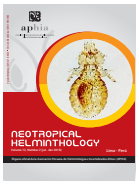
ISSN Versión impresa 2218-6425 ISSN Versión Electrónica 1995-1043

Neotropical Helminthology, 2018, 12(2), jul-dic:141-146.

aphia
ASOCIACIÓN PERUANA DE HELMINTOLOGÍA E INVERTEBRADOS AFINES

Neotropical Helminthology



ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

METAZOAN PARASITES OF *SERRASALMUS ALTISPINIS* (SERRASALMIDAE) FROM FLOODPLAIN LAKES OF THE BRAZILIAN AMAZON

METAZOÁRIOS PARÁSITOS DE *SERRASALMUS ALTISPINIS* (SERRASALMIDAE) DE LAGOS INUNDABLES DE LA AMAZONÍA BRASILEÑA

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ABSTRACT

This work describes the parasitic fauna of *Serrasalmus altispinis* Merckx, Jégu and Santos, 2000 caught in floodplain lakes of the Brazilian Amazon. All parasite species reported represent first records for this host. The studied lakes were: Baixio, Preto, São Tomé, Ananá, Araçá and Maracá, located between the cities of Manaus and Coari in Central Amazonia. Sixty *S. altispinis* were collected and examined in March, June, September, and December 2013. Thirty-six species belonging to Monogenoidea, Digenea, Nematoda, Copepoda, Branchiura and Isopoda were identified. Parasitological indices obtained in this study indicate that the community of endoparasites of *S. altispinis* is characterized by low prevalence, low number of individuals and low number of species. In contrast, ectoparasites presented higher prevalence and higher number of individuals and species.

Keywords: Amazon – ectoparasites – endoparasites – parasitological indices – piranha – *Serrasalmus altispinis*

RESUMEN

Este trabajo describe la fauna parasitaria de *Serrasalmus altispinis* Merckx, Jégu y Santos, 2000 provenientes de lagos inundables de la Amazonía brasileña. Todas las especies identificadas representan los primeros registros para este hospedero. Los lagos estudiados fueron: Baixio, Preto, São Tomé, Ananá, Araçá y Maracá, localizados entre las ciudades de Manaus y Coari en la Amazonía Central. Sesenta *S. altispinis* fueron colectados y examinados durante cuatro expediciones en Marzo, Junio, Septiembre y Diciembre del 2013. Fueron identificadas 36 especies pertenecientes a Monogenoidea, Digenea, Nematoda, Copepoda, Branchiura e Isopoda. Los índices parasitológicos obtenidos en este estudio indican que la comunidad de endoparásitos de *S. altispinis* es caracterizada por baja prevalencia, bajo número de individuos y bajo número de especies. En contraste, los ectoparásitos presentan alta prevalencia y un alto número de individuos y especies.

Palabras clave: Amazonas – ectoparásitos – endoparásitos – índices parasitarios – piraña – *Serrasalmus altispinis*

INTRODUCTION

Within Serralsamidae, *Serrasalmus altispinis* Merckx, Jégu & Santos, 2000, commonly known as "piranha seca" can reach 19 cm and inhabits lakes of white water rivers, being usually captured near to the aquatic vegetation and in flooded forest (Claro-Jr., 2003). According to Claro-Jr. (2003) *S. altispinis* feeds on scales and fins of fishes and can also swallow small fishes and invertebrates.

Taxonomic studies that discover new species, new host and geographical occurrences represent enormous contribution to the knowledge of the biodiversity of a determinate area and constitute a base for other studies in parasitological ecology, environmental impacts, biotic integrity and conservation of ecosystems (Luque & Poulin, 2007). Studies on parasite communities and diversity in fish from the Amazon increase the knowledge of the richness and diversity in this ecosystem.

For *S. altispinis* there is still scarce information on their parasitic fauna. The only records for this species are cited by Oliveira *et al.* (2017) who found the crustaceans *Braga patagonica* Schiodte & Meinert, 1884 on the mouth and *Argulus nattereri* Heller, 1857 on the integument of specimens collected in the state of Amapá, Brazil. The parasitic fauna of *S. altispinis* has been poorly studied. Thus, the objective of the present study was to identify the metazoan parasite fauna of *S. altispinis* collected in different floodplain lakes from the Brazilian Amazon.

