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FIRST RECORD OF *Dipetalonema robini* PETIT, BAIN & ROUSSILHON 1985 (NEMATODA: ONCHOCERCIDAE) PARASITIZING *Sapajus nigritus* IN NORTHEASTERN ARGENTINA

Ezequiel Vanderhoeven¹, Juliana Notarnicola², and Ilaria Agostini²

¹ Instituto Nacional de Medicina Tropical (INMet), Ministerio de Salud, Puerto Iguazú, Misiones, Argentina.

² Instituto de Biología Subtropical (IBS), Consejo Nacional de Investigaciones Científicas y Técnicas, CONICET-CCT Nordeste, Universidad Nacional de Misiones (UNaM), Puerto Iguazú, Misiones, Argentina. [Correspondence: Juliana Notarnicola <julinota@yahoo.com.ar>]

ABSTRACT. Species of the genus *Dipetalonema* are filarial parasites of Neotropical monkeys. Herein, we report the first record of *Dipetalonema robini* from Argentina and from the black horned capuchin monkey, *Sapajus nigritus*, providing additionally information on its morphology. Nematodes were found in the abdominal cavity of a male capuchin monkey found in the Parque Nacional Iguazú, Misiones, Argentina. Among *Dipetalonema* species, the proportion of the different parts of the left spicule (handle and lamina; membranous alae and filament) is a character of taxonomic relevance. The membranous ala is longer than the filament in the single male parasite examined, differing from published data. The differences observed could be due to the small number of specimens measured.

RESUMEN. Primer registro de *Dipetalonema robini* Petit, Bain & Roussilhon 1985 (Nematoda: Onchocercidae) parásito de *Sapajus nigritus* en el noreste de Argentina. Las filarias del género *Dipetalonema* son parásitos de monos neotropicales. En este trabajo, reportamos el primer registro de *Dipetalonema robini* para la Argentina y para el mono caí, *Sapajus nigritus*, además de proveer nuevos datos de la morfología de la especie. Tres filarias fueron encontradas en la cavidad abdominal de un mono caí macho hallado en el Parque Nacional Iguazú, Misiones, Argentina. Un carácter taxonómico relevante entre las especies de *Dipetalonema* es la proporción de las diferentes partes de la espícula izquierda (mango y lámina; alas membranosas y filamento). En el macho hallado, la sección de alas membranosas es más larga que el filamento, difiriendo con los datos publicados. Esta diferencia puede deberse al pequeño número de ejemplares medidos.

Key words: Argentina. Atlantic forest. Capuchin monkey. Filarioids. Misiones.

Palabras clave: Argentina. Bosque Atlántico. Filarias. Monos caí. Misiones.

Documenting parasites infecting primate hosts is an important component of monitoring programs aimed at evaluating the health status and disease risk of wild primate populations (Altizer et al. 2003). This parasite record was gathered during a parallel study on the interaction between nutrition and parasitism in a population of the wild black horned capuchin monkey *Sapajus nigritus* (Goldfuss, 1809) in Iguazú National Park, Argentina. *Sapajus nigritus* is endemic of the Atlantic Forest, whose range within Argentina is restricted to the northeastern of the Province of Misiones. This region is inhabited by two other primate species, *Alouatta caraya* (Humboldt, 1812) and *A. guariba clamitans* (Humboldt, 1812), which are found in very low densities, compared to *S. nigritus* (Agostini et al. 2015). These monkeys have an omnivorous diet based mostly on fruits and arthropods, and groups spend 70–90% of their day harvesting food. They invest more time in looking for insects than they do in feeding on fruits (Terborgh 1983; Robinson & Janson 1987; Brown & Zunino 1990). *Sapajus nigritus* lives in multi-male, multi-female polygamous groups, consisting of seven to 30 individuals, maintaining tight grooming bonds among themselves and with the alpha male (Di Bitetti 1997).

