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Original Article

New observations from the intestinal fauna of *Kerodon rupestris* (Wied, 1820) (Rodentia, Cavidae), Brazil: a checklist spanning 30,000 years of parasitism

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(With 1 figure)

Abstract

This checklist of parasites of *Kerodon rupestris*, an endemic rodent from the Brazilian semiarid region, revealed records of 25 enteroparasite taxa comprising Cestoda (Anoplocephalidae), Trematoda, Acanthocephala and Nematoda (Ancylostomidae, Ascarididae, Heterakidae, Oxyuridae, Pharyngodonidae, Trichuridae, Capillariidae, Trichostrongylidae, and Strongyloididae), and two taxa of coccidian. Paleoparasitological and parasitological studies published until 2019 were assessed in the present study and locality information, site of infection, sample dating, and host data were summarized from each reference. Analyses of recent feces and coprolites revealed the highest species richness in the Piauí State. The chronological data corroborated that *Trichuris* spp. and oxyurids are part of the parasitic fauna of *K. rupestris*. This represents the first checklist of intestinal parasites from *K. rupestris.*

Keywords: Kerodon rupestris, helminths, biodiversity, rodent, Northeast Brazil.

Novas observações da fauna intestinal de *Kerodon rupestris* (Wied, 1820) (Rodentia, Cavidae), Brasil: uma lista de verificação que abrange 30.000 anos de parasitismo

Resumo

Este levantamento de parasitos intestinais de *Kerodon rupestris*, um roedor endêmico da região semiárida brasileira, revelou registros de 25 táxons de enteroparasitos compreendendo Cestoda (Anoplocephalidae), Trematoda, Acanthocephala e Nematoda (Ancylostomidae, Ascarididae, Heterakidae, Oxyuridae, Pharyngodonidae, Trichuridae, Capillariidae, Trichostrongylidae, and Strongyloididae), e dois táxons de coccídios. Os estudos paleoparasitológicos e parasitológicos publicados até 2019 foram avaliados no presente trabalho e as informações de localização, local da infecção, datação da amostra e dados do hospedeiro, foram resumidas a partir de cada referência. Análises de fezes recentes e coprólitos revelaram a maior riqueza de espécies no estado do Piauí. Os dados cronológicos corroboram que *Trichuris* spp. e oxiurídeos fazem parte da fauna parasitária de *K. rupestris*. Essa é a primeira lista de verificação de parasitos intestinais de *K. rupestris*.

Palavras-chave: Kerodon rupestris, helmintos, biodiversidade, roedor, Nordeste do Brasil.

1. Introduction

Infections caused by parasites have an important role in conservation biology, for management decisions and issues related to the biology of the host population (Hudson, 2005; Thompson et al., 2010). For many vertebrate species there is a deficiency in the knowledge of their parasite fauna, thus important data area lacking concerning components of biodiversity (Poulin and Morand, 2004). Rodents account for approximately 44% of extant mammal species (see Wolf and Sherman, 2007), and serve as reservoirs for many zoonotic parasites. There are few parasite inventories from wild rodents in Brazil, and the Brazilian Northeast is especially deficient for these studies.

The genus *Kerodon* Cuvier, 1825 belongs to Caviidae and includes two endemic species from Brazil: *K. rupestris* (Wied-Neuwied, 1820) and *K. acrobata* Moojen, Locks and Langguth, 1997 (Oliveira and Bonvicino, 2011). These species exhibit larger corporeal size than other species in the Caviinae. Both *K. rupestris* and *K. acrobata* have inhabited the semi-arid region of Brazil since the Pleistocene. These rodents are also reported in small zones of the humid region in the Northeast, and northern regions of Minas Gerais State, Southeast (Moojen, 1952; Alho, 1982; Almeida et al., 2008). Both species' habitats are confined to rocky outcrops and walls of mountains where they shelter in cracks (Oliveira and Bonvicino, 2011; Lacher Junior, 2016). Historically, these rodent species suffer from hunting pressure, as they are culturally used as an alternative source of animal protein by population in the interior of northeastern Brazil (Almeida et al., 2008; Lacher Junior, 2016). They are easily hunted and highly sought after due to their large size and the quality of the meat, respectively (Alves et al., 2009; Oliveira and Bonvicino, 2011). *Kerodon rupestris* is considered a species of least concern because it has a sizable population and occurs in protected areas according to the List of Species Threatened by the IUCN (Catzeflis et al., 2016; Lacher Junior, 2016). *Kerodon rupestris* serve as a host for blood feeding triatomines, Chagas disease vectors, in the Northwest Brazil, Caatinga biome, thus, it plays an important role in *Trypanosoma cruzi* transmission (Bezerra et al., 2014; Almeida et al., 2016).