MATERIAL AND METHODS

Between March and December 2013, 60 *S. altispinis* (Figure 1) were caught in six floodplain lakes of the Solimões River: Lake Baixio (03°17'27, 2"S/ 60°04'29,6"W) at the city of Iranduba, Lake Preto (03°21'17, 1''S/ 60°37'28,6"W) at Manacapurú; Lake Ananá (03°53'54,8"S/ 61°40'18,4"W) at Anori; Lake Araçá (S03°45' 04,3" S/ 62°21' 25,9" W) at Codajás and Lake Maracá (03°50'32,8''S/ 62°34'32,4"W) at Coari and Lake São Tomé at the the Purus River (03°49' 39,0"S/ 61°25' 24,6" W).

Fish were caught using 100 mm between adjacent nodes-meshed, 20 m long x 2 m high gillnets. Posteriorly the fishes were quickly immersed in 75 mg clove oil·L^{-1} solution and euthanized (CONCEA, 2013). In the field, fishes were measured and weighed. The gills, operculum and fins were examined for the presence of ectoparasites. Gills and nostrils were removed and preserved 5% formalin; the gastrointestinal tract was preserved in 70% ethanol for posterior analyses at the laboratory of Fish Parasitology (LPP) in the National Institute of Amazonian Research (INPA), Manaus, Brazil.

At the laboratory, the parasites found were processed according to Amato *et al.* (1991).

Specimens were studied using a light microscope Zeiss Axioscope 2. Voucher specimens were deposited at the invertebrate collection of the National Institute of Amazon Research (INPA), Manaus, Brazil. The ecological terminology applied to parasites followed Bush *et al.* (1997).

RESULTS

All specimens of *S. altispinis* were parasitized by at least one parasite species. There were found 1,122 specimens of parasites. We identified 36 species, 23 belonging to Monogenoidea, 1 to Digenea, 5 to Nematoda, 4 to Copepoda, 1 to Branchiura and 2 to Isopoda (Table 1).

The highest prevalence of infection was 50% for *Anacanthorus jegui* Van Every & Kritsky, 1992, the highest mean intensity and mean abundance of infection was found for *Amplexibranchius bryconis* Thatcher & Paredes, 1995 (Table 1).

DISCUSSION

In this study *S. altispinis* was parasitized by 23 species of Monogenoidea from eight genera. Species allocated in five of these genera are specific of Serrasalmidae namely: *Amphithecium;*

Table 1. Metazoan parasites in *Serrasalmus altispinis* Merckx, Jégu and Santos, 2000 from Brazilian Amazon floodplain lakes. P% = prevalence, N = number of parasites, mI = mean intensity, mA = mean abundance.

