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NEW PARASITE RECORDS FROM *Kerodon rupestris* (RODENTIA, CAVIIDAE) AN ENDEMIC SPECIES TO NORTHEASTERN BRAZIL

*Mônica Vieira de Souza[1,2], Sergio Augusto de Miranda Chaves[2], Jean-Pierre Hugot[3] & Alena Mayo Iñiguez[1]**

[1] Fundação Oswaldo Cruz (Fiocruz), Instituto Oswaldo Cruz (IOC), Laboratório de Tripanosomatídeos (LABTRIP), Avenida Brasil 4365 Manguinhos, CEP 21040-900 Rio de Janeiro, RJ, Brazil.

[2] Fundação Oswaldo Cruz (Fiocruz), Escola Nacional de Saúde Pública Sérgio Arouca (ENSP), Laboratório de Palinologia/ Ecologia, Rua Leopoldo Bulhões 1480 Manguinhos, CEP 21041-210, Rio de Janeiro, RJ, Brazil.

[3] Museum National d'Histoire Naturelle (MNHN), UMR 7205, 55 rue Buffon, Paris, France, cedex 05, 75231.

E-mails: mvieira26@gmail.com; sdemirandachaves8@gmail.com; hugot@mnhn.fr; alenainiguez@gmail.com; alena@ioc.fiocruz.br (*corresponding author)

Abstract: The present study aimed to identify endoparasites from faecal samples of *Kerodon rupestris,* an endemic rodent of the Brazilian semiarid region. Samples collected from 10 locations at the Parque Nacional Serra da Capivara, Piauí State, Brazil were analyzed. Each faecal samples was processed, rehydrated, homogenized, and processed by spontaneous sedimentation. Morphological and morphometric characteristics of gastrointestinal parasites were observed using light microscopy. A total of three taxa from helminth and protozoan parasites were found. The results demonstrated parasite remains in 6/10 localities, and a high occurrence of *Trichuris* cf. *gracilis,* in 5/10 localities. Egg morphometric data was compared with *Trichuris* spp. egg Brazilian rodents. Two new parasite records were identified in *K. rupestris,* a nematode, *Helminthoxys* sp. (Oxyuridae) and a possible coccidian. The findings are discussed with taxonomic and ecological literature of intestinal parasites from rodents. The role of *K. rupestris* as source of ecological information in the region is suggested.

Keywords: Caviidae; Northeast Brazil, Rodentia; Oxyuridae; *Trichuris* cf. *gracilis.*

Kerodon rupestris Wied-Neuwied 1820 (*mocó* or rocky cavy) is one of two *Kerodon* species (subfamily Caviinae), which comprise small mammals adapted to conditions of low altitude and are distributed throughout South America (Alho 1982). *Kerodon* spp. attain larger body size than other Caviinae, being most common rodent species in the area of São Raimundo Nonato, Piauí State (Chame 1988). They have been found since The Pleistocene in the semi-arid region and in a small extension of the humid region of northern Brazil, confined to rocky outcrops and mountain walls (Lacher 1981, Oliveira & Bonvicino 2011). Specifically, the species *K. rupestris* is distributed throughout Northeastern Brazil (NEB) and some northern regions of Minas Gerais State (Alho 1982, Oliveira & Bonvicino 2011).

Parasitological and paleoparasitological studies have been conducted in Parque Nacional Serra da Capivara (PNSC), Piauí State, since the 1980s. These studies demonstrate morphotypes from *Trichuris* genus infecting *K. rupestris* since at least 30,000 years ago (Ferreira *et al.* 1991). In addition to *Trichuris* spp., the most recent investigations also reported the presence of *Strongyloides* sp.,

Trichostrongylidae, Ancylostomidae, Ascaridae, Oxyuridae and Trematoda (Souza 1960, Sianto *et al.* 2006, Almeida *et al.* 2008, Saldanha 2016). In this study, we present new records of nematode eggs and protozoa cyst in faecal material of *K. rupestris* from PNSC, and discuss the role of this rodent in the ecology of NEB.