Parasitological studies in *K. rupestris* have been performed that analyze feces, coprolites and enteric helminths have been reported from necropsies in several regions and archaeological sites in the Northeast of Brazil (i. e. Rodrigues et al., 1985; Araújo et al., 1989; Almeida et al., 2008; Lima et al., 2017). The main objective of this study is to compile and summarize information about enteroparasites reported in *K. rupestris* a Brazilian endemic rodent.

2. Material and Methods

2.1. Review of the literature

The systematic review through September 2019 of the enteroparasites helminth species (Nematoda, Platyhelminthes, Acanthocephala) and the Apicomplexa reported from *K. rupestris* was conducted based on information obtained online electronic databases. The following databases were used: BioOne Complete, PubMed, Scopus, Scielo, Google Scholar, Web of Science and BioOne. For electronic search the following words were utilized: "*Kerodon*", "Caviidae", "faeces", "stool", "feces", "coprolites", "helminths", "protozoa", "coccidian", "parasitology", "paleoparasitology", "archaeology", "necropsy", "Nematoda", "Trematoda", "Cestoda", "Acanthocephala", "Apicomplexa", "parasite", "ancient parasites", "semiarid", "Northeast Brazil". The published data included journal articles and doctoral theses referring to the analysis of feces, coprolites and necropsied free-living and captive animals. Logical operators "AND" and "OR" were used to combine descriptors and track publications, as well as symbols "$" and "*" to cut off keywords in order to search all derivations. All of the studies published were included. Abstracts and presentations at conferences were not included.

The following references were used in the list for classification and systematic arrangements: Levine (1988) and the current literature for Apicomplexa (i. e. Morrison 2009); Khalil et al. (1994) for Cestoda; Vicente et al. (1997) for Nematoda; and Amin (2013) for Acanthocephala. In addition, the checklist includes some helminth species recorded only to the order or filo level (undetermined species). The names of the species follow those provided in the most recent taxonomic literature.

The species of helminths and coccidian are presented in alphabetical order, followed by information on the locality of collection, site of infection and reference. The checklist includes helminths recorded only at the genus level (undetermined species).

3. Results

Reports of parasites of *K. rupestris* consisted of 25 enteroparasite taxa identified based on morphometrics of eggs, oocysts and cyst as well as from whole parasite animals. Enteroparasites including Nematoda (n=20), Cestoda (n=1), Trematoda (n=1), Acanthocephala (n=1) and coccidians (n=2). A total of 6 partially identified species of helminths studies was also included here. Nine and 20 taxa were found in coprolites and recent fecal samples, respectively (Figure 1). Nineteen records were found in the literature that reported on fecal parasites; 6 (31.6%) were paleoparasitological analyses and 13 (68.4%) used recent feces of *K. rupestris*. The list of species and genera reported follows in this section and further information on the studies is summarized in Table 1.

The coccidians, cestodes, and trematodes did not appear in past periods in *K. rupestris*. *Trichuris* spp. (11 reports), *Strongyloides* spp. (7 reports), and *P. uncinata* (5 reports), are the enteroparasites that infected the host with the highest prevalences of 58%, 37% and 26%, respectively. *Strongyloides ferreirai* was described in *K. rupestris* and found in 8,000-year-old samples until the present. *Paraspidodera uncinata* appears in three studies with prevalence that reach 31%. *Lagochilascaris* sp. was identified for the first time after 30 years of studies in the region, with *K. rupestris* acting as an intermediate host.

