

Ticks infesting captive and free-roaming wild animal species at the São Paulo Zoo, São Paulo, Brazil

Carrapatos infestando espécies de animais silvestres cativas e de vida livre no Zoológico de São Paulo, São Paulo, Brasil

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Abstract

Ticks are ectoparasites of worldwide distribution that affect vertebrates and can transmit pathogens to animals and humans. The Zoological Park Foundation of São Paulo (FPZSP) is located in a Conservation Unit in one of the most important remaining fragments of the Atlantic Rainforest biome in the suburbs of São Paulo, Brazil. The FPZSP houses more than 3,000 wild animals on exhibit, in breeding programs and in environmental education programs, and also attracts migratory birds and free-roaming wildlife. This study focused on identifying the diversity of tick species that infest captive and free-roaming animals at the FPZSP. The collection of ticks kept at the FPZSP contains 523 specimens that were collected from different host species between 1990 and 2017. Ten tick species were found. In addition, *Amblyomma aureolatum* (Pallas) was found on stray cats living in the Atlantic forest fragment in the FPZSP. This study reveals a low occurrence of parasitism in captive animals and a high diversity of tick species collected from hosts in this Atlantic forest fragment, contributing information about host-parasite relationships and potential vectors of zoonotic diseases, since the vectors of Brazilian spotted fever, *A. aureolatum* and *Amblyomma sculptum* Berlese, were found in some hosts.

Keywords: Ticks, wild animals, zoo, Atlantic forest.

Resumo

Os carrapatos são ectoparasitas da classe Arachnida, conhecidos como importantes vetores de agentes infecciosos para animais e humanos. A Fundação Parque Zoológico de São Paulo (FPZSP) localizada em uma Unidade de Conservação do bioma Mata Atlântica e inserida na cidade de São Paulo, mantém mais de 3.000 animais selvagens cativos, abrigando ainda diversas espécies silvestres nativas da Mata Atlântica. Devido à importância do conhecimento dos carrapatos que parasitam a fauna selvagem, o objetivo deste trabalho foi identificar a coleção de carrapatos da FPZSP e analisar a diversidade desses parasitas em animais cativos e de vida livre. O acervo de carrapatos mantidos pela FPZSP contém 523 exemplares que foram coletados de diferentes espécies hospedeiras, desde 1990 até 2017. Dez espécies de carrapatos foram encontradas. Além dos animais silvestres, foram encontrados *Amblyomma aureolatum* (Pallas) em gatos domésticos errantes que circulam nas áreas da FPZSP. Este trabalho demonstra a baixa ocorrência de parasitismo em animais cativos e a alta diversidade de carrapatos nos hospedeiros deste fragmento de Mata Atlântica, contribuindo com informações sobre a relação parasita-hospedeiro e potenciais vetores de doenças zoonóticas, já que os vetores da Febre Maculosa Brasileira *A. aureolatum* e *Amblyomma sculptum* Berlese, foram encontrados em alguns hospedeiros.

Palavras-chave: Carrapatos, animais silvestres, zoológico, Mata Atlântica.

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Ticks are ectoparasites of worldwide distribution that affect vertebrates and can transmit pathogens to animals and humans (GUGLIELMONE et al., 2014; NAVA et al., 2017). The host specificity of ticks is variable; some species are associated with specific groups of hosts while other species are less selective. Generally, larvae and nymphs of species that must infest more than one host species to complete their life cycles feed on small animals, while adult ticks prefer to parasitize medium and large sized-animals (BARROS-BATTESTI et al., 2006; ESSER et al., 2016).

The Zoological Park Foundation of São Paulo (FPZSP) is located in a Conservation Unit covering an area of 824,529 square meters in the Fontes do Ipiranga State Park (PEFI), one of the most important remaining fragments of the Atlantic forest biome in the suburbs of São Paulo, southeastern Brazil. The FPZSP, which maintains more than 3,000 wild mammal, bird, reptile, amphibian and invertebrate species, in breeding programs, also provides sanctuary for migrating birds and free-roaming animals (ZOOLOGICO DE SÃO PAULO, 2017)

The role played by modern zoos is not only to preserve the quality of life of captive animals but also to find ways to preserve wild animals and their habitats. Thus, when a free-roaming wild animal is debilitated it is cared for by a specialized support team from the FPZSP, which includes a close examination to detect the presence of ectoparasites. As a result, this institution started a collection of ticks removed from captive and free-living wildlife, which now contains hundreds of specimens.

The purpose of this study was to identify the tick species that have been collected from captive animals in the FPZSP, and from free-roaming animals living in the PEFI.

