

First report of the intestinal helminth community in the broad-headed spiny-rat *Clyomys laticeps* (Rodentia, Echimyidae)

Primeiro registro da comunidade de helmintos intestinais do rato de espinho
Clyomys laticeps (Rodentia, Echimyidae)

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Abstract

The broad-headed spiny rat, *Clyomys laticeps*, is an echimyid rodent found in open areas of Cerrado and Pantanal biomes in central Brazil and Paraguay. Little is known about the parasites associated with this semi-fossorial species, as no previous studies have been conducted on their helminth fauna. The aim of this study was to report the helminth community structure of *C. laticeps* inhabiting Serra de Caldas Novas State Park, a Cerrado area in central Brazil. Trappings were carried out in dry grasslands from January to October 2016, and the large and small intestines of 14 *C. laticeps* individuals were examined for the presence of helminths. Three nematode species were found: *Fuellebornema almeidai*, *Pterygodermatites (Paucipectines) sp.*, and *Subulura forcipata*, and 85.7% of the studied species were infected with at least one of these helminths. *F. almeidai* was the most prevalent species among hosts, and *S. forcipata* was the most abundant. This study is the first report on helminth community structure in *C. laticeps*. We report a new host species and increase the known geographical range of *F. almeidai*, and provide the first record of *Pterygodermatites (Paucipectines) sp.* infecting echimyids. This is also the first report of *S. forcipata* in a mammal host.

Keywords: Endoparasites, Fossorial rodents, *Fuellebornema almeidai*, *Pterygodermatites (Paucipectines) sp.*, *Subulura forcipata*.

Resumo

Clyomys laticeps é um roedor equimídeo encontrado em áreas abertas dos biomas Cerrado e Pantanal, ao longo do Brasil central e Paraguai. Essa espécie apresenta hábitos semi-fossoriais e atividade noturna. Até o momento, não existem estudos sobre seus parasitas. O objetivo deste trabalho foi descrever a comunidade de helmintos encontrados em *C. laticeps*, capturados no Parque Estadual da Serra de Caldas Novas, uma área de Cerrado no Brasil Central. Os indivíduos foram capturados em área de “campo sujo” entre janeiro e outubro de 2016. Os intestinos delgado e grosso de 14 roedores foram examinados quanto à presença de helmintos. Três espécies de nematóides foram encontradas: *Fuellebornema almeidai*, *Pterygodermatites (Paucipectines) sp.* e *Subulura forcipata*. Considerando-se as três espécies, 85,7% dos roedores apresentaram pelo menos um helminto. *F. almeidai* foi a espécie mais prevalente, enquanto *Subulura forcipata* foi a mais abundante. Este estudo é o primeiro registro da estrutura da comunidade de helmintos para *C. laticeps*. Como resultado, foi registrado um novo hospedeiro e o

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aumento da área de distribuição geográfica para o nematódeo *F. almeidai* e o primeiro caso de *Pterygodermatites (Pauciptectines)* sp. infectando um roedor equimídeo. Além disso, este estudo também traz o primeiro registro de *S. forcipata* infectando um mamífero.

Palavras-chave: Endoparasitas, Roedores fossoriais, *Fuellebornema almeidai*, *Pterygodermatites (Pauciptectines)* sp., *Subulura forcipata*.

Introduction

South-American rodents comprise approximately 45% of the mammalian fauna in this region, and they are commonly known for their role as reservoirs of several parasites and zoonotic diseases (Han et al., 2015). The broad-headed spiny rat *Clyomys laticeps* (hereafter referred to as 'spiny rat') is a spiny rat in the family Echimyidae, and is the only species in this genus. It is found in open areas of Cerrado and Pantanal biomes, and occurs in grassland habitats in central Brazil and Paraguay (Bezerra & Bonvicino, 2015). It has semi-fossorial habits and sexual size dimorphism, with males having a larger body mass and daily home range than females (Ferrando et al., 2019). A recent study suggested that spiny rat burrows are occupied by a single individual of this species, indicating that they are solitary, and also that this species has non-seasonal, year-round reproduction, and a polygynous mating system (Ferrando et al., 2019). Spiny rats are considered mainly as frugivore-herbivores, acting both as predators and dispersers of seeds of palms (Bezerra & Bonvicino, 2015), although insect fragments have been frequently recorded in their stomachs (Ferrando, pers. obs)