List of species of helminths and coccidian in Kerodon rupestris

Apicomplexa Levine, 1970 (=Sporozoa Leuckart, 1879)
Coccidia Leuckart, 1879
Site of infection: small intestine
Locality: Serra da Capivara National Park, State of Piauí
Reference: Vieira de Souza et al., 2019
Eucoccidiorida Léger & Duboscq, 1910
Eimeriidae Minchin, 1903
Eimeria Schneider, 1875
Eimeria sp.
Site of infection: small intestine
Locality: Serra das Confusões National Park, State of Piauí; Fernando de Noronha, State of Pernambuco
Reference: Sianto et al., 2006; Lima et al. 2017
Platyhelminthes Gegenbaur 1859

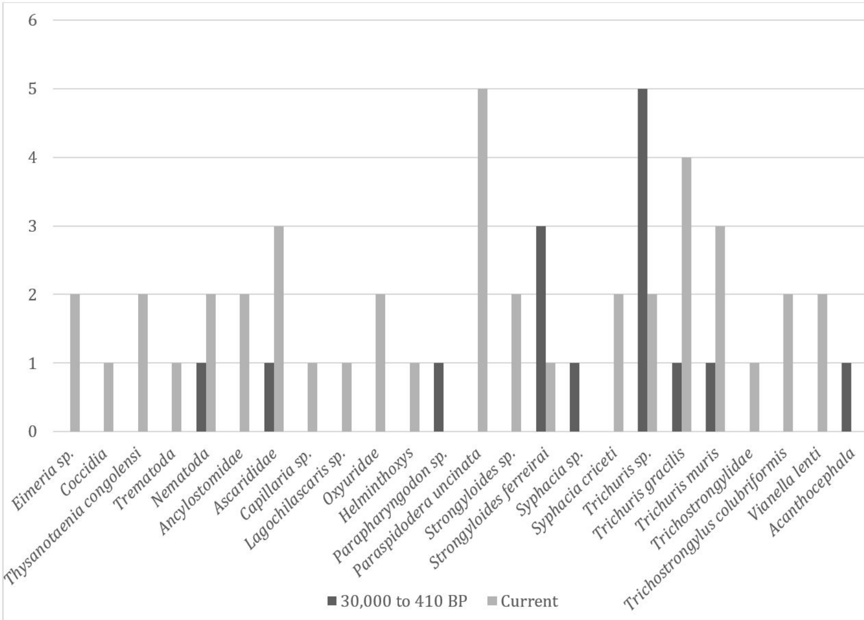

Figure 1. Number of studies by endoparasites reported on *Kerodon rupestris* parasitological and paleoparasitological studies.

Table 1: Endoparasites of *Kerodon rupestris* reported over 80 years of parasitological and paleoparasitological studies.

Taxon	Dating	Location[a]	N pos/ total	Prevalence (%)	N eggs/ cyst	Eggs measurements (µm)	Material	References
Eimeriidae								
Eimeria sp.	current	PI, Brazil	NA	NA	NA	28 x 22	feces	Sianto et al. (2006)
	current	PE, Brazil	4/5	80%	NA	NA	feces	Lima et al. (2017)
Coccidia	current	PI, Brazil	1/10	10%	1	38.33 x 35.25	feces	Vieira de Souza et al. (2019)
Cestoda								
Thysanotaenia congolensi	current	RN, Brazil	NA	22%	NA	48 x 48	necropsy	Almeida (2004); Almeida et al. (2008)
Trematoda	current	PI, Brazil	2/231	1%	2	67-45 x 37-17	feces	Saldanha (2016)*
Nematoda	current	PI, Brazil	2/231	1%	6	47-67 x 30-45	feces	Saldanha (2016)*
	current	PI, Brazil	NA	NA	NA	55 x 18	feces	Sianto et al. (2006)*
	8,870 to 2,000	PI, Brazil	2/42	5%	1	58 x 40,9	coprolites	Sianto (2009)*
Ancylostomidae	current	PI, Brazil	4/231	2%	7	40-70 x 25-45	feces	Saldanha (2016)
	current	PI, Brazil	2/231	0,8%	5	64.89 x 40.96	feces	Saldanha (2016)
	current	PE, Brazil	3/5	60%	NA	NA	feces	Lima et al. (2017)
Ascarididae	current	RN, Brazil	NA	NA	NA	NA	feces	Pinheiro et al. (1989)

Measurements are in µm. Dating are in BP (Before Present). *a*: States/Country. *b*: larvae finding, no eggs were found. PI: Piauí; RN: Rio Grande do Norte; PE: Pernambuco; SP: São Paulo; MG: Minas Gerais. NA: Not available. N pos/total: number of positive samples/total of samples. N eggs: number of parasite eggs. *undetermined species.

