*                              |                 |
| Strandmann, 1962           | NA               | Texas (EUA)            | *Nycteriglyphus bifolium* (Strandmann, 1962)  |                 |
| Whitaker & Easterla, 1975  | NA               | Texas (EUA)            | *Chiroptonyssus robustipes*                   |                 |
|                            |                  |                        | *Steatonyssus occidentalis*                   |                 |
| Ritzi *et al.*, 2001       | 96               | Texas (EUA)            | *Chiroptonyssus robustipes*                   | 83.3            |
|                            |                  |                        | *Ewingana longa*                              | 11.4            |
| Foster & Mertins, 1996     | 45               | Florida (EUA)          | *Chiroptonyssus robustipes*                   | 100             |
|                            |                  |                        | *Dentocarpus macrotrichus* Dusbábek & Cruz, 1966| 3.5          |
|                            |                  |                        | *Ewingana inaequalis*                         | 3.5             |
|                            |                  |                        | *Ewingana longa*                              | 3.5             |
|                            |                  |                        | *Ewingana sp.*                                | 3.5             |
|                            |                  |                        | *Notoedres sp.*                               | 3.5             |
|                            |                  |                        | *Raphignathus sp.*                            | 3.5             |
|                            |                  |                        | *Cheyletidae*                                 | 3.5             |
| Dusbábek & Cruz, 1966      | NA               | Camagüey (Cuba)        | *Dentocarpus macrotrichus*                    |                 |
| Dusbábek, 1968             | NA               | Camagüey (Cuba)        | *Ewingana inaequalis*                         |                 |
| Guzmán-Cornejo *et al.*, 2003 | 31       | Nombre de Dios (Mexico)| *Chiroptonyssus robustipes*                   | 100             |
|                            |                  |                        | *Macronyssus unidens* (Radovsky, 1967)        | 3.2             |
|                            |                  |                        | *Ewingana inaequalis*                         | 26              |
|                            |                  |                        | *Ewingana Longa*                               | 42              |
|                            |                  |                        | *Leptotrombidium mexicana* Wharton & Fuller, 1952| 13             |
|                            |                  |                        | *Whartonia (Asolentria) sp.*                  | 3.2             |
|                            |                  |                        | *Dentocarpus macrotrichus*                    | 3.2             |
|                            |                  |                        | *Notoedres lassionycteris* (Boyd, 1950)       | 25.8            |
| Guzmán-Cornejo *et al.*, 2003 | 12       | Río Salado (Mexico)    | *Chiroptonyssus robustipes*                   | 100             |
|                            |                  |                        | *Ewingana inaequalis*                         | 58.3            |
|                            |                  |                        | *Ewingana Longa*                               | 50              |
|                            |                  |                        | *Whartonia (Asolentria) sp.*                  | 41.7            |
|                            |                  |                        | *Dentocarpus macrotrichus*                    | 25              |
|                            |                  |                        | *Notoedres lasionycteris*                     | 58.3            |
| Guzmán-Cornejo *et al.*, 2003 | 27       | Cueva de la Boca (Mexico)| *Chiroptonyssus robustipes*                   | 100             |
|                            |                  |                        | *Ewingana inaequalis*                         | 33.3            |
|                            |                  |                        | *Ewingana Longa*                               | 63              |
|                            |                  |                        | *Leptotrombidium mexicana*                    | 15              |
|                            |                  |                        | *Dentocarpus macrotrichus*                    | 14.8            |
|                            |                  |                        | *Notoedres (Notoedres)*                       | 7.4             |
|                            |                  |                        | *Notoedres lasionycteris*                     | 51.8            |
in aequa ls showed a prevalence of 10% (Tab. I), higher than that recorded by Foster & Mertins (1996) in USA (3.5%), however lower than those reported by Muñoz et al. (2003) in Chile (32.22%) and Gzmá-N-Cor nejo et al. (2003) in Mexico (26%, 33.3%, 57.1%, and 58.3%) (Tab. II). There are no reports of occurrence of these mites in Brazil or infestation by these mites in other bat species.

