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Austrodiplostomum compactum (Lutz, 1928) (Digenea, Diplostomidae) in the eyes of fishes from Paraná river, Brazil

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ABSTRACT. Parasitological indexes of *Austrodiplostomum compactum* (Digenea, Diplostomidae) in fishes from the Paraná River, Presidente Epitácio region, state of São Paulo, Brazil, and their relationship with climate and water quality are evaluated. Fifty-one specimens of *Plagioscion squamosissimus*, 39 *Geophagus surinamensis*, 27 *Hoplias malabaricus* and 23 *Cichla* sp. were collected between June 2007 and June 2008. Water quality and rainfall indexes were measured monthly. *P. squamosissimus* had the highest parasite rate, with 98% total prevalence, intensity of infection varying between 1 and 255 and parasite mean abundance totaling 40.5 ± 9.9. *H. malabaricus* had the next parasite rate, with 66.6% total prevalence, parasite intensity between 2 and 184 and mean abundance totaling 22.4 ± 20.9. *Cichla* sp. had a total prevalence of 52.1%, intensity between 1 and 21, and mean abundance 4.3 ± 2.9. Finally, *G. surinamensis* had a total prevalence of 46.1%, intensity between 1 and 53 and mean abundance 7.1 ± 8.8. A survey of diplostomid infection in Brazil and the role of piscivore fish as an important host have also been discussed.

Keywords: fish, *Plagioscion squamosissimus*, *Geophagus surinamensis*, *Hoplias malabaricus*, *Cichla*, *Diplostomum*, infection.

Austrodiplostomum compactum (Lutz, 1928) (Digenea, Diplostomidae) em olhos de peixes do rio Paraná, Brasil

RESUMO. Este estudo avaliou os índices parasitológicos de *Austrodiplostomum compactum* (Digenea, Diplostomidae) em peixes do rio Paraná, região de Presidente Epitácio, Estado de São Paulo, Brasil e sua relação com o clima e qualidade da água. Cinquenta e um espécimes de *Plagioscion squamosissimus*, 39 *Geophagus surinamensis*, 27 *Hoplias malabaricus* e 23 *Cichla* sp. foram coletados de junho de 2007 a junho de 2008. Qualidade da água e pluviosidade foram medidas mensalmente. O peixe mais parasitado foi *P. squamosissimus* com 98% de prevalência total, intensidade de infecção variando de 1 a 255 e abundância média de 40,5 ± 9,9. O segundo peixe mais parasitado foi *H. malabaricus* com 66,6% de prevalência total, intensidade de 2 a 184 e abundância média de 22,4 ± 20,9. *Cichla* sp. apresentou 52,1% de prevalência, intensidade de 1 a 21 e abundância média de 4,3 ± 2,9. Finalmente, *G. surinamensis* apresentou 46,1% de prevalência, intensidade de 1 a 53 e abundância média de 7,1 ± 8,8. Um levantamento de infecções por diplostomídeos no Brasil e o papel de peixes piscívoros como importantes hospedeiros é também discutido.

Palavras-chave: peixe, *Plagioscion squamosissimus*, *Geophagus surinamensis*, *Hoplias malabaricus*, *Cichla*, *Diplostomum*, infecção.

Introduction

Metacercariae of *Diplostomum* and *Austrodiplostomum* are frequently reported parasitizing freshwater fishes which are the second intermediate hosts in the parasite's life-cycle (RINTAMAKI-KINNUNEN et al., 2004; SEPPALA et al., 2004). Whereas the adult stage inhabits the digestive tract of piscivore birds, its larval cercariae stage may be found in aquatic mollusks. The parasite has a geographically wide range with reports from over 125 fish species (EIRAS, 1994).

