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FIRST REPORT OF *TAENIA MUSTELAE* (EUCESTODA, TAENIIDAE) PARASITIZING THE BUSHY-TAILED OLINGO, *BASSARICYON GABBII* (CARNIVORA, PROCYONIDAE) IN SOUTH AMERICA WITH AN UPDATED CHECKLIST OF CESTODES FROM OTHER AMERICAN PROCYONID HOSTS

PRIMER REPORTE DE *TAENIA MUSTELAE* (EUCESTODA, TAENIIDAE) PARASITANDO LA CHOSNA PERICOTE, *BASSARYCION GABBII* (CARNIVORA, PROCIONYDAE), EN SUD AMÉRICA CON UNA LISTA ACTUALIZADA DE CESTODOS DE OTROS HOSPEDEROS PROCIÓNIDOS AMERICANOS

Roberto Magalhães Pinto[1,2*]; Marcelo Knoff [1]; Alessandra Queiroga Gonçalves [3,4]; Magda Sanches[5]; Dely Noronha[1]

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Resumen

Se describe el primer caso de infección natural por el cestodo *Taenia mustelae* en un ejemplar del prociónido chosna pericote, *Bassaricyon gabbii*, procedente de la localidad de Barcelos, Estado do Amazonas, Brasil. Un inventario de 15 especies de cestodos parásitos de otros hospederos prociónidos en las Américas entre 1958 y 2009 es incluido, con la finalidad de actualizar datos anteriores. En el período considerado, no hay registros en México y países de América Central. Esta es la primera citación de *T. mustelae* en América del Sur y *B. gabbii*, es un nuevo hospedero para esta especie de cestodo.

Palabras clave: Amazonas - Américas - *Bassaricyon gabbii* - Cestodos - Chosna pericote - Floresta húmeda - Infección natural - Procyonidae - *Taenia mustelae*

Abstract

The first case of a natural helminth infection with the cestode *Taenia mustelae* in a specimen of the procyonid *Bassarycion gabbii*, the bushy-tailed olingo, from the municipality of Barcelos, State of Amazonas, Brazil is reported here. A checklist of 15 cestode species parasitizing other procyonid hosts in the Americas, between 1958 and 2009 is included in order to update previous data. In the considered period there are no records in Mexico and Central America countries. This is the first report of *T. mustelae* in South America and *B. gabbii* is a new host record for this cestode species.

Key words: Amazonas - Americas - *Taenia mustelae* - Bushy-tailed olingo - Cestodes - Natural infection - Procyonidae - Rain forest - *Bassaricyon gabbii*

[1] Laboratório de Helmintos Parasitos de Vertebrados, Instituto Oswaldo Cruz. Av. Brasil, 4365, 21040-900 Rio de Janeiro, Rio de Janeiro, Brasil.
[2] Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) Research Fellow.
[3] Laboratório de Doenças Parasitárias, Instituto Oswaldo Cruz, Rio de Jsneiro, Brasil.
[4] Instituto Leonidas e Maria Deane, Fiocruz, Manaus, Amazonas, Brasil.
[5] Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) fellow.