Parasites	Accession Nº	P%	N	mI	mA
MONOGENOIDEA					
Amphithecium diclonophallum Kritsky, Boeger & Jégu, 1997	INPA 622	11.67	12	1.71 ± 1.49	0.20
Amphithecium falcatum Boeger & Kritsky, 1988	INPA 623	36.67	71	3.22 ± 3	1.18
Anacanthorus amazonicus Kritsky & Boeger 1995	INPA 624	13.33	21	2.62 ± 4.20	0.35
Anacanthorus cintus Van Every & Kritsky, 1992	INPA 625	3.33	4	2 ± 1.41	0.07
Anacanthorus cladophallus Van Every & Kritsky, 1992	INPA 626	1.67	1	1	0.02
Anacanthorus crytocaulus Van Every & Kritsky, 1992	INPA 627	3.33	2	1	0.03
Anacanthorus gravihamulatus Van Every & Kritsky, 1992	INPA 628	3.33	2	1	0.03
Anacanthorus jegui Van Every & Kritsky, 1992	INPA 629	50.00	104	3.46 ± 2.99	1.73
Anacanthorus lepyrophallus Kritsky, Boeger & Van Every 1992	INPA 630	21.67	45	3.46 ± 4.99	0.75
Anacanthorus mesocondylus Van Every & Kritsky, 1992	INPA 631	30.00	34	1.88 ± 2.80	0.57
Anacanthorus peryphallus Kritsky, Boeger & Van Every 1992	INPA 632	21.67	21	1.61 ± 0.76	0.35
Anacanthorus prodigiosus Van Every & Kritsky, 1992	INPA 633	15.00	12	1.33 ± 0.70	0.20
Anacanthorus sciponophallus Van Every & Kritsky, 1992	INPA 634	33.33	44	2.2 ± 1.63	0.73
Anacanthorus serrasalmi Van Every & Kritsky, 1992	INPA 635	5.00	4	1.33 ± 0.57	0.07
Ancanthorus sp.	INPA 636	36.67	68	3.04 ± 1.60	1.13
Calpidothecium crescentis Mizelle & Price, 1965	INPA 635	1.67	1	1	0.02
Enallothecium aegidatum Kritsky, Boeger & Jégu, 1998	INPA 636	26.67	54	3.31 ± 1.92	0.90
Myramothecium whittingtoni Kritsky, Boeger & Jégu, 1996	INPA 637	3.33	2	1	0.03
Notothecium cyphophallum Kritsky, Boeger & Jegú, 1998	INPA 638	28.33	71	4.17 ± 5.99	1.18
Notothecium deleastoideum Kritsky, Boeger & Jegú, 1998	INPA 639	38.33	149	6.43 ± 6.05	2.48
Notozothecium euzeti Kritsky, Boeger & Jegú, 1996	INPA 640	1.67	1	1	0.02
Notozothecium minor Boeger & Kritsky, 1988	INPA 641	20.00	16	1.33 ± 0.77	0.27
Rhinoxenus piranhus Kritsky, Boeger & Thatcher, 1988	INPA 642	35.00	78	3.71 ± 4.05	1.30
DIGENEA					
Clinostomum marginatum (Rudolphi, 1819)	INPA 689 a-b	16.67	22	2.2 ± 3.15	0.37
NEMATODA					
Procamallanus (*Spirocamallanus*) *inopinatus* Travassos, Artigas & Pereira, 1928	INPA 79, 80	55.00	48	1.45 ± 1	0.8
Anisakis sp.	INPA 77, 78	11.67	13	1.86 ± 1.9	0.21
Contracaecum sp.	INPA 83	1.67	2	2	0.03
Pseudoproleptus sp.	INPA 82	3.33	6	3	0.1
Philometra nattereri Cárdenas, Moravec, Fernándes & Morais 2011	INPA 81	1.67	1	1 ± 2.82	0.01
COPEPODA					
Amplexibranchius bryconis Thatcher & Paredes, 1995	INPA 2236	35.00	163	7.8 ± 2.82	2.72
Ergasilus jaraquensis Thatcher & Robertson, 1982	INPA 2235	17.00	10	1 ± 0.5	0.17
Gamidactylus jaraquensis Thatcher & Boeger, 1984	INPA 2234	17.00	22	2.2 ± 1.5	0.4
Rhinergasilus piranhus Boeger & Thatcher, 1988	INPA 2233	1.67	1	1	0.02
BRANCHIURA					
Argulus chicomendesi Malta & Varella, 2000	INPA 2231	1.67	1	1	4.4
ISOPODA					
Amphira branchialis Thatcher, 1993	INPA 2229	11.67	14	2	0.23
Vanamea symetrica (Van Name, 1925)	INPA 2230	1.67	1	1	0.02

Figure 1. Lateral view of *Serrasalmus altispinis* Merckx, Jégu and Santos, 2000 captured in floodplain lakes of the Brazilian Amazon.

Calpidothecium; Enallothecium; Myramothecium and *Notothecium*. Three genera are not host specific namely: *Anacanthorus*, which also parasitizes fish species of Characidae and Curimatidae, *Notozothecium* that is also found in Cynodontidae and *Rhinoxenus* that parasitizes Characidae (Braga *et al.,* 2014). All monogenoideans recorded in the present study are first records for *S. altispinis.*

In floodplain lakes from the Brazilian Amazon, *Clinostomum marginatum* was recorded infecting the gills of *Cichla monoculus* Spix & Agassiz, 1831 (Paredio, 2014), in the musculature of *Pygocentrus nattereri* Kner, 1858 (Morais, 2011), and in gills, eyes, intestine and liver of *Acestrorhynchus falcirostris* (Cuvier, 1819) (Dumbo, 2014). In the present study, *C. marginatum* is cited for the first time parasitizing *S. altispinis*. This parasite is capable to parasitize different organs of several fish species in floodplain lakes of the Brazilian Amazon.