There are several reports from Brazil on diplostomid metacercariae parasitizing fishes. Metacercariae have been found in *Plagioscion squamosissimus* Heckel, 1840 (KOHN et al., 1995; MACHADO et al., 2005; MARTINS et al., 2002; PAES et al., 2003, 2010; SANTOS et al., 2002; TAKEMOTO et al., 2009), *Hypostomus regani* Ihering, 1905 (TAKEMOTO et al., 2009; YAMADA et al., 2008; ZICA et al., 2009), *Cichla monoculus* Spix and Agassiz, 1831 (MACHADO et al., 2000, 2005; TAKEMOTO et al., 2009), *Cichla ocellaris* Bloch and Schneider, 1801 (MACHADO et al., 2005; SANTOS et al., 2002), *Pimelodus maculatus* Lacepéde, 1803 (BRASIL-SATO; PAVANELLI, 2004; BACHMANN et al., 2007), *Hoplias malabaricus* Bloch, 1794 (MACHADO et al., 2005; TAKEMOTO et al., 2009), *Satanoperca pappaterra* Heckel, 1840 (MACHADO et al., 2005; TAKEMOTO et al., 2009), *Geophagus brasiliensis* Quoy and Gaimard, 1824 (AZEVEDO et al., 2006; NOVAES et al., 2006) and *Crenicichla britskii* Kullander, 1982 (MACHADO et al., 2005; TAKEMOTO et al., 2009), *Serrasalmus maculatus* Kner, 1858, *Schizodon borellii* Boulenger, 1900 and *Auchenipterus osteomystax* Mirando Ribeiro, 1918 (TAKEMOTO et al., 2009; YAMADA et al., 2008), *Conorhynchos conirostris* Valenciennes, 1840 (BRASIL-SATO; SANTOS, 2005), *Cyphocharax Gilbert* Quoy and Gaimard, 1824 (ABDALLAH et al., 2005) and *Cichlasoma paranaense* Kullander, 1983 (MACHADO et al., 2005; TAKEMOTO et al., 2009).

The River Paraná is the second largest river in extension in South America and commercial fishing is one of its important local economic activities. Kohn et al. (1995), Santos et al. (2002), Brasil-Sato and Pavanelli (2004), Machado et al. (2005) and Yamada et al. (2008) have registered parasitosis by *A. compactum* in fishes from the Paraná river basin.

Current research reports on the occurrence of *Austrodiplostomum compactum* (Lutz, 1928) in four fish species from the Paraná river, as well as its ecological aspects with regard to parasitological indexes, rainfall and water quality.

Material and methods

Current research was undertaken at the Aquaculture Center of the Universidade do Oeste Paulista (UNOESTE), on the shores of the Paraná river, near the town of Presidente Epitácio, state of São Paulo (21° 45′ 48″ S; 52° 06′ 56″ W). Fifty-one specimens of *P. squamosissimus*, 39 *G. surinamensis*, 27 *H. malabaricus* and 23 *Cichla* sp. were collected with gill nets and hooks, between June 2007 and June 2008, comprising the winter of 2007 thru the winter of 2008, for parasitological exam undertaken according to Santos et al. (2002). *Geophagus surinamensis*, *H. malabaricus* and Cichla sp. were not captured during the summer of 2007. Parasite specimens were fixed in 5% formaldehyde, washed in distilled water, stained in carmine or diaphanized in beechwood creosote and mounted on permanent slides using Canada balsam. The terms prevalence, mean intensity of infection and mean parasite abundance were attributed according to Bush et al. (1997).

The water quality was monthly measured. Water temperature and dissolved oxygen were measured with digital oxymeter YSI 5512; ammonia, pH, and alkalinity were calculated with Merk's colorimetric method. Rainfall indexes were obtained from the meteorological station of the Universidade do Oeste Paulista (UNOESTE) in Presidente Prudente, São Paulo State, Brazil.

Collected data underwent statistical tests to compare rainfall, air temperature and water quality between seasons; to determine differences between the intensity of infection and abundance of parasites in fish between the seasons; to verify which fish species was more parasitized during the whole period and the possible differences in host weight and length for each fish species examined according to season. ANOVA and Bartlett's test for variance homogeneity were used, with significance for all statistical analyses set at $\alpha = 0.05$.

Results and discussion

No significant differences in rainfall indexes between seasons were observed. However, temperature rates were high ($p < 0.05$) in the spring and summer 2007. The highest water temperatures ($p < 0.05$) occurred in the spring 2007, summer 2007 and autumn 2008. High alkalinity rates were reported in the winter and spring 2007 and autumn 2008, but no difference in pH and dissolved oxygen occurred during the seasons (Table 1).

Mean highest rainfall during the studied period occurred in the winter 2007, spring 2007 and autumn 2008. Oscillations occurred in water alkalinity and pH during the period under analysis. The highest temperature rates were registered between spring 2007 and autumn 2008, although there were considerable variations in all months. Dissolved oxygen levels also varied during the year (Table 1).

Metacercariae at different stages of development were collected from the crystalline of host´s eyes in all fish species.