Faecal samples were collected in 2009, from 10 rocky areas of the PNSC and surroundings (Figure 1). The collection of samples was limited to possible access, since roads were rare and the displacements were mostly done on foot. The locations were: Toca da Baixa do Cipó, Toca do Arapuá do Gongo, Toca do Paraguaio, Toca do Morcego, Toca do Boqueirão da Pedra Furada, Toca do Baixão do Perna I, Toca do Antonião, Toca do Sítio do Meio, Toca do Gongo I and Toca de Cima dos Pilão. All the areas are shelters under rock, except for Toca de Cima dos Pilão that is a limestone grotto. The whole region is located within the Caatinga biome, a typically semiarid region with low averages of annual precipitation of around 689 mm, and with eight months of drought without any prolonged rainfall every year (Martin 2008).

The identification of *K. rupestris* faecal samples (Figure 2) was performed according to Chame (2003). From each area, 10 g of feces (approximately 100 pellets) were rehydrated in a 0.5 % aqueous solution of trisodium phosphate for a period of 72 hours (Callen & Cameron 1960). After rehydration, the spontaneous sedimentation technique was employed (Lutz 1919). Slides were prepared with 20 µL of sediment, and the addition of 20 µL of glycerol. Observations were made using a binocular light microscope at magnifications of 100x and 400x. Parasites were measured and photographed with an ocular micrometer at 400x using Image Pro™® software. Dimensions and morphology were compared with data from the taxonomic literature in order to identify the lowest possible taxon.

The faecal material were dark brown, cylindrical, oval, with the presence of an evident groove that runs through their concave face from one extremity to the other of the pellet, which is

