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Taxonomy and systematics

Parasitic nematodes of three species of wild carnivore mammals from Atlantic forest in the state of Minas Gerais, Brazil

Nemátodos parásitos de tres especies de mamíferos carnívoros silvestres del bosque atlántico en el estado de Minas Gerais, Brasil

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Abstract

This study aimed to report the occurrence of species of nematodes in wild carnivore mammals from a locality of Atlantic forest in Brazil. Specimens of wild carnivore mammals of 3 species were necropsied: *Chrysocyon brachyurus* (Illiger, 1815), *Cerdocyon thous* (Linnaeus, 1766), and *Puma* (*Herpailurus*) *yagouaroundi* (É. Geoffroy, 1803). Seven species of nematodes were recorded: 5 in *C. brachyurus* [*Uncinaria stenocephala* (Railliet, 1884), *Dioctophyma renale* (Goeze, 1782), *Strongyloides* sp., *Trichuris vulpis* (Froelich, 1789), and *Oslerus* (*Oslerus*) sp.]; 2 in *C. thous* [*Angiostrongylus raillieti* (Travassos, 1927), and *Strongyloides* sp.], and only 1 species [*Cylicospirura subaequalis* (Molin, 1860)] in *P.* (*H.*) *yagouaroundi*. *Strongyloides* sp., *T. vulpis* and *Oslerus* (*Oslerus*) sp. were recorded for the first time in *C. brachyurus* from Brazil, and the first one of *C. subaequalis* in a host from Brazil in their type host since the original description date from 1860.

Keywords: Parasitic nematodes; Brazil; Wild mammals

Resumen

El objetivo de este estudio fue registrar la presencia de especies de nemátodos en mamíferos carnívoros salvajes de una localidad del bosque atlántico en Brasil. Ejemplares de 3 especies de mamíferos carnívoros silvestres fueron necropsiados: *Chrysocyon brachyurus* (Illiger, 1815), *Cerdocyon thous* (Linnaeus, 1766) y *Puma (Herpailurus) yagouaroundi* (É. Geoffroy, 1803). Se registraron 7 especies de nemátodos: 5 en *C. brachyurus uncinaria stenocephala* (Railliet, 1884), *Dioctophyma renale* (Goeze, 1782), *Strongyloides* sp., *Trichuris vulpis* (Froelich, 1789) y *Oslerus (Oslerus)* sp.; 2 en *C. thous* (*Angiostrongylus raillieti* [Travassos, 1927] y *Strongyloides* sp.) y solo una especie (*Cylicospirura subaequalis* [Molin, 1860]) en *P. (H.) yagouaroundi*. *Strongyloides* sp., *T. vulpis* y *Oslerus (Oslerus)* sp. fueron colectados por primera vez en *C. brachyurus* de Brasil, mientras que *C. subaequalis* se registra en su hospedador tipo en Brasil desde la descripción original hecha en 1860.

Palabras clave: Nemátodos parásitos; Brasil; Mamíferos silvestres

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Introduction

The first reports of helminths in wild carnivore mammals from Brazil were made by Rudolphi (1819), who described the cestode *Taenia crassipora* Rudolphi, 1819 and the nematode *Toxocara alienata* (Rudolphi, 1819), both collected in the intestine of *Nasua nasua* (Linnaeus, 1766). Until the early 20th Century, one of the most significant contributions to the study of helminths of wild carnivores from Brazil was that of Diesing (1850, 1851), in which a total of 18 species of nematodes, cestodes, acanthocephalans, and trematodes, were described and reported.