Except for autumn 2008, the prevalence of *A. compactum* in *P. squamosissimus* was 100%, even though the highest parasite numbers were observed in autumn 2008 (255) and spring 2007 (222) (Table 2). The mean highest infection intensities were reported in spring 2007 (45.0 ± 65.8) and in autumn 2008 (59.3 ± 70.0) (Table 2).

Parasites from *G. surinamensis* were reported only between autumn and winter 2008. Although no fish was collected in the summer 2008, mean infection intensities were low, varying between 12 and 18.2 parasites, and mean abundance varying between 10.4 and 18.2 (Table 3).

Prevalence of *H. malabaricus* varied from 46.6 to 83.3% between winter 2007 and autumn 2008 (Table 4). The highest number of parasites was registered in winter 2007 (247) with mean infection intensity (35.2 ± 18.2) and mean abundance (16.4), followed by winter 2008, with total number of parasites 214, mean intensity 71.3 ± 97.6 and abundance 53.5 (Table 4).

Table 1. Rainfall, air temperature and water quality mean rates measured at the shores of the Paraná river, near Presidente Epitácio, São Paulo State, Brazil.

Seasons	Rainfall (mm)	Air temperature (°C)	Water temperature (°C)	Alkalinity (mg L^{-1})	pH	Oxygen (mg L^{-1})
Winter 2007	3.1 (0-90)	21.9 (12.6-26.3) c	22.5 (21.5-23.0) a	17.0 (15.0-18.0) ab	7.0	7.7 (7.5-7.8)
Spring 2007	4.6 (0-54)	26.8 (19.6-32.1) a	26.5 (25.8-28.4) bc	18.7 (18.0-21.0) a	7.0	6.9 (6.3-7.2)
Summer 2007	2.1 (0-28)	27.7 (24.6-29.8) a	29.0 c	15.0 a	6.8	5.6
Autumn 2008	5.7 (0-82)	23.7 (16.2-28.4) b	25.7 (26.2-27.3) b	16.9 (12.0-18.0) ab	7.0 (6.8-8.0)	6.3 (3.8-7.5)
Winter 2008	0.8 (0-8)	20.6 (13.0-24.8) c	21.4 (21.3-21.6) a	13.8 (12.0-15.0) b	7.0	7.7 (6.4-8.4)

*Different letters indicate significant difference ($p < 0.05$) between the seasons.

Table 2. Parasitological indexes (± standard error) and biometry of *Plagioscion squamosissimus* parasitized by *Austrodiplostomum compactum* from the Paraná river, region of Presidente Epitácio, São Paulo State, Brazil. Mean values and variation, between parentheses, of fish weight and length, infected fish/examined fish (IF/IE), prevalence, total number of parasites (TNP), mean intensity and range, between parenthesis, and mean abundance.

Seasons	Fish weight (g)	Fish length (cm)	IF/EF	Prevalence (%)	TNP	Mean intensity	Mean abundance
Winter 2007	480.1 (185-1360)	33.3 (25-50)	16/16	100	577	36.1 ± 7.2 (2-90)	36.1 ± 7.2
Spring 2007	626.0 (162-1998)	33.8 (24-54)	15/15	100	634	45.0 ± 20.8 (7-222)	45.0 ± 20.8
Summer 2007	497.0 (236-1290)	32.8 (26.5-47)	6/6	100	201	36.8 ± 14.4 (12-92)	36.8 ± 14.4
Autumn 2008	666.9 (214-2560)	32.8 (25-52)	14/15	93.3	831	59.3 ± 18.7 (2-255)	55.4 ± 17.9
Winter 2008	231.2 (166-276)	27.8 (26-31)	5/5	100	148	29.6 (1-76)	29.6 ± 13.4

Table 3. Parasitological indexes (± standard error) and biometry of *Geophagus surinamensis* parasitized by *Austrodiplostomum compactum* from the Paraná river, region of Presidente Epitácio, São Paulo State, Brazil. Mean values and variation, between parentheses, of fish weight and length, infected fish/examined fish (IF/IE), prevalence, total number of parasites (TNP), mean intensity and range, between parentheses, and mean abundance.

