Parasitology Research
https://doi.org/10.1007/s00436-018-5964-x

ORIGINAL PAPER

Description of a new species *Physaloptera goytaca* n. sp. (Nematoda, Physalopteridae) from *Cerradomys goytaca* Tavares, Pessôa & Gonçalves, 2011 (Rodentia, Cricetidae) from Brazil

Nicole Brand Ederli[1] · Samira Salim Mello Gallo[2] · Luana Castro Oliveira[2] · Francisco Carlos Rodrigues de Oliveira[2]

Received: 7 May 2018 / Accepted: 7 June 2018

Abstract
Nematodes of the genus *Physaloptera* are common in rodents, including in species of the Family Cricetidae. There is no report of nematodes parasitizing *Cerradomys goytaca*, so this is the first one. For this study, 16 rodents were captured in the city of Quissamã, in the northern of Rio de Janeiro State. The rodents were necropsied, and the digestive tracts were analyzed under a stereomicroscope for the presence of parasites. The nematodes were fixed in hot AFA, clarified in Amann's lactophenol, mounted on slides with coverslip, and observed under an optical microscope. Part of the nematodes was fixed in Karnovisk solution for scanning electron microscopy. Nematodes presented evident sexual dimorphism. Oral openings had two semicircular pseudolabia, with an external lateral tooth and an internal lateral tripartite tooth on each pseudolabium. Males had a ventral spiral curved posterior ends with the presence of a caudal alae with 21 papillae with four pairs of pedunculated papillae arranged laterally, three pre-cloacal sessile papillae arranged rectilinearly and five pairs of post-cloacal sessile papillae. There was also a pair of phasmids located between the fourth and fifth pairs of post-cloacal papillae as well as two spicules that were sub-equal in size but of distinct shapes. The females have five uterine branches. The morphological and morphometrical analyses of the nematodes collected from *C. goytaca* were compared with other species, and the results indicated that this is a new species of the genus *Physaloptera*, *Physaloptera goytaca* n. sp.

Keywords Cricetidae · Nematoda · Sandplain · Endoparasites · Physalopteridae

Introduction

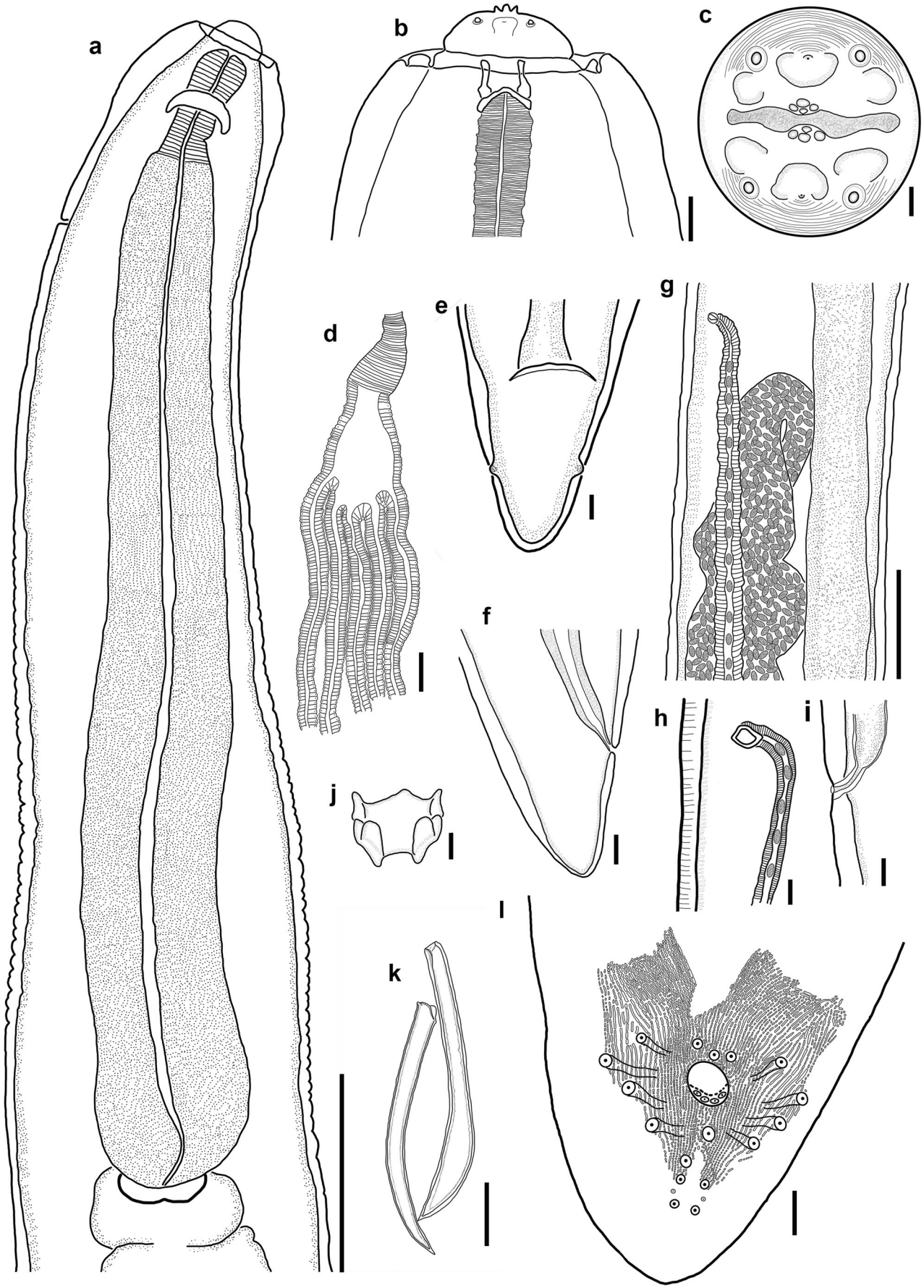
The genus *Cerradomys* Weksler, Percequillo and Voss, 2006, is composed of eight valid species: *Cerradomys subflavus* (Wagner, 1842), *Cerradomys maracajuensis* (Langguthand and Bonvicino, 2002), *Cerradomys scotti* (Langguthand and Bonvicino, 2002), *Cerradomys marinhus* (Bonvicino, 2003), *Cerradomys vivoi* (Percequillo, Hingst-Zaher and Bonvicino, 2008), *Cerradomys langguthi* (Percequillo, Hingst-Zaher and Bonvicino, 2008), *Cerradomys goytaca* Tavares, Pessôa and Gonçalves, 2011, and *Cerradomys akroai* Bonvicino, Casado and Weksler, 2014. These rodents inhabit mainly open vegetation biomes, which form a belt across South America, spanning from the northeastern and southeastern Atlantic coast of Brazil to eastern Paraguay and Western Bolivia (WEKSLER et al. 2006; D'ELÍA et al. 2008; PERCEQUILLO et al. 2008). *Cerradomys goytaca* is an endemic species of the sandy coastal plains known as restingas, which are covered by open shrub vegetation that extend from the southern coast of the Espírito Santo State to the northern region of the State of Rio de Janeiro, Brazil (TAVARES et al. 2011). There is only one study on the helminths that infect this species, and it reported that the cestode *Fuhrmannetta jurubatensis* Oliveira, Oliveira and Ederli, 2017, infects the intestine of this rodent (Oliveira et al., 2017).