The first helminth species described in wild carnivore mammals by Brazilian researchers was the nematode *Uncinaria carinii* Travassos, 1915, collected in the intestine of *Cerdocyon thous* (Linnaeus, 1766) in the municipality of São Paulo, State of São Paulo (Travassos, 1915). Since then, according to the checklist of helminth parasites in wild carnivore mammals from Brazil (Vieira, Luque, & Muniz-Pereira, 2008), 21 species of hosts are reported for a total of 95 helminth species. After the study of Vieira et al. (2008) some new records of helminths in this group of hosts were reported (see Filoni et al., 2009; Gallas & Silveira, 2011; Gallas, Silveira, & Périco, 2014; Gomes, Olifiers, Santos, Simões, & Maldonado, 2015; Gomes, Olifiers, Souza, et al., 2015; Lux-Hoppe, Araújo-de Lima, Tebaldi, & Nascimento, 2010; Pinto, Knoff, Gonçalves, Sanches, & Noronha, 2009; Ribeiro, Verocai, & Tavares, 2009; Suárez, Pesenti, Macedo, Mascarenhas, & Müller, 2015; Vieira, Luque, Souza-Lima, Moraes-Neto, & Muniz-Pereira, 2012; Vieira, Muniz-Pereira, et al., 2012; Vieira et al., 2013). This demonstrates the potential for discovery of new data on the helminth parasites in wild carnivore mammals in Brazil.

The current study aimed to report the species of nematodes found in wild carnivore mammals from the municipality of Juiz de Fora, Minas Gerais state, Brazil.

Materials and methods

Twelve specimens of 3 species of wild carnivore mammals (Table 1) were necropsied, between June 2002 and January 2010: *Chrysocyon brachyurus* (Illiger, 1815) (Carnivora, Canidae) (Maned Wolf) (5 specimens), *Cerdocyon thous* (Linnaeus, 1766) (Carnivora, Canidae) (Crab-eating Fox) (6 specimens), and *Puma* (*Herpailurus*) *yagouaroundi* (É. Geoffroy, 1803) (Carnivora, Felidae) (Jaguarundi) (1 specimen). The hosts examined were accidentally 'road killed' and were donated by the Regional Office of the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), in the municipality of Juiz de Fora, in the state of Minas Gerais (21°41′20″ S, 43°20′40″ W). The hosts were identified according to Berta (1982), Dietz (1985), and Oliveira (1998).

The nematodes collected were fixed in AFA for 48 h, and preserved in 70% ethanol with 5% glycerin. For light microscopy studies, the nematodes were cleared in Amann's lactophenol, and mounted on temporary slides.

Identification and classification of nematodes to the generic level follow Anderson, Chabaud, and Willmott (2009) and Gibbons (2010). The specific identification follows Grisi (1971), Junker et al. (2013), Travassos (1927), Vicente, Rodrigues, Gomes, and Pinto (1997), and Waid and Pence (1988).

Voucher specimens are deposited in the Instituto Oswaldo Cruz Helminthological Collection (CHIOC), Rio de Janeiro, Brazil (Table 1).

Table 1
Quantitative data of nematode species reported in 3 species of wild carnivore mammals in the state of Minas Gerais, Brazil (% = prevalence, M = mean intensity, SD = standard deviation).

	Chrysocyon brachyurus (*n* = 5)		*Cerdocyon thous* (*n* = 6)		*Puma* (*H.*) *yagouaroundi* (*n* = 1)	
	%	M ± SD	%	M ± SD	%	M ± SD
Ancylostomatoidea						
Uncinaria stenocephala (CHIOC 35935)	60	33 ± 16	–	–	–	–
Dioctophymatoidea						
Dioctophyma renale (CHIOC 35932)	60	1.66 ± 1.15	–	–	–	–
Metastrongyloidea						
Angiostrongylus raillieti[a] (CHIOC 35930)	–	–	20	19	–	–
Oslerus (*Oslerus*) sp. (CHIOC 35929c)	40	205.5 ± 82.7	–	–	–	–
Rhabditoidea						
Strongyloides sp. (CHIOC 35933)	100	232.8 ± 120.2	100	227 ± 131.2	–	–
Spiruroidea						
Cylicospirura subaequalis[a] (CHIOC 35931)	–	–	–	–	100	27
Trichinelloidea						
Trichuris vulpis[a] (CHIOC 35934)	20	27	–	–	–	–

[a] The nematodes were collected in only 1 host.