Table 1: Continued...

Taxon	Dating	Location[A]	N pos/ total	Prevalence (%)	N eggs/ cyst	Eggs measurements (µm)	Material	References
	current	PI, Brazil	NA	NA	NA	69 x 39	feces	Sianto et al. (2006)
	2,000 to 3,000	PI, Brazil	1/42	2%	0	NA	coprolites	Sianto (2009)
	current	PI, Brazil	1/231	1%	1	50.0 x 32.5	feces	Saldanha (2016)
Capillaria sp.	current	PE, Brazil	1/5	20%	NA	NA	feces	Lima et al. 2017
Helminthoxys sp.	current	PI, Brazil	1/10	10%	5	99.85-87.50 x 52.50-40.00	feces	Vieira de Souza et al. (2019)
Lagochilascaris sp.	current	PI, Brazil	3/231	1%	22	30 -52 x 31-48	feces	Saldanha (2016)
Oxyuridae	NA	PI, Brazil	1/42	2%	2	76.5 x 36.6; 93.2 x 39.9	coprolites	Sianto (2009)
	current	PI, Brazil	2/231	0,80%	2	72-80 x 38-45	feces	Saldanha (2016)
	current	PI, Brazil	10/231	4%	31	91-102 x 38-42	feces	Saldanha (2016)
	current	PI, Brazil	3/231	3%	2	77-90 x 40-50	feces	Saldanha (2016)
Parapharyngodon sp.	8,870±60	PI, Brazil	7/42	17%	5	75.9-80.7 x 47.0-53.3	coprolites	Sianto (2009)
Paraspidodera uncinata	current	Bolivia	NA	NA	NA	NA	cecum	Gardner (1991)
	current	MG, Brazil	NA	NA	NA	NA	necropsy	Lent and Freitas (1939)
	current	PI, Brazil	1/231	0,4%	1	46.72 x 35.99	feces	Saldanha (2016)
	current	RN, Brazil	NA	33%	NA	26-28 x 42-45	necropsy	Almeida (2004); Almeida et al. (2008)
Strongyloides sp.	current	PI, Brazil	NA	NA	NA	NA	feces	Pinheiro et al. (1989)
	current	PI, Brazil	1/231	0,4%	1	56.69 x 29.13	feces	Saldanha (2016)
Strongyloides ferreirai	8,000 to 2,000	PI, Brazil	NA	NA	NA	NA	coprolites	Araújo et al. (1989)
	7,230 to 2,090	PI, Brazil	NA	NA	NA/0[B]	NA/larvae	coprolites	Sianto (2009)
	30,000	PI, Brazil	NA	NA	0[B]	larvae	coprolites	Ferreira et al. (1991)
	current	PI, Brazil	NA	NA	NA	60 x 35	necropsy	Rodrigues et al. (1985)
Strongyloides ratti	current	PE, Brazil	3/5	60%	NA	NA	feces	Lima et al. (2017)
Syphacia sp.	5,300	PI, Brazil	3/93	3%	1	101 x 35.7	coprolites	Vieira de Souza et al. (2012)
Syphacia criceti	current	SP, Brazil	NA	NA	NA	90-98 x 34-36	necropsy	Vaz and Pereira (1934)
	current	PE, Brazil	NA	NA	NA	83-87 x 27-34	necropsy	Quentin (1971)
Trichuris sp.	30,000	PI, Brazil	NA	NA	20	60-65 x 30-33	coprolites	Ferreira et al. (1991)

Measurements are in µm. Dating are in BP (Before Present). *a*: States/Country. *b*: larvae finding, no eggs were found. PI: Piauí; RN: Rio Grande do Norte; PE: Pernambuco; SP: São Paulo; MG: Minas Gerais. NA: Not available. N pos/total: number of positive samples/total of samples. N eggs: number of parasite eggs. *undetermined species.

Table 1: Continued...

