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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

FIRST REPORT FROM THE STATE OF RIO GRANDE DO SUL, BRAZIL ON *CYLICOSPIRURA* (*CYLICOSPIRURA*) *FELINEUS* (CHANDLER, 1925) SANDGROUND, 1932 (NEMATODA, SPIROCERCIDAE) IN *LEOPARDUS GEOFFROYI* D'ORBIGNY & GERVAIS, 1844 (CARNIVORA, FELIDAE)

CYLICOSPIRURA (*CYLICOSPIRURA*) *FELINEUS* (CHANDLER, 1925) SANDGROUND, 1932 (NEMATODA, SPIROCERCIDAE) EM *LEOPARDUS GEOFFROYI* D'ORBIGNY & GERVAIS, 1844 (CARNIVORA, FELIDAE): PRIMEIRO REGISTRO PARA O ESTADO DO RIO GRANDE DO SUL, BRASIL

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Abstract

In the Neotropical Region, the only species of *Cylicospirura* reported so far in felines is *Cylicospirura* (*Cylicospirura*) *subaequalis* in Paraguay and Brazil. Between 2007 and 2009, roadkilled specimens of *Leopardus geoffroyi* (n = 6) were donated for necropsy. Nematodes found in the stomach of one individual were identified as *Cylicospirura* (*Cylicospirura*) *felineus* by the presence of six large tricuspid teeth, a vulva anterior to the junction of the esophagus and intestine, and the size of the spicules. The prevalence of *C.* (*C.*) *felineus* in *L. geoffroyi* was 16.7%. No lesions caused by the nematodes were found in the infected feline, as reported in other studies. This is the first report of *C.* (*C.*) *felineus* in the Neotropical Region (State of Rio Grande do Sul, Brazil) and *L. geoffroyi* represents a new host.

Keywords: felines - Geoffroy's Cat - helminth fauna – nematode - Neotropical Region - taxonomy.

Resumo

Para a Região Neotropical, a única espécie de *Cylicospirura* registrada para felídeos silvestres foi *Cylicospirura* (*Cylicospirura*) *subaequalis* no Paraguai e Brasil. Durante 2007 e 2009, espécimes atropelados de *Leopardus geoffroyi* (n = 6) foram doados para necropsia. Nematoides encontrados no estômago foram identificados como *Cylicospirura* (*Cylicospirura*) *felineus* pela presença de seis dentes trífidos, vulva anterior à junção do esôfago com intestino e, tamanho dos espículos. A prevalência de *C.* (*C.*) *felineus* em *L. geoffroyi* foi 16,7%. Não foram observadas lesões causadas pelos nematoides no hospedeiro infectado, como registrado em outros estudos. Este é o primeiro registro de *C.* (*C.*) *felineus* para a Região Neotropical (Estado do Rio Grande do Sul, Brasil) e, *L. geoffroyi* como novo hospedeiro.

Palavras-chave: felídeos - gato-do-mato-grande - helmintofauna - nematoide - Região Neotropical - taxonomia.

INTRODUCTION

The genus *Cylicospirura* was originally proposed to accommodate the species *Spiroptera subaequalis* Molin, 1860, due the differences found in the morphology of the buccal capsule (Vevers, 1922). Three subgenera were subsequently proposed by Chabaud (1975): *Cylicospirura* Vevers, 1922 (parasites of carnivores), *Gastronodus* Singh, 1934 (parasites of insectivores) and *Skrjabinocercina* Matschulsky, 1952 (parasites of rodents), although this arrangement was not accepted by Junker *et al*. (2013) who elevated all these taxa to the genus level.

Chandler (1925) described *Spirocerca felineus* Chandler, 1925 from specimens removed from cysts collected from the stomach of domestic cats in India. This nematode was subsequently transferred to the genus *Cylicospirura*, based on the examination of specimens collected from *Felis bengalensis* (= *Prionailurus bengalensis* Kerr, 1792) in Indochina by Sandground (1932). *Cylicospirura* (*Cylicospirura*) *subaequalis* (Molin, 1860) Vevers, 1922, and *Cylicospirura* (*Cylicospirura*) *felineus* (Chandler, 1925) Sandground, 1932 have all been considered to be synonymous, although Pence *et al*. (1978) and Waid & Pence (1988) consider them to be valid species.