Although there are several reports on helminths occurrence in Brazilian rodents, compiled by Pinto et al. (2011), there is a lack of studies evaluating the helminth community structure of the broad-headed spiny rat. Considering echimyids, the genera *Trichomys*, *Euryzygomatomys*, and *Proechimys* were the most studied in relation to their helminth fauna (Simões et al., 2010, Robles et al., 2012; Maldonado et al., 2020). This gap in knowledge is even more pronounced among burrowing rodents, including strictly subterranean species and semi-fossorial species, which perform their activities above and belowground. The aim of this study was therefore to describe the helminth community structure of spiny rats inhabiting a Cerrado area in central Brazil.

Materials and Methods

The study was carried out at Serra de Caldas Novas State Park (PESCAN), Goiás state, Brazil, which is located in the Cerrado biome. Rodents were captured at the top of a mountain plateau (750-1,043 m above sea level), in a dry grassland site (17° 48.377' S and 48° 41.979' W). The climate of the region is characterized by a dry season (with temperatures from 9 °C to 35 °C) from April to September, and a wet season (with temperatures from 17 °C to 33 °C) from October to March (AMAT, 2019). Total monthly rainfall at the study site varies between 0 and 675 mm (AMAT, 2019).

Spiny rats were collected during a capture-mark-recapture study (Ferrando et al., 2019) from January to October 2016 using Sherman (43 × 12.5 × 14.5 cm) and Tomahawk (30 × 17.30 × 15.5 cm) live traps. Fieldwork was performed with ethical permission from the Environmental Department of Goiás state (SECIMA), and the Ethics Committee on Animal Use of the Federal University of Uberlândia (UFU), Minas Gerais state, Brazil (permit number: 152/13). Specimens were collected with permission of the Brazilian Government's Chico Mendes Institute for Biodiversity and Conservation (ICMBio Permit Number: 22629-1). Individuals that were found dead inside the traps were necropsied, and we recorded information regarding sex, body mass, and reproductive condition of females (including the presence of embryos). Spiny rats were identified based on their external morphology. The large and small intestines of the spiny rats were examined for the presence of helminths. Intestines were placed in Petri dishes, washed twice in a physiological saline solution, and dissected under a stereomicroscope. Helminths were preserved in 70% ethanol prior to identification. To examine morphological structures, helminths were cleared in lactophenol, mounted on temporary slides, and examined using a Zeiss Scope Z1 light microscope (Zeiss, Göttingen, Germany). Morphological structures of helminths were measured using digital images taken by a Zeiss Axio Cam HRC and using the accessory software, Axio Vision Rel. 4.7. The species were identified according to Vicente et al. (1995, 1997), Lynggaard et al. (2014) and Durette-Desset et al. (2017). Voucher specimens were deposited at the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC numbers: F.a.: 38784; Pt.: 38785; S.f.: 38786).

Prevalence, mean abundance, and mean intensity of infection were calculated for each helminth species, and for each host sex, according to Bush et al. (1997). The mean species richness of the helminths was calculated as the sum of helminth species in each infracommunity (each rodent specimen) divided by the number of analyzed

infracommunities. Importance indices of each helminth species were calculated according to Thul et al. (1985). Species in each community were classified as dominant ($I \geq 1.0$), co-dominant ($0.01 \leq I < 1.0$), or subordinate ($0 < I < 0.01$).