✉ Nicole Brand Ederli
nicoleederli@yahoo.com.br

[1] Instituto do Noroeste Fluminense de Ensino Superior (INFES), Universidade Federal Fluminense (UFF), Av. João Jasbick, s/n°, Aeroporto, Santo Antônio de Pádua, RJ 28470-000, Brazil

[2] Laboratório de Sanidade Animal (LSA), Universidade Estadual do Norte Fluminense Darcy Ribeiro (UENF), Campos dos Goytacazes, RJ 28013-602, Brazil

Published online: 20 June 2018


a
b
c
d
e
f
g
h
i
j
k
l

◀ **Fig. 1** *Physaloptera goytaca* n. sp. parasite of *Cerradomys goytaca* Tavares, Pessôa & Gonçalves, 2011. **a** Anterior region. Bar 500 μm. **b** Anterior end. Bar 100 μm. **c** *In face* view. Bar 30 μm. **d** Uterine branches. Bar 200 μm. **e** Female posterior end, ventral view. Bar 100 μm. **f** Female posterior end, lateral view. Bar 100 μm. **g** Vulva region. Bar 500 μm. **h** Vulva. Bar 50 μm. **i** Excretory pore. Bar 25 μm. **j** Gubernaculum. Bar 25 μm. **k** Spicules. Bar 100 μm. **l** Male posterior end. Bar 100 μm

Nematodes of the genus *Physaloptera* are common in rodents and were reported in Muridae, Cricetidae, Sciuridae, and Dasyproctidae (VECIANA et al. 2013). *Physaloptera galvaoi* was reported in *C. subflavus* from Minas Gerais State, Brazil, on the Cerrado biome. In Brazil, another species, *Physaloptera bispiculata* Vaz and Pereira, 1935, was reported in *Nectomys squamipes* Brants, 1827 (Cricetidae, Sigmodontinae), from the States of São Paulo and Rio de Janeiro (VAZ and PEREIRA 1935; GOMES and VICENTE 1984; GOMES et al. 2003). This is the first report of nematodes parasitizing *C. goytaca*, and it contains a description of a new species *Physaloptera goytaca* n. sp.

Material and methods

Cerradomys goytaca were captured from a total of 16 rodents in the sandplain areas in the city of Quissamã, in the northern region of Rio de Janeiro State, Brazil, using live traps and lures made with a mix of fruits, seeds, and peanut butter. Rodents were euthanized in a CO_2 chamber and necropsied, and the gastrointestinal organs were analyzed in Petri dishes with 0.65% saline solution under a stereomicroscope for the presence of parasites. Stomach and intestinal contents were passed in a sieve with 0.025-mm mesh and observed under a stereomicroscope. Nematodes were collected, washed in 0.65% saline solution, fixed in hot A.F.A [93% etha1mnol (70° GL), 5% formaldehyde (37%), 2% glacial acetic acid] overnight, conserved in 70% ethanol, and clarified in lactophenol (one part distillated water, two parts glycerin, one part lactic acid, one part phenic acid) between a slide and coverslip, according to Amato et al. (1991), for light microscopy. Five females were dissected after mensuration to analyze the pattern of uteri ramification.

Measurements were taken to the nearest micrometer (range (mean ± standard deviation)) from adult specimens (four males and six females), and 48 eggs in utero were isolated from different rodents. Measurements were performed with an Axioplan Zeiss light microscope (Carl Zeiss, Germany) equipped with a Canon Power-Shot A640 digital camera (Canon, China) and Zeiss AxionVision Sample Images Software (Carl Zeiss, Germany) for image analysis. Drawings of the parasites were obtained using an Axioplan Zeiss light microscope (Carl Zeiss, Germany) equipped with a camera lucida and were digitized using the Adobe Photoshop Elements 8.0 software with the aid of an Intuos4 Wacon® pen tablet (Wacon Co. Ltd., Japan).