Taxon	Dating	Location[A]	N pos/ total	Prevalence (%)	N eggs/ cyst	Eggs measurements (µm)	Material	References
	10,050 to 410	PI, Brazil	16/42	38%	21	48.5-66.6 x 27.2-37.4	coprolites	Sianto (2009)
	9,000	PI, Brazil	1/93	1%	20	59-66 x 33	coprolites	Araújo et al. (1993)
	8,000 to 2,000	PI, Brazil	NA	NA	NA	61.96 x 31.65	coprolites	Araújo et al. (1989)
	NA	PE, Brazil	1/15	7%	3	66.60 x 33.30	coprolites	Duarte (1994)
	current	PI, Brazil	NA	NA	NA	62-70 x 32-37	feces	Sianto et al. (2006)
	current	PI, Brazil	18/231	8%	28	57-67 x e 30-35	feces	Saldanha (2016)
Trichuris gracilis	3,430 ± 40	PI, Brazil	6/9	67%	17	58.42-64.50 x 30.16-38.46	coprolites	Vieira de Souza (2013)
	current	RN, Brazil	NA	22%	NA	60-66 x 30-34	necropsy	Almeida (2004); Almeida et al. (2008)
	current	PI, Brazil	10/231	4%	30	55-69 x 32-35	feces	Saldanha (2016)
	current	PI, Brazil	5/10	50%	29	68.05-59.49 x 35.00-31.61	feces	Vieira de Souza et al. (2019)
Trichuris muris	3,430 ± 40	PI, Brazil	6/9	67%	8	57.50-65.00 x 34.03-37.84	coprolites	Vieira de Souza (2013)
	current	RN, Brazil	NA	22%	NA	63-69 x 36-40	necropsy	Almeida (2004); Almeida et al. (2008)
	current	PI, Brazil	3/231	1%	20	58-75 x 33-40	feces	Saldanha (2016)
Trichostrongylidae	current	PI, Brazil	29/231	13%	130	44-67 x 15-22	feces	Saldanha (2016)
Trichostrongylus colubriformi	current	RN, Brazil	NA	56%	NA	NA	necropsy	Almeida (2004); Almeida et al. (2008)
Vianella lenti	current	RN, Brazil	NA	33%	NA	40-50 x 30	necropsy	Almeida (2004); Almeida et al. (2008)
Acanthocephala	3,000	PI, Brazil	1/42	2%	1	86.5 x 46.6	coprolites	Sianto (2009)*

Measurements are in µm. Dating are in BP (Before Present). *a*: States/Country. *b*: larvae finding, no eggs were found. PI: Piauí; RN: Rio Grande do Norte; PE: Pernambuco; SP: São Paulo; MG: Minas Gerais. NA: Not available. N pos/total: number of positive samples/total of samples. N eggs: number of parasite eggs. *undetermined species.

Cestoda van Beneden, 1849
Cyclophyllidea Braun, 1900
Anoplocephalidae Cholodkovsky, 1902
Thysanotaenia Beddard, 1911
Thysanotaenia congolensis Dronen, Simcik, Scharninghausen and Pitts, 1999
Site of infection: small intestine
Locality: Mossoró, State of Rio Grande do Norte
Reference: Almeida, 2004; Almeida et al., 2008
Trematoda Rudolphi, 1808
(not identified the genus and species)
Site of infection: bile ducts, pancreatic, urinary tract
Locality: Serra das Capivara National Park, State of Piauí
Reference: Saldanha, 2016
Nematoda Rudolphi, 1808
(not identified the genus and species)
Site of infection: small intestine, large intestine and cecum
Locality: Serra das Capivara and Serra das Confusões National Park, State of Piauí
Reference: Sianto et al., 2006; Sianto, 2009; Saldanha, 2016.
Ascaridoidea Baird, 1853
Ascarididae Baird, 1853
(not identified the genus and species)
Site of infection: large intestine, stomach
Locality: Serra das Capivara and Serra das Confusões National Park, State of Piauí; State of Rio Grande do Norte

Reference: Pinheiro et al., 1989; Sianto, 2009; Sianto et al., 2006; Saldanha, 2016

Lagochilascaris Leiper, 1919

Lagochilascaris sp.

