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 Serrasalmidae, *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. On their 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 Manacapuru; 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 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, ml = mean intensity, mA = mean abundance.

| Parasites                              | Accession N° | P%  | N  | ml ± | mA  |
|----------------------------------------|--------------|-----|----|------|-----|
| **MONOGENOIDEA**                        |              |     |    |      |     |
| Amphithecium diconophallum              | INPA 622     | 11.67 | 12 | 1.71 ± 1.49 | 0.20 |
| Amphithecium falcatum                   | INPA 623     | 36.67 | 71 | 3.22 ± 3 | 1.18 |
| Anacanthorus amazonicus                 | INPA 624     | 13.33 | 21 | 2.62 ± 4.20 | 0.35 |
| Anacanthorus cintus                     | INPA 625     | 3.33  | 4  | 2 ± 1.41 | 0.07 |
| Anacanthorus cladophallum               | INPA 626     | 1.67  | 1  | 0.02  |     |
| Anacanthorus cryptocaulis               | INPA 627     | 3.33  | 2  | 0.03  |     |
| Anacanthorus gravivamulatus             | INPA 628     | 3.33  | 1  | 0.03  |     |
| Anacanthorus jegui                      | INPA 629     | 50.00 | 104| 3.46 ± 2.99 | 1.73 |
| Anacanthorus lepyrophallus              | INPA 630     | 21.67 | 45 | 3.46 ± 4.99 | 0.75 |
| Anacanthorus mesocondylus               | INPA 631     | 30.00 | 34 | 1.88 ± 2.80 | 0.57 |
| Anacanthorus peripherallus              | INPA 632     | 21.67 | 21 | 1.61 ± 0.76 | 0.35 |
| Anacanthorus prodigiosus                | INPA 633     | 15.00 | 12 | 1.33 ± 0.70 | 0.20 |
| Anacanthorus sciponophallus             | INPA 634     | 33.33 | 44 | 2.2 ± 1.63 | 0.73 |
| Anacanthorus serrasalmi                 | INPA 635     | 5.00  | 4  | 1.33 ± 0.57 | 0.07 |
| Anacanthorus sp.                        | INPA 636     | 36.67 | 68 | 3.04 ± 1.60 | 1.13 |
| Calpidothecium crescentis               | INPA 635     | 1.67  | 1  | 0.02  |     |
| Enallothecium aegidatum                 | INPA 636     | 26.67 | 54 | 3.31 ± 1.92 | 0.90 |
| Myramothecium whittingtoni              | INPA 631     | 30.00 | 34 | 1.88 ± 2.80 | 0.57 |
| Notothecium cyphophallum                | INPA 638     | 28.33 | 71 | 4.17 ± 5.99 | 1.18 |
| Notothecium delcaostoides               | INPA 639     | 38.33 | 149| 6.43 ± 6.05 | 2.48 |
| Notothecium euzeti                      | INPA 640     | 1.67  | 1  | 0.02  |     |
| Notothecium minor                       | INPA 641     | 20.00 | 16 | 1.33 ± 0.77 | 0.27 |
| Rhinexenus piranhus                     | INPA 642     | 35.00 | 78 | 3.71 ± 4.05 | 1.30 |
| **DIGENEA**                             |              |     |    |      |     |
| Clinostomum marginatum                  | 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 |
| Contracacecum sp.                      | INPA 83      | 1.67  | 2  | 0.03  |     |
| Pseudoproleptus sp.                    | INPA 82      | 3.33  | 6  | 3.0  | 0.1  |
| Philometra nattereri                    | INPA 81      | 1.67  | 1  | 1 ± 2.82 | 0.01 |
| **COPEPODA**                            |              |     |    |      |     |
| Ampelibranchius bryconis                | INPA 2236    | 35.00 | 163| 7.8 ± 2.82 | 2.72 |
| Ergasilus jaraquensis                   | INPA 2235    | 17.00 | 10 | 1 ± 0.5 | 0.17 |
| Gamidactylus jaraquensis                | INPA 2234    | 17.00 | 22 | 2.2 ± 1.5 | 0.4  |
| Rhinergasilus piranhus                  | INPA 2233    | 1.67  | 1  | 0.02  |     |
| **BRANCHIURA**                          |              |     |    |      |     |
| Argulus chicomendesi                    | INPA 2231    | 1.67  | 1  | 4.4   |     |
| **ISOPODA**                             |              |     |    |      |     |
| Amphira branchialis                     | INPA 2229    | 11.67 | 14 | 2.03  | 0.23 |
| Vanamea symetrica (Van Name, 1925)      | INPA 2230    | 1.67  | 1  | 1.02  |     |
Figure 1. Lateral view of *Serrasalmus altispinis* Merckx, Jégú 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, *Notozotheicum* 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, *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*.

In floodplain lakes of the Brazilian Amazon, 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 *Salmaprochilodus 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 spilopleura* sp. (Thatcher, 1993; Tavares-Dias et al., 2015). *Vananea 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. 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.