Species of the genus *Dipetalonema* Diesing 1861 sensu stricto are filarial parasites of Neotropical monkeys (Bain et al. 1982). The genus currently comprises 6 species: *Dipetalonema gracile* (Rudolphi, 1809); *D. caudispina* (Molin, 1858); *D. graciliformis* Freitas 1964; *D. robini* Petit, Bain & Roussilhon 1985; *D. freitasi* Bain, Diagne & Muller 1987; and *D. yatesi* Notarnicola, Jiménez & Gardner 2007. The adult filarioids are frequently located in the peritoneal cavity of the hosts and microfilariae invade the blood stream. It has been experimentally demonstrated that the vectors of *Dipetalonema* spp. are biting midges (*Culicoides* spp.; Diptera: Ceratopogonidae) (Eberhard et al. 1979; Travi et al. 1985).

More than 20 species of Neotropical monkeys (tribe Platyrrhini) are hosts for *Dipetalonema* spp. (Notarnicola et al. 2008). *Sapajus nigritus* (syns. *Cebus nigritus*; *Cebus apella nigritus*) was recorded to harbor *D. caudispina* in Brazil

(Molin 1858; Freitas 1943) and *D. gracile* in Brazil, Paraguay (Freitas 1964; Notarnicola et al. 2008), Colombia (Dunn & Lambrecht 1963), and in one captive individual at the New York Zoological Park (McClure 1932).

The present work reports the first record of *D. robini* from Argentina and from the host *Sapajus nigritus* and provides new information on the morphology of this filarioid.

The Iguazú National Park (25° 40' S, 54° 30' W), located in Misiones Province, Argentina, is characterized by a humid subtropical climate with marked seasonality in day length and temperature (Crespo 1982). The vegetation in the park is predominantly a secondary forest, with large parts covered by dense bamboo thickets (Brown & Zunino 1990).

On 22th September 2014 a black-horned capuchin monkey *Sapajus nigritus* (Primates: Cebidae) was found on the roadside of the Ruta Nacional 101 in Iguazú National Park. The cause of the monkey's death was probably electrocution because its hands showed signs of burns and its body was found under an electric pole. The monkey was identified as an adult male (approximately 6 years old) and showed a good condition. Worms from abdominal cavity were fixed in 10% formalin and preserved in 70% ethanol (necropsy performed by EV). Worms were studied under light microscopy and cleared in lactophenol by JN. In addition, microfilariae were obtained from the uteri of a mature female. We report measurements in micrometers (μm), unless otherwise stated. The specimen was deposited at the Colección de Mamíferos from Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN) MASTO215 (accession number), Buenos Aires, and nematodes (1 male and 2 females) were deposited at Colección de Helmintos Museo de La Plata (MLP-He 7288), La Plata, Argentina.

Three filarioids (one male and two females) of *Dipetalonema robini* Petit, Bain & Roussilhon 1985 found in the abdominal cavity of the male capuchin monkey showed the following characters.

Female (n = 2): Body length 188.54 and 170.6 mm; width 440 and 528. Labial papillae in a rectangle of 40 by 26; cephalic papillae in a rectangle of 113 by 54; other female 53

by 38 and 93 by 70, buccal capsule length 9 and 10; width 24 and 21. Nerve ring 195 and 300 from anterior end. Esophagus 4070 and 3187 long with muscular portion 270 and 600 (**Fig. 1A**). Tail 600 and 660 long. Vulva 1150 and 700 from anterior end. Vagina 240 long and 100 wide, constituted by a bent tube with a flattened lumen, and a chamber with wrinkled walls (**Fig. 1C**); ovjector 4.608 mm long. Caudal lappets 15 long, located at 28 and 30 from the tip of tail, phasmids at the base of the lappets (**Fig. 1B**).