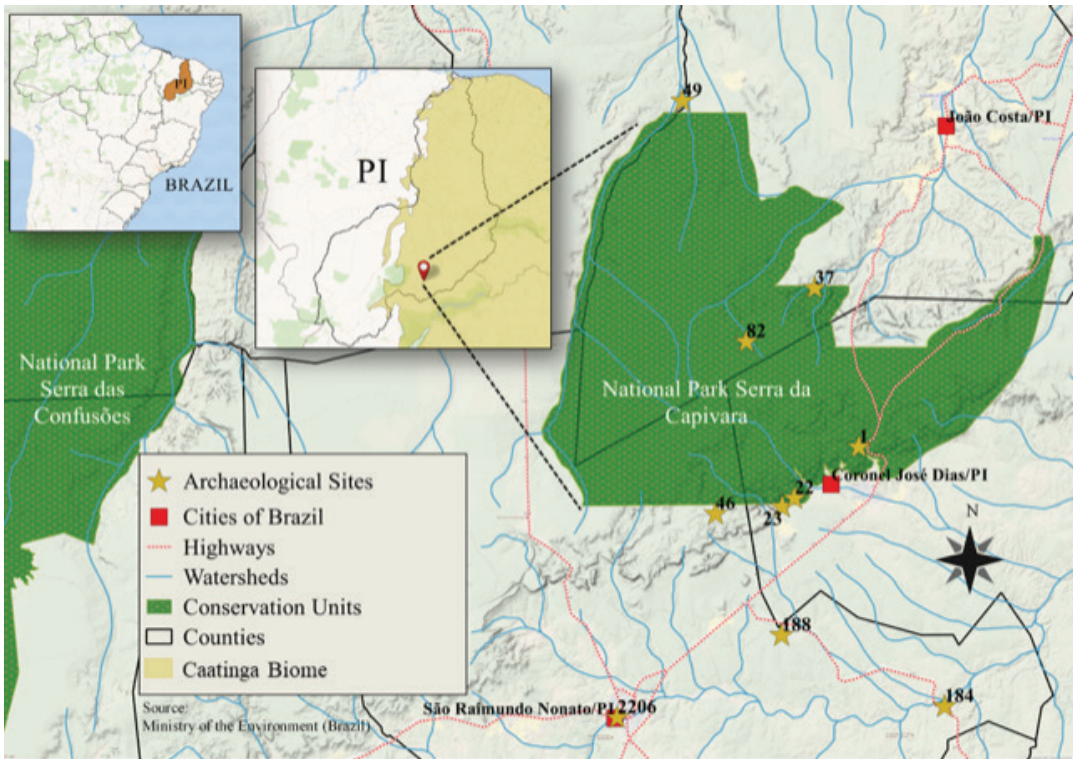

Figure 1. Geographical locations of the archaeological sites in Parque Nacional Serra da Capivara, Piauí State, Brazil, where fecal samples of *K. rupestris* were collected for this study. Toca da Baixa do Cipó (2206), Toca do Arapuá do Gongo (37), Toca do Paraguaio (001), Toca do Morcego (049), Toca do Boqueirão da Pedra Furada (023), Toca do Baixão do Perna I (046), Toca do Antonião (184), Toca do Sítio do Meio (022), Toca do Gongo I (082) and Toca de Cima dos Pilão (188).

Figure 2 – The typical morphology of *K. rupestris* feces collected in Parque Nacional Serra da Capivara, Piauí, Brazil. Arrows indicate the groove on the inner part of pellets, which is characteristic of this rodent species.

peculiar in *K. rupestris* feces (Chame 2003) (Figure 2). Average measurements of faecal samples were 0.8-1.4 mm x 0.4-0.5 mm. Parasite remains were found in 6/10 localities examined (Table 1). Three taxa of gastrointestinal parasites were identified (Figure 3).

Eggs of *Trichuris* cf. *gracilis* Roederer 1761 (Nematoda: Trichuridae) were identified (Figure 3A and 3B, Table 1) in 5/10 localities. With the exception of Toca do Gongo I, parasites were found in areas from the southern region of PNSC (Figure 1). The eggs exhibited the characteristic barrel shape, brown coloration, shell with smooth and thin walls, and operculum's at each end. The total size of eggs was 68.05-59.49 x 38.00-31.61 µm (N = 29).

Eggs of *Helminthoxys* sp. (Nematoda: Oxyuridae) were identified (Figure 3C) in faecal samples from Toca da Baixa do Cipó (Figure 1, Table 1). The eggs exhibited thickening at the edges, a light brown color, outer shell with thin walls and without striations, an oblong shape and no formed larva in the interior. The size of eggs was 99.85-87.50 x 52.50-40.00 µm (N = 5). In this study, *Helminthoxys* sp. was found in concomitance with *Trichuris* cf. *gracilis* (Table 1).

A single cyst of an unidentified coccidian was found (Figure 3D) in faecal samples from Toca do Paraguaio (Figure 1, Table 1). It possessed a thin cell wall, with contents without reproduction or vegetative multiplication and measures of 38.33 x 35.25 µm (N = 1).Nematoda larvae were found (N = 5) in faecal samples from Toca do Gongo I.

Trichurids are present in all vertebrate groups, but mainly birds and mammals, with eggs that mature in the soil (Schmidt & Roberts 2000). Possess a stenoxenic cycle, adapted to a single host or to phylogenetically close zoological groups, with a high host specificity. Eggs are quite resistant to environmental factors due to their thick shell, and can remain viable in the soil for up to six years (Fortes 1997). About 24 *Trichuris* spp. have been reported in the Americas in 10 families of rodents (Robles *et al.* 2014). Twelve *Trichuris* spp. have been described in rodents from South America, with only five reported in Brazil: *T. myocastoris* parasite of members of Myocastoridae (Barus *et al.* 1975); *T. travassosi* parasite of members of Cricetidae (Correa *et al.* 1992); *T. gracilis* parasite of members of Caviidae and Dasyproctidae (Almeida *et al.* 2008); *T. muris* parasite of members of Caviidae (Almeida *et*