From 1990 to 2017, ticks were collected from animals kept by the Department of Applied Research, including captive and free-living wild animals at the FPZSP and PEFI. During the handling or clinical examination of animals, ticks were manually removed from their hosts and immediately stored in plastic vials containing 70% ethanol for subsequent taxonomic identification under a stereomicroscope, based on taxonomic keys and corresponding literature (ARAGÃO & FONSECA, 1961; ONOFRIO et al., 2006a, b, 2009; MARTINS, T., et al., 2010, 2016). The nomenclature used for the identification of bird and mammals followed Sick (1997) and Reis et al. (2011), respectively.

A total of 523 tick specimens were collected (163 males, 309 females, 44 nymphs and 7 larvae) from 156 hosts belonging to 13 different wildlife species, four of them captive, nine free-living, and one of unknown origin. The sampled animals comprised: one green-winged saltator (*Saltator similis* d'Orbigny & Lafresnaye), one opossum (*Didelphis* sp.), 101 Brazilian common opossums (*Didelphis aurita* Wied-Neuwied), one short-tailed opossum (*Monodelphis americana* Müller), ten porcupines [one *Coendou* sp., nine *Sphiggurus villosus* (Cuvier)], three red howler monkeys (*Alouatta guariba clamitans* Cabrera), two small wild rodents (*Akodon* sp. and *Oligoryzomys* sp.), one capybara [*Hydrochoerus hydrochaeris* (Linnaeus)], 32 brown-throated sloths (*Bradypus variegatus* Schinz), one southern tamandua [*Tamandua tetradactyla* (Linnaeus)], one crab-eating fox [*Cerdocyon thous* (Linnaeus)], and two lowland tapirs [*Tapirus terrestris* (Linnaeus)].

The following tick species were found: *Amblyomma aureolatum* (Pallas) on *A. guariba clamitans* and *C. thous*; *Amblyomma calcaratum*

Neumann on *T. tetradactyla*; *Amblyomma dubitatum* Neumann on *H. hydrochaeris*; *Amblyomma fuscum* Neumann on *Didelphis* sp.; *Amblyomma longirostre* (Koch) on *S. similis*, *Coendou* sp. and *S. villosus*; *Amblyomma parkeri* Fonseca & Aragão on *A. guariba clamitans* and *S. villosus*; *Amblyomma sculptum* Berlese on *T. terrestris*; *Amblyomma varium* Koch on *B. variegatus*; *Amblyomma* sp. on *A. guariba clamitans* and *B. variegatus*; *Ixodes loricatus* Neumann on *D. aurita*, *M. americana*, *Akodon* sp., and *Oligoryzomys* sp.; and *Rhipicephalus sanguineus* (Latreille) sensu lato on *T. terrestris*. Detailed results are listed in Table 1.

Although most of the tick-host reports cited in this study have been reported in earlier studies conducted in Brazil and in Argentina (FONSECA, 1933; ARAGÃO, 1936; LABRUNA et al., 2005, 2007, 2009; MARTINS, J., et al., 2006; MARTINS, T., et al., 2009, 2013, 2015; GUGLIELMONE & NAVA, 2011), the present study demonstrates new heretofore unpublished associations between stages of ticks and hosts, namely adults of *I. loricatus* on *M. americana* and on *Akodon* sp., *A. varium* nymph on *B. variegatus*, and *R. sanguineus* s.l. on *T. terrestris*.

In previous studies, immature stages of *I. loricatus* were found on *M. americana*, *Monodelphis dimidiata* (Wagner) and *Monodelphis sorex* (Hensel) (GUGLIELMONE et al., 2011), and on *Akodon azarae* Fischer (GUGLIELMONE & NAVA, 2011). Our identification of adults of *I. loricatus* on *M. americana* and *Akodon* sp. corroborates previous records about this tick species parasitizing marsupials and rodents.

Nymphs of *A. varium* have been recorded on *Bradypus tridactylus* Linnaeus, and *Bradypus torquatus* Illiger in Brazil (MARQUES et al., 2002). The present record of nymphs of *A. varium* on *B. variegatus* in the FPZSP is consistent with an earlier study which found that nymphs of this tick species use sloths of the genus *Bradypus* as hosts.

We report for the first time the occurrence of *R. sanguineus* s.l. on a captive *T. terrestris*. In Brazil, *R. sanguineus* s.l. is described as a nidicolous tick that is associated with human dwellings usually inhabited by domestic dogs, the primary host of this tick species (LABRUNA et al., 2005). While we have no information about habitat sharing by the *R. sanguineus* infested tapir and domestic dogs, this finding confirms the potential of this exotic tick to infest native wild mammals, provided they are reared under artificial conditions.