In North America, *C*. (*C*.) *felineus* has been reported in two host species: *Felis rufus* (= *Lynx rufus* Schreber, 1777) in United States (Pence *et al*., 1978; Tiekotter, 1985; Waid & Pence, 1988; Ferguson *et al*., 2011) and *Felis canadensis* (= *Lynx canadensis* Kerr, 1792) in Canada (Pence *et al*., 1978; Smith *et al*., 1986). Domestic and wild felines in Asia, Africa, and Oceania have also been reported as hosts of *C*. (*C*.) *felineus* (Yamaguti, 1961; Ferguson *et al*., 2011; Junker *et al*., 2006, 2013).

However, there are few data on the distribution of the *Cylicospirura* species in South America (Junker *et al*., 2006). In Paraguay, Junker *et al*. (2006) recorded *C*. (*C*.) *subaequalis* parasitizing *Herpailurus yaguarondi* (= *Puma yagouaroundi* É. Geoffroy Saint-Hilaire, 1803), while in Brazil, Yamaguti (1961) recorded the species in *Felis concolor* (= *Puma concolor* Linnaeus, 1771) and *Felis mellivora* (= *P. yagouaroundi* ?). The present study reports the occurrence of *C*. (*C*.) *felineus* for the first time in the Neotropical Region (State of Rio Grande do Sul, Brazil), and *Leopardus geoffroyi* d'Orbigny & Gervais, 1844 as new host.

MATERIALS AND METHODS

Six roadkilled specimens of *L. geoffroyi* were collected during the monitoring of the road system in the State of Rio Grande do Sul, Brazil between 2007 and 2009. The felines were donated to the 'Laboratório de Zoologia dos Invertebrados' of the 'Museu de Ciências Naturais da ULBRA'. The collection and transportation of the specimens was conducted according to normative ruling no. 154 of March 1st, 2007, chapter VI, article 26 (Ibama, 2007). The nematodes found in these specimens were fixed in A.F.A. (glacial acetic acid, formalin and ethanol) at 65º C, and the helminths were mounted temporally with Amann's lactophenol for the visualization and measurement of morphological characters (Humason, 1972; Amato & Amato, 2010).

All measurements are given in micrometers (μm) unless otherwise indicated. The range of values (minimum–maximum) are presented for the eggs, together with the mean, standard deviation, and number of eggs measured between parentheses. Ecological terminology followed Bush *et al*. (1997). The drawings were produced using a drawtube attached to the microscope. The systematic and identification of the parasite was based on Chabaud (2009), and that of the host following Wozencraft (2005). A representative specimen of the host was deposited in the 'Coleção de Vertebrados' of the 'Museu de Ciências Naturais da ULBRA' (MCNU), Canoas, Brazil; and voucher specimens of the helminths were deposited in the 'Coleção Helmintológica' of the 'Museu de Ciências Naturais da ULBRA' (CHMU).

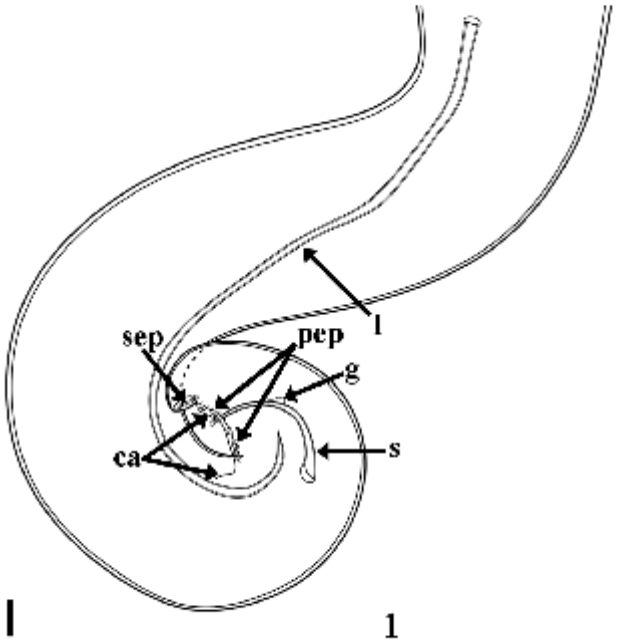
RESULTS

Cylicospirura (*Cylicospirura*) *felineus* (Chandler, 1925) Sandground, 1932. (Figures 1 and 2)

Description based on two specimens, clarified in lactophenol. Spirocercidae, Spirocercinae. Nematodes of small size, spiraled body and cuticle with transversal striations. Anterior region with buccal capsule sclerotized with six large tricuspid teeth. Esophagus with muscular and glandular portions.

