

Scientific Note

Evidence of co-parasitism between different species of chiggers (Trombidiformes: Trombiculidae) parasitizing cricetid rodents in Morro Grande Forest Reserve, São Paulo State, Brazil

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Abstract. Chigger mites are ectoparasites of terrestrial vertebrates and can even accidentally bite humans, causing lesions on their skins. The co-parasitism is gradually being reported for this family, and recent studies have highlighted this relationship worldwide. In Brazil, only some records of chigger species co-parasitizing rodents and lizards in the Pernambuco and Piauí States were done. The present study reports six co-parasitism situations in cricetid rodents collected in the Morro Grande Forest Reserve, Cotia Municipality, São Paulo State, Brazil.

Keywords: Trombiculids, ectoparasites, Neotropical region, Rodentia.

Chigger mites (Trombidiformes: Trombiculidae s. l.) are ectoparasites of terrestrial vertebrates, such as amphibians, reptiles, birds, and mammals, as well as, these mites accidentally can bite humans, causing lesions in the skin host (Miyajima & Okumura 1917; Shatrov 2000).

Many studies have been done on the taxonomy and systematics of chigger mites, but little is known about their ecology. The co-parasitism relationship exists for mites and is gradually being reported for this family as well. Although there are few records in literature (Goff 1979), recent studies have highlighted the co-parasitism within different species of chiggers around the world (Barnard et al. 2015; Moniuszko et al. 2018; Jacinavicius et al. 2019; 2021).

In Brazil, some co-parasitism cases were already reported for two states (Jacinavicius et al. 2019; 2021). In Pernambuco State, *Pseudoschoengastia petrolinensis* Jacinavicius, Bassini-Silva & Barros-Battesti, 2019, *Eutrombicula batatas* (L., 1758) and *Quadraseta falconensis* Goff & Brennan, 1977 parasitizing the same white-eared opossum, *Didelphis albiventris* Lund, 1840 (Didelphimorphia: Didelphidae) and also, *P. petrolinensis* and *Q. falconensis* were collected again together in a second host of the same species, *D. albiventris*, in the same state (Jacinavicius et al. 2019). While in the state of Piauí, six cases of co-parasitism were reported, (1) *Eutrombicula alfreddugesi* (Oudemans, 1910), *Microtrombicula brachytrichia* Brennan, 1971, and *Neoschoengastia ochoai* Jacinavicius & Bassini-Silva, 2021 were collected parasitizing the same Peters' lava lizard, *Tropidurus hispidus* (Spix, 1825) (Squamata: Tropiduridae); (2) *Susa bauchani* Jacinavicius & Bassini-Silva, 2021 and *Quadraseta welbourni* Jacinavicius & Bassini-Silva, 2021 parasitizing the same São Lourenço Punare, *Thrichomys laurentius* Thomas, 1904 (Rodentia: Cricetidae); and three different situations of chiggers parasitizing an unidentified rodent of the genus *Rhipidomys* Tschudi, 1845 (Rodentia: Cricetidae), which occurred among *Paraguacarus klompeni* Jacinavicius & Bassini-Silva, 2021 and *M. brachytrichia*; *P. klompeni* and *Microtrombicula rhipidomysi* Goff, Whitaker & Dietz, 1983; and *P. klompeni* and *P. petrolinensis* (Jacinavicius et al. 2021).

The taxonomy chigger mites survey of Morro Grande Forest Reserve, Cotia Municipality, São Paulo State, Brazil, was previously reported by

Jacinavicius et al. (2015, 2018a, 2018b). However, the present study aims to show the co-parasitism observed between different chigger mite species collected from small mammals in the Morro Grande Forest Reserve. The Morro Grande Forest Reserve represents one of the most significant remnants of forests on the Planalto Paulistano (Metzger et al. 2006), extending from the Serra do Mar to the city of Campinas. The collections of the small mammals took place in two localities of this reserve, one close to the Pedro Beicht Dam (23°42'56"S; 46°57'29"W) and Graça Dam (23°39'11"S; 46°57'58"W) between March 2013 and December 2015, during five days per month. All mites were collected and stored in 100% alcohol for further studies. Each host represented a collection event; thus, all collected mites were stored together to do the screening later.

