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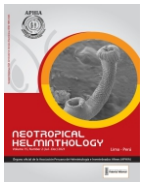

RESEARCH NOTE / NOTA CIENTÍFICA

IDENTIFICATION OF PARASITIC FAUNA IN FISHES OF THE PERICUMÃ RIVER BASIN IN THE STATE OF MARANHÃO, BRAZIL

IDENTIFICACIÓN DE LA FAUNA PARASITARIA EN PECES DE LA BACIA DEL RIO PERICUMÃ EM EL ESTADO DE MARANHÃO, BRASIL

Márcia Mirella Silva Mello[1]; Carine Almeida Miranda Bezerra[2]; Diego Carvalho Viana[3] & Danilo Francisco Corrêa Lopes[1*]

[1]Universidade Federal do Maranhão, Pinheiro, Maranhão, Brazil.
[2]Universidade Estadual do Maranhão, São Luís, Maranhão, Brazil.
[3]Núcleo de Estudos Morfofisiológicos Avançados (NEMO), Universidade Estadual da Região Tocantina do Maranhão (UEMASUL), Imperatriz, MA, Brazil.
*Corresponding author: danilo.correa@ufma.br
Márcia Mirella Silva Mello: https://orcid.org/0000-0001-6521-9175
Carine Almeida Miranda Bezerra: https://orcid.org/0000-0003-4842-1595
Diego Carvalho Viana: https://orcid.org/0000-0002-3302-9892
Danilo Francisco Corrêa Lopes: https://orcid.org/0000-0001-8711-3881

ABSTRACT

Between March and July 2019, 11 fish belonging to the species *Cichlasoma zarskei* Ottoni, 2011 (Acará), *Serrasalmus aff. rhombeus* Linnaeus, 1766 (Piranha), *Trachelyopterus galeatus* Linnaeus, 1766 (Bagrinho) and *Hoplias malabaricus* Bloch, 1794 (Traíra) in the Pericumã river basin, Maranhão, Brazil were evaluated. Stomach, intestine and eye samples were taken for parasite analysis. Parasites belonging to the groups were identified: nematodes, genus *Contracaecum* sp.; Cystacanth of acantocephala; and larva of cestoda. In this research it was possible to report new associations in the host-parasite relationship, such as the first record of the genus *Contracaecum* sp. in the species *C. zarskei*, a parasite that presents zoonotic potential when infected raw or undercooked fish is consumed. The knowledge about the parasitofauna of the fish community in the Pericumã river basin, Maranhão, Brazil is expanded through this study, with the registration of new species of helminths described for the region.

Keywords: Brazil - *Contracaecum* – Endoparasite – Maranhão – Nematoides – Zoonoses

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RESUMEN

Entre marzo y julio de 2019, 11 peces pertenecientes a las especies *Cichlasoma zarskei* Ottoni, 2011 (Acará), *Serrasalmus aff. rhombeus* Linnaeus, 1766 (Piranha), *Trachelyopterus galeatus* Linnaeus, 1766 (Bagrinho) y *Hoplias malabaricus* Bloch, 1794 (Traíra) en la cuenca del río Pericumã, Maranhão, Brasil fueron evaluados. Se tomaron muestras de estómago, intestino y ojos para el análisis de parásitos. Se identificaron parásitos pertenecientes a los grupos: nematodos, género *Contracaecum* sp.; cistiacanto de acantocéfalo, y larva de céstoda. En esta investigación fue posible reportar nuevas asociaciones en la relación huésped-parásito, como el primer registro del género *Contracaecum* sp. en la especie *C. zarskei*, parásito que presenta potencial zoonótico cuando se consume pescado infectado crudo o con poca cocción. El conocimiento sobre la parasitofauna de la comunidad de peces en la cuenca del río Pericumã, Maranhão, Brasil se amplía a través de este estudio, con el registro de nuevas especies de helmintos descritos para la región.

Palavras-Chave: Brasil – *Contracaecum* – Endoparásito – Maranhão – Nematodes – Zoonosis

INTRODUCTION

Brazil has a large variety of fish species, accounting for approximately 20% of all freshwater fishes in the world and 55% of freshwater fishes in the neotropical region. The country has a greater diversity of families of endemic freshwater fishes compared to families of marine fishes, with an estimated 2600 to 3100 species belonging to families that only inhabit freshwater environments (Reis *et al*., 2003; Buckup *et al*., 2007; Froese & Pauly, 2019). In the state of Maranhão (northeast region of Brazil), studies have addressed the parasitism of fishes in natural and artificial (farms) environments, but few studies conducted in the state have investigated the parasite-host relationship and associated diseases in fishes (Bezerra *et al*., 2020; Nascimento *et al*., 2021). In the region known as the Maranhense Lowlands in the state of Maranhão, fishes are part of the diet of the population and many local communities depend on the production and sale of catches as the principal means of supporting the family, demonstrating the economic importance of the activity (Bernadi, 2005). In this context, parasites of these fishes can cause high mortality rates, reducing the size of the landings and the commercial value of the catch (Bastos-Gomes *et al*., 2017).