The present report of females of *A. sculptum* on *T. terrestris* supports a recent study at another zoo located in the state of São Paulo (MARTINS, T., et al., 2015). It should be noted that *A. sculptum* is considered the main vector of *Rickettsia rickettsii*, the etiological agent of Brazilian spotted fever, a potentially fatal tick-borne disease in Brazil (MARTINS, T., et al., 2016).

During our study, three stray cats [*Felis catus* (Linnaeus)] were also captured inside the FPZSP, and one male and three females of *A. aureolatum* were collected from these cats. The tick *A. aureolatum* is incriminated as the main vector of *R. rickettsii* in Atlantic forest fragments in the São Paulo metropolitan region, where domestic dogs (its main hosts) are considered to be carriers of infected ticks from the forest to human dwellings, thereby increasing the risk of human cases of Brazilian spotted fever (SZABÓ et al., 2013; SARAIVA et al., 2014). Our findings indicate that stray domestic cats are also potential carriers of *A. aureolatum* ticks to human

Table 1. Ticks collected from wild animals at the Zoological Park Foundation of São Paulo and the Fontes do Ipiranga State Park in São Paulo, Brazil, from 1990 to 2017, and previous records of tick-host relationship.

Hosts	Source	Date	Ticks	Species recorded in the literature
PASSERIFORMES				
<i>Saltator similis</i>	Free-living	2010	1N <i>Amblyomma longirostre</i>	Labruna et al. (2007)
DIDELPHIMORPHIA				
<i>Didelphis</i> sp.	Not recorded	1990	33N <i>Amblyomma fuscum</i>	Martins, T., et al. (2009)
<i>Didelphis aurita</i> (101)	Free-living	2011/2015/2016 /2017	20M, 242F <i>Ixodes loricatus</i>	Aragão (1936)
<i>Monodelphis americana</i>	Free-living	2015	1F* <i>I. loricatus</i>	
PRIMATE				
<i>Alouatta guariba clamitans</i> (3)	Free-living	2012/2014/2015	1F <i>Amblyomma aureolatum</i> 1N <i>Amblyomma parkeri</i> 5L <i>Amblyomma</i> sp.	Martins, J., et al. (2006) / Martins, T., et al. (2013)
RODENTIA				
<i>Akodon</i> sp.	Free-living	2016	1M*, 2F* <i>I. loricatus</i>	
<i>Oligoryzomys</i> sp.	Free-living	2016	2N <i>I. loricatus</i>	Guglielmone & Nava (2011)
<i>Coendou</i> sp.	Free-living	1991	1M, 1F <i>A. longirostre</i>	Labruna et al. (2009)
<i>Sphiggurus villosus</i> (9)	Free-living	2015/2011/2015/2017	25M, 5F, 1N <i>A. longirostre</i> 4M, 4F, 3N <i>A. parkeri</i>	Fonseca (1933) / Labruna et al. (2009) / Martins, T., et al. (2013)
<i>Hydrochoerus hydrochaeris</i>	Captive	1992	5M <i>Amblyomma dubitatum</i>	Martins, T., et al. (2015)
PILOSA				
<i>Bradypus variegatus</i> (32)	Free-living	2003-2016	104M, 46F, 3N* <i>Amblyomma varium</i> 2L <i>Amblyomma</i> sp.	Martins, T., et al. (2015) =
<i>Tamandua tetradactyla</i>	Captive	2008	1M <i>Amblyomma calcaratum</i>	Martins, T., et al. (2015)
CARNIVORA				
<i>Cerdocyon thous</i>	Captive	2000	2M, 1F <i>A. aureolatum</i>	Labruna et al. (2005)
PERISSODACTYLA				
<i>Tapirus terrestris</i> (2)	Captive	2011	5F <i>Amblyomma sculptum</i> 1F* <i>Rhipicephalus sanguineus</i> sensu lato	Martins, T., et al. (2015)

(number of examined animals). M: male; F: female; N: nymph; L: larvae; *New host association for the tick stage.

dwelling, a fact that should also be taken into account in the surveillance of Brazilian spotted fever in the metropolitan area of São Paulo, since human cases of the disease have been recorded in the surroundings of this forest fragment (OGRZEWALSKA et al., 2012).

This paper describes the relatively low occurrence of tick parasitism on captive wild animals at the FPZSP, and at the same time demonstrates a high diversity of tick species in free-roaming animal species living in the Atlantic forest fragment of the PEFI. These findings contribute with information about host-parasite relationships and potential vectors of tick-borne diseases transmitted to animals and humans, as indicated by two main vectors of *R. rickettsii*, the ticks *A. aureolatum* and *A. sculptum*, which were found in the study area.

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