The mites collected were sent to the Acarological Collection of Instituto Butantan (IBSP) to be slide-mounted and identified, following the preparations described by Barros-Battesti et al. (2021). For the chigger identification, we use the genera key made by Brennan & Goff (1977) and the original descriptions of all species described in the identified genera.

At the end of the collection campaign, 72 hosts parasitized by mites were collected. They were 16 marsupials (Didelphimorphia: Didelphidae) - 10 *Didelphis aurita* (Wied-Neuwied, 1826); 1 *Metachirus nudicaudatus* (É. Geoffroy, 1803), and 5 *Monodelphis americana* (Müller, 1776); and 56 cricetid rodents (Rodentia: Cricetidae) - 32 *Akodon montensis* Thomas, 1913, 1 *Delomys dorsalis* (Hensel, 1873), 4 *Delomys sublineatus* (Thomas, 1903), 7 *Euryoryzomys russatus* (Wagner, 1848), 5 *Holochilus brasiliensis* (Desmarest, 1819), 1 *Necomys lasiurus* (Lund, 1840), 1 *Nectomys squamipes* (Brants, 1827), 1 *Sooretamys angouya* (Fischer, 1814), and 4 *Thaptomys nigrita* (Lichtenstein, 1830). Of which 35 hosts (5 marsupials and 30 cricetid rodent species) had been collected with chigger mites.

The co-parasitism was observed on six hosts examined. Four of them with two different chigger species, and the associations were: *Quadraseta mirandae* Goff & Brennan, 1977 (IBSP 10606C) and *Quadraseta pazca* (Brennan & Jones, 1964) (IBSP 10606B) parasitizing the same montane akodont, *Akodon montensis* Thomas, 1913 (Rodentia: Cricetidae) (Fig. 1A); *Quadraseta trapezoides* (Brennan