Results and Discussion

Fourteen spiny rats were captured in this study, including four males and 10 females. Twelve spiny rats were infected by at least one helminth species, representing a prevalence of 85.7%. All 10 females were infected, but only half of the male hosts (i.e. two of the four) were infected with helminths. Three nematode species were recovered from the hosts, and were identified as *Fuellebornema almeidai* (Travassos, 1937) (Heligmonellidae), *Pterygodermatites (Pauciptectines) sp.*, and *Subulura forcipata* (Rudolphi, 1819) (Subuluridae). *Fuellebornema almeidai* and *Pterygodermatites (Pauciptectines) sp.* were found in the small intestines and *S. forcipata* was found in the cecum of the hosts. *F. almeidai* life cycle is direct (monoxenous), while *Pterygodermatites (Pauciptectines) sp.* and *S. forcipata* present indirect life cycles (heteroxenous), using insects as intermediate hosts (Anderson, 2000). The occurrence of these heteroxenous species may be attributed to an eventual consumption of insects by the rodents. None of these helminths has zoonotic potential so far.

The mean species richness was 1.5 considering all hosts, and mean species richness was 0.5 for male hosts, and 1.9 for female hosts. *F. almeidai* showed the highest prevalence rates, and was the only helminth species found in male hosts (Table 1). *Pterygodermatites (Pauciptectines) sp.* and *S. forcipata* had similar prevalences. However, *S. forcipata* had the highest mean abundance and intensity rates among the helminth species (Table 1). All species were considered dominant in the communities analyzed according to the importance index (*F. almeidai*: $I = 50.14$; *Pterygodermatites (Pauciptectines) sp.*: $I = 10.41$; *S. forcipata*: $I = 39.45$).

Table 1. Prevalence rates (95% confidence interval for a proportion), mean abundance (\pm SD) and mean intensity (\pm SD) of three helminth species of *Clyomys laticeps* in Serra de Caldas Novas State Park, Goiás state, Brazil.

| Parameters \ Helminths | <i>Fuellebornema almeidai</i> | <i>Pterygodermatites (Pauciptectines) sp.</i> | <i>Subulura forcipata</i> | Total |
|-------------------------|-------------------------------|---|---------------------------|-----------------------|
| Total prevalence | 64.29 (39.2 - 89.4) | 42.86 (16.9 - 68.8) | 42.86 (16.9 - 68.8) | 85.71 (67.4 - 100) |
| Total mean abundance | 4.36 \pm 4.52 | 1.36 \pm 2.13 | 5.14 \pm 7.51 | 10.86 \pm 7.30 |
| Total mean intensity | 6.78 \pm 3.83 | 3.17 \pm 2.23 | 12.00 \pm 6.93 | 12.67 \pm 6.17 |
| Female hosts prevalence | 70.00 (41.6 -98.4) | 60.00 (29.6 - 90.4) | 60.00 (29.6 - 90.4) | 100.00 (100 -100) |
| Female hosts abundance | 4.50 \pm 4.70 | 1.90 \pm 2.33 | 7.20 \pm 8.07 | 13.60 \pm 6.36 |
| Female hosts intensity | 6.43 \pm 4.31 | 3.17 \pm 2.23 | 12.00 \pm 6.93 | 13.60 \pm 6.36 |
| Male hosts prevalence | 50.00 (49.85 - 50.15) | 0.00 | 0.00 | 50.00 (49.85 - 50.15) |
| Male hosts abundance | 4.00 \pm 4.69 | 0.00 | 0.00 | 4.00 \pm 4.69 |
| Male hosts intensity | 8.00 \pm 1.41 | 0.00 | 0.00 | 8.00 \pm 1.41 |

Number of hosts analyzed: 10 females and 4 males.

This is the first report on helminth occurrence and helminth community structure in *C. laticeps*. This is a new host and a new geographical report for *F. almeidai*, which has not been previously reported in echimyid rodents. Moreover, this is the first report of *F. almeidai* in the Cerrado biome, since this species was first described as parasitizing red-rumped agoutis, *Dasyprocta leporina*, in Pará state, Brazil (Durette-Desset et al., 2017). The morphology of the caudal bursa, with rays 9 parallel to rays 10 and synlophes with carene and eleven continuous ridges in both sexes are the main characters which defined the species as *F. almeidai*.