INTRODUCTION

The bushy-tailed olingos (*Bassaricyon gabbii* Allen, 1876), have a restricted geographical distribution, since they are typically found from Nicaragua to Bolivia, where they are locally abundant in the latter locality although sparsely distributed in the western Amazon basin. The bushy-tailed olingo, is found in evergreen forests, and on forest edges; they prefer the upper canopy of the forest and are rarely seen on the ground. Specimens of *B. gabbii* are nocturnal and arboreal animals, found alone or in groups of six, at the most, feeding together in large fruit trees. Usually, they avoid kinkajous [*Potos flavus* (Schreber, 1774)], since the closely related kinkajous will chase them out of trees. Because they are nocturnal, olingos do not compete directly with most primates and feed on fruits, nectar, flowers, insects, and small vertebrates. They are primarily frugivores but actively hunt warm-blooded animals. Five species of the genus *Bassaricyon* Allen, 1876, are currently recognized by most authorities. However, some think that these five species should be demoted to the rank of subspecies of a single species. Natives of the Amazon consider the olingos dangerous and kill them on sight (Nowak, 1999; Kays, 2000; Pontes & Chivers, 2002). Natural infections with ecto and endoparasites of the olingo, *B. gabbii* are very few and restricted to the thick *Ixodes rubidus* Neumann, 1901 and the protozoan *Leishmania brasiliensis panamensis Lainson* & Shaw, 1972, both referred in Panama (Wenzel, 1996, Christensen *et al*. 1983). Considering the peculiar geographical distribution, behavioral, ecological approaches and feeding habits of the olingos the present report of the first natural helminth infection in an Amazonian specimen of *B. gabbii* with *Taenia mustelae* Gmelin, 1790, adds important new data to the biology of this poorly known endangered group of hosts.

MATERIAL AND METHODS

A single cestode worm was recovered from the small intestine of one specimen of the olingo, *Bassaricyon gabbii* Allen, 1876, killed on March, 10, 2001, in the settlement Sitio da Mamãe, Japomeri waterway, Padauiri River, Barcelos municipality, (00°20'51"N, 64°00'28"W), Amazonas, Brazil. The olingo was shot by a local hunter and immediately after, transferred to one of the authors (A.Q.G.) to be investigated for helminths during an official fieldwork. The animal was identified and deposited in the National Museum of Rio de Janeiro, Brazil, after the carcass was prepared by taxidermists. Worm briefly rinsed alive in a 0.85% NaCl solution, was fixed in hot AFA (70º GL ethanol, 93%; formaldehyde, 5%; glacial acetic acid, 2%) and stored as wet material in the same solution. The cestode was further dehydrated in an ethanol series, stained with Langeron's carmine clarified in phenol and preserved as whole mount in Canada balsam. Classification of the host follows Novack (1999) and that of the cestode, is in accordance with Khalil *et al*. (1994) and Loos-Frank (2000). Figures were obtained with a drawing tube connected to a bright-field BX41 Olympus microscope. Measurements are in micrometers (µm) unless otherwise indicated. Shooting and necropsy of the host specimen were authorized by the IBAMA (Instituto Brasileiro de Meio Ambiente e Recursos Renováveis) [Brazilian Institute of Environment and Renewable Resources], Brazil, process nº 02001.002659/97-02, permits nº 056/2000 – DIFAS/DIREC (validity 01/04/00 to 01/04/01) and nº 012/2002-COEFA (validity 22/01/02 to 22/04/02). NHR and NGD refer to New Host Record and New Geographical Distribution, respectively. The cestode was deposited in the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC), Rio de Janeiro, Brazil.

RESULTS

Taenia mustelae Gmelin, 1790 (= *T. tenuicollis* Rudolphi, 1819)

(Figs. 1-3)

Description based on one adult, mounted and measured specimen. Strobila 8.11 mm long, with numerous proglottids, wider than longer, largest proglottid 175.1 long, 333.6 wide. Scolex 260 long, 360 wide, with 56 hooks in two rows of 28 hooks each. Large hooks 22.5-23.7 (23.4) long, 22.5 (22.5) wide (base); small hooks 18.7-20 (19.7) long, 18.7-20 (19.4) wide (base). Rostellum everted 97.5 long, widest at the level of rostellar hooks, 97.5-107.5 long. Rostellum receptacle 172.5 long, 100 wide. Suckers 92.5-95 (93.7) long, 90- 92.5 (91.2) wide.

Mature proglottids, 58.4-175.1 (132.2) long**,** 191.8-333.6 (132.2-260.3) wide. Large, protruding, irregularly alternating genital cones (pores) containing the conspicuous genital atrium at the lateral margin of mature proglottids, anterior to the middle portion. Testes rounded, extending to the middle of the ovary until the anterior margin of the proglottid 80-120 in number, 8.3-16.7 (12.5) in diameter. Cirrus pouch (in mature proglottids), 83.4-120 (104.7) long, 25-41.7 (41.3) wide. Ovary bilobed, of similar size, at posterior region of proglottid. Vitellaria imediatelly posterior to the ovary. Vagina opening posterior to the cirrus pouch; no vaginal sphincter before genital atrium. Uterus saccular, elongate. Gravid proglottids absent.