Seasons	Fish weight (g)	Fish length (cm)	IF/EF	Prevalence (%)	TNP	Mean intensity	Mean abundance
Winter 2007	147.5 (85-215)	20.2 (17-23)	0/15	0	0	0 a	0
Spring 2007	130.4 (122-144)	19.6 (19-20)	0/5	0	0	0 a	0
Summer 2007	-	-	-	-	-	-	-
Autumn 2008	179.8 (132-254)	21.2 (18-23)	13/15	86.6	157	12.0 ± 4.1 bc (0-53)	10.4 ± 3.7 b
Winter 2008	144.0 (108-178)	19.8 (18-22)	5/5	100	91	18.2 ± 7.6 c (3-46)	18.2 ± 7.6 c

*Different letters indicate significant difference between months ($p < 0.05$).

Table 4. Parasitological indexes(± standard error) and biometry of *Hoplias malabaricus* parasitized by *Austrodiplostomum compactum* from Paraná river, region of Presidente Epitácio, São Paulo State, Brazil. Mean values and variation, between parentheses, of fish weight and length, infected fish/examined fish (IF/IE), prevalence, total number of parasites (TNP), mean intensity and range, between parentheses, and mean abundance.

Seasons	Fish weight (g)	Fish length (cm)	IF/EF	Prevalence (%)	TNP	Mean intensity	Mean abundance
Winter 2007	643.5 (410-1025)	40.1 (35-47)	7/15	46.6	247	35.2 ± 6.9 (0-57)	16.4 ±1.7
Spring 2007	407.3 (250-580)	35.0 (29-41)	2/3	66.6	26	13 ± 11.1 (0-24)	8.6 ±7.8
Summer 2007	-	-	-	-	-	-	-
Autumn 2008	729.0 (394-1022)	40.3 (32-46)	5/6	83.3	68	13.6 ± 6.6 (0-38)	11.3 ±5.9
Winter 2008	609.5 (360-782)	39.5 (35-44)	3/4	75.0	214	71.3 ± 57.4 (0-184)	53.5 ±43.5

Metacercariae prevalence in *Cichla* sp. varied between 23 and 100%, with the mean lowest infection intensities (1.3 to 8.5 parasites). Therefore, mean abundance values varied from 0.3 to 7.1, with the highest number of parasites in the autumn 2008 (50) (Table 5).

Table 5. Parasitological indexes (± standard error) and biometry of *Cichla* sp. parasitized by *Austrodiplostomum compactum* from Paraná river, region of Presidente Epitácio, São Paulo State, Brazil. Mean values and variation, between parenthesis, of fish weight and length, infected fish/examined fish (IF/IE), prevalence, total number of parasites (TNP), mean intensity and range, between parentheses, and mean abundance.

Seasons	Fish weight (g)	Fish length (cm)	IF/EF	Prevalence (%)	TNP	Mean intensity	Mean abundance
Winter 2007	450.6 (225-2365)	29.7 (26-53)	3/13	23	4	1.3 ± 0.3 (0-2)	0.3 ±0.2 a
Spring 2007	311.3 (296-320)	29 (28-30)	2/3	66.6	17	8.5 +6.5 (0-15)	5.6 ± 4.7 ab
Summer 2007	-	-	-	-	-	-	-
Autumn 2008	378.5 (140-498)	30.2 (22-33)	7/7	100	50	7.1 ± 3.3 (1-21)	7.1 ±3.3 b
Winter 2008	-	-	-	-	-	-	-

*Different letters indicate significant difference between the months ($p < 0.05$).

Regardless of fish species, no significant difference ($p > 0.05$) between the seasons was reported in parasitological indexes. Contrastingly, when each fish species was analyzed regardless of the season, *P. squamosissimus* was found to be the most parasitized fish ($p < 0.05$).

No significant difference ($p > 0.05$) occurred between host weight and total length for all fish species between the seasons.

Santos et al. (2002) registered a positive relationship between mean infection intensity and rainfall, associated with high temperatures. Current study agrees with previous one in which all fish species were reported with the highest infection intensity during the months with the mean highest rainfall and which coincided with the highest temperatures.

In contrast, analyzing *P. squamosissimus* from Nova Avanhandava reservoir in the state of São Paulo, Brazil, Paes et al. (2010) did not report any influence either of aquatic parameters or of rainfall on the parasitic fauna. Since transmission is a major determinant of parasite fitness, perhaps other factors, such as local host population dynamics, fish feeding habits, strategies in cercarial release from first intermediate hosts and also the type of fresh water environments (lotic or lentic environment), would be primarily influencing success in parasite transmission.