Results

In the 3 wild carnivore mammal species studied herein, 7 nematodes species were recorded (Table 1). *Oslerus* (*Oslerus*) sp. (Filaroididae) was collected under the mucosa of the inner surface of the trachea and bronchii of *C. brachyurus*. *Uncinaria stenocephala* (Railliet, 1884) (Ancylostomatidae) was found in the small intestine of *C. brachyurus*. Specimens of *Dioctophyma renale* (Goeze, 1782) (Dioctophymatidae) were collected in the right kidney of *C. brachyurus*. *Angiostrongylus raillieti* (Travassos, 1927) (Angiostrongylidae) (=*Angiostrongylus vasorum* [Raillet, 1866] sensu Costa, Costa, & Guimarães, 2003) were registered in the pulmonary artery of *C. thous*. Unidentified *Strongyloides* sp. (Strongyloididae) specimens were collected in the small intestine of *C. brachyurus* and in *C. thous*. *Trichuris vulpis* (Froelich, 1789) (Trichuridae) were found in the intestinal caecum of *C. brachyurus*. Specimens of *Cylicospirura subaequalis* (Molin, 1860) (Spirocercidae) were collected from the cysts in the inner wall of the stomach of *P.* (*H.*) *yagouaroundi*.

Discussion

The genus *Oslerus* was proposed to accommodate *Filaria osler* described by Cobbold (1879), in domestic dogs in Europe. Anderson (1978) divided the genus in 2 subgenera based on the presence [*Oslerus* (*Anafilaroides*) (Gerichter, 1949)] or absence [*Oslerus* (*Oslerus*) (Hall, 1921)] of vaginal sphincters. Our specimens lack vaginal sphincter, thus were included in the subgenus *Oslerus* (*Oslerus*). *Olerus* (*Oslerus*) *osleri* (Cobbold, 1879) is reported in wild and domestic canids in Europe, North America, Africa, Asia and Oceania (Dunsmore & Spratt, 1979; Hare, 1930; Kotani et al., 1995; Ortlepp, 1945). However, reports of this nematode in South America are scarce, restricted to domestic dogs from Chile (Alcaíno & Gorman, 1999; Muñoz, Fredes, Faúndes, Sanz, & Gonzáles, 2007), and *C. brachyurus* from Brazil (Dias et al., 2012). However, this last report is doubtful because it was only based on clinical and coprological diagnosis of larval parasites. Due to significant morphological and morphometric differences between the males of the current study in comparison with previous morphological descriptions of *Oslerus* (*Oslerus*) *osleri*, we prefer to not identify them as *O.* (*Oslerus*) *osleri*. A more detailed study of the morphological features integrated with genetic studies of the specimens collected is necessary to verify that these specimens are a new species of *Oslerus*. Therefore, the current study is the first confirmed report *Oslerus* (*Oslerus*) parasitizing *C. brachyurus* from Brazil.

Reports of *D. renale* in wild hosts from Brazil document this nematode parasitizing, *C. brachyurus* and *Lontra longicaudis* (Olfers, 1818) (Carnivora, Mustelidae) (Diesing, 1851); *D. renale* has been widely reported in Brazil parasitizing domestic dogs and *C. brachyurus* (Vicente et al., 1997; Vieira et al., 2008); and less frequently in other carnivores as *Galictis cuja* (Molina, 1782), *G. vittata* (Schreber, 1776), *N. nasua*, *Speothos venaticus* (Lund, 1842), and *Cerdocyon thous* (Linnaeus, 1766) (Pesenti et al., 2012; Ribeiro et al., 2009; Vieira et al., 2008).

