



BIOLOGICAL SCIENCES

Occurrence of metacercariae of *Austrodiplostomum compactum* (Lutz, 1928) (Trematoda, Diplostomidae) in *Pimelodus platicirris* in the Ilha Solteira Reservoir, São Paulo, Brazil

DENIS W.J. CAMPOS, LETÍCIA O. MANOEL, LIDIANE FRANCESCHINI, ROSICLEIRE VERÍSSIMO-SILVEIRA, ROSILENE L. DELARIVA, CRISTIÉLE S. RIBEIRO & IGOR P. RAMOS

Abstract: This study reports the occurrence of metacercariae of *Austrodiplostomum compactum* in *Pimelodus platicirris* from a Neotropical reservoir in the Grande River, SP, Brazil. A total of 164 fish were collected, of which 12.80% were infected with metacercariae in the eyes. The mean intensity of infection and mean abundance were 1.52 ± 0.14 (1–3) and 0.23 ± 0.05 (0–3), respectively. The presence of this parasite with a high intensity of infection can cause exophthalmos, retinal displacement, opacity of the lens, blindness or even death. This is the first record of ocular metacercariae for *P. platicirris*, thus increasing the number of hosts for *A. compactum*.

Key words: Diplostomiasis, freshwater fish, mandi, Neotropical reservoir.

INTRODUCTION

The superfamily Diplostomoidea Poirier, 1886, comprises a group of digenetic trematodes possessing a holdfast organ found posterior to the ventral sucker, a morphological innovation unique to this trematode group. This superfamily contains over 250 described species, 88 genera, 16 subfamilies and 6 families, including the family Diplostomidae (Blasco-Costa & Locke 2017).

The biological cycle of diplostomids involves a first intermediate host (gastropod mollusks), a second intermediate host (fish) or rarely observed paratenic host (amphibians), and finally a definitive host (piscivorous birds)

(Violante González et al. 2009), in which the adult parasite is harbored in the intestine.

In general, adults of diplostomid species reproduce sexually in the intestine of infected piscivorous birds, depositing their eggs into the water through feces, with the hatching and release of miracidia (free-swimming larva) occurring within 22 days (Grobbelaar et al. 2014). Miracidia actively penetrate planorbid gastropods belonging to the genus *Biomphalaria* Preston, 1910 (in Brazil this has specifically been reported in *B. glabrata* (Say, 1818) and *B. straminea* (Dunker, 1848)) (Pinto & Melo 2013), undergo morphological alterations, such as the loss of cilia, becoming saccular with cells (sporocyst) from which several redia originate and from which the cercariae finally develop

(Thatcher 2006). The cercariae subsequently leave the snails and may remain encysted in vegetation or actively penetrate their second intermediate host (fish), commonly by the gills, reaching the eyes, brain and/or muscles through the bloodstream, where they develop into metacercariae. Finally, piscivorous birds prey the infected fish, giving continuity to the cycle (Thatcher 2006, Rassier et al. 2015).

Metacercariae of the diplostomid *Austrodiplostomum compactum* (Lutz, 1928) are widely distributed in the Neotropical region (Vital et al. 2016) and require at least three hosts until reaching the adult stage. Due to its low specificity, *A. compactum* can infect various species of freshwater fish, as described by Santos et al. (2002), Pinto et al. (2014), Costa et al. (2015), Rassier et al. (2015), Ramos et al. (2016), Vital et al. (2016), Albuquerque et al. (2017), at various sites of infection, such as the gills, swim bladder, brain, musculature and, preferably, the eyes (vitreous humor) (Ramos et al. 2013). Although the number of new records of this parasite in native fish species in Brazil is increasing (Ramos et al. 2013, Ramos et al. 2016), the potential impact of the occurrence of these metacercariae on wild fauna and transmission to animals raised in fish farms remains unknown (Pinto & Melo 2013).

Research aimed at characterizing the biology and ecology of the freshwater siluriform *Pimelodus platicirris* Borodin, 1927 is of fundamental importance for its conservation, as it is a medium-sized species with potential for artisanal fishing and human consumption. The objective of the present study was to report the occurrence of metacercariae *A. compactum* in *P. platicirris* in the Upper Paraná River basin.