Taxonomic summary
Host: *Bassaricyon gabbii* (NHR).
Site of infection: intestine.
Locality: Sítio da Mamãe, Japomeri waterway, Padauiri River, Barcelos, Amazonas, Brazil, South America **(**NGD).
Specimen deposited: CHIOC n. 37.227 (whole mount).
The following data on cestodes infecting other procyonid hosts in the Americas complement those of Yamaguti (1959). Parasites appear in alphabetical order followed by host (s), locality (ies) and bibliographical reference (s).
Atriotaenia procyonis (Chandler, 1942) Gallati, 1956 (= *Oochoristica procyonis* Chandler, 1942), *Procyon lotor* (L., 1758), Arkansas, South Dakota, Florida, Illinois, Georgia, Kentucky, North Carolina, Kansas, Ohio, South Carolina, Tennessee, Texas, Virginia, U.S.A., (Gallati, 1959; Jordan & Hayes, 1959; Harkema & Miller, 1964; Boddicker & Progulske, 1968; Barnstable & Dyer, 1974; Bafundo *et al*., 1980; Schaffer *et al*., 1981; Smith *et al*., 1985; Snyder & Fitzgerald, 1985; Cole & Shoop 1987; Robel *et al*., 1989; Richardson *et al*., 1992; Kelley & Norman 2008; Kresta *et al*., 2009), *Procyon lotor hirtus* Nelson & Goldman, 1930, Saskatchewan, Canada (Hoberg & McGee, 1982), *Procyon lotor litoreus* Nelson & Goldman, 1930, St. Catherines Island, Georgia, U.S.A., (Price & Harman, 1983), raccoon [unindentified], Georgia, U.S.A (Babero & Shepperson, 1958); *Atriotaenia sandgroundi* (Baer, 1935), *Nasua nasua* (L., 1758), Brazil (Vieira *et al*. 2008); Cestoda (unindentified), *Procyon lotor*, Maryland and other states (not named), U.S.A (Clark & Herman, 1959), Metropolitan Toronto Zoo, Canada (Cranfield *et al*., 1984); *Diphyllobothrium trinitatis* (Cameron, 1936), *Procyon cancrivorus* (G. Cuvier, 1798), São Paulo, Brazil (Vieira *et al*., 2008); *Diphyllobothrium* sp., *Procyon cancrivorus*, Argentina, Rio de Janeiro, Brazil (Martinez *et al*., 2000, Vieira *et al*., 2008); *Mesocestoides lineatus* (Goeze, 1782) Railliet, 1893, raccoon [unidentified], Georgia, U.S.A (Babero & Shepperson, 1958); *Mesocestoides variabilis* Mueller, 1927, *Procyon lotor*, Florida, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Texas, Virginia, Illinois, U.S.A (Harkema & Miller, 1964; Bafundo *et al*., 1980; Schaffer *et al*., 1981; Smith *et al*., 1985; Cole & Shoop, 1987; Birch *et al*., 1994); *Mesocestoides* spp., *Procyon lotor*, *Bassariscus astutus* (Lichtenstein, 1830) Coues, 1887, Arkansas, Illinois, Kansas, Texas, U.S.A (Boddicker & Progulske, 1968; Pence & Willis, 1978; Snyder & Fitzgerald, 1985; Robel *et al*., 1989; Richardson *et al*., 1992; Kelley & Horner, 2008); Procercoid (unidentified), *Procyon lotor*, British Columbia, Canada, (Ching *et al*., 2000), Spargana (*Spirometra mansonoides*), *Procyon lotor*, Florida, Texas, Virginia, U.S.A (Schaffer *et al*., 1981), *Spirometra mansonoides* (Mueller, 1935), *Procyon lotor*, Florida, U.S.A (Harkema & Miller, 1964); *Taenia crassipora* Rudolphi, 1819, *Nasua nasua*, Brazil (Vieira *et al*., 2008); *Taenia martis* (Zeder, 1803) Wahl, 1967, *Bassariscus astutus*, Texas, U.S.A. (Pence & Willis, 1978); *Taenia pencei* Rausch, 2003, *Bassariscus astutus*, Texas, U.S.A (Raush, 2003); *Taenia pisiformis* Bloch, 1780, *Procyon lotor*, Texas, U.S.A (Kelley & Horner, 2008), *Taenia taeniformis* (Batsch, 1786) Wolffügel, 1911 [=*Hydatigera taeniformis* (Batsch, 1786) Lamark, 1816], *Procyon l. lotor*, South Dakota, U.S.A (Boddicker & Progulske, 1968).