Male (n = 1): Body length 90 mm, width 290. Labial papillae in a rectangle of 45 by 26 and cephalic papillae in a rectangle of 100 by 50, buccal capsule length 10, width 16. Nerve ring 204 from anterior end. Esophagus 3696 long with muscular portion 479 long. Excretory pore not visible. Tail 313 long. Left spicule 980 long, with a handle shorter than lamina representing the 27% of the spicule length; lamina consisting of a portion with membranous alae and a terminal filament or flagellum, and portion with membranous alae longer than filament (**Fig. 1D**); handle 260 long; membranous alae 420 and filament 300 long.

Right spicule 247 long; lamina with cuticular axes, distal extremity S-shaped, cuticularized, surrounded by a folded membrane (**Figs. 1E, F**). Spicular ratio 3.96; gubernaculum 40 long. Area rugosa 5 mm long, extending through the coiled region including the tail, consisting of rows of small longitudinal crest. Caudal lappets 5 long, located at 20 from the tip of tail, phasmids placed at the base of the lappets. Caudal papillae distributed as follows: 5 pairs of adcloacal papillae arranged in 2 rows on both sides of the cloaca, 1 precloacal, 1 submedian postcloacal pair, and 2 submedian and 1 pair of subventral papillae at the caudal extremity. Precloacal area rugosa consisting of

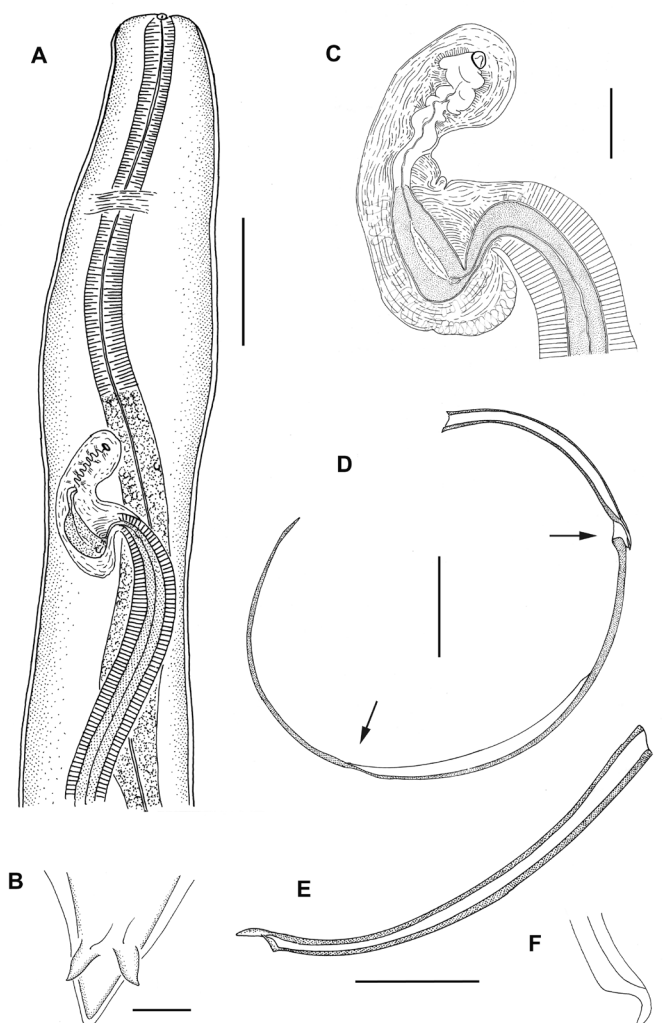


Fig. 1 A-F. *Dipetalonema robini*. A. Anterior region of a female, ventral view, scale bar 200 μ m. B. Caudal lappets from a female, ventral view, scale bar 20 μ m. C. Detail of the vulva, scale bar 50 μ m. D. Left spicule, lateral view, arrows indicate the beginnings of membranous ala and filament respectively, scale bar 100 μ m. E. Right spicule, lateral view, scale bar 50 μ m. F. Distal extremity of the right spicule, scale bar 20 μ m.

Table 1
 Comparative measurements of the spicules of the 6 species of *Dipetalonema*. Data are given in micrometers (μm).