Site of infection: large intestine, stomach

Locality: Serra das Capivara, State of Piauí

Reference: Saldanha, 2016

Aspidoderidae Skrjabin and Schikobalova, 1947

Paraspidodera uncinata (Rudolphi, 1819) Travassos, 1914

Site of infection: large intestine, stomach

Locality: Bolivia; States of Minas Gerais, Piauí, and Rio Grande do Norte, Brazil

Reference: Lent and Freitas, 1939; Gardner, 1991; Almeida, 2004; Almeida et al., 2008; Saldanha, 2016.

Oxyurida Chabaud, 1974

Oxyuroidea Cobbold

Oxyuridae Cobbold, 1864

Syphaciinae Railliet, 1916

Helminthoxys Freitas, Lent and Almeida, 1937

Site of infection: Caecum and large intestine

Locality: Serra da Capivara National Park, State of Piauí

Reference: Vieira de Souza et al., 2019

Syphacia Seurat, 1916

Syphacia criceti (Quentin, 1969)

Site of infection: Caecum and large intestine

Locality: Serra das Capivara National Park, State of Piauí; State of Pernambuco; State of São Paulo

Reference: Vaz and Pereira, 1934; Quentin, 1971; Vieira de Souza et al., 2012.

Pharyngodonidae Travassos 1919

Oxyurinae Hall, 1916

Parapharyngodon Chatterji, 1933

Parapharyngodon sp.

Site of infection: Caecum and large intestine

Locality: Serra das Capivara National Park, State of Piauí

Reference: Sianto, 2009

Secernentea von Linstow, 1905

Trichostrongyloidea Chitwood, 1933

Trichostrongylidae Leiper, 1909

(not identified the genus and species)

Site of infection: small intestine

Locality: Serra das Capivara National Park, State of Piauí

Reference: Saldanha, 2016

Trichostrongylus Looss 1905

Trichostrongylus colubriformis (Giles, 1892)

Site of infection: small intestine

Locality: Serra das Capivara National Park, State of Piauí

Reference: Almeida, 2004; Almeida et al., 2008.

Rhabditida Chitwood, 1933

Strongyloidea Weinland, 1858

Ancylostomatidae Looss, 1905

(not identified the genus and species)

Site of infection: large intestine, stomach

Locality: Serra das Capivara National Park, State of Piauí; Fernando de Noronha, State of Pernambuco

Reference: Saldanha, 2016; Lima et al. 2017

Strongyloididae Chitwood and MacIntosh, 1934

Strongyloides Grassi, 1879

Strongyloides sp.

Site of infection: small intestine

Locality: State of Piauí

Reference: Pinheiro et al., 1989; Saldanha, 2016

Strongyloides ferreirai Rodrigues, Vicente and Gomes 1985

Site of infection: small intestine

Locality: Serra das Capivara National Park and surroundings, State of Piauí

Reference: Rodrigues et al., 1985; Araújo et al., 1989; Ferreira et al., 1991; Sianto, 2009

Strongyloides ratti Sandground, 1925

Site of infection: small intestine

Locality: Fernando de Noronha, State of Pernambuco

Reference: Lima et al., 2017

Viannaiidae Durette-Desset and Chabaud, 1981

Vianella Travassos, 1918

Vianella lenti Durette-Desset, 1968

Site of infection: small intestine

Locality: Mossoró, State of Rio Grande do Norte

Reference: Almeida, 2004; Almeida et al., 2008

Trichocephalida (=Trichinellida) Spasski, 1954

Capillariidae Railliet, 1915

Capillaria Zeder, 1800

Capillaria sp.

Site of infection: uninformed

Locality: Fernando de Noronha, State of Pernambuco

Reference: Lima et al., 2017

Trichuridae Railliet, 1915

Trichuris sp. Roederer, 1761

Site of infection: small intestine

Locality: Mossoró, State of Rio Grande do Norte; Serra das Capivara National Park and surroundings, State of Piauí; State of Pernambuco

Reference: Araújo et al., 1989, 1993; Ferreira et al., 1991; Duarte, 1994; Sianto et al., 2006; Sianto, 2009; Saldanha, 2016.

Trichuris gracilis (Roederer, 1819) Hall, 1916

Site of infection: small intestine

Locality: Mossoró, State of Rio Grande do Norte; Serra da Capivara and Serra das Confusões National Park, State of Piauí; State of Pernambuco

Reference: Almeida, 2004; Almeida et al., 2008; Vieira de Souza, 2013, et al., 2019; Saldanha, 2016.