MATERIALS AND METHODS

The study was carried out in the Ilha Solteira Reservoir, in the municipal region of Santa Clara D'Oeste, (50°55'57"60"W and 20°02'33.62"S) on the Can-Can branch of the Grande River, São Paulo state, Brazil (Figure 1). The specimens of *P. platicirris* were collected bimonthly from September 2014 to October 2016 with the aid of gill nets of different meshes (3 to 16 cm between adjacent nodes) in an area adjacent to a fish farm. The fish were euthanized, frozen and sent to the laboratory of the Department of Biology and Animal Science, School of Engineering, Ilha Solteira (FEIS) (SISBIO n° 42229-1, CEUA/FEIS n° 001/2014, SisGen n° A278D23). The metacercariae were recovered from the eyes, fixed under pressure between a lamina and coverslip, and preserved in 70% ethanol (Eiras et al. 2006). Then, the metacercariae were stained with hydrochloric carmine and clarified in eugenol for identification using an optical microscope with a coupled camera connected to a computerized image analysis system (Optical Microscope with AXIOCAM MRc5 ZEISS camera). The morphological identification followed the recommendations of Ostrowsky de Núñez (2017). The following parasitological parameters were calculated: prevalence (P), mean abundance (MA) and mean intensity of infection (MII) (Bush et al. 1997), being are expressed as mean, followed by standard error and the range (minimum – maximum) in parentheses.

Voucher specimens of *P. platicirris* were deposited in the DZSJRP Fish Collection of UNESP, municipality of São José do Rio Preto (DZSJRP-Pisces 21316) and *A. compactum* were recorded in the Helminthological Collection of the Institute of Biosciences of Botucatu (CHIBB – 8458).

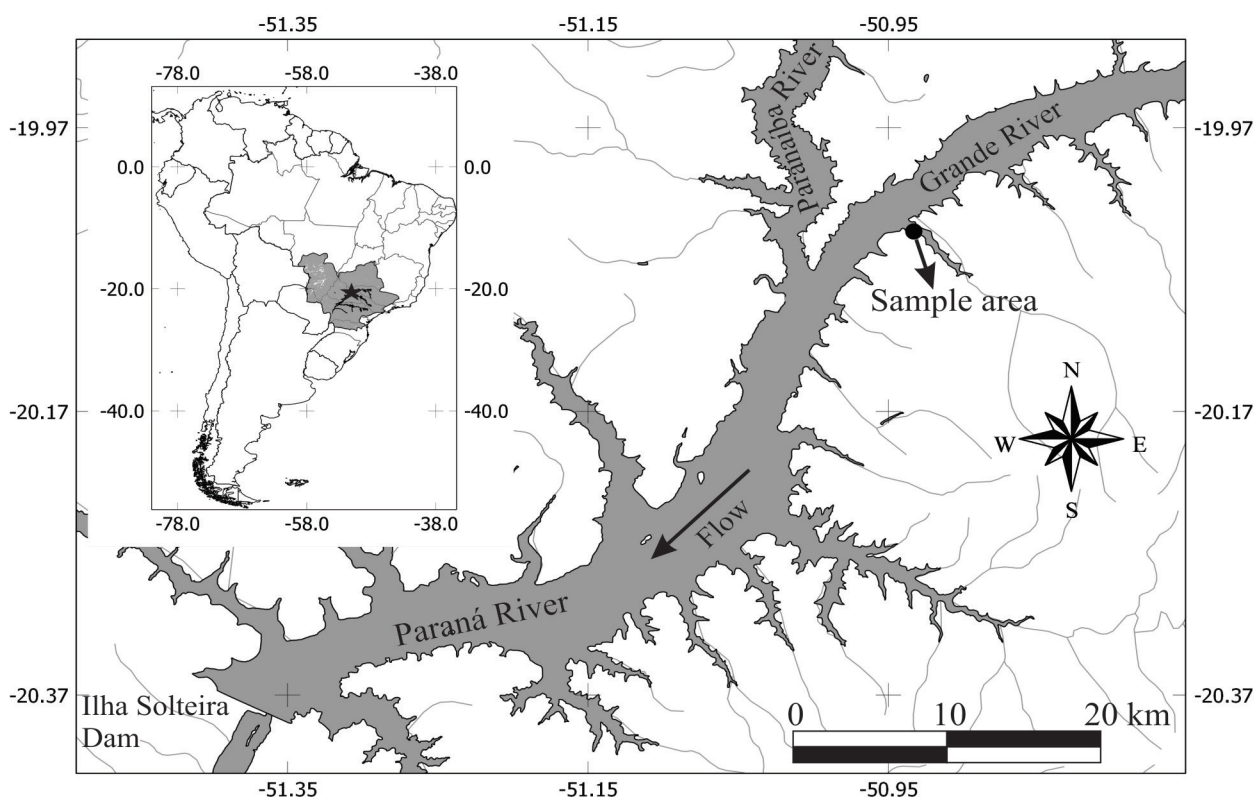


Figure 1. Study area on the Can-Can branch of the Ilha Solteira Reservoir, Grande River, São Paulo state, Brazil.