In Brazil, 12 species of the genus *Trichuris* Roederer & Wagler, 1761 parasitizing several groups of mammals are reported (Vicente et al., 1997). However, only 2 species occur in carnivores: *T. serratus* (Linstow, 1879) in domestic canids and felids (Vicente et al., 1997), and *T. vulpis* in domestic dogs and cats, as well as in wild specimens of *C. thous* (Mundim, Oliveira-Júnior, Rodrigues, & Cury, 2004; Vicente et al., 1997; Vieira et al., 2008). The current study reports for the first time the parasistim by *T. vulpis* in *C. brachyurus* in this country.

Four species of *Uncinaria* Froelich, 1789 parasitizing wild carnivores (Vieira et al., 2008) have been recorded in Brazil: *Uncinaria bidens* Lent & Freitas, 1938 in *N. nasua*, and *Procyon cancrivorus* (Cuvier, 1798) (Vicente et al., 1997; Vieira et al., 2008); *Uncinaria maxillaris* (Molin, 1861) in *Procyon cancrivorus* (Vicente et al., 1997; Vieira et al., 2008); *Uncinaria carinii* Travassos, 1915 has been recorded only once in *C. thous* by Travassos (1915), and *U. stenocephala*, species was reported initially in Europe and USA as intestinal parasite of the canids of the genus *Vulpes* Frisch, 1775 (Erickson, 1944; Saeed, Maddox-Hyttel, Monrad, & Kapel, 2006). In Brazil, this species was first recorded by Mundim et al. (1991) parasitizing *C. brachyurus* in the state of Minas Gerais, as in the present study.

Angiostrongylus raillieti was described by Travassos (1927) as *Haemostrongylus railiieti*, from *C. thous* in the municipality of São Paulo, in the state of São Paulo. According to Grisi (1971), *A. raillieti* should be considered a valid species and not a synonym of *A. vasorum* from Brazil. In the study by Costa et al. (2003), using specimens collected in domestic dogs from Brazil, the authors considered *A. raillieti* a synonym of *A. vasorum*. However, the molecular study conducted by Jefferies, Shaw, Viney, and Morgan (2009) supports the idea that *A. vasorum* does not occur in Brazil, based on the comparison of molecular characters of specimens of *A. vasorum* from Europe and South America, which corroborates with that affirmed by Grisi (1971).

Strongyloides Grassi, 1879 has a wide geographical distribution, mainly as parasite of mammals, but some species infect birds, reptiles and amphibians (Little, 1996a,b). Ten species of *Strongyloides* parasitizing several species of mammals in Brazil (Vicente et al., 1997). The only species of this genus recorded in Brazilian domestic dogs is *S. stercoralis* (Bavay, 1876) (Vicente et al., 1997), but so far it has not been recorded in wild carnivores of this country. Vieira et al. (2008) reported an undetermined species of *Strongyloides* parasitizing *C. thous* and *G. cuja* from Brazil. Therefore, the current study is the first report of *Strongyloides* sp. in *C. brachyurus* in Brazil.

Cylicospirura subaequalis was described by Molin (1860) as *Spiroptera subaequalis* Molin, 1860 in *Puma concolor* (Linnaeus, 1771) and *P.* (*H.*) *yaguaroundi* from Brazil (Molin, 1860). This species is recorded in domestic and wild felids throughout the world (Bowman, Hendrix, Lindsay, & Barr, 2002); however, after the description by Molin (1860) this species has never been registered again in Brazilian hosts until now, that we found this parasitizing *P.* (*H.*) *yaguaroundi*. These nematodes are inserted into cysts in the stomach wall of their hosts, which can cause severe pathologies (Bowman et al., 2002).

Table 2
Updated list of helminth parasites of wild carnivore mammals from Brazil, after study of Vieira et al. (2008).

