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MONOGENOIDEANS PARASITIZING *RHAPHIODON VULPINUS* SPIX & AGASSIZ, 1829 (CHARACIFORMES: CYNODONTIDAE) FROM LAKES BAIXIO AND CATALÃO, AMAZONAS, BRAZIL

MONOGENÓIDEOS PARASITANDO *RHAPHIODON VULPINUS* (CHARACIFORMES: CYNODONTIDAE) PROVENIENTES DE LOS LAGOS BAIXIO Y CATALÃO, AMAZONAS, BRASIL

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ABSTRACT

Rhaphiodon vulpinus Spix & Agassiz, 1829 is a neotropical fish species that inhabits lakes and rivers throughout the Orinoco, Amazonas and Prata basins, and rivers of the Atlantic slopes of the Guianas. Up to now in the Neotropical region, only one species of Monogenoidea is known from this fish. The present study aims to identify the monogenoideans that parasitize *R. vulpinus* collected in two floodplain lakes. Twelve specimens of *R. vulpinus* were captured and examined from Lake Baixio and 32 specimens from Lake Catalão, both located in the township of Iranduba, Amazonas, Brazil. Two species of Monogenoidea were identified: *Notozothecium lamotheargumedoi* Cohen & Kohn, 2008 infecting the gills and *Rhinoxenus piranhus* Kritsky, Boeger & Thatcher, 1988 infecting the nostrils. *Notozothecium lamotheargumedoi* is reported for the second time in *R. vulpinus*, while *R. piranhus* is cited for the first time in a cynodontid species, increasing the number of known hosts for this parasite.

Keywords: floodplain lakes – gills – nostrils – *Notozothecium lamotheargumedoi* – *Rhinoxenus piranhus*

RESUMEN

Rhaphiodon vulpinus Spix & Agassiz, 1829, es una especie de pez neotropical que habita lagos y ríos de las vacías del Orinoco, Amazonas y Prata, y en ríos de los declives atlánticos de las Guayanas. Hasta ahora en la región Neotropical, sólo una espécie de Monogenoidea es conocida para esta especie de pez. El presente estudio pretende identificar las especies de monogenóideos que parasitan *R. vulpinus* colectados en dos lagos inundables. Doce especímenes de *R. vulpinus* provenientes del lago Baixio y 32 especímenes del lago Catalão, localizados en el município de Iranduba, Amazonas, Brasil, fueron capturados y examinados. Dos especies de monogenóideos fueron identificadas: *Notozothecium lamotheargumedoi* Cohen & Kohn, 2008 infectando las branquias y *Rhinoxenus piranhus* Kritsky, Boeger & Thatcher, 1988 en las fosas nasales *Notozothecium lamotheargumedoi* es citado por segunda vez en *R. vulpinus*, mientras que, *R. piranhus* es citada por primera vez en una especie de cynodontídeo, aumentando el número de hospederos conocidos para este parásito

Palabras clave: branquias – fosas nasales – lagos – *Notozothecium lamotheargumedoi* – *Rhinoxenus piranhus*

INTRODUCTION

Cynodontidae comprises 13 species grouped into two subfamilies: Cynodontinae with the genera *Cynodon* Agassiz, 1829; *Hydrolycus* Cuvier, 1819; *Rhaphiodon* Spix & Agassiz, 1829 and Roestinae with the genera *Gilbertolus* (Steindachner, 1878), and *Roestes* (Kner, 1858) (Lucena & Menezes, 1998). Cynodontines inhabit rivers, lakes, and flooded forests in all water types, throughout the Orinoco, Amazonas and Prata basins, and in rivers of the Atlantic slopes of the Guianas (Toledo-Piza, 2000).

Rhaphiodon vulpinus Spix & Agassiz, 1829 is a neotropical fish species identified by the oblique mouth, large canine teeth and relatively long pectoral fins (Lucena & Menezes, 1998). In lakes, adults are caught in open areas and in the flooded forest. Young specimens are caught in the aquatic vegetation (Saint-Paul *et al*. 2000). It is a pelagic and migratory fish, with diurnal habit, piscivorous, hunting in shoals and predates its prey swallowing it whole (Pouilly *et al*., 2004).