Trichuris muris (Schrank, 1788)

Site of infection: small intestine

Locality: Mossoró, State of Rio Grande do Norte; Serra da Capivara and Serra das Confusões National Park, State of Piauí; State of Pernambuco

Reference: Almeida, 2004; Almeida et al., 2008; Vieira de Souza, 2013; Saldanha, 2016

Acanthocephala Koelreuter, 1771

(not identified the genus and species)

Site of infection: small intestine

Locality: Serra das Capivara National Park, State of Piauí

Reference: Sianto, 2009

4. Discussion

Intestinal helminths that have a close and long association with their hosts over the time, may reflect behaviors and lifestyles of rodents as well as with the local environmental conditions, allowing a better understanding of the host-parasite relationship (Hugot et al., 1999; Ferreira, 2011). In this work, we observed a large number of intestinal taxa in *K. rupestris*. These studies on *K. rupestris* began in the 1980s, in the Serra do Capivara National Park, with the aim of comparing the results obtained by Paleoparasitology (Felice et al., 2014). Since then, the most frequently reported taxa have been the nematode *Trichuris* spp., followed by Oxyuridae and Ascarididae. The first study registered was conducted by Vaz and Pereira (1934) who reported the presence of *Syphacia criceti* (Nematoda: Oxyuridae) in a necropsied animal dead in captivity in São Paulo, Brazil. *Trichuris* sp. is one of the oldest helminths recorded in the New World, at 30,000 years BP (Ferreira et al., 1991).

Eimeria sp. was the only coccidia report in *K. rupestris*, and could be an occasional parasite, since is found in a great diversity of hosts in Brazil as Canidae, Felidae, Suidae, ruminant mammals, birds, and few rodents. However, others coccidia were reported in the region as *Giardia* sp., *Cryptosporidium* sp., and *Cystoisospora* sp., but in other caviids (Gressler et al., 2010). The survey presented here, spanning more than 80 years of studies, shows that the analyses have been done focusing mainly on helminth parasites and little is known about the protozoan parasites.

Trichurids are present in all vertebrate groups, but mainly in birds and mammals (Anderson, 2000; Schmidt and Roberts, 2009). They possess a stenoxenic cycle adapted to a single host or hosts phylogenetically close related. The 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). Twenty-seven species of *Trichuris* were described in rodents from South and North America, with only four species reported in Brazil, one in Caviidae (Yamaguti, 1963; Robles et al., 2018). The species *T. gracilis* and *T. muris* were reported in studies with ancient and modern material (Almeida et al., 2008; Vieira de Souza, 2013; Vieira de Souza et al., 2019; Saldanha, 2016). In the more recent study, *Trichuris* sp. eggs were found near human villages, where the small populations of *K. rupestris* remained in the border areas of the hill ranges and rocky canyons (Saldanha, 2016; Vieira de Souza et al., 2019). It is not possible to affirm that the same species is found in modern and ancient material, however, the present review shows the persistence of the *Trichuris* genus in this Brazilian region for at least 30,000 years, until present day. The data allow to speculated a possible adaptation of this parasite to the climate, since the genus is dependent on specific conditions of humidity and temperature to conclude its biological cycle in the soil. The suitable temperature for the development of *Trichuris* sp. eggs in soil varies between 25 °C and 37.5 °C, with lower temperatures retarding or preventing the process, and higher temperatures accelerating or harming egg development (Spindler, 1929; Vejzagic et al., 2016). In periods of rain, *Trichuris* sp. becomes more active due to greater humidity, while in periods of less humidity, such as in the dry season, the reproduction of helminths is low, with little egg elimination. In times of drought, however, the parasite may remain in available humid places (Spindler, 1929; Vejzagic et al., 2016).

Capillaria, which belongs to the same order as *Thichuris* sp., is a large genus that includes species found in almost every organ and tissue of all vertebrate classes (Schmidt and Roberts, 2009). Therefore, finding eggs in *K. rupestris* feces may be an occasional case due to the rodent's coprophagy habit.