There is a wide range of fish species collected from Brazil which are parasitized by metacercariae of *A. compactum*. Fifty percent of these fish species, namely, *A. osteomystax*, *C. monoculus*, *C. ocellaris*, *S. pappaterra*, *H. malabaricus* and *P. squamosissimus*, registered over 50% prevalence rates. The latter species achieved indexes up to 100% (Table 6). *Plagioscion squamosissimus*, also with mean high infection intensity, was the most parasitized fish species reported not only in current study but also in Santos et al. (2002), Martins et al. (2002) and Paes et al. (2010). Santos et al. (2002) reported the highest parasitological indexes in March 2001 for fish species, with infection intensities ranging from 4 to 137 parasites per host eye, while Martins et al. (2002) reported the highest infection intensities during late winter 2000 and late summer 2001. Although no significant difference in mean intensity and abundance of metacercariae throughout the seasons has been reported in current research, *P. squamosissimus* examined in spring and autumn had the highest parasitic load when compared to findings by Paes et al. (2010) in the same fish species in the Nova Avanhandava reservoir.

According to Lyholt and Buchmann (1996) and Hakalahti et al. (2006), infection of fishes by *Diplostomum spathaceum* (Rudolphi, 1819) metacercariae is temperature dependent. Hoglund and Thulin (1990) observed in their study that the maximum temperature (up to 23°C) coincided with the period of reduced recruitment of *Diplostomum baeri* Dubois 1937 metacercariae in perch *Perca fluviatilis* Linnaeus 1758. The highest prevalence and mean intensity observed in this study for *P. squamosissimus*, *G. surinamensis* and *H. malabaricus* were registered at water temperatures between 21.4 and 29.0°C. Such data may be explained by data from Hakalahti et al. (2006), according to whom extended summer temperatures would alter the dynamic population of cercariae and consequently the fish infection by metacercariae.

Due to the fact that water temperature at the collection site analyzed in current research was higher than that in Hakalahti et al. (2006), infection behavior at low temperatures cannot be evaluated. Martins et al. (2002) registered the positive influence of high temperatures on *A. compactum* infection in *P. squamosissimus*. In fact, their suggestion may be confirmed in current study for *P. squamosissimus,* a fish collected during the whole period under analysis. According to Berrie (1960), *Diplostomum* cercariae emerge in waters only at temperatures above 10°C. Lyholt and Buchmann

(1996) registered that daily shedding of *D. spathaceum* cercariae in *Lymnaea stagnalis* (Linnaeus, 1758) reached a maximum of 58,000 cercariae snail^{-1} day^{-1} at 20°C and a maximum of 10,000 cercariae snail^{-1} day^{-1} at 10°C. These authors also concluded that cercariae were 4 to 5 times more infective at 15°C than at 7°C, reinforcing the impact of temperature on the parasite's life-cycle. Although adaptations in temperature margins would be expected to suit local conditions, it seems that parasite biology is dependent on high temperatures, as suggested by Santos et al. (2002), Martins et al. (2002) and Hakalahti et al. (2006).

Luque and Poulin (2004) compared 50 teleost fish species from the coast of Brazil to evaluate the effects of host traits on the richness and abundance of larval helminths and reported that among all the potential correlates, host body length was positively correlated with helminth larvae abundance. Machado et al. (2005) registered a positive correlation between *C. britskii* size and the prevalence of *A. compactum* and attributed this fact to the possibility of larger fish being easier targets for cercariae. The parasite load in *P. squamosissimus* increased with fish length, as reported by Paes et al. (2010). These authors also attributed the cumulative process to a greater body surface available for cercariae infection. According to Pojmanska (1994), there is evidence on the positive correlation between parasite number and fish size, arguing that accumulation is due to the metacercariae's long life. On the other hand, Valtonen and Gibson (1997) concluded that the diplostomid metacercariae infection in fishes from northern Finland provided little or no association between the prevalence of infection and host-size, even though there was a distinct accumulation in the number of parasites.

With regard to the above, Burrough (1978), analyzing the population biology of *D. spathaceum* in roach *Rutilus rutilus* and rudd *Scardinius erythrophthalmus*, concluded that parasite accumulation occurred up to the time fish reached 130 mm. Unfortunately, it was not possible to compare our results with those of the latter author due to the lack of analyzed fishes measuring less than 130 mm. This fact did not depend on fishing tactics since the animals were captured with hook and net, similar to that for collection species. No distinct accumulation was reported and thereafter intensity ranged between all levels.

Table 6. Parasitological indexes and sites of infection of *Austrodiplostomum compactum* collected in fishes from Brazil.