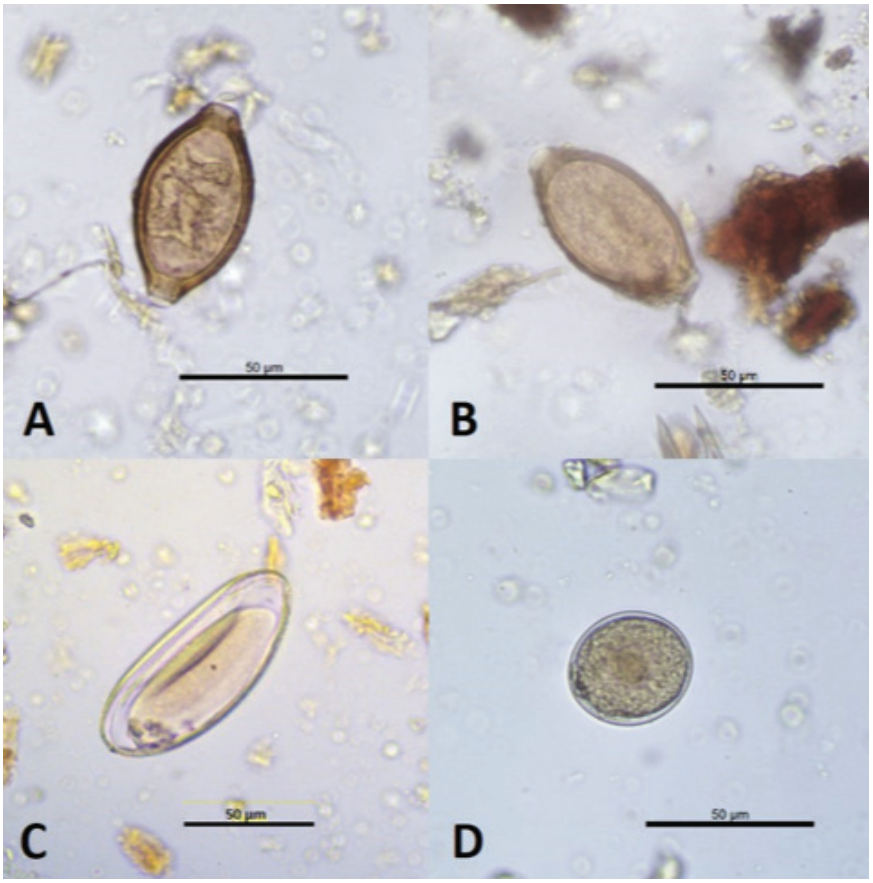

Figure 3 – Eggs and cyst of the enteroparasites found in *K. rupestris* feces from archaeological sites in the Serra da Capivara National Park, and surroundings. A and B- *Trichuris* cf. *gracilis*; C- *Helminthoxys* sp.; D- Coccyde cyst. 400x.

al. 2008); and *T. thrichomysi* parasite of *Thrichomys apereoides* (Torres *et al.* 2011). *Trichuris* sp. eggs found in the present study are more closely related to the species *T. gracilis* (Vicente *et al.* 1997), due to morphology of the eggs in the form of an elongated barrel, three membranes that when not visible, the junction of them gives the appearance of a single thick membrane (Souza 2013). However, they differ slightly in morphometry, with the proximity of measurements of eggs to those reported for *T. muris* (Figure 4), and thus, this species cannot be rule out. These are the only two species reported in *K. rupestris* so far (Almeida et al. 2008, Souza 2013). The other three species do not present characteristics compatible with the eggs found in the present study (Figure 4). The genus *Trichuris* has been found in samples dated up to 30,000 years in the same region of the Brazilian semiarid (Ferreira *et al.* 1991). The data suggest a possible adaptation of the parasite to the semiarid climate, since it is dependent on specific conditions of humidity and temperature to conclude the biological cycle in the soil.