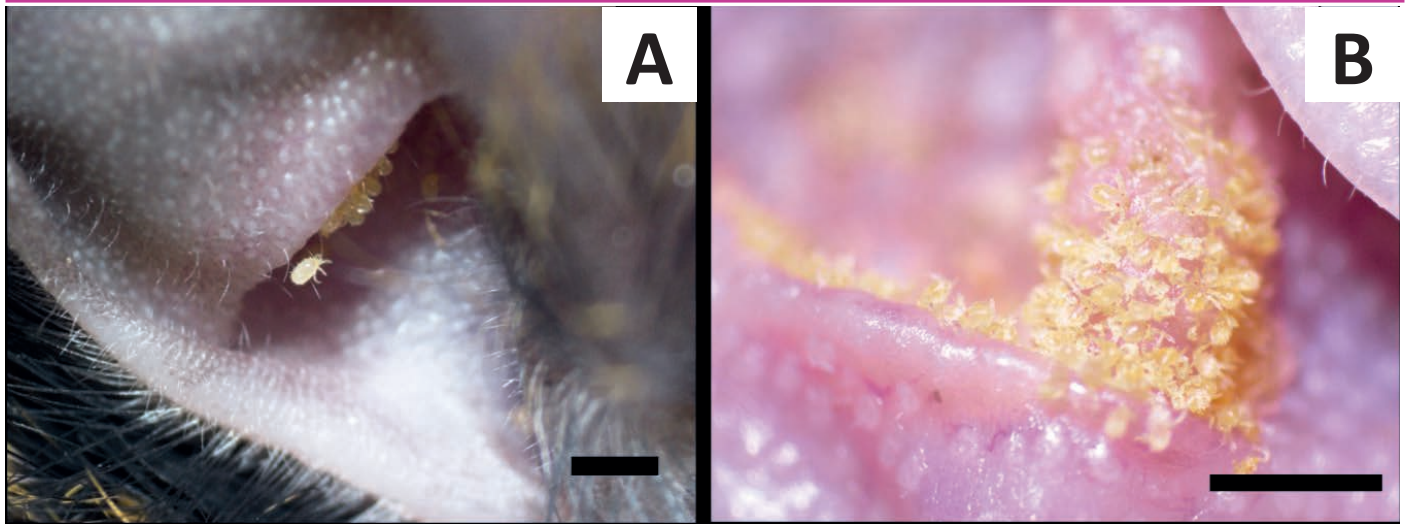


Figure 1. Chiggers attached to rodent host's ear. **A.** Larvae of *Quadraseta* spp. (Trombiculidae) on *Akodon montensis* Thomas, 1913 (Cricetidae). **B.** Larvae of *Quadraseta* spp. on larvae *Euryoryzomys russatus* (Wagner, 1848) (Cricetidae). Scale bars: 1000µm.

& Jones, 1964) (IBSP 11110C) and *Quadraseta brasiliensis* Goff & Gettinger, 1989 (IBSP 11110E) parasitizing the same South American water rat, *Nectomys squamipes* (Brants, 1827) (Rodentia: Cricetidae); *Trombewingia bakeri* (Fonseca, 1955) (IBSP 11364A) and *Speleocola tamarina* Goff, Whitaker & Dietz, 1987 (IBSP 11364B) parasitizing the same *Sooretamys angouya* (Fischer, 1814) (Rodentia: Cricetidae); and *T. bakeri* (IBSP 11369A) and *Q. brasiliensis* (IBSP 11369B) parasitizing the same striped Atlantic Forest rat, *Delomys dorsalis* (Hensel, 1873) (Rodentia: Cricetidae). A record of three different species that are *Kymoceta brasiliensis* (Fonseca, 1936) (IBSP 11129C), *Q. mirandae* (IBSP 11129B), and a novel *Kymoceta* Yunker & Brennan, 1962 species (IBSP 11129D) parasitizing another specimen of *A. montensis*. And finally, the same russet rice rat, *Euryoryzomys russatus* (Wagner, 1848) (Rodentia: Cricetidae), was collected parasitized with four different species of chigger mites, *Quadraseta flochi* Goff & Brennan, 1977 (IBSP 11096F), *Q. pazca* (IBSP 11096E), *Q. brasiliensis* (IBSP 11096 G) and a novel *Kymoceta* species (IBSP 11096D) (Fig. 1B). Of the marsupials examined, none were collected with more than one species of the chigger.

It is worth commenting that in all these collections, in addition to the chigger collections, ticks (Ixodida: Ixodidae), laelapid, and macronyssid mites (Mesostigmata: Laelapidae and Macronyssidae) were also collected.

During the field work, it was observed that the surroundings of the Morro Grande Forest Reserve are highly anthropogenic. The area receives considerable pressure due to the expansion of real estate and being constantly invaded for fishing and illegal hunting activities. The idea raised by Goff (1979) and Moniuszko et al. (2018) that co-parasitism can happen due to anthropogenic pressure may be one of the causes of the present study.

On the other hand, a parasitic preference was observed, because each genus has been found in a different place on the host's body. The species of *Quadraseta* Brennan, 1970 were all found inside the host's ear. In contrast, *Kymoceta* species were all intranasal, and *T. bakeri* was found parasitizing the ear edge region of the same hosts. In this way, it can be said that at least the co-parasitism observed in these hosts did not bring competition for space or food regarding genera competition. However, the *Quadraseta* species appear to compete among them, which was found up to three different species in one same host's ear. New studies must be carried out, and the co-parasitism reported. In this way, we can begin to understand the population dynamics and patterns of parasitism related to chiggers.

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Authors' Contributions

RLA collected the data of chiggers in co-association with the small mammals and prepared the material for examination. FCJ, RB-S, performed the study and confirmed the identification of the mites. RB-S, FCJ, RLA, and DMBB conducted the mite's preparations and wrote the manuscript.

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