Parasites in the genus *Pterygodermatites* (subgenus *Pauciptectines*) are commonly found in mammals, including rodents (Vicente et al., 1997), marsupials (Lopes-Torres et al., 2007) and bats (Cardia et al., 2015). Among the 11 species of this subgenus that occur in Neotropical regions, only four were previously recorded in rodents in the subfamily Sigmodontinae (Lynggaard et al., 2014). *Pterygodermatites (Pauciptectines) zygodontomys* has already been described in the Cerrado biome, and was found infecting the hairy-tailed bolo mouse, *Necomys lasiurus*, a terrestrial rodent found in Minas Gerais state, Brazil (Costa et al., 2018). Morphology of the buccal capsule, in the apical position of the oral opening, enables us to include them in the subgenus *Pterygodermatites (Pauciptectines)*.

However, the number of prevulvar cuticular processes and number of buccal denticles in the studied specimens differs from the previously described species. Based on its morphological characteristics, we believe that the *Pterygodermatites (Paucipectines)* sp. found in this study represents a new species.

This is the first record of *S. forcipata* infecting a mammal host. This species has been recorded only in birds, and was first described in the dark-billed cuckoo, *Coccyzus melacoryphus*, later on *C. minor minor*, *Piaya cayana*, *Crotophaga ani* and *Guira guira* (Vicente et al., 1995). Both of the latter bird species inhabit Serra de Caldas Novas State Park, where *C. laticeps* were sampled. However, other parasites in this genus have been found in mammals. For example, *S. amazonica* was recorded in the bare-tailed woolly opossum, *Caluromys philander*, *S. interrogans* was recorded in the bare-tailed woolly opossum and in Tate's woolly mouse opossum, *Marmosa paraguayana* (syn. *Marmosa cinerea*), as well as in Emilia's gracile opossum, *Gracilinanus emiliae* (syn. *Marmosa emiliae*). Furthermore, there are records of *Subulura* sp. in the capuchin monkeys, *Sapajus apella* (syn. *Cebus apella*) in Brazil, including Amazonia and Atlantic forest biomes (Vicente et al., 1997). The morphological characteristics that defined the species *S. forcipata* were the position of the precloacal pseudosucker and vulva, the length of oesophagus and spicules, and the number and arrangement of the caudal papillae. Female specimens of *S. forcipata* found infecting *C. laticeps* in the present study contained eggs in the uterus, which corroborates the possible adaptations of this parasite to infecting mammals.

The observed helminth species richness was low, with only three dominant species. Low helminth species richness has already been reported for other Hystricognathi rodents with burrowing habits in the Neotropics, such as the tuco-tuco, *Ctenomys talarum*, in Argentina (Rossin & Malizia, 2002), and the degu, *Octodon degus*, in Chile (Yáñez-Meza et al., 2019), as two helminth species were recorded in the first study and four in the second. On the other hand, a study on the helminth fauna of the scansorial echimyid *Thrichomys pachyurus* in the Pantanal (Brazil) reported 12 helminth species (Simões et al., 2010). Although spiny rats forage above ground, which increases their exposure to parasites, their predicted solitary, territorial behavior, and low population density (Ferrando et al., 2019) seem to contribute to the observed low helminth species richness. Solitary habits associated with low population density may reduce the encounters between individuals in a population, which may reduce transmission of helminth parasites with direct life-cycles (Rossin & Malizia, 2002). However, the small sample size in our study must also be taken into account.

Conclusion

The present study contributes to the expansion of the geographic distribution and host range of *F. almeidai*, the presence of *Pterygodermatites (Paucipectines)* sp. in an echimyid rodent, and to the host range of *S. forcipata*. Although the number of hosts analyzed was low, this report is an important contribution to the present knowledge of the helminth fauna of spiny rats, and to the present knowledge on Echimyidae parasites.

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