Oxyurids are parasites that infect mainly mammals, but also invertebrates, amphibians and birds. They have a high host specificity and a monoxenic cycle. *Helminthoxys* spp. are parasites of Neotropical caviomorphs and inhabit the cecum and large intestine of their hosts (Hugot & Sutton 1989). The genus currently comprises eight species: *H. caudatus* (syn. *H. pujoli*), the type species parasite of *Microcavia australis* from Argentina; *H. efflilatus* (syn. *H. velizi*) parasite of *Lagidium* sp. from Argentina, Bolivia and Peru; *H. freitasi* parasite of *Thrichomys apereoides* from Brazil; *H. tiflophila* and *H. quentini* parasites of *Capromys* sp. from Cuba; *H. urichi* parasite of *Dasyprocta* sp. from Trinidad and French Guiana; *H. gigantea* parasite of *Octodon* sp. from Chile; and *H. abrocomae* parasite of *Abrocoma* sp. from Bolivia (Hugot & Sutton 1989, Hugot & Gardner 2000). *Helminthoxys freitasi* is the only species described in Brazil, but the egg size was not mentioned in the taxonomic study of the species (Quentin 1969). The range of measurements found in the present

Table 1: Endoparasites found in faecal of *Kerodon rupestris* at the archaeological sites of Parque Nacional Serra da Capivara, Piauí, Brazil, from this study. *Measurements are in µm. N eggs: numbers of parasite eggs. SD = Standard Deviation.

Archaeological site	Parasites found	N eggs	Range of length (µm)	Range of width (µm)	Mean (SD) (µm)	
Toca da Baixa do Cipó	*Trichuris* cf. *gracilis*	1	65.60	34.12		
	Helminthoxys sp.	5	99.85-87.50	52.50-40.00	91.21 (±6.55)	42.88 (±6.62)
Toca do Arapuá do Gongo	negative	-				
Toca do Paraguaio	coccidian cyst	1	38.33	35.25		
	Trichuris cf. *gracilis*	3	65.00-59.49	38.00-33.37	61.50 (±3.05)	35.46 (±2.35)
	Nematoda	1	53.40	37.95		
Toca do Morcego	negative	-				
Toca do Boqueirão da Pedra Furada	negative	-				
Toca do Baixão do Perna I	negative	-				
Toca do Antonião	*Trichuris* cf. *gracilis*	21	68.05-60.97	35.71-31.61	64.09 (±2.06)	33.51 (±1.33)
Toca do Sítio do Meio	*Trichuris* cf. *gracilis*	2	65.00	37.50		
Toca de Cima dos Pilão	negative	-				
Toca do Gongo I	*Trichuris* cf. *gracilis*	2	65.00-62.50	35.00-32.50		
	larvae	5				

study is close to that reported for *H. gigantea* (92 x 35 µm) (Sutton & Hugot 1993). However is also morphologically and morphometrically similar to the morphotype Oxyuridae 003 (91 - 102 x 38 - 42 µm), recently reported in the southern region of PNSC (Saldanha 2016), which suggests that it may be the same species. *Helminthoxys* sp. eggs with similar size (77.5 - 92.5 x 45.0 - 52.5 µm) were also reported in rodent coprolites from Patagonia (Beltrame *et al.* 2014). In this study, it was not possible to define the *Helminthoxys* species found due to the absence of complementary information to compare the parasite eggs. The genus *Helminthoxys* seems to be restricted to Hystricognath (Caviomorpha), and may have infected *K. rupestris* overtime, since it is found in the same region in other sympatric caviomorphas such as *Thrichomys apereoides* (Sutton & Hugot 1993). However, because the biology of parasite, a greater number of findings is difficult. Oxyuridae have fragile and light eggs, and eggs are deposited in the perianal region of the host, and rarely eliminated with the feces, which may hamper the number of nematode findings in faecal samples. Other genera of the Oxyuridae have been reported in paleoparasitological studies of *K. rupestris*. *Syphacia* sp. was found in Parque Nacional Serra das Confusões (Souza *et al.* 2012), as the first report of the genus in rodents from the New World and the oldest dating (5,300 years) of oxyuriids registered for *K. rupestris*. *Parapharyngodon* sp. was documented in the PARNA Serra da Capivara as an event of accidental parasitism related to the ingestion of lacertid feces (Sianto 2009).