In floodplain lakes of the Brazilian Amazon, *Anisakis* sp., *Pseudoproleptus* sp. and *P.* (*S.*) *inopinatus* were found parasitizing the intestine, stomach and liver of *P. nattereri* (Morais, 2011) and *A. falcirostris* (Dumbo, 2014). Morais (2011) cited *Philometra nattereri* parasitizing the eyes of *P. nattereri.* Dumbo (2014) found *Contracaecum* sp. parasitizing the intestine and stomach of *A. falcirostris*. In the present study, all these nematodes are cited for the first time in *S. altispinis*, expanding the number of known hosts for these parasites.

Amplexibranchius bryconis was cited for the first time in Brazil parasitizing the gills of *Potamorhina latior* (Spix & Agassiz, 1829) captured in floodplain lakes of the Brazilian Amazon (Morey *et al.,* 2015). The second record was reported in *A. falcirostris* captured in the same lakes (Dumbo, 2014). In the present study, this copepod species is cited for the third time in Brazil, parasitizing a new host, representing the first record for *S. altispinis*.

Ergasilus jaraquensis was found for the first time parasitizing the gills of *Semaprochilodus insignis* (Jardine, 1841) collected in the River Solimões (Thatcher & Robertson, 1982). In floodplain lakes of the Brazilian Amazon, *E. jaraquensis* was cited parasitizing *P. latior* (Morey *et al.,* 2015). In the

present study, *S. altispinis* is cited as a new host for this parasite species.

In floodplain lakes of the Brazilian Amazon, *Rhinergasilus piranhus* was found in the nostrils of *P. nattereri* (Morais, 2011). According to Varella & Malta (1995), *R. piranhus* is usually found together with *Gamidactylus jaraquensis*. These two copepods were also collected in the nostrils of different fish species from the River Paraná (Lacerda *et al.,* 2008). In the present study, *R. piranhus* and *G. jaraquensis* were found in the nostrils of *S. altispinis,* being new records for this fish.

The branchiuran *Argulus chicomendesi* was found parasitizing the body surface of *P. nattereri* collected in floodplain lakes of the Brazilian Amazon (Morais, 2011). In the present study, only one specimen of *A. chicomendesi* was found in *S. altispinis*. However, it represents the first record of this parasite in this host; it may also be considered as an accidental infestation.

For Serrasalmidae, the isopod *Anphira branchialis* was cited parasitizing *P. nattereri* (Thatcher, 1993; Carvalho *et al.,* 2004; Vital *et al.,* 2011; Morais, 2011; Tavares-Dias *et al.,* 2015), *Serrasalmus spilopleura* Kner, 1858 *Serrasalmus* sp. (Thatcher, 1993; Tavares-Dias *et al.,* 2015). *Vanamea symetrica* was cited parasitizing *S. elongatus* Kner, 1858*, S. rhombeus* (Linnaeus, 1766), *S. spilopleura* and *Serrasalmus* sp. (Thatcher, 1993). In the present study, these two isopods are cited for the first time in *S. altispinis*.

The presence of parasites in larval stage indicates that a fish species is a prey with an intermediate position in the food chain and is an intermediate or paratenic host of one or more parasite species (Bellay *et al.,* 2013, Poulin & Leung 2011). In the present study two endoparasite species were found in adult stage and four were found in larval stage, indicating that *S. altispinis* is a definitive host of *P.* (*S.*) *inopinatus* and *Philometra nattereri* Cardenas, Movarec, Fernandes & Morais, 2012 and intermediate or paratenic host of *C. marginatum, Anisakis* sp, *Contracaecum* sp and *Pseudoproleptus* sp. This fish occupies an intermediate position in the food web, feeding on other organisms and being predated by other vertebrates.

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Received August 9, 2018.
Accepted October 5, 2018.