For scanning electron microscopy analysis, nematodes were fixed for 2 h in 2.5% glutaraldehyde, 4% freshly prepared paraformaldehyde, 5 mM calcium chloride in 0.1 M

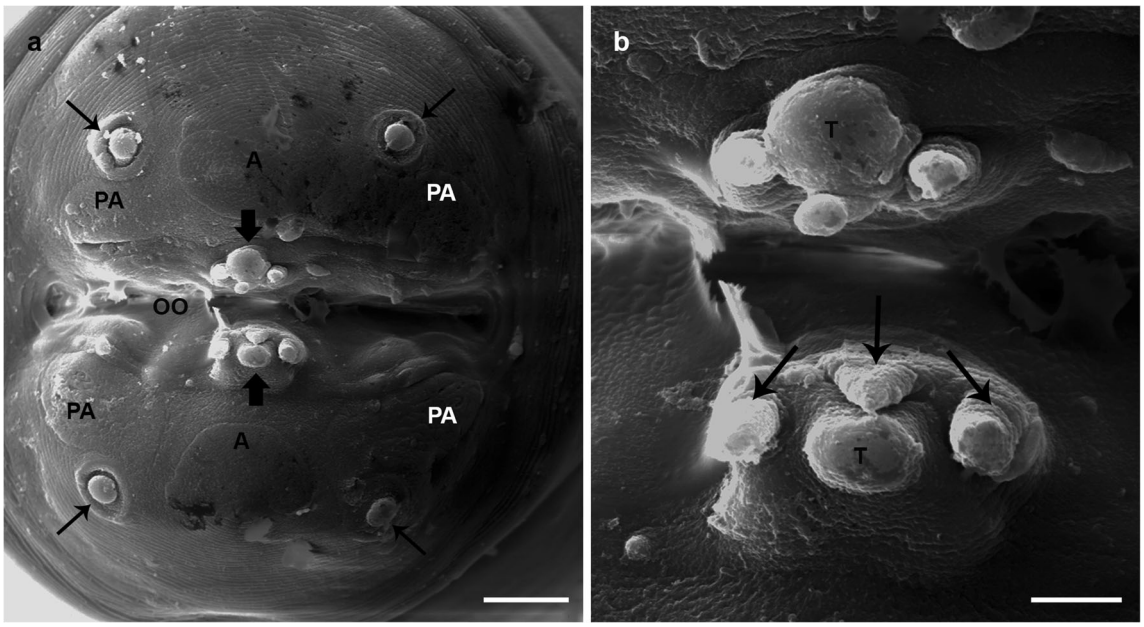
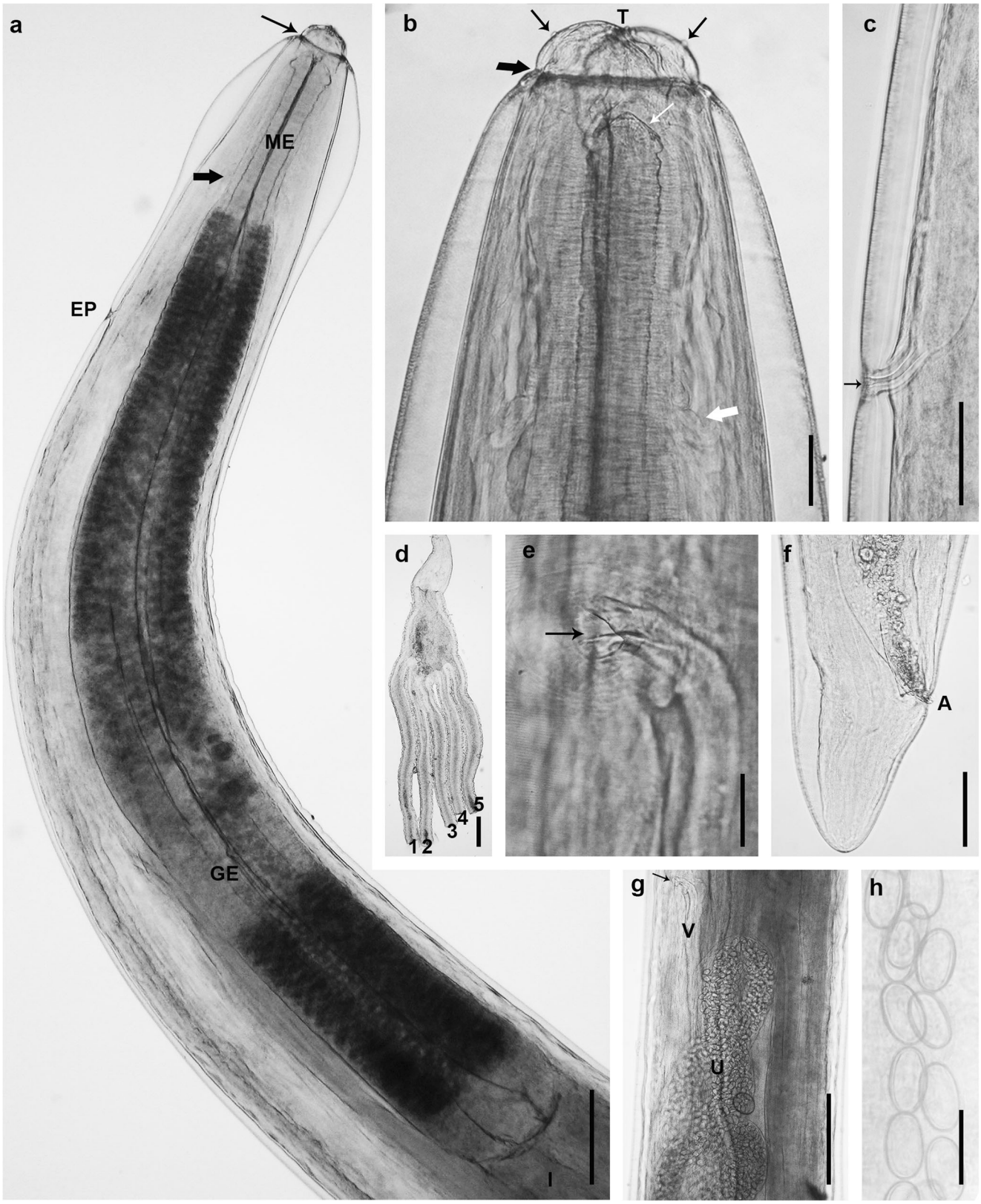


