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Hematological characteristics and relative condition factor (Kn) associated with parasitism in *Schizodon borellii* (Osteichthyes, Anostomidae) and *Prochilodus lineatus* (Osteichthyes, Prochilodontidae) from Paraná River, Porto Rico region, Paraná, Brazil

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ABSTRACT. Forty-two adult specimens of "piava", *Schizodon borellii* (Boulenger, 1900), and 42 adult specimens of "curimbatá", *Prochilodus lineatus* (Valenciennes, 1836), were captured in the floodplain of the upper Paraná River, PR, Brazil, in February 1994 and in March 1995. The aim of the present research was to verify changes caused by parasitism in the blood profile of the above species. The number of erythrocytes (Er), hematocrit (Ht), hemoglobin rate (Hb), percentage of leukocytes were determined and absolute hematimetric indexes, mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration were calculated. Parasites collected from gills and intestines were processed by routine methods. Nine specimens of *S. borellii* were infested with Dactylogyridae in the gills showing mean infestation intensity (MII) of 278.3 (1 to 1740) and 16 were infested with *Cucullanus pinnai* (Nematoda: Cucullanidae) in the intestine (MII = 3.3; 1 to 9). Six other fish were infested with Dactylogyridae (MII = 121.5; 2 to 360) and with *C. pinnai* (MII = 2.0; 1 to 4). No parasite infestation occurred in eleven fish. With regard to this species, no significant change in leukocytes differential counts or in the red series for parasitized fish was found. Individuals with Dactylogyridae were the only ones with special granulocytic cell and without eosinophils. Ten *P. lineatus* showed Dactylogyridae in the gills with MII = 86.9 (1 to 239), six were infested with Ergasilidae (MII = 27.5; 1 to 81), just one presented *Neoechinorhynchus curemai* (Acantocephala: Neoechinorhynchidae) in the intestine, and 25 were not parasitized. Dactylogyridae infestation in gills of this species caused only a decrease in hemoglobin rate. Significant differences occurred in Hb and in lymphocyte, neutrophil and monocyte percentages in fish infested with Ergasilidae. The specimen with *N. curemai* had low percentage of lymphocytes and a high percentage of neutrophils and monocytes. Relative condition factor (Kn) registered that parasites do not affect significantly the hosts' condition.

Key words: fish hematology, parasitism, *Schizodon borellii, Prochilodus lineatus,* Paraná River, Brazil.

RESUMO. Características hematológicas e fator de condição relativo (Kn) associados ao parasitismo em *Schizodon borellii* (Osteichthyes, Anostomidae) e *Prochilodus lineatus* (Osteichthyes, Prochilodontidae) do rio Paraná, região de Porto Rico, Paraná. Nos meses de fevereiro de 1994 e 1995, foram capturados, na planície de inundação do rio Paraná, PR, Brasil, 42 espécimes adultos de piava, *S. borellii*, e 42 espécimes adultos de curimbatá, *Prochilodus lineatus.* O objetivo era verificar as alterações no quadro hemático destas espécies causadas por parasitismo. Foram determinados o número de eritrócitos (Er), o hematócrito (Ht), a taxa de hemoglobina (Hb), a porcentagem de leucócitos e calculados os índices hematimétricos absolutos: volume corpuscular médio, hemoglobina corpuscular média e concentração de hemoglobina corpuscular média. Os

parasitos foram coletados de brânquias e intestinos e processados por métodos de rotina. Nove espécimes de *S. borellii* estavam parasitados por Dactylogyridae nas brânquias, com intensidade média de infestação(IMI)=278,3 (1 a 1740) e 16 apresentavam *Cucullanus pinnai* (Nematoda: Cucullanidae) no intestino, com IMI=3,3 (1 a 9). Outros 6 peixes estavam parasitados por Dactylogyridae com IMI=121,5 (2 a 360) e *C. pinnai* com IMI=2,0 (1 a 4). Onze peixes não apresentaram nenhuma infestação parasitária. Para esta espécie não foi encontrada nenhuma alteração significativa na contagem diferencial dos leucócitos ou na série vermelha, para os peixes parasitados. Os indivíduos com Dactylogyridae foram os únicos que apresentaram célula granulocítica especial e não tinham eosinófilos. Dez espécimens de *P. lineatus* apresentaram Dactylogyridae nas brânquias com IMI=86,9 (1 a 239), 6 tinham Ergasilidae com IMI=27,5 (1 a 81), 1 estava com 16 *Neoechinorhynchus curemai* (Acantocephala: Neoechinorhynchidae) no intestino e 25 não estavam parasitados. A infestação por Dactylogyridae nas brânquias desta espécie causou apenas uma diminuição na taxa de hemoglobina. Diferenças significativas foram encontradas em Hb e na porcentagem de linfócitos, neutrófilos e monócitos em peixes infestados por Ergasilidae. No espécime com *N. curemai* foram observadas baixa porcentagem de linfócitos e altas porcentagens de neutrófilos e monócitos. Através do fator de condição relativo (Kn) verificou-se que os parasitos não afetam de modo significativo a condição dos hospedeiros.

Palavras-chave: hematologia de peixes, parasitismo, *Schizodon borellii, Prochilodus lineatus,* rio Paraná, Brasil.

In specialized literature extant in Brazil, descriptions of various parasite species of fish are found. However, few reports deal with the parasites' activity on hosts. Rego and Pavanelli (1985) and Eiras *et al*. (1986) described lesions caused by *Jauella glandicephalus* and *Megathylacus brooksi* in the "jaú" of the Itaipu Reservoir. Pavanelli *et al.* (1990) characterized the metacercariae of *Icthyoclinostomum dimorphum* collected in the Paraná River and described histopathological damage in fish. Reichenbach-Klinke (1980), Roberts (1981) and Kinkelin *et al.* (1991) showed results on the activity of pathogenic agents in the host. However, the above information might not apply to fish species in Brazil since the former are animals from temperate regions.

Parasite diseases may also change the hematological values of fish. Mahajan and Dheer (1979) found low values of all blood parameters in species of *Channa punctatus* with parasite infections. Pilarczyk (1986) showed that there was a deviation of normal value of blood condition in specimens of *Cyprinus carpio* with bacteriosis, necrosis of the gills and parasites. Ranzani-Paiva *et al.* (1987) registered anemia in carps kept in captivity and infested by *Argulus* sp. Ranzani-Paiva *et al.* (1997) recorded significant differences in some hematological parameters and in the condition factor when examples of non-parasited *Mugil platanus* were compared with those with parasites on gills.

The aim of this research was to understand the hematological profile of the "piava", *Schizodon borellii* and "curimbatá", *Prochilodus lineatus*, captured in the floodplain of the Paraná River, Porto Rico region, PR, Brazil, verifying changes caused by parasites.

Materials and methods

The Paraná River is one of the most important river basins in South America. According to Maack (1968), the total stretch of the Paraná River, from its source in the Paranaíba River to the estuary of the Plata River, amounts to 4,695 km. Although the principal bed of the river is a big deep canyon, there are areas subject to floods or periodically flooded valleys in its course, such as the Porto Rico region in the state of Paraná (Bonetto *et al.*, 1969).

Collection was undertaken in the Porto Rico region, Paraná (22°40' to 22°50'S and 53°10' to 53°40'W) in February 1994 and in March 1995. The stretch comprises the Paraná River and its right margin affluent Baía River, marginal lakes and the channels derived from them.

Blood samples were obtained