Hosts	n	P (%)	MI	MA	Site of infection	Reference
Anostomidae						
Schizodon borellii	15	6.6	-	0.1	Aqueous humor	Yamada et al. (2008)
Auchenipteridae						
Auchenipterus osteomystax	2	50.0	-	0.5	Aqueous humor	Yamada et al. (2008)
Characidae						
Serrasalmus maculatus	3	33.3	-	0.3	Aqueous humor	Yamada et al. (2008)
Cichlidae						
Cichla monoculus	40	65.0	7.8	5.1	Cranial cavity/vitreous humor	Machado et al. (2005)
C. monoculus	136	5.2	2.7	0.1	Eyes	Machado et al. (2000)
C. ocellaris	80	56.2	6.0	5.3	Eyes	Santos et al. (2002)
C. ocellaris	66	12.5	3.5	-	Eyes	Martins et al. (2002)
Cichla sp.	23	52.1	5.9	3.0	Crystalline	Current study
Cichlasoma paranaense	25	12.0	1.0	0.1	Cranial cavity/vitreous humor	Machado et al. (2005)
Crenicichla britskii	44	22.7	6.2	1.4	Cranial cavity/vitreous humor	Machado et al. (2005)
Geophagus brasiliensis	50	14.0	1.5	0.2	Eyes	Azevedo et al. (2006)
G. surinamensis	39	46.1	13.7	6.3	Crystalline	Current study
Satanoperca pappaterra	89	71.9	8.0	5.7	Cranial cavity/vitreous humor	Machado et al. (2005)
Curimatidae						
Cyphocharax Gilbert	60	1.7	1.0	0	Eyes	Abdallah et al. (2005)
Erythrinidae						
Hoplias malabaricus	198	11.1	1.4	0.1	Cranial cavity/vitreous humor	Machado et al. (2005)
H. malabaricus	27	66.6	32.6	20.5	Crystalline	Current study
Loricariidae						
Hypostomus regani	8	25.0	-	0.1	Aqueous humor	Yamada et al. (2008)
Pimelodidae						
Conorhynchus conirostris	24	8.3	7.5	0.6	Gills/Eyes	Brasil-Sato and Santos (2005)
Pimelodus maculatus	82	17.0	1.0	0.1	Eyes	Bachmann et al. (2007)
Sciaenidae						
Plagioscion squamosissimus	378	94.3	21.6	20.2	Eyes	Paes et al. (2010)
P. squamosissimus	61	92.6	39.0	43.0	Eyes	Santos et al. (2002)
P. squamosissimus	70	52.8	2.6	-	Eyes	Martins et al. (2002)
P. squamosissimus	81	95.0	38.9	37.0	Cranial cavity/vitreous humor	Machado et al. (2005)
P. squamosissimus	17	100.0	2-100 per eye	-	Eyes	Kohn et al. (1995)
P. squamosissimus	51	98.0	44.1	43.2	Crystalline	Current study

The Brazilian records for diplostomid metacercariae parasitosis show different sites of parasite infection in the host's body, despite an apparent preference for the fish's eyes, including aqueous humor and crystalline (Table 6). Amato et al. (2001) recorded an unidentified Diplostomidae from kidney, body cavity, mesentery and brain of *Loricariichthys anus* (Valenciennes, 1835), whereas Brasil-Sato and Santos (2005) registered *A. compactum* (*D. compactum*) in the gills and eyes of *C. conirostris* (Table 6). According to Eiras (1994), reports by several authors suggest that *Diplostomum* species have their own location preferences. Bortz et al. (1988) verified that parasites collected from the hosts' retina and crystalline corresponded to populations with different epidemiological characteristics and thus different parasite species. Alternatively, the parasite infection site may be related to fish species. Whatever the mechanisms involved in parasite's preferences, more studies identifying correctly the parasite location and also a revision of the group systematics are necessary to elucidate this question. The taxonomy, especially regarding larval stages, is still unclear and several species, considered adults in nature, have never actually been observed as larvae and vice-versa (HOGLUND; THULIN, 1990).

Conclusion

Hoglund and Thulin (1990) state that fishes harboring more than 40 diplostomid metacercariae on their eyes are largely parasitized. In the present study, *P. squamosissimus* and *H. malabaricus* may therefore be considered the main host resources used by the parasite within the context of the river under analysis. It may be concluded that these fish species may not only be the most susceptible fish species but also good indicators of *Austrodiplostomum* infection.

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