DISCUSSION

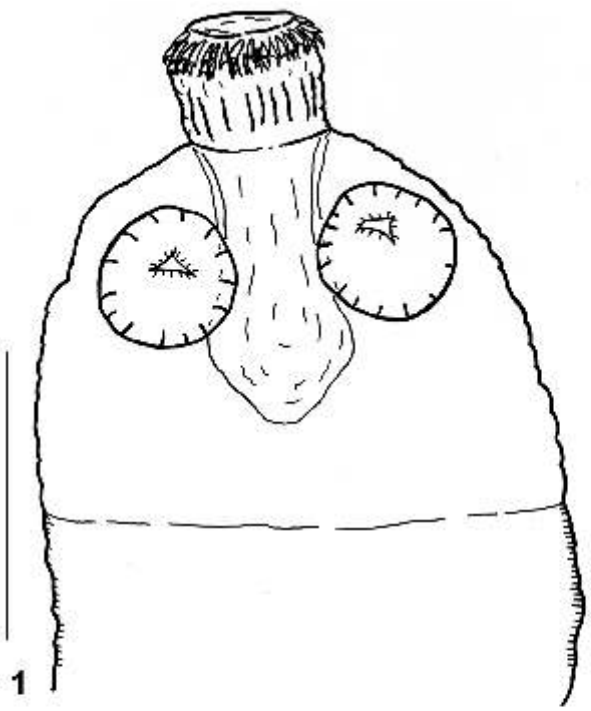
Overstreet (1970) in a study of the nematode *Baylisascaris procyonis* (Stefánsky and Zarkowiski, 1951) from the Colombian kinkajou (*P. flavus*) refers to the parasitism of a specimen of *B. gabbii* with a single worm of *B. procyonis* with no information related to the geographical location of the host and the nature of the infection with the statement that "…A single male worm, identical to those from the kinkajou, was obtained from a bushy-tailed olingo, *B. gabbii*, after it was fed infective eggs from the worms of the kinkajou. It is not known if this infection was natural or