Source	<i>D. caudispina</i>	<i>D. freitasi</i>	<i>D. gracile</i>	<i>D. graciliformis</i>	<i>D. robini</i>		<i>D. yatesi</i>
	Bain et al. (1986)	Bain et al. (1987)	Notarnicola et al. (2008)	Bain et al. (1986)	Petit et al. (1985)	Present study	Notarnicola et al. (2007)
Specimens studied	1	2	4	1	2	1	6
Left spicule length	1030	1035	1059	1130	1050	980	1193
Handle (% of the spicule length)	450 (44%)	425 (41%)	306 (29%)	250 (22%)	290 (28%)	260 (27%)	300 (25%)
Lamina (% of the spicule length)	580 (56%)	610 (59%)	752 (71%)	880 (78%)	760 (72%)	720 (73%)	893 (75%)
Membranous alae (% of the lamina length)	480 (83%)	485 (79%)	437.5 (58%)	330 (37.5%)	382 (50.5%)	420 (58%)	533 (60%)
Filament (% of the lamina length)	100 (17%)	125 (21%)	315 (42%)	550 (62.5%)	377 (49.5%)	300 (41%)	360 (40%)
Lamina/Handle ratio	1.28	1.44	2.46	3.52	2.59	2.76	2.97
Right spicule length	270	255	260	260	242	247	253
Spicular ratio	3.81	4.05	4.07	4.34	4.5	3.96	4.71

1 ventral band, postcloacal area arranged in 1 ventral band.

The differential morphology of the vagina, the left spicule with membranous alae longer than the filament, the postcloacal area rugosa in 1 ventral band on the median line, and the distribution of the cloacal papillae are in accordance with the description of *D. robini* (Petit et al. 1985). This filarioid species was previously recorded in *Saimiri sciureus* from Guyana and Peru, in *Saimiri boliviensis* from Peru, and in *Sapajus* sp. (mentioned as *Cebus* sp., the common brown monkey) from Surinam (van Thiel 1926; Dunn & Lambrecht 1963; Petit et al. 1985; Bain et al. 1986). The present record is the southernmost for the genus and the first for *Sapajus nigrinus* and for Argentina.

It is important to note that the length of the left spicule is similar in the 6 known species of *Dipetalonema* (Table 1), however there are differences in the lengths of the different portions of the spicule. According with Bain et al. (1987), the length of the handle decreases its size among the different species, which is clearly denoted by the handle:lamina ratio. Moreover, in *D. caudispina* and *D. freitasi* the lamina is constituted largely by the portion with membranous alae and the terminal filament is very short; whereas in *D. gracile* and *D. yatesi* the membranous alae represents the 60% of the lamina; in *D. robini* and *D. graciliformis*, the membranous alae represent 50% and 40% of the lamina, respectively (see Table 1). However, in our male, the membranous ala is longer than the filament, differing from the data of Petit et al. (1985). The differences observed could be due to the small number of specimens measured, 2 in Petit et al. (1985) and 1 herein.

Studies based on gastrointestinal parasites of capuchin monkeys are scarce in the Neotropics (Phillips et al. 2004; Parr et al. 2013). It is known that parasite loads affect health and physical appearance of their hosts; thus the knowledge of the helminth fauna in capuchin monkeys (including those parasites located in organs other than the intestine) is an important issue for conservation purposes.

Actually, there are no reports of *Dipetalonema* species causing any disease in monkeys or humans. However, it is known that generally,

filarioids may cause eosinophilia, while the most studied filarioids such as the lymphatic *Wuchereria* spp. or *Brugia* spp. adults cause dilatation of lymphatic channels and microfilaria cause pulmonary eosinophilia nodular, granulomatous lesions, among other pathologies (Mak 2012). Finally, since filarioids are potentially zoonotic diseases (Orihel & Eberhard 1998), the presence of *Dipetalonema robini* in capuchin monkeys or any other filarioid species could potentially have consequences for human health.

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