RESULTS

The morphology of the recovered metacercariae followed the redescription proposed by Ostrowski de Núñez (2017): body bipartite; forebody spatulate, slightly concave ventrally; hindbody very short, with a small conical segment. Oral sucker subterminal, two lateral pseudosuckers well developed, on each side of oral sucker; ventral sucker absent. Small pharynx, esophagus short, ceca simple, reaching until level of genital primordia. Holdfast organ (= tribocytic organ) elliptical and bilobed. Genital primordia poorly developed, differentiated in two small testes, ovary not distinct.

A total of 164 specimens of *P. platicirris* were captured, with a mean standard length of 26.98 ± 0.28 (15–47 cm) and a mean total mass

of 378.22 ± 12.76 (78.99–912.36 g). As for the parasitological parameters, 21 were infected with metacercariae of *A. compactum* (prevalence 12.80%), with a mean intensity of infection and mean abundance of 1.52 ± 0.14 (1–3) and 0.23 ± 0.05 (0–3), respectively.

DISCUSSION

These results may be associated with the availability of organic matter from fish farming deposited in the sediment (Beveridge 2004), increasing the abundance of gastropod mollusks in these areas (Edgar et al. 2005). This increase has also been reported by authors such as Oliveira & Krau (1970), Barbosa (1983) and Callisto et al. (2005) in environments not used by fish farming but with a high content

of organic matter. Moreover, according to Karvonen et al. (2006), the dynamics of infection of *Diplostomum spathaceum* (Rudolphi, 1819) (Diplostomidae) in fish are mainly related to population variations in the first intermediate host (Gastropoda). Thus, the presence of fish farming may directly affect the life cycle of *A. compactum*, as proposed by Ramos et al. (2014).

These data corroborate the observations of Ramos et al. (2013), Ramos et al. (2016) and Barrett et al. (2019) which reported that fish farm contributed with resources, in the form of organic matter, to the aquatic environment, attracting the local biota and altering the abundance of intermediate hosts (gastropods and fish). These, in turn, may attract the definitive hosts (piscivorous birds), resulting in an increase in the dissemination/availability of infective forms of *A. compactum* in areas near to fish farms. In this way, wild fish attracted to these areas most likely are more susceptible to contact with infecting forms and can thus be infected, as may have occurred with *P. platicirris*.

The occurrence of metacercariae of *A. compactum* in *P. platicirris* was similar to the infection values reported for *Pimelodus maculatus* Lacepède, 1803, from the Paranapanema River, Chavantes Reservoir, São Paulo (Ramos et al. 2013), in the Itajaí-Açu River in Blumenau, Santa Catarina (Bachmann et al. 2007) and in the Guandu River, Rio de Janeiro (Santos et al. 2007). We can therefore infer that *P. platicirris* and *P. maculatus* have similar susceptibility to the metacercariae of *A. compactum*, due to the fact that they are congeneric, have similar alimentary habits and occupy the same habitat (Silva 2015).

The occurrence of metacercariae of *A. compactum* has been recorded in at least 43 freshwater species fish in Brazil, demonstrating their low parasitic specificity (Ramos et al. 2013, Sabas & Brasil-Sato 2014, Costa et al. 2015,

Kubitza & Campos 2014, Ramos et al. 2016 and Vital et al. 2016). They are often found in the eyes of fish (the second intermediate host), and may in extreme cases cause exophthalmos, retinal displacement, lens opacity and blindness (Seppälä et al. 2004). However, penetration of the cercariae into different structures such as the surface of the body, the fins, the buccal cavity and gills, together with migration to the eyes, can cause lesions and hemorrhages in various tissues, as well as obstruction of the blood vessels, phenomena that may be associated with fish death in cases of high infection rates (Silva-Souza 1998). The reduction of visual acuity has also been reported, with a consequent reduction in feeding activity (Seppälä et al. 2004). In addition, blindness or poor vision makes fish more susceptible to predation, facilitating the transmission of the parasite to the definitive host (birds).