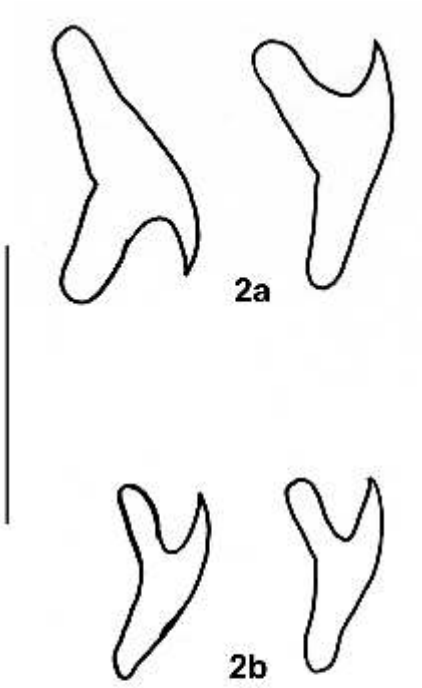
experimental." Kazacos (2001) referring to *B. procyonis* and related species only reproduces data after Overstreet (1970) in a table, with no further comments. Thus, taking these facts into account and also considering the impossibility to check and enlighten those previous data, it is to be assumed that the first confirmed natural helminth infection represented by the cestode *T. mustelae* in the bushy-tailed olingo is reported now. The early attempt to catalogue cestodes infecting vertebrate hosts in Brazil was that of Travassos (1965); these species had already been referred by Yamaguti (1959) and those reported in wild carnivore mammals from Brazil were recently surveyed by Vieira *et al*. (2008). In the present paper, data on cestode species recovered from Procyonidae hosts in the Americas is updated. Most of the references in the checklist are related to cestodes parasitizing specimens of raccoons (*P. lotor*) in the U.S.A. and, interestingly, the animals, except for those from South Dakota (Boddicker & Proglske, 1968), were captured in states sharing common or close political borders, namely Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Kentucky, Ohio, Illinois, Tennessee, Kansas, Arkansas, and Texas, thus explaining the occurrence of the same cestode species in these neighboring areas. It was suggested that the low diversity of the helminth fauna as well as the low worm burdens recovered from raccoons in Canada were due to unsuitable conditions affecting the life cycles of helminths that commonly parasite specimens of these hosts elsewhere (Hoberg & McGee, 1982). Miller (1992) summarized the literature on helminths occurring in specimens of *P. lotor* in the southeastern United States, presenting a dichotomous key to some common forms in that area. Briefly, in the present survey of 28 cases related to cestode infections occurring in procyonid hosts in the Americas, specimens of *P. lotor* (subspecies not considered) appeared in 20 cases (16 in the U.S.A, 04 in Canada), *P. cancrivorus* in 03 (02 in Brazil, 01 in Argentina), *B. astutus* in 02 (U.S.A), *N. nasua* in 02 (Brazil), and raccoons (unidentified) in 01 (U.S.A). In the period that has been taken into account (51 years), there are no records of cestodes parasitizing procyonids in Mexico as well as in Central America countries.