Male (n = 1). Body 331.92 wide. Glandular esophagus 138.3 wide. Spicules dissimilar, the smallest with distal extremity blunt tipped, measuring 0.3 mm long; and the largest with distal extremity acicular, 1.39 mm long. Gubernaculum 46.1 long and 27.66 wide. Caudal alae present. Four pairs of precloacal pedunculated papillae, two pairs of poscloacal pedunculated papillae and five pairs of poscloacal sessile papillae next to the tip of tail. Cloaca 147.52 from posterior extremity.

Female (n = 1). Body 13.91 mm long, 0.33 mm wide in the glandular esophagus region. Buccal capsule 73.76 long, 110.64 wide. Cephalic papillae not observed. Muscular esophagus 0.39 mm long, 55.32 wide; glandular esophagus 1.46 mm long, 0.13 mm wide. Nerve ring 0.30 mm from anterior extremity. Excretory pore 0.46 mm from anterior extremity. Vulva 2.99 mm



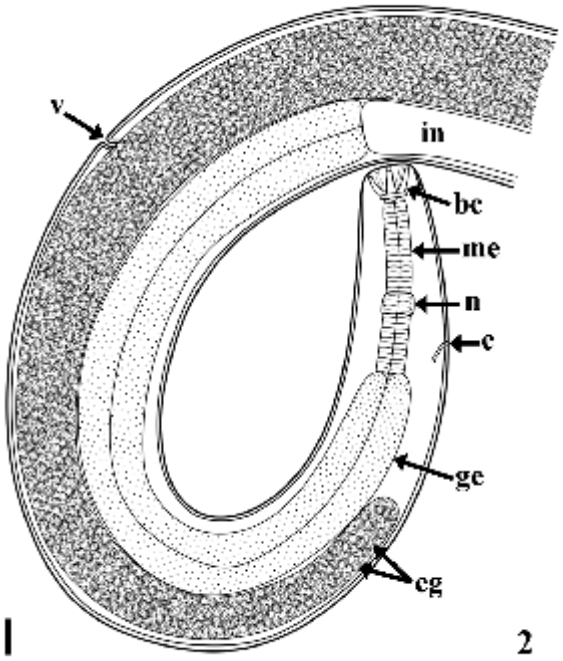


Figure 1. Incomplete diagram of *Cylicospirura* (*Cylicospirura*) felineus (Chandler, 1925) Sandground, 1932: Male posterior extremity showing long (l) and short (s) spicule, gubernaculum (g), pedunculated papillae (pep), sessile papillae (sep) and caudal alae (ca). Scale bar = 100 µm.

Figure 2. Incomplete diagram of *Cylicospirura* (*Cylicospirura*) felineus (Chandler, 1925) Sandground, 1932: Female anterior extremity with buccal capsule (bc), muscular esophagus (me), glandular esophagus (ge), nerve ring (n), excretory pore (e), vulva (v), eggs (eg) and intestine (in). Scale bar = 100 µm.

from anterior extremity. Embryonated eggs, 27.66–36.88 (33.2 ± 3.5; n = 10) long, 18.44–36.88 (19.64 ± 1.46; n = 10) wide. Anus 110.64 from posterior extremity.

Taxonomic summary:

Synonyms: *Spirocerca subaequalis* Seurat, 1913; *Spirocerca felineus* Chandler, 1925.
Host: *Leopardus geoffroyi* d'Orbigny & Gervais, 1844 – new host record.
Host specimen deposited: MCNU 1015.
Locality: Bagé, BR-293 (31º02'34"S, 54º32'15"W), RS, Brazil.
Site of infection: stomach.
Prevalence: 16.67%.
Mean abundance of infection: 0.33 helminth/host.
Voucher specimen of the helminth deposited: CHMU 37-1-1-male; 37-1-2-female.

DISCUSSION

Nematodes found in the stomach of *L. geoffroyi* were identified as *C.* (*C.*) *felineus* by the presence of a buccal capsule with triphid teeth, a vulva on the anterior junction of the esophagus and intestine, and from the size of the spicules. The measurements recorded in the present study are close to the range reported by Pence *et al.* (1978) and Junker *et al.* (2006). Chandler (1925) reported much larger specimens from India, however.

The presence of a papilla anterior to the cloacal aperture was reported in *C.* (*C.*) *felineus* from North America (Pence *et al.*, 1978), although this structure was not observed in the male examined in the present study. In *L. geoffroyi*, the nematodes were found in the stomach unattached, although lesions caused by *C.* (*C.*) *felineus* have been reported in a number of other hosts (Pence *et al.*, 1978; Watson *et al.*, 1981; Smith *et al.*, 1986; Junker *et al.*, 2006; Ferguson *et al.*, 2011).