This is the first record of the occurrence of metacercariae of *A. compactum* in *P. platicirris*, contributing to the knowledge of the distribution of this parasite and providing the first information on the parasitological aspects of this Neotropical fish. The occurrence of this parasite in wild fish near fish farms, together with its low specificity, raises concerns about the potential impacts of infection and dissemination to other species of wild fish.

Acknowledgments

This study was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) - process number 443103/2014-3) and Fundação para o Desenvolvimento da UNESP (Fundunesp) - process number 0305/001-14 Prope-CDC). The authors would like to thank Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for financial and scientific support (Finance Code 001), and the post-graduate scholarships granted to L.F. (CAPES/PNPD 17/2016). The Faculdade de Engenharia de Ilha Solteira (FEIS), São Paulo State University - UNESP, Laboratório de Ictiologia Neotropical (LINEO-FEIS/UNESP), Instituto de Biociências

de Botucatu (IBB/UNESP), for the use of laboratory facilities and logistics, and Prof. Francisco Langeani Neto for fish identification (IBILCE/UNESP). I.P.R. is supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (process 303311/2018-5).

REFERENCES

- ALBUQUERQUE NB, MOREY GAM, MORAIS AM & MALTA JCO. 2017. Metacercariae of *Austrodiplostomum compactum* (Lutz, 1928) (Trematoda, Diplostomidae) infecting the eyes of *Plagioscion squamosissimus* (Heckel, 1840) (Perciformes, Scienidae) from Lake Catalão, Amazonas, Brazil. *Acta Amaz* 47: 141-146.
- BACHMANN F, GREINERT JA, BERTELLI PW, SILVA FILHO HH, LARA NOT, GHIRALDELLI L & MARTINS ML. 2007. Parasitofauna de *Pimelodus maculatus* (Osteichthyes: Pimelodidae) do rio Itajaí-Açu em Blumenau, estado de Santa Catarina, Brasil. 2007. *Acta Sci Biol Sci* 29: 109-114.
- BARBOSA FS. 1983. Atuação dos serviços de saúde no controle das doenças endêmicas. *Saúde no Brasil* 1: 198-204.
- BARRETT LT, SWEARER SE & DEMPSTER T. 2019. Impacts of marine and freshwater aquaculture on wildlife: a global meta-analysis. *Rev Aquacult* 11: 1022-1044.
- BEVERIDGE MCM. 2004. *Cage aquaculture*. 3rd ed., Oxford: Blackwell Publishing, 380 p.
- BLASCO-COSTA I & LOCKE SA. 2017. Life history, systematics and evolution of the Diplostomoidea Poirier, 1886: progress, promises and challenges emerging from molecular studies. In: Rollinson D and Stothard JR (Eds). *Advances in parasitology*. Academic Press, United Kingdom, p. 167-225.
- BUSH AO, LAFFERTY KD, LOTZ JM & SHOSTAK AW. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *J Parasitol* 83: 575-583.
- CALLISTO M, MORENO P, GONÇALVES J, FERREIRA WR & GOMES CLZ. 2005. Malacological assessment and natural infestation of *Biomphalaria straminea* (Dunker, 1848) by *Schistosoma mansoni* (Sambon, 1907) and *Chaetogaster limnaei* (K. Von Baer, 1827) in an urban eutrophic watershed. *Braz J Biol* 65: 217-228.
- COSTA DPC, MONTEIRO CM & BRASIL-SATO MC. 2015. Digenea of *Hoplias intermedius* and *Hoplias malabaricus* (Actinopterygii, Erythrinidae) from upper São Francisco River, Brazil. *Rev Bras Parasitol Vet* 24: 129-135.
- EDGAR GJ, MACLEOD CK, MAWBAY RB & SHIELDS D. 2005. Broad-scale effects of marine salmonid aquaculture on macrobenthos and the sediment environment in southeastern Tasmania. *J Exp Mar Bio Ecol* 327: 70-90.
- EIRAS JC, TAKEMOTO MR & PAVANELLI GC. 2006. *Métodos de estudo e técnicas laboratoriais em parasitologia de peixes*. 2nd ed., Maringá: EdUEM, 199 p.
- GROBBELAAR A, VAN AS LL, BUTLER HJB & VAN AS JG. 2014. Ecology of diplostomid (Trematoda: Digenea) infection in freshwater fish in southern Africa. *Afr Zool* 49: 222-232.
- KARVONEN A, SAVOLAINEN M, SEPPÄLÄ O & VALTONEN ET. 2006. Dynamics of *Diplostomum spathaceum* infection in snail hosts at a fish farm. *Parasitol Res* 99: 341-345.
- KUBITZA F & CAMPOS JL. 2014. Tambaqui em Rondônia: parasito causa prejuízo a produtores. *Panor Aquicult* 24: 14-23.
- OLIVEIRA PH & KRAU L. 1970. Hidrobiologia geral, aplicada particularmente a veiculadores de esquistossomose: hipereutrofia, mal moderno das águas. *Mem Inst Oswaldo Cruz* 68: 89-118.
- OSTROWSKI DE NÚÑEZ M. 2017. Redescription of *Austrodiplostomum compactum* (Trematoda: Diplostomidae) from its type host and locality in Venezuela, and of *Austrodiplostomum mordax* from Argentina. *J Parasitol* 103: 497-505.
- PINTO HA, MATI VLT & MELO AL. 2014. Metacercarial infection of wild Nile tilapia (*Oreochromis niloticus*) from Brazil. *Sci World J* 2014: Article ID 807492.
- PINTO HA & MELO AL. 2013. *Biomphalaria straminea* and *Biomphalaria glabrata* (Mollusca: Planorbidae) as new intermediate hosts of the fish eyefluke *Austrodiplostomum compactum* (Trematoda: Diplostomidae) in Brazil. *J Parasitol* 99: 729-733.
- RAMOS IP, FRANCESCHINI L, ZAGO AC, ZICA EOP, WUNDERLICH AC & CARVALHO ED. 2013. New host records and a checklist of fishes infected with *Austrodiplostomum compactum* (Digenea: Diplostomidae) in Brazil. *Rev Bras Parasitol Vet* 22: 511-518.
- RAMOS IP, FRANCESCHINI L, ZAGO AC, ZICA EOP, WUNDERLICH AC, LIMA FP & SILVA RJ. 2016. *Austrodiplostomum compactum* metacercariae (Digenea: Diplostomidae) in *Schizodon intermedius* (Characiformes: Anostomidae) from Jurumirim reservoir, Brazil. *Rev Bras Parasitol Vet* 25: 240-243.
- RAMOS IP, FRANCESCHINI L, ZICA EOP, CARVALHO ED & SILVA RJ. 2014. The influence of cage farming on infection of the corvine fish *Plagioscion squamosissimus* (Perciformes: Sciaenidae) with metacercariae of *Austrodiplostomum*