Fig. 2 Scanning electron micrography of *Physaloptera goytaca* n. sp. parasite of *Cerradomys goytaca* Tavares, Pessôa & Guimarães, 2011 (Rodentia, Cricetidae). **a** Anterior end, showing oral opening (OO), teeth (thick arrow), amphids (A), cephalic papillae (thin arrow), and porous area (PA). Bar 30 μm. **b** External lateral tooth (T) and internal lateral tripartite teeth (arrows). Bar 10 μm



cacodylate buffer, at pH 7.2, and were post-fixed in 2% osmium tetroxide in 0.1 M cacodylate buffer, according to Ederli et al. (2008). The samples were dehydrated in an acetone series, critical-point dried with CO_2, sputter-coated with gold, and examined in a Zeiss EVO 40 scanning electron microscope (SEM) at 15 kV.

◀ **Fig. 3** Light micrography of females of *Physaloptera goytaca* n. sp. parasite of *Cerradomys goytaca* Tavares, Pessôa & Guimarães, 2011 (Rodentia, Cricetidae). **a** Anterior region with cephalic collarette (thin arrow), muscular esophagus (ME), glandular esophagus (GE), nerve ring (thick arrow), excretory pore (EP), and intestine (I). Bar 200 μm. **b** Anterior end with tripartite teeth (T), lateral teeth (black thin arrows), cephalic collarette (black thick arrow), esophageal cap (white thin arrow), and nerve ring (white thick arrow). Bar 100 μm. **c** Excretory pore (arrow). Bar 50 μm. **d** Uterine branches. Bar 200 μm. **e** Vulva opening. Bar 100 μm. **f** Posterior region with anus (A). Bar 200 μm. **g** Vulva region (arrow), vagina (V), and uteri (U). Bar 400 μm. **h** Eggs *in uteri*. Bar 50 μm

Results

Physaloptera goytaca n. sp.

Taxonomic summary

Type-host: *Cerradomys goytaca* (Tavares, Pessôa and Gonçalves, 2011) (Rodentia, Cricetidae)

Type-locality: Reserva de Jurubatiba, Quissamã, Rio de Janeiro, Brazil (22° 10′ 36.5″ S, 41° 25′ 42.0″ W)

Dates of collection: Between April and December 2015

Site in host: Stomach

Prevalence: 37.5% (6 of the 16 specimens examined)

Mean intensity: 5 (2–12 worms per host)

Type-material: Holotype and alotype CHIOC 38550

Etymology: The scientific name "*goytaca*" derives from the host of the new species, *Cerradomys goytaca*

General description

Body filiform and robust, pinkish in vivo. Evident sexual dimorphism, with females larger and more robust than males (proportion of 1:0.54) and males with a well-developed caudal alae. Thick cuticle with strong transverse striations, forming rings, and an evident cephalic collarette near the anterior end. Longitudinal oral opening with the presence of two semicircular pseudolabia, with an external lateral tooth and an internal lateral tripartite tooth on each pseudolabium (Figs. 1c and 2a, b). The tripartite teeth are composed of unequal subunits, including the two lateral ones with a rounded tip and a central one that is triangular (Figs. 1c and 2a, b). In the apical region, there are four cephalic papillae, one pair of amphids and four porous regions close to the oral opening (Figs. 1c and 2a). Pharynx present; long esophagus divided into an anterior muscular portion and another, longer, posterior glandular portion. Esophagus with greater diameter at the posterior end (Fig. 1a). Excretory pore well visible (Fig. 3a, c). Nerve ring surrounding the final muscular portion of the esophagus. Rectilinear intestine separated from the esophagus by a well-delimited esophageal-intestinal valve (Fig. 3a).

Males

Males shorter than females (Table 1), with a body total length of 23,273 ± 3471 (18,963–26,976) and major body wide at the median region of the body, measuring 1002 ± 191 (782–1188). Cephalic collarette present at anterior end, highly visible, at 73 ± 14 (57–90) from anterior extremity. Body width measured at the level of the cephalic collarette 202 ± 77 (106–271). Pharynx measuring 68 ± 12 (57–84) long by 67 ± 14 (51–84) wide. Muscular esophagus approximately 489 ± 93 (394–617) long by 110 ± 24 (79–135) wide, measured at the nerve ring level, and glandular esophagus approximately 3176 ± 558 (2385–3611) long by 392 ± 75 (296–470) wide at the posterior region. Proportion of esophagus total length relative to body total length approximately 1:0.16. Anterior esophagus region covered by a chitinous cap with an irregular surface, measuring 13.7 ± 0.1 (13.6–13.7) thickness (Fig. 1b). Distance from nerve ring to anterior end approximately 510 ± 97 (426–644), and body width at the level of nerve ring approximately 476 ± 11 (468–483). Distance from excretory pore to anterior end approximately 814 ± 62 (770–858), and body width measured at the level of excretory pore approximately 398 ± 46 (365–431). Posterior end ventrally curved in spiral with a well-developed caudal alae, ornamented with an irregular, linear texture (Figs. 1l and 4b). Cloacal aperture at 641 ± 116 (479–755) from posterior extremity. Body width measured at the cloaca level approximately 595 ± 146 (456–801).