Mites of Myobiidae show high specificity, and many species are specific to a single host genus (Fain, 1994). Ewingana longa and E. in aequa ls probably infest T. brasiliensis throughout its geographic distribution (Tab. II). The compiled data indicate that E. in aequa ls is present in T. brasiliensis populations, from the USA (Durden et al., 1992; Foster & Mertins 1996) to Chile (Muñoz et al., 2003; Muñoz et al., 2011), and in southern Brazil (this study), and E. longa occurs in populations from the USA (Jameson, 1959; Durden et al., 1992; Foster & Mertins, 1996; Ritti et al., 2001), Mexico (Gzmá-N-Cor nejo et al., 2003), and southern Brazil (this study).

The low prevalence of Cheyletid e obtained (Tab. I) is similar to that reported by Foster & Mertins (1996) (3.5%) in USA (Tab. II). In this country, Speaks et al. (1999) reported the occurrence of Cheletonella vespertilionis (Womersley, 1941) in T. brasiliensis. Most species of Cheyletidae are free-living predators preying on other arthropods, including mites; however, some species can parasitize small mammals, among them bats (Ezequiel et al., 2008). There is no previous report of these mites parasitizing T. brasiliensis in Brazil.

This review shows that there is a reasonable number of studies that report the occurrence of mite ectoparasites in T. brasiliensis, however, few have data of large numbers of hosts and parasitic indexes. Moreover, only four studies have data from populations in South America, and the current was the only study conducted in Brazil.

We can consider that are two major gaps in knowledge on mite parasites of T. brasiliensis: diversity related to geographic variation, and temporal and spatial dynamics of populations. Data currently available show that there is great specificity between T. brasiliensis and C. robusti pes throughout its geographic distribution, and this mite species is highly prevalent and abundant. Both Ewingana species are also present along the geographic distribution of T. brasiliensis, however with much lower prevalence and abundance.

Acknowledgements. We thank the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) for the license (Nº 23720-1) for capturing the bats; Núcleo de Reabilitação da Fauna Silvestre e Centro de Triagem de Animais Silvestres da Universidade Federal de Pelotas (NURFS/CETAS/UFPel) for opening the building for the bats capture, and CNPq and CAPES for financial support.

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| Reference                  | No bats examined | Location                  | Mites                                      | Parasitic Index |
|----------------------------|------------------|----------------------------|--------------------------------------------|-----------------|
|                            |                  |                            | Olabidocarpus nyctinosum                  | P(%)* MI* MA*   |
| Ewingana robustipes        |                  |                            |                                            | 29.6 - 5.07     |
| Ewingana inaequalis        |                  |                            |                                            | 100 - 186.2     |
| Ewingana longa             |                  |                            |                                            | 57.1 - 2        |
| Whartonia sp.              |                  |                            |                                            | 68 - 2          |
| Dentocarpus macrotrichus   |                  |                            |                                            | 8 - 0.2         |
| Notoedres lasionycteris    |                  |                            |                                            | 3.6 - 0.03      |
|                            |                  |                            |                                            | 3.7 - 0.5       |
|                            |                  |                            |                                            | 21.7 - 0.25     |
| Pearce et al., 1981        | 2                | Antillean island           | Chiroptonyssus robustipes                  | - - -           |
| Saunders, 1975             | NA               | Mérida (Venezuela)         | Chiroptonyssus robustipes                  | - - -           |
| Yunker & Radovsky, 1966    | NA               | Cerro Punta (Panamá)       | Chiroptonyssus robustipes                  | - - -           |
| Muñoz et al., 2003         | 90               | Concepción (Chile)         | Chiroptonyssus robustipes                  | 100 - -         |
| Muñoz et al., 2011         | 195              | Santiago (Chile)           | Chiroptonyssus robustipes                  | - - -           |
| Mau r, 1982                | NA               | La Plata (Argentina)       | Chiroptonyssus robustipes                  | - - -           |
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Received 7 April 2014. Accepted 22 December 2014. ISSN 0073-4721
Article available at: www.scielo.br/isz

Iheringia, Série Zoologia, Porto Alegre, 104(4):451-456, 31 de dezembro de 2014