compactum (Digenea: Diplostomidae) from the Chavantes reservoir, São Paulo State, Brazil. J Helminthol 88: 342-348.

RASSIER GL, PESENTI TC, PEREIRA JÚNIO J, SILVA DS, WENDT EW, MONTEIRO CM & BERNE MEA. 2015. Metazoan parasites of *Geophagus brasiliensis* (Perciformes: Cichlidae) in Patos lagoon, extreme south of Brazil. Rev Bras Parasitol Vet 24: 447-453.

SABAS CSS & BRASIL-SATO MC. 2014. Helminth fauna parasitizing *Pimelodus pohli* (Actinopterygii: Pimelodidae) from the upper São Francisco River, Brazil. Rev Bras Parasitol Vet 23: 375-382.

SANTOS MD, LEMOS-PITA SRLC & BRASIL-SATO MC. 2007. Metazoan parasite fauna of *Pimelodus maculatus* La Cépède, 1803 (Siluriformes, Pimelodidae) from the Guandu river, Rio de Janeiro State, Brazil. Acta Sci Biol Sci 29: 101-107.

SANTOS RDS, PIMENTA FDA, MARTINS ML, TAKAHASHI HK & MARENGONI NG. 2002. Metacercárias de *Diplostomum (Austrodiplostomum) compactum* Lutz, 1928 (Digenea, Diplostomidae) em peixes do rio Paran , Brasil. Preval ncia, sazonalidade e intensidade de infec o. Acta Sci Biol Sci 24: 475-480.

SEPP L  O, KARVONEN A & VALTONEN ET. 2004. Parasite-induced change in host behaviour and susceptibility to predation in an eye fluke–fish interaction. Anim Behav 68: 257-263.

SILVA TT. 2015. *Pimelodus maculatus* e *P. platycirris* (Siluriformes: Pimelodidae) no alto rio Paran : caracteriza o morfol gica, dieta e reprodu o. Disserta o de Mestrado. Universidade Estadual Paulista, 39 f. (Unpublished).