Helminth species	Hosts	Localities (States)	References
Acanthocephala			
Archiacanthocephala			
Oligacanthorhynchidae			
Prosthenorchis cerdocyonis Gomes, Olifiers, Souza, Barbosa, D'Andrea & Maldonado Jr, 2015	*Cerdocyon thous* (Canidae)	Mato Grosso do Sul	Gomes, Olifiers, Souza, et al. (2015)
Nematoda			
Acuaroidea			
Chandleronema longigutturata (Chandler 1942)	*Procyon cancrivorus* (Procyonidae)	Rio Grande do Sul	Suárez et al. (2015)
Ascaridoidea			
Ascaridia galli (Schrank, 1788)	*Cerdocyon thous* (Canidae)	Mato Grosso do Sul	Gomes, Olifiers, Santos, et al. (2015)
Dioctophymatoidea			
Dioctophyma renale	*Cerdocyon thous* (Canidae)	Rio de Janeiro	Ribeiro et al. (2009)
Filaroidea			
Dirofilaria immitis (Leidy, 1856)	*Leopardus tigrinus* (Felidae)	São Paulo	Filoni et al. (2009)
Metastrongyloidea			
Crenosoma brasiliense Vieira, Muniz-Pereira, Souza Lima, Moraes Neto, Gonçalves & Luque, 2012	*Galictis cuja* (Mustelidae)	Minas Gerais	Vieira, Luque, et al. (2012)
Angiostrongylus felineus Vieira, Muniz-Pereira, Souza Lima, Moraes Neto, Guimarães & Luque, 2013	*Puma* (*H.*) *yagouaroundi* (Felidae)	Minas Gerais	Vieira et al. (2013)
Physalopteroidea			
Physaloptera sp.	*Galictis cuja* (Mustelidae)	Rio de Janeiro	Corrêa, Bueno, Vieira, and Muniz-Pereira (2016)
Pterygodermatites (*Multipectines*) *pluripectinata* Lux Hoppe, Araújo de Lima, Tebaldi & Nascimento, 2010 (Spirurida, Rictulariidae)	*Cerdocyon thous* (Canidae)	Paraíba	Lux-Hoppe et al. (2010)
Spiruroidea			
Cylicospirura felineus (Chandler, 1925)	*Leopardus* geoffroyi (Felidae)	Rio Grande do Sul	Gallas et al. (2014)
Trichostrongyloidea			
Molineus elegans (Travassos, 1921)	*Galictis cuja* (Mustelidae)	Rio de Janeiro Minas Gerais	Corrêa et al. (2016)
Platyhelminthes			
Eucestoda			
Cyclophyllidea			
Taenia mustelae Gmelin, 1790	*Bassaricyon gabbii* (Procyonidae)	Amazonas	Pinto et al. (2009)
Mesocestoides sp.	*Leopardus colocolo* (Felidae) *L.* (*Oncifelis*) *geoffroyi* *L. tigrinus* *Puma* (*H.*) *yagouaroundi* (Felidae)	Rio Grande do Sul	Gallas and Silveira (2011)
Dipylidium caninum (Linnaeus, 1758)	*Cerdocyon thous* (Canidae)	Minas Gerais	Vieira, Muniz-Pereira, et al. (2012)
Trematoda			
Digenea			
Platynosomum illiciens (Braun, 1901)	*Galictis cuja* (Mustelidae)	Rio de Janeiro Minas Gerais	Corrêa et al. (2016)

The most recent inventory of helminth parasites in wild carnivores in Brazil is the study of Vieira et al. (2008), which lists 95 helminth species in 21 species of this hosts group. After the publication of Vieira et al. (2008) and until the current study, no new information had been published about the helminth parasites of Brazilian wild carnivores (Table 2).

Data from the current study combined with data published after the study of Vieira et al. (2008) include 15 helminth species more not reported previously in these host species (Table 2), including 2 new hosts (*B. gabbii*, and *L. colocolo*) for helminth in the list of wild carnivore mammals from Brazil. Therefore, we can affirm that currently 109 helminth taxa in 23 species are reported for wild carnivores in Brazil.

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