The female reproductive system of *C.* (*C.*) *felineus* was described as having vulva located anterior in relation to the esophagus and intestine junction and, ovejector directed anteriorly until form a structure similar to a sac, which bifurcates into two uterine branches (Chandler, 1925). In their redescription of the species, Pence *et al.* (1978) described the ovejector as being directed towards the posterior extremity. This was also the case in the female examined in the present study, although one of the uterine branches full of embryonated eggs was directed to the anterior extremity, possibly due to a fold in the tissue (Fig. 2).

To date, the nematode species reported parasitizing *L. geoffroyi* are *Gnathostoma americanum* Travassos, 1925 in the Municipality of Angra dos Reis, State of Rio de Janeiro (Travassos, 1925; Vicente *et al.*, 1997; Vieira *et al.*, 2008) and *Toxocara cati* (Schrank, 1788) Sprent, 1956 in the State of Rio Grande do Sul (Gallas & Silveira, 2013). While Travassos (1925) reported the occurrence of *G. americanum* in *Felis tigrina* Linnaeus, 1758, Vicente *et al.* (1997) and Vieira *et al.* (2008) considered this host to be *L. geoffroyi*. However, as the geographic distribution of *L. geoffroyi* in Brazil is restricted to the southernmost State of Rio Grande do Sul (Trigo *et al.*, 2013), it seems likely that the host may have actually been *Leopardus pardalis* Linnaeus, 1758 or *Leopardus tigrinus* Schreber, 1775, which are both found in Rio de Janeiro. In the present study, *C.* (*C.*) *felineus* was reported for the first time in the Neotropical Region and *L. geoffroyi* was confirmed as a new host of the species.

Ecological parameters available in the literature (Table 1) were compared with data from the present study, and suggest that the prevalence of *C.* (*C.*) *felineus* is not related to the number of hosts examined. The ample distribution of *C.* (*C.*) *felineus* in North America, between Canada (Alberta) and the southern United States (western Texas) has been attributed the use of a large variety of intermediate and paratenic host species (Pence *et al.*, 1978). The life cycles of generalist nematodes that use a large variety of intermediate or paratenic hosts may affect their prevalence in different environments, due to the variation in the distribution of these hosts. The reduced prevalence of *Cylicospirura* may also reflect the diet and rareness of their definitive

hosts, for which few data on the helminth fauna are available (Junker *et al*., 2013).

The occurrence of *C.* (*C.*) *felineus* in the southern extreme of the Neotropical Region may reflect an ample geographic distribution, determined at least in part by the variability and availability of intermediate or paratenic hosts. The Geoffroy's Cat, *L. geoffroyi*, is currently listed as near-threatened by the IUCN (Lucherini *et al*., 2008) and as vulnerable in Rio Grande do Sul (Indrusiak & Eizirik, 2003). The examination of roadkilled specimens constitutes an important resource of material for studies of the helmith fauna of wild felines, contributing to the understanding of the ecology of these felines in the Neotropical Region and, as in the present case, extending the geographic distribution of *C.* (*C.*) *felineus*.

Research using animals killed on the roads avoids the need to sacrifice the host and requires no authorization. While these specimens may also be utilized for the evaluation of ecological aspects of the impact of roads on natural populations and as indicators of the composition of the local fauna, their usefulness is limited by the generally small size of the sample.

Table 1. Comparison of the ecological parameters of *C.* (*C.*) *felineus* in wild felines of different localities.

Host (n)	Locality	Prevalence (%)	Mean intensity (helminths/ host)	Amplitude of infection	Reference
Felis rufus (= *Lynx rufus*) (n = 66)	Texas	69.7	–	–	Pence *et al.* (1978)
Felis canadensis (= *Lynx canadensis*) (n = 33)	Alberta	72.7	–	–	Pence *et al.* (1978)
F. rufus (= *Ly. rufus*) (n = 143)	West Virginia	10	3	1-10	Watson *et al.* (1981)
Ly. rufus (n = 75)	Nebraska	12	8	2-15	Tiekotter (1985)
F. canadensis (= *Ly. canadensis*) (n = 360)	Ontario	91	20.9	1-153	Smith *et al.* (1986)
Ly. rufus (n = 17)	Oregon	53	10.9	1-25	Ferguson *et al.* (2011)
Leopardus geoffroyi (n = 6)	Bagé	16.7	2	2	Present study

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