Despite the importance of fishing activities and the occurrence of parasites of fishes of economic interest, few investigations have addressed the parasitic fauna of freshwater fishes in the region of the Maranhense Lowlands (Rodrigues *et al*., 2017). Thus, studies on the ecology, morphology and zoonotic potential of fish parasites are needed.

The aim of the present study was to characterize the parasitic fauna of the species *Cichlasoma zarskei* Ottoni, 2011, *Serrasalmus aff. rhombeus* Linnaeus, 1766, *Trachelyopterus galeatus* Linnaeus, 1766 and *Hoplias malabaricus* Bloch, 1794 from the Pericumã River in the Maranhense Lowlands, state of Maranhão, Brazil.

MATERIAL AND METHODS

This study was conducted in the main channel of the Pericumã River in the state of Maranhão, Brazil, at three points where artisanal fishing is performed: Cachoeira – P1 (coordinates: 2°41'13.15" S 45°7'14.78" W); Juçareira – P2 (2°30'28.22" S 45°4'26.04" W); and Comporta – P3 (2°27'53.08" S 45°1'56.38" W). A total of 81 individuals were acquired from local fishermen between March and July 2019. The individuals were packed in ice and sent to the Environmental Chemistry Lab (AMBIO) of the Fishery Engineering Department of Universidade Federal do Maranhão (UFMA), Pinheiro campus, where data were collected from each individual on total length (TL), standard length (SL) and total weight (WT). The project received authorization from the SISBIO Authorization and Information System in Biodiversity (process number: 58236). Parasites were collected using the method established by

Eiras *et al*. (2006). Each fish was submitted to necropsy for the analysis of the viscera, eyes and gastrointestinal tract at a total of four infection sites: eyes, stomach, intestine and mesentery. Helminths were transferred to Petri dishes for fixation according to the different techniques employed for each group and studied under a light microscope.

Nematodes were fixed in 70% ethyl alcohol for the relaxation of the specimens and conserved in the same solution, whereas acanthocephalans were fixed in 70% ethyl alcohol. Cestodes were placed in Petri dishes with water and maintained refrigerated for 24 hours for the relaxation of the scolex and extroversion of the tentacles. The specimens were subsequently sent for identification at the Morphophysiology Laboratory of the State University of the Tocantina Region of Maranhão, Brazil. Cestodes were transferred to 70% ethyl alcohol, stained with alcoholic hydrochloric acid-carmine, dehydrated in an increasing series of ethyl alcohol (70%, 80%, 90% and absolute), cleared with phenol and Faia's creosote or methyl salicylate and mounted on slides with Canada balsam. Nematodes were cleared in phenol and mounted on slides for examination (Pavanelli *et al*., 2008). Acanthocephalans were stained with Meyer's paracarmine for a variable time until impregnation of the dye, differentiated in 2% hydrochloric acid for the removal of excess dye, dehydrated in an increasing ethyl alcohol series (70%, 80%, 90% and absolute for 30 minutes each), diaphanized in increasing concentrations of clove oil (10%, 50% and 100%) for a variable time and mounted on slides with Canada balsam (Oliveira, 2019). The taxonomic organization and identification of the helminths was performed using taxonomic keys and specific original works for each parasite, following Campbell & Beveridge (1994) and Palm (1999) for Cestoda, Moravec (1998) for Nematoda and other studies on taxonomy on the specific level for the other parasites. The specimens studied were deposited in the 'Coleção Helmintológica do Instituto Oswaldo Cruz (CHIOC 39718; CHIOC 39719; CHIOC 39173; CHIOC 39174; CHIOC 39175; CHIOC 39176; CHIOC 39177; CHIOC 39178).

Ethical aspects

This investigation was subject to ethical norms that facilitated the minimization of possible harm to the specimens, breeding grounds and technical personnel involved in the identification of the samples to generate new knowledge without violating established ethical principles for these cases. All the authors involved in the investigation, publication and dissemination of the results are responsible for the reliability and accuracy of the data (DHAMM, 2013).

RESULTS AND DISCUSSION

Twenty-nine tissues were analyzed, including stomachs, intestines, celomatic cavity and eyes, of the following species: *C. zarskei*, *S. aff. rhombeus*, *T. galeatus* and *H. malabaricus* (Table 1). These species were chosen due to their economic importance and abundance in the region, as they are commonly sold and consumed by the local population.

Table 1. List of helminths and infection sites of endoparasites of fishes collected from Pericumã River, state of Maranhão, Brazil.