The only protozoan found in *K. rupestris* to date is *Eimeria* sp. (Sianto *et al.* 2006). However, the cyst found here is similar to coccidians, so does not resembles *Eimeria* genus. Other protozoa reported for caviids are *Giardia* sp., *Cryptosporidium* sp., and *Cystoisospora* sp. (Gardner 1991), which have

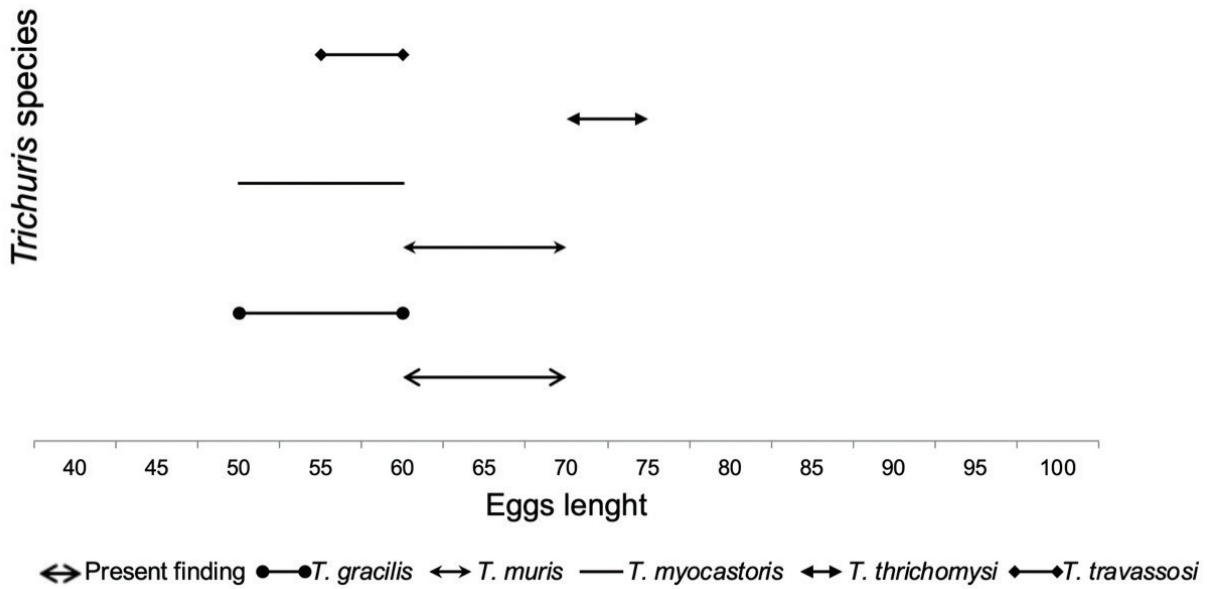

Figure 4 – Graphic of length measurements of *Trichuris* sp. eggs found in rodents from Brazil.

taxonomic structures that were not observed in the cyst found in the present study. The present study may be the first identification of a coccidian in *K. rupestris* in the semiarid region. In Brazil, coccidians parasitizing wild rodents are poorly known. Coccidians are intestinal parasites of variety of animals, spanning rodents to birds (Schmidt & Roberts 2000), and the presence could represent a data related to other wild animals in sympatry with *K. rupestris*, including carnivore predators.

It was not possible to reach a lower taxa classification for Nematoda larvae observed in *K. rupestris* feces because the larvae were damaged. These larvae are probably related to the helminth eggs recovered. Still, we cannot rule out that it may represent free-living larvae from the soil aggregated to the sample.

Kerodon rupestris seems to be an excellent source of information on the parasitic fauna present in the semiarid region because it has coprophagic habits (Alho 1982, Almeida *et al.* 2008), and thus acquires parasites from sympatric wild animals, such as, canids and felines. Herbivorous feeding may also have assisted the transmission of parasites from animals that cohabit theses ecosystems. Investigations of helminthofauna can help to determine the possible emergence or extinction of species, and allow to predict the impacts that these processes may have on future parasite populations (Ogunseitan 2005). This is the first report of the genus *Helminthoxys* and a coccidian, in *K. rupestris*, increasing the richness of parasites found in this caviid rodent.

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