The class Monogenoidea is very diverse in number of species, morphology and ecology (Poulin & Valtonen 2002). Monogenoideans are found parasitizing the skin, outer and inner organs of several aquatic vertebrates, and they are well known by their high host and infestation site's specificity (Poulin, 1992).

For cynodontines, Domingues & Boeger (2005) reported undetermined species of *Rhinoxenus* from *Hydrolicus scomberoides* (Cuvier, 1819) and posteriorly, Cohen & Kohn (2008) described *Notozothecium lamoarthogumedoi* from the gills of *R. vulpinus* collected in different localities of the Paraná River, State of Paraná, Brazil, being the only monogenoidean known for cynodontids. The last report from a monogenoidean parasitizing a cynodontid was made by Kohn *et al.* (2011) who reported an undetermined species from *R. vulpinus* collected in the reservoir of the Hydroelectric Power Station of Itaipu, Paraná, Brazil.

During an investigation in two Amazon floodplain lakes, two species of Monogenoidea were recorded from the gills and nostrils of the cynodontid freshwater fish *R. vulpinus*.

MATERIAL AND METHODS

Between March and December 2013, 12 *R. vulpinus* (Fig. 1) were captured in Lake Baixio (03^{0}17'27, 2"S/ 60^{0}04'29,6"W) in the township of Iranduba, and between March and July 2016, 32 *R. vulpinus* were captured in Lake Catalão (3^{0}10'04"S/ 59^{0}54'45"W), also in Iranduba, Amazonas, Brazil.

Fish were caught using 100 mm between adjacent nodes-meshed, 20 m long x 2 m high gillnets.

Posteriorly, fishes were quickly immersed in 75 mg clove oil·L^{-1} solution and euthanized following the recommendations of the Ethics and Animal Welfare Committee (CONCEA, 2013). In the field, fishes were measured and weighed and posteriorly gills and nostrils were removed and preserved in formalin 5% for posterior analyses at the laboratory of Fish Parasitology (LPP) in the National Institute of Amazonian Research (INPA).

For morphological studies, the parasites were mounted in Grey and Wess medium (Amato *et al.,* 1991). Taxonomical identification was according to Cohen & Kohn (2008) and Kritsky *et al.* (1988). Voucher specimens were deposited in the Crustacean Collection of the National Institute of Amazon Research (INPA), Manaus, AM, Brazil (INPA – 643 and 644). The ecological terms in parasitology follow Bush *et al.* (1997).

RESULTS

Notozothecium lamotheargumedoi (Fig. 2) was found parasitizing the gills of *R. vulpinus* collected in both lakes, while *Rhinoxenus piranhus* (Fig. 3) was found in the nostrils from specimens collected only in the Lake Baixio. The highest parasitic levels were registered for *N. lamotheargumedoi* (Table 1).

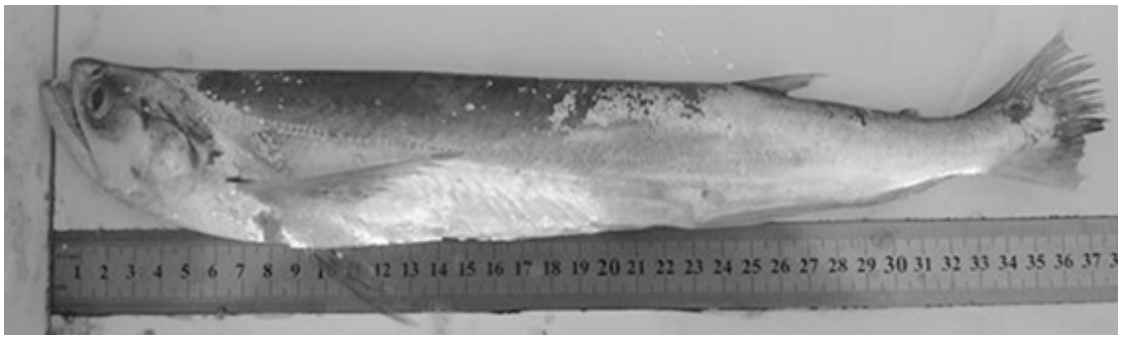

Figure 1. Lateral view of *Raphiodon vulpinus* Spix & Agassiz, 1829 collected in Amazon floodplain lakes