Host	Parasite	Infection site
Cichlasoma zarskei	*Contracaecum* sp. larva (N=1)	Mesentery
Trachelyopterus galeatus	*Contracaecum* sp. larva (N=1) Cestoda larva (N=1)	Mesentery
Hoplias malabaricus	*Contracaecum* sp. larva (N=4)	Mesentery
Serrasalmus aff. rhombeus	*Contracaecum* sp. larva (N=1)	Intestine
	Capillaridae gen. sp. fam (N=2)	Intestine
	Acanthocephala, Cystacanth (N=1)	Stomach

Among the helminths analyzed in the present study, *Contracaecum* sp. was found in seven of the eleven samples, which may be associated with the low parasitic specificity of this nematode (Gonçalves *et al*., 2016). In a previous study, Oliveira (2019) also found that *Contracaecum* sp. was abundant among all host species, found in the mesentery and intestinal lumen of the fish species *Serrasalmus spilopleura* Kner, 1858, *H. malabaricus*, *Cichla monoculus* Spix, 1831 and *Serrasalmus rhombeus* Linnaeus, 1766 caught in the lower stretch of the Jari River in the state of Amapá. Rodrigues *et al*. (2017) reported a higher mean intensity, dominance coefficient and coefficient of variation for the genus *Contracaecum* located in the mesentery of *H. malabaricus* collected from open markets and directly from fishermen in the city of São Bento, which is located in the microregion of the Maranhense Lowlands.

Numerous variables can determine the existence of endoparasites, especially infecting forms, which are obtained directly through the diet of the host (Mesquita *et al.,* 2011; Tavares-Dias *et al*., 2013). Indeed, the diet of fishes can be inferred by parasites disseminated in this manner. The fishes of the present study occupy an intermediate position in the trophic chain, serving as food for birds and piscivorous aquatic mammals, which then become the definitive hosts of species of *Contracaecum* (Neves *et al*., 2013; Bittencourt *et al*., 2014; Tavares-Dias *et al*., 2014). *Contracaecum* sp. depreciates the catch and, when affecting young fishes, the larvae can cause death or invade the heart region, cause changes to the stomach wall and compromise the musculature (Germano & Germano, 2008).

In the present study, *Serrasalmus aff. rhombeus* presented parasitic variety. This may have been influenced by the trophic level of this fish, as carnivorous fishes can become infected with different nematoid larvae when feeding on previously infested smaller fishes and are therefore more prone to infections by *Contracaecum* sp. (Benigno *et al*., 2012; Meneguetti *et al*., 2013; Alcantara *et al*., 2015; Gonçalves *et al*., 2016). Moreover, taking into consideration that most endoparasites are related to a specific ecological niche and diet, a high diversity of parasitic fauna in a host specific indicates a varied diet of another host. Therefore, this variety of parasitic species suggests that the host population consumed a diversity of prey items in the habitat (Neves *et al*., 2013; Tavares-Dias *et al*., 2013; Bittencourt *et al*., 2014; Tavares-Dias *et al*., 2014).

Adult capillariids (females containing eggs) were found in the stomach of *Serrasalmus aff. rhombeus*, suggesting that this fish species may be considered the definitive host. However, the lifecycle of capillariids has not yet been fully clarified (Pereira *et al.*, 2020; Pelligra *et al*., 2020). According to Moravec (1994), these organisms have a direct lifecycle, but there is the possibility of having intermediate hosts, such as annelids or crustaceans. Capillariids can be found in the digestive tube or several other organs of fishes. Specimens of the family Capillariidae were found in the stomach and intestine of freshwater fishes in studies conducted in the São Francisco River in the state of Minas Gerais and floodplain lakes in the state of Amazonas, respectively (Morais, 2011). Some capillariids are pathogenic and have the capacity for accentuated infection that can cause the death of the host (Moravec, 1994; Moravec, 1998).

A representative of the phylum Acanthocephala was found in only one individual, parasitizing *Serrasalmus aff. rhombeus*. The specimen was found in the cystacanth (infecting larval) stage and, thus, its classification could not be determined. Paratenic hosts may also be part of the life cycle of acanthocephalans by feeding on an intermediate host that is not part of the diet of the definitive host and are then consumed by the definitive host, thereby completing the cycle. However, some fishes tend to be infected accidentally when feeding on organisms that harbor cystacanths (Eiras *et al*., 1995; Goater *et al.,* 2014).

Regarding the cestoid larva found in the stomach of *T. galeatus*, this may be considered its intermediate or paratenic host. In the carrier, more serious harm can be found when the parasites use more efficient attachment structures, which can cause significant harm to the host intestine and high infection intensities can cause intestinal occlusion, which can lead to the death of the host (Pavanelli *et al*., 2008).

There is a certain absence of cases of zoonoses

transmitted by fishes in the Amazon region of the state of Maranhão. However, this scenario is directly influenced by the insufficiency of reports of this type of parasitosis. Indeed, there is a need to improve the networks of data on parasitic diseases from water bodies so that tropical diseases do not continue being omitted (Corrêa & Pinheiro, 2017). Further studies involving molecular biology are needed to broaden knowledge on the parasite community of fishes of the Pericumã River.

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Competing Interests
The authors declare no conflicts of interest regarding the publication of this paper.

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