The 21 total caudal papillae are four pairs of pedunculated papillae organized laterally at the caudal alae, three pre-cloacal papillae organized rectilinear arrangement and five pairs of post-cloacal papillae (Figs. 1l and 4a, b), with the following distribution: two pairs of papillae immediately after the cloaca in rectilinear arrangement and slightly internal in the cloacal opening; the third pair located below, with a perpendicular orientation; and the fourth and fifth pairs arranged in an equidistant, parallel arrangement near the caudal end (Figs. 1l and 4b). Presence of a pair of phasmids located between the fourth and fifth pairs of post-cloacal papillae (Figs. 1l and 4b). Spicules sub-equal in size and different in shape, with the left one slightly larger than the right one, measuring 379 ± 65 (323–451) and 372 ± 22 (339–385), respectively (Figs. 1k and 4d). Left spicule with a dilation at the final third, measuring 45.9 wide, with a slightly curved end. Right spicule with constant width measuring 34.3, with a sharp end and a curve slightly more pronounced than the left spicule (Figs. 1k and 4d). Spicules ratio:body total length of approximately 1:0.02. Right spicule with a striated sheath in its upper third (Fig. 4c). Gubernaculum gondola-shaped (Figs. 1j and 4c).

Table 1 Morphometry, in micrometers, of males of the species of the genus *Physaloptera* Rudolphi 1819, parasite of rodents

Characteristics	*Physaloptera goytaca* n. sp.	*P. galvaoi*[5] São Luiz et al. 2015	*P. calnuensis*[6] Sutton, 1989	*P. hyspida*[7] Schell, 1950	*P. bispiculata*[8] Vaz and Pereira, 1935	*P. murisbrasiliensis*[9] Diesing, 1860	*P. longispicula*[10] Quentin, 1968	*P.* aduensis[11] Baylis, 1928
Body total length	19,000–27,000	10,000–23,000	17,100	30,000–42,000	25,000	22,000–28,000	34,400	9000–14,000
Body width	800–1200	800–900	610	900–1400	800	870–950	1400	650–800
Muscular esophagus length	390–610	460–580	330	560–730	500	–	600	–
Glandular esophagus length	2400–3600	3000–3740	2990	3700–4500	3200	–	5300	–
Nerve ring[1]	420–640	200–430	340–410	550–700	–	–	500	–
Excretory pore[1]	770–860	520–950	800	870–1200	–	–	830	–
Cloaca[2]	480–750	280–610	580	–	870	–	1900	–
Rigth spicule	340–380	190–230	310	390–550	400	400	710	320–540
RSp/BL[3]	1.60%	1.29%	1.81%	1.57%	1.6%	1.6%	2.06%	–
Left spicule	320–450	230–280	420	230–280	460	400	850	800–1700
LSp/BL[4]	1.63%	1.13%	2.45%	1.27%	1.84%	1.6%	2.47%	–
Host	*Cerradomys goytaca*	*Cerradomys subflavus*	*Abrothrix olivaceus*	*Sigmodon hispidus*	*Nectomys squamipes*	*Mus brasiliensis*	*Cercomys cunicularius*	*Hybomys univittatus*

[1] Distance from anterior end

[2] Distance from posterior end

[3] RSp/BL, ratio of right spicule—body total length

[4] LSp/BL, ratio of left spicule—body total length

[5] São Luiz et al. (2015)

[6] Sutton (1989)

[7] Schell (1950)

[8] Vaz and Pereira (1935)

[9] Morgan (1943); Vicente et al. (1997)

[10] Vicente et al. (1997); São Luiz et al. (2015)

[11] Baylis (1928)