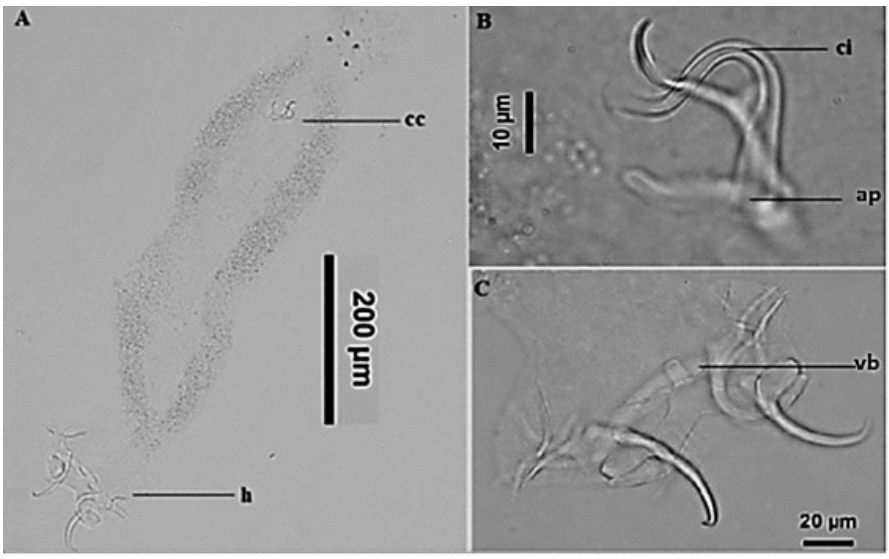

Figure 2. A. Total body of *Notozothecium lamotheargumedoi* Cohen & Kohn, 2008 collected from *Rhaphiodon vulpinus* Spix & Agassiz, 1829. cc = copulatory complex, B. male copulatory complex. ci = cirrus, ap = accessory piece. C. Haptor. vb = ventral bar.

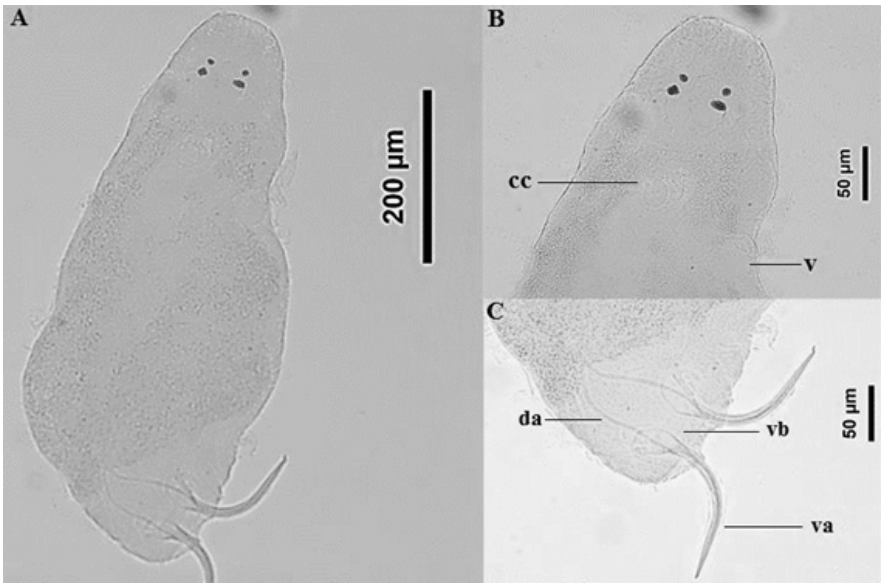

Figure 3. A. total body of *Rhinoxenus piranhus* Kritsky, Boeger & Thatcher, 1988 collected from *Rhaphiodon vulpinus* Spix & Agassiz, 1829. B. anterior part. cc = copulatory complex, v = vagine, C. Haptor. da = dorsal anchor, va = ventral anchor, vb = ventral bar.