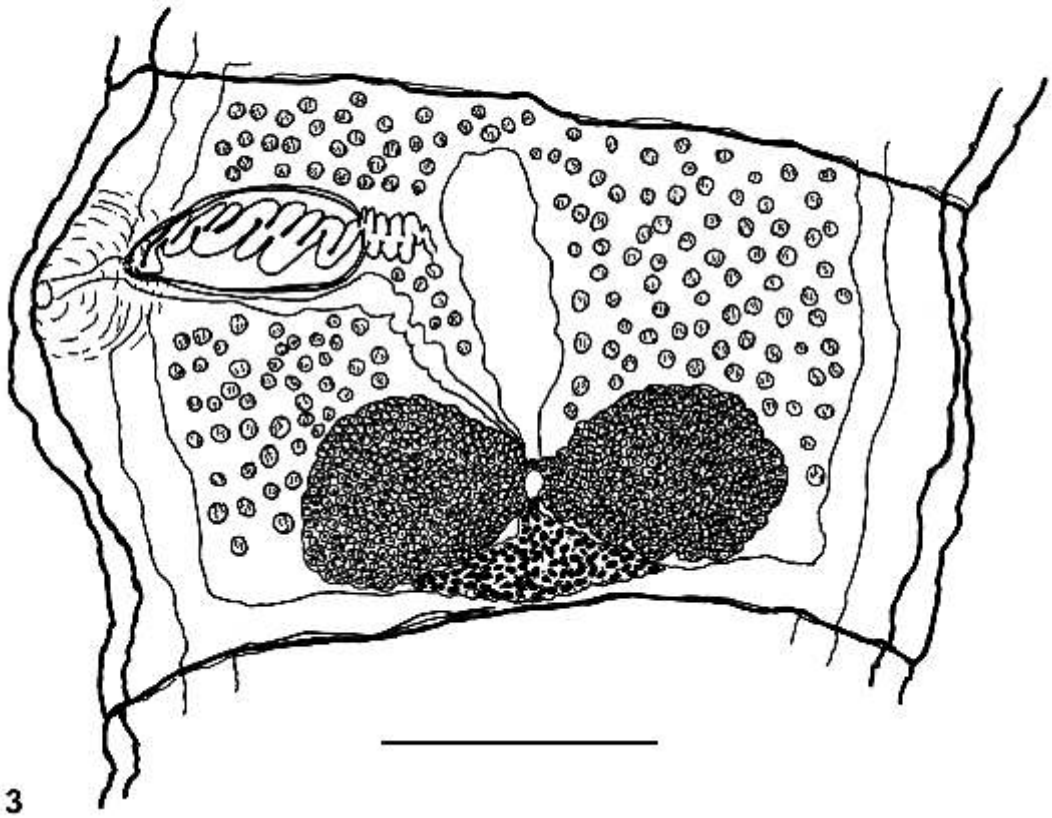
The life-cycle of *T. mustelae* was previously studied and several definitive and intermediate hosts from Europe, North America and Japan have been reported. The former are represented by species of the genera *Martes* Pinel, 1792 and *Mustela* Linnaeus, 1758 whereas the latter by a wide range of rodents and lagomorphs (Freeman, 1956, Dollfus 1961, Iwaki *et al*., 1996, Loos-Frank, 2000). Mustelids occurring in the Brazilian Amazon, are represented by the Amazon weasel *Mustela africana* Desmarest, the tayara *Eira barbara* (L.), the grison *Galictis vitatta* (Schreber), the river otter *Lontra longicaudis* (Olfers) and the giant otter *Pteronura brasiliensis* (Gmelin). Considering that olingos feed on small vertebrates (Kays, 2000) it is to be supposed that they ingest some small rodents that can act as intermediate hosts for *T. mustelae*.

Taking into account that mainly in the last three decades unauthorized necropsies of wild animals are strongly discouraged worldwide, it seems more likely that *T. mustelae* so far investigated may be infecting other South American hosts; nevertheless, under the above circumstances, these occurrences have probably remained unreported to date.

Morphological data on the specimen studied here are in agreement with previous descriptions of this species, mainly considering the number, and length of the large and small rostellar hooks that in the present studied sample was of 56, 22.5-23.7 and 18.7-20, respectively, when compared to early data on other specimens of *T. mustelae*, with referred values of 22-74, 12-38 and 12-38, respectively; dimensions of internal structures of male and female apparatus were also taken into consideration for the proper specific identification (Verster, 1969; Loos-Frank, 2000). Although small variations related to the diameter of testes and smaller width of cirrus pouches were observed in our single specimen devoid of gravid proglottids, the species was easily identified to *T. mustelae* that is referred for the first time in South America and in a new host. Specimens of *T. mustelae* are the only to share rostelar hooks of this size, since *Taenia brachiachanta* Baer & Fain, 1951, parasitizing the mustelid *Poecilogale albinucha* (Gray, 1864) [White naped weasel], from the Republic of South Africa, although presenting rostellar hooks with similar dimensions is to be regarded as a junior synonym or a subspecies of *T. mustelae* in accordance with Verster.







*Taenia mustela*e. **Figure 1**. Scolex, ventral view. **Figure 2.** Rostellar larger hooks (a), smaller hooks (b). **Figure 3**. Mature proglottid, ventral view. Bar = 200 in Figure 1, 25 in Figure 2 (a-b), 100 in Figure 3.

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*Correspondence to author:

Roberto Magalhães Pinto
Laboratório de Helmintos Parasitos de Vertebrados,
Instituto Oswaldo Cruz. Av. Brasil, 4365, 21040-900
Rio de Janeiro, Rio de Janeiro, Brasil

E-mail: rmpinto@ioc.fiocruz.br
Telefax: 55 (21) 2562-1511