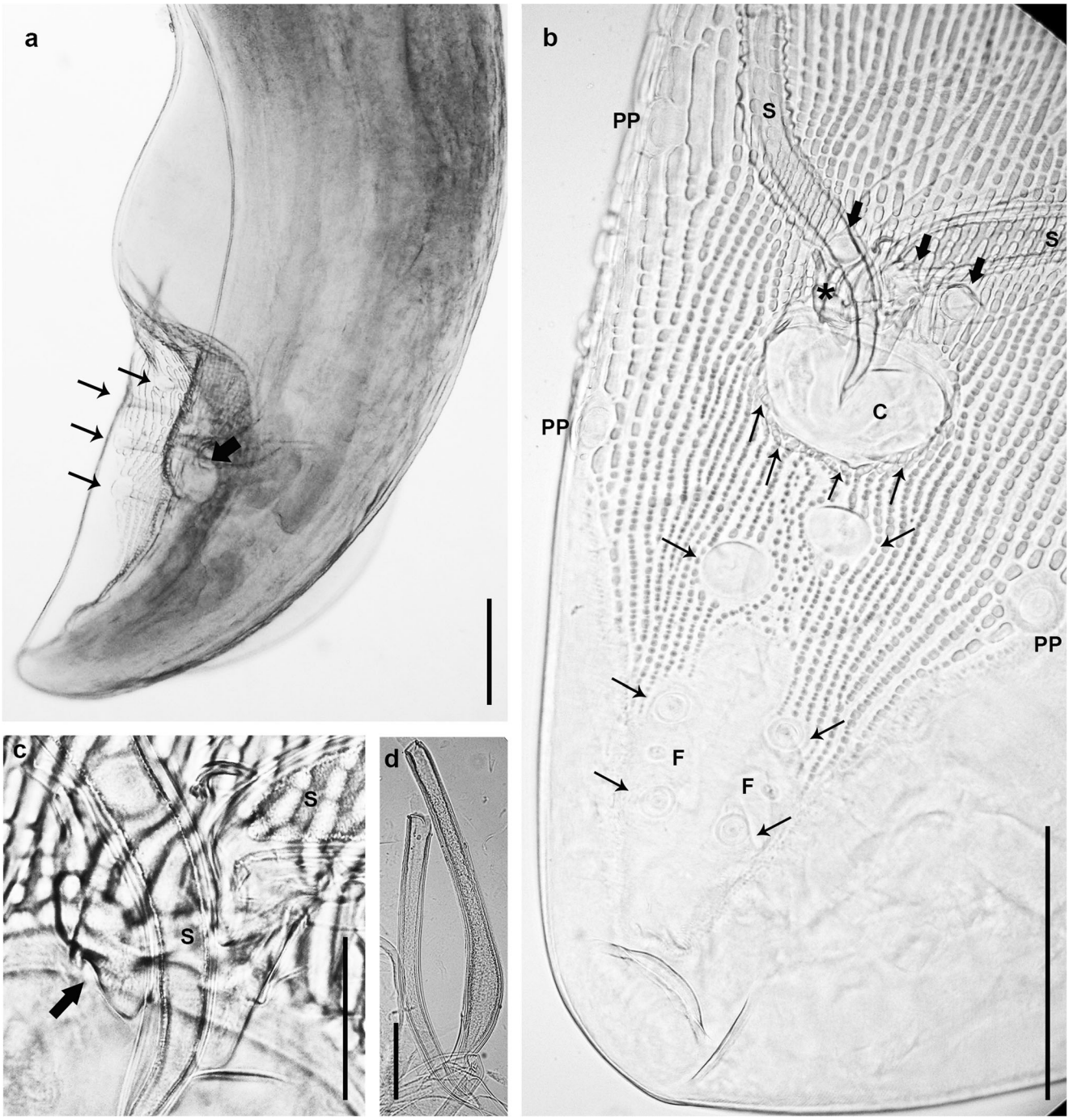


Fig. 4 Light micrography of males of *Physaloptera goytaca* n. sp. parasite of *Cerradomys goytaca* Tavares, Pessôa & Guimarães, 2011 (Rodentia, Cricetidae). **a** Tail in lateral view, with pedunculated papillae (thin arrows) and cloacal opening (thick arrow). Bar 200 μm. **b** Tail in ventral view, with pre-cloacal papillae (thick arrows) and post-cloacal papillae (thin arrows), pedunculated papillae (PP), cloacal opening (C), spicules (S), and phasmids (F). Bar 200 μm. **c** Gubernaculum (thick arrow) and spicules (S). Bar 50 μm. **d** Spicules. Bar 100 μm

Females

Females larger than males (Table 2), with a body total length approximately 43,043 ± 15,311.1 (25,902–58,166), and a major body width measured at the median region of the body approximately 1388 ± 370 (997–1848). Distance from the cephalic collarette to the anterior extremity approximately 98 ± 33.6 (61–161), and body width measured at the level of the cephalic collarette approximately 208 ± 67.5 (131–298). Pharynx measured 93 ± 24.5 (72–137) deep by 75 ± 30 (43–119) wide. Muscular esophagus measured 525 ± 137 (369–665) long by 163 ± 55.1 (94–234) at the level of the nerve ring; glandular esophagus approximately 4702 ± 1611 (3192–7323) long by 504 ± 76.9 (402–602) wide, measured

Table 2 Morphometry, in micrometers, of females of the species of the genus *Physaloptera* Rudolphi 1819, parasite of rodents

Characteristics	*Physaloptera goytaca* n. sp.	*P. galvaoi*[3] São Luiz et al. 2015	*P. calnuensis*[4] Sutton, 1989	*P. hyspida*[5] Schell, 1950	*P. bispiculata*[6] Vaz and Pereira, 1935	*P. murisbrasiliensis*[7] Diesing, 1860	*P. longispicula*[8] Quentin, 1968	*P. aduensis*[9] Baylis, 1928
Body total length	25,900–58,170	16,400–31,300	28,070	53,000–64,000	27,000–55,000	35,000–43,000	15,280–30,410	13,000–20,000
Body width	990–1850	1100–3180	990	1900–2000	1000–1900	1100–1750	400–570	800–1200
Muscular esophagus length	370–660	420–710	390	640–690	540–700	–	250–400	–
Glandular esophagus length	3200–7300	1270–4140	3320	5000–7000	3800–5400	–	2700–3760	–
Nerve ring[1]	350–770	200–280	380	710–740	–	–	260–400	–
Excretory pore[1]	590–1520	680–1660	780	840–1080	1.200	–	360–560	–
Vulva[1]	7200–19,080	6420–11,140	12,280	11,000–16,000	460	–	9350–19,460	–
Anus[2]	410–800	430–500	520	–	–	–	220–610	–
Eggs	50 × 20	50 × 30	39 × 19	52 × 23	50 × 36	45 × 26	56 × 35	60 × 40
Uterine branches	5	4–5	–	2	2	2	–	6–7
Hospedeiro	*Cerradomys goytaca*	*Cerradomys subflavus*	*Abrothrix olivaceus*	*Sigmodon hispidus*	*Nectomys squamipes*	*Mus brasiliensis*	*Cercomys cunicularius*	*Hybomys univittatus*

[1] Distance from anterior end

[2] Distance from posterior end

[3] São Luiz et al. (2015)

[4] Sutton (1989)

[5] Schell (1950)

[6] Vaz and Pereira (1935)

[7] Morgan (1943); Vicente et al. (1997)

[8] Vicente et al. (1997); São Luiz et al. (2015)

[9] Baylis (1928)

at the posterior region. Ratio of esophagus total length by body total length approximately 1:0.12. Esophageal cap measured 15 ± 5.9 (10–23) thickness (Figs. 1a and 3a). Distance from the nerve ring to the anterior end approximately 570 ± 172 (350–774), and body diameter at the level of nerve ring approximately 634 ± 194.5 (450–954). Distance from the excretory pore to the anterior end approximately 1052 ± 412 (586–1522), and body diameter at the level of the excretory pore approximately 671 ± 182.8 (482–932).