Table 1. Parasitic indexes of the Monogenean parasite species in *Rhaphiodon vulpinus* Spix & Agassiz, 1829 collected in Amazon floodplain lakes. N = number of examined fish, Ni = number of infected fish, P% = prevalence, I = intensity of infection, mI = mean intensity of infection, mA = mean abundance.

Species	Lake	N	Ni	P%	I	mI	mA
Notozothecium lamotheargumedoi	Baixio	12	6	50	1090	181.66	90.83
	Catalão	32	32	100	1372	42.88	42.88
Rhinoxenus piranhus	Baixio	12	3	25	10	3.33	0.83

DISCUSSION

Notozothecium species were reported only for Characiformes (Characidae and Serrasalmidae) (Cohen *et al.,* 2013). *Notozothecium lamotheargumedoi* seems to be very specific and was only cited for *R. vulpinus* (Cohen & Kohn, 2008) being the only species of *Notozothecium* reported for a species of Cynodontidae. In the present study, *N. lamotheargumedoi* is reported for the second time in *R. vulpinus*, expanding its geographic distribution to the state of Amazonas.

If a parasitic species infects a host belonging to a small family, the probability of a close coevolution between the parasite and the host species will be greater than if the host belongs to a larger family in which the colonization of a new host will be more frequent (Poulin, 1992). This is probably the case of *N. lamotheargumedoi* which parasitizes *R. vulpinus,* a fish from a small family in which the coevolutionary processes may be stronger, resulting in high parasite-host specificity.

The chemical composition of fish skin is well known to be species-specific. Initial contact between the adhesive areas of oncomiracidium

larvae and host epidermis may contribute to the interaction of the sensory organs of the parasite with the specific chemicals of the host epidermis and the recognition between those components and the adherents secreted by monogeneans (Whittington *et al.,* 2000). The occurrence of *N. lamotheargumedoi* only in *R. vulpinus* is a clear example of host-specificity, where apparently exists a specialized communication between both organisms, which allows this parasite species recognize and parasitize this fish.

Rhinoxenus spp. were recorded parasitizing the nostrils of some Anostomidae, Bryconidae, Prochilodontidae and Triportheidae species (Eiras *et al.,* 2010; Moreira *et al.,* 2017). *R. piranhus* was registered only on Serrasalmidae species in three different countries. In Brazil, it was cited on *Pygocentrus nattereri* Kner, 1858 and *Serrasalmus altuvei* Ramírez, 1965 (Kritsky *et al.,* 1988; Vital *et al.,* 2011; Morais *et al*., 2012), in French Guiana on *P. nattereri* and *S. spilopleura* Kner, 1858 (Domingues & Boeger, 2005) and in Peru on *P. nattereri* (Iannacone & Luque, 1993; Luque *et al*., 2016). In the present study *R. piranhus* is recorded for the first time in the nostrils of a Cynodontidae especies, increasing the number of known hosts for this parasite.

The high values in the parasitic indexes of *N. lamotheargumedoi* indicate its efficiency on the transmission of new individuals and the colonization of the gills of *R. vulpinus.* Lentic environments such as the Lake Baixio and Catalão, facilitate the life cycle of this parasites, influencing positively in the abundance of specimens that parasitize the gills of this fish. In contrast, *R. piranhus* seems to be less efficient. This could be, because the nostrils are smaller than the gills, so the space of colonization is reduced.

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