SILVA-SOUZA AT. 1998. Estudo do parasitismo de *Plagioscion squamosissimus* (Heckel, 1940) (Perciformes, Sciaenidae) por *Diplostomum (Austrodiplostomum) compactum* (Lutz, 1928) (Trematoda, Digenea) no Rio Tibagi, PR. Disserta o de Mestrado. Universidade Federal de S o Carlos, 125 f. (Unpublished).

THATCHER VE. 2006. Amazon Fish Parasites. 2nd ed., Bulg ria: Pensoft Publishers, 509 p.

VIOLANTE-GONZ LEZ J, GARC A-VARELA M, ROJAS-HERRERA A & GUERRERO SG. 2009. Diplostomiasis in cultured and wild tilapia *Oreochromis niloticus* in Guerrero State, Mexico. Parasitol Res 105: 803-807.

VITAL JF, MOREY GAM, PEREIRA NB & MALTA JCO. 2016. Metacerc rias de *Austrodiplostomum compactum*

(Lutz, 1928) em peixes de lagos de v rzea da Amaz nia brasileira. Folia Amaz 25: 153-158.

How to cite

CAMPOS DWJ, MANOEL LO, FRANCESCHINI L, VER SSIMO-SILVEIRA R, DELARIVA RL, RIBEIRO CS & RAMOS IP. 2020. Occurrence of metacercariae of *Austrodiplostomum compactum* (Lutz, 1928) (Trematoda, Diplostomidae) in *Pimelodus platycirris* in the Ilha Solteira Reservoir, S o Paulo, Brazil. An Acad Bras Cienc 92: e20180649. DOI 10.1590/0001-3765202020180649.

Manuscript received on June 29, 2018;

accepted for publication on November 13, 2018

DENIS W.J. CAMPOS¹

<https://orcid.org/0000-0001-6841-9623>

LET CIA O. MANOEL²

<https://orcid.org/0000-0003-3350-3934>

LIDIANE FRANCESCHINI²

<https://orcid.org/0000-0002-4733-4820>

ROSICLEIRE VER SSIMO-SILVEIRA^{2,3}

<https://orcid.org/0000-0002-8298-5004>

ROSILENE L. DELARIVA⁴

<https://orcid.org/0000-0002-6489-2437>

CRISTI LE S. RIBEIRO³

<https://orcid.org/0000-0003-4382-9575>

IGOR P. RAMOS^{2,3}

<https://orcid.org/0000-0003-4525-6491>

¹Programa de P s-Gradua o em Aquicultura, Universidade Estadual Paulista/UNESP, Centro de Aquicultura, Via de Acesso Prof. Paulo Donato Castellane, s/n, 14884-900 Jaboticabal, SP, Brazil

²Programa de P s-Gradua o em Ci ncias Biol gicas - Zoologia, Universidade Estadual Paulista/UNESP, C mpus de Botucatu, Instituto de Bioci ncias, Rua Prof. Dr. Ant nio Celso Wagner Zanin, 250, 18618-689 Botucatu, SP, Brazil

³Universidade Estadual Paulista/UNESP, C mpus de Ilha Solteira, Faculdade de Engenharia de Ilha Solteira, Departamento de Biologia e Zootecnia, Rua Mon o, 226, 15385-000 Ilha Solteira, SP, Brazil

⁴Universidade Estadual do Oeste do Paran /UNIOESTE, Centro de Ci ncias Biol gicas e da Sa de, Rua Universit ria, 2069, 85819-110 Cascavel, PR, Brazil

Correspondence to: **Igor Paiva Ramos**

E-mail: igor.paiva.ramos@gmail.com

Author contributions

Main author, general structure of the manuscript and discussion of the results: Denis William Johanssem de Campos; contributed to the laboratorial analysis: Letícia de Oliveira Manoel and Denis William Johanssem de Campos; participated in the sampling of fish: Rosicleire Veríssimo-Silveira, Letícia de Oliveira Manoel and Crístiele da Silva Ribeiro; took part in the structuration: Letícia de Oliveira Manoel and Lidiane Franceschini also contributed to parasite identification and laboratorial analysis; revision of the manuscript: Rosicleire Veríssimo-Silveira and Crístiele da Silva Ribeiro; Igor Paiva Ramos acted as supervisor of Mr. Campos during the structuration, scientific discussions and interpretation contained in this manuscript.