Oxyurids mainly infect mammals, but also invertebrates, amphibians and birds (Hugot, 1988). They have a high host specificity and a monoxenic cycle, with transmission and development similar in invertebrate and vertebrate hosts (Hugot, 1988; Hugot et al., 1999; Anderson, 2000). Oxyuroidea are currently grouped into three families: Oxyuridae, Pharyngodonidae and Heteroxynematidae (Skrjabin et al., 1974; Hugot, 1988; Petter and Quentin, 2009). According to the present review, the oldest oxyuriid recorded in *K. rupestris* was *Syphacia* sp., 5,300 years ago. Modern records included two studies in necropsied animals and one in feces. Syphaciinae is apparently a recent group that emerged and dispersed in the main groups of rodents, with morphological adaptations of their different hosts (Hugot, 1988). However, Oxyuridae have fragile and light eggs, deposited in the perianal region of the host, which may hamper the number of egg findings in feces. Other oxyurid reported was *Parapharyngodon* sp. (Pharyngodonidae), parasite of reptilians, in Serra da Capivara National Park. The finding represents an accidental parasitism event, related to the ingestion of lacertid feces (Sianto, 2009). *Helminthoxys* sp. was most recently recorded for the first time in *K. rupetris* from the same region, parasites of neotropical caviomorphas rodents that inhabit the caecum and large intestine of their hosts (Hugot and Sutton, 1989). It currently comprises nine species, with *H. freitasi* Quentin, 1969 and *H. urichi* (Cameron & Reesal, 1951) Hugot, 1986 described for rodents from Brazil (Gonçalves et al., 2006; Quentin, 1969).

Eggs of nematodes belonging to the genus *Paraspidodera* (Gardner, 1991), which infect Caviidae, Dasyproctidae and Leporidae (Vicente et al., 1997) were also reported. In Brazil, three species of *Cavia* (*C. fulgida*, *C. porcellus* and *C. aperea*) were cited as hosts for *Paraspidodera uncinata* (Vicente et al., 1997). Since they are in sympatry with *K. rupestris*, it is possible to suggests that they share these parasites. Another interesting finding is *Lagochilascaris* cf. *minor,* a parasite of Public Health importance (Saldanha, 2016). However, it was not possible to confirm true parasitism due to lack of complementary information on the biological cycle of this helminth. The parasite has been identified in humans (Fortes, 1997), dogs and domestic cats (Campos et al., 1992). According to experimental studies, rodents would act as intermediate hosts of *Lagochilascaris* spp. (Campos et al., 1992). Other authors argue that rodents can be considered definitive hosts of *L. minor* due to the observation of an adult helminth, but without data of egg laying (Freitas et al., 2008).

Thysanotaenia congolensis is a cestode currently described for African rodents (Dronen et al., 1999), and was found in a single study in Rio Grande do Norte (Almeida et al., 2008). *Thysanotaenia congolensis* is a cestode currently found in African rodents of the Thynomyidae family (Dronen et al., 1999). However, there is one report in *K. rupestris* from Rio Grande do Norte, Brazil (Almeida et al., 2008). The authors suggested that their presence in *K. rupestris* is probably due to the common origin of these rodent families, or could be acquired by cohabitation with other caviomorphas, as already suggested for *Vianella lenti*, parasite of *Galea spixii*, also found in *K. rupestris* (Almeida et al. 2008).

A species of *Strongyloides* was described only for the host *K. rupestris* and named *S. ferreirai* by Rodrigues, Vicente and Gomes (1985).

In addition, it has coprophagic habits (Moojen, 1952; Alho, 1982; Chame, 2007; Almeida et al., 2008), that allow the acquisition of parasites from sympatric animals, as canids and felines. Investigations of the helminth fauna could help in the monitoring of parasite populations in the region, in the prediction of the emergence or extinction of parasites species, and in the impacts that these ecological processes may have on future of animal populations (Ogunseitan, 2005).

In conclusion, the present compilation of literature demonstrated that *Trichuris* spp. are still the most reported helminths parasitizing *K. rupestris*, followed by oxyurids. Consequently, they appear to be, in fact, the parasitic fauna of this rodent. Sporadic reports of other helminths and coccidia are probably related to the presence of animals that cohabit the region, or to anthropization.

This survey constitutes the first checklist of enteroparasites in *K. rupestris.* These data may be useful for studies on the biology of local species conservation.

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