The uteri have five branches (Figs. 1d and 3d). The uterine loops occupy a large part of the body, filled with eggs (Figs. 1g and 3g). Muscular vagina, with total length of difficult observation (Figs. 1g and 3g). Vulva with prominent small lips, which open in a transverse slit (Figs. 1h and 3e), in the anterior third of the body at 14,008 ± 5691.4 (7187–19,079) from the anterior end. Diameter of the body at the level of the vulva approximately 1322 ± 337.3 (948–1709). Anus near the posterior end, with a transverse opening (Figs. 1e, f and 3f) at 617 ± 158.7 (415–806) from the posterior end. Body width measured at the level of anus approximately 584 ± 133.6 (426–745). Eggs are small (Fig. 3h), measuring 46 ± 2.3 (41–52) long by 25 ± 2.4 (22–29) wide.

Discussion

The nematodes collected from *C. goytaca* were identified as *Physaloptera* according to the characteristics described by Yamaguti (1961) and Yorke and Maplestone (1969) as follows: thick cuticle with striations; the presence of two triangular, well-developed pseudolabia, each with teeth on the free edge and cephalic papillae; the presence of a cephalic collarette; a cervical papillae posterior to the nerve ring; males with an ornamented caudal alae connected ventrally, anterior to the cloaca; 21 caudal papillae, including four pedunculated and 13 sessile pairs (seven surrounding the cloaca and three at tail); spicules sub-equal in size and with different in shape; and females with the vulva located on the anterior third of the body and five uterine branches. However, a more recent key for identification, as described by Chabaud (1975), considered the genus *Physaloptera* to include species with two to four uterine branches; species with more than four uterine branches were placed in the genus *Turgida*. However, the species included in the genus *Turgida* presented more uterine branches, ranging from 9 to 14 (TRAVASSOS 1920). São Luiz et al. (2015) recently described a new species of the *Physaloptera* parasite of the stomach of *Cerradomys subflavus*, an endemic rodent from the State of São Paulo, Minas Gerais, Bahia, and Goiás (Brazil). That species, *P. galvaoi* São Luiz et al. (2015), has four to five uterine branches, similar to that observed in *P. goytaca* n. sp. described herein. In addition, both species have three internal lateral teeth, forming a tripartite structure and a triangular external lateral tooth and a pair of papillae in each pseudolabia. However, *P. galvaoi* has two pairs of small external lateral teeth, located in the cuticular fold on each side of the pseudolabia, for a total of four small teeth. These characters were not observed in *P. goytaca* n. sp. in the light and scanning electron microscopy. In addition, *P. goytaca* n. sp. differs from *P. galvaoi* by the pattern of the fourth pair of post-cloacal papillae. In *P. goytaca* n. sp., this pair of papillae has a parallel arrangement and is equidistant to the fifth pair (Fig. 1l), whereas these papillae are organized in an inclined pattern in *P. galvaoi*, which means that the left one is superior to the right one. The pattern of the other papillae is similar in both species, as are the location of the phasmids and the presence of a circular structure with a button shape (SÃO LUIZ et al. 2015).

Physaloptera goytaca n. sp. differs from the other species reported from rodents, mainly in the number of uterine branches. *Physaloptera bispiculata* Vaz and Pereira, 1955, *P. murisbrasilliensis* (Diesing, 1861), *P. longispicula* Quentin, 1968, and *P. hispida* Schell, 1950, have two uterine branches (ORTLEPP 1922; VAZ and PEREIRA 1935; MORGAN 1943; SCHELL 1950; SUTTON 1989; VICENTE et al. 1997; SÃO LUIZ et al. 2015), while the uteri of *P. aduensis* Baylis, 1928, divide into three primary branches. Ultimately, each primary branch subdivides in two secondary branches, for a total of six uterine branches. In one specimen of this species, the author noted that one of the three primary branches subdivided into three secondary branches (seven branches in total) (BAYLIS 1928). Thus, in *P. aduensis*, the females have six to seven uterine branches, distinguishing them from *P. goytaca* n. sp. in both the quantity (five) and pattern of the uterine branches.

Among the species of the genus *Physaloptera* that infect rodents with more than four uterine branches, *P. goytaca* n. sp. stands out due to its higher total body length (Tables 1 and 2), with *P. aduensis* being the smallest species (males 9000–14,000; females 13,000–20,000) (BAYLIS 1928) and *P. goytaca* n. sp. being the largest (males 19,000–27,000; females 25,900–58,170). Another characteristic that distinguishes these species is the length of the spicules (Table 1). In *P. goytaca* n. sp., the difference in the spicule length (right and left) was discreet (right 340–380, left 320–450), but in the other two parasites of rodents, which had similar numbers of uterine branches, the lengths of the spicules were considerably different in both *P. galvaoi* (right 190–230, left 230–280) and *P. aduensis*; in the latter species, the maximum value of the smallest spicule did not reach the smallest value of the largest spicule (right 320–540; left 800–7700) (BAYLIS 1928; SÃO LUIZ et al. 2015).

The maximum body width described by São Luiz et al. (2015) for *P. galvaoi* females was considerably higher (1110–3180) than those observed for *P. goytaca* n. sp. (990–

1850). However, this characteristic is not reliable for distinguishing the species. The egg size of *P. aduensis* is larger than that observed for other species (Table 2). Another difference observed in the morphometry among the species of *Physaloptera* rodent parasites was the length of the muscular esophagus of the females of *P. galvaoi*. Although the females of this species are smaller than those of *P. goytaca* n. sp., the maximum value of the muscular esophagus of *P. galvaoi* is higher (710) than that observed in *P. goytaca* n. sp. (660). A similar fact was observed in the morphometry of the glandular esophagus of the males of *P. galvaoi*, where the maximum value for this structure was slightly higher (3740) than that observed in *P. goytaca* n. sp. (3600). However, it is emphasized that *P. goytaca* n. sp. has an average total body length that is greater than that of *P. galvaoi* (Tables 1 and 2). Moreover, *P. galvaoi* has two extra small teeth, which is not observed in the new species described in the present study (SÃO LUIZ et al. 2015).

In Brazil, four species of *Physaloptera* have been described: *P. murisbrasiliensis* which parasitizes *Mus brasiliensis* (MORGAN 1943); *P. bispiculata* from the Cricetid *Nectomys squamipes* (MORGAN 1943; GOMES et al. 2003); *P. longispicula* from the rodent *Thrichomys apereoides* (SUTTON 1989; SÃO LUIZ et al. 2015); and *P. galvaoi*, which is found in *C. subflavus* (SÃO LUIZ et al. 2015). This last species, although it infects a congeneric rodent, inhabits different biomes, including *C. subflavus* in the cerrado and *C. goytaca* in sandplain.

Thus, morphological, morphometric, and ultrastructural analyses of characteristics such as the number and pattern of the uterine branches, the pattern of the fourth pair of postcloacal papillae, the spicule length, the absence of small external lateral teeth in the cuticular fold of the pseudolabia, and the body total length allow us to distinguish the nematodes collected from *C. goytaca* from other species that have been reported to parasitize rodents. In this manner, the description of a new species of *P. goytaca* n. sp. that parasitizes the stomach of *C. goytaca* is justified. In addition, this is the first report of nematodes parasitizing *C. goytaca*.

References

Amato JFR, Boeger WA, Amato SB (1991) Protocolos para laboratório: coleta e processamento de parasitos de pescado. Imprensa Universitária da Universidade Federal Rural do Rio de Janeiro, Seropédica

Baylis HA (1928) On a collection of nematodes from Nigerian mammals (chiefly rodents). Parasitol Camb 20:280–304

Chabaud AG (1975) Key to the genera of the Physalopteroidea. In: Anderson RC, Chabaud AG, Willmott S (Eds) (2009) Keys to the nematode parasites of vertebrates, Commonwealth Agricultural Bureau, UK, pp 12–16

D'elía G, Mora I, Myers P, Owen RD (2008) New and noteworthy records of Rodentia (Erethizontidae, Sciuridae, and Cricetidae) from Paraguay. Zootaxa 1784:39–57

Ederli NB, Bonadiman SF, Neto AHAM, DaMatta RA, Santos CP (2008) Mixed infection by *Libyostrongylus douglassii* and *L. dentatus* (Nematoda: Trichostrongylidae) in Struthio camelus (Ratites: Struthioniformes) from Brazil with further morphological characterization of adults. Vet Parasitol 151:227–232

Gomes DC, Vicente JJ (1984) Helmintos de *Nectomys squamipes* (Brants) do município de Sumidouro, RJ. Mem Inst Oswaldo Cruz 79:67–73

Gomes DC, Cruz RP, Vicente JJ, Pinto RM (2003) Nematode parasites of marsupials and small rodents from the Brazilian Atlantic forest in the state of Rio de Janeiro, Brazil. Rev Bras Zool 20:699–707

Morgan BB (1943) The *Physaloptera* (Nematoda) of rodents. Wasmann Collect 5:99–107

Oliveira LC, Oliveira FCR, Ederli NB (2017) Description of a new species *Fuhrmannetta jurubatensis* n. sp. (Cestoda, Davaineidae) from *Cerradomys goytaca* Tavares, Pessôa & Gonçalves, 2011 (Rodentia, Cricetidae). J Helminthol 4:1–6

Ortlepp RJ (1922) The nematode genus Physaloptera Rud. Proc Zool Soc Lond 92:999–1107

Percequillo AR, Hingst-Zaher E, Bonvicino CR (2008) Systematic review of genus Sigmodontinae: Oryzomyini, with description of two new species from eastern Brazil. Am Mus Novit 3622:1–46

São Luiz J, Simões RO, Torres EL, Barbosa HS, Santos JN, Giese EG, Rocha FL, Júnior AM (2015) A new species of *Physaloptera* (Nematoda: Physalopteridae) from *Cerradomys subflavus* (Rodentia: Sigmodontinae) in the Cerrado biome, Brazil. Neotrop Helminthol 9:301–312

Schell SC (1950) A new species of Physaloptera (Nematoda: Spiruroidea) from the cotton rat. J Parasitol 36:423–425

Sutton CA (1989) Contribution to the knowledge of Argentina's parasitological fauna. XVII Spirurida (Nematoda) from neotropical Cricetidae: *Physaloptera calnuensis* n sp and *Protospirura numidica criceticola* Quentin, Karimi and Rodriguez de Almeida. Bull Mus Natl Hist Nat 4:61–67

Tavares WC, Pessoa LM, Gonçalves PR (2011) New species of *Cerradomys* spp from coastal sandy plains of southeastern Brazil (Cricetidae: Sigmodontinae). J Mammal 92:645–658

Travassos L (1920) Contribuição para o conhecimento da fauna helmintológica brasileira. Mem Inst Oswaldo Cruz 12:73–77

Vaz Z, Pereira C (1935) Some new Brazilian nematodes. Trans Am Microsc Soc 54:36–40

Veciana M, Chaisiri K, Morand S, Miquel J, Ribas A (2013) A new biogeographical and morphological information on *Physaloptera ngoci* Le-van-Hoa, 1961 (Nematoda: Physalopteridae) in Southeast Asia rodents. Parasite 20:1–5

Vicente JJ, Rodrigues HO, Gomes DC, Pinto RM (1997) Nematóides do Brasil. Parte V. Nematóides de mamíferos. Rev Bras Zool 14:1–452

Weksler M, Percequillo AR, Voss RS (2006) Ten new genera of Oryzomyine rodents (Cricetidae, rodents). Am Mus Nat Hist 3537:1–29

Yamaguti S (1961) Systema Helminthum, the nematodes of vertebrates part. I. Intersci Publ 3:1–679

Yorke W, Maplestone PA (1969) The nematode parasites of vertebrates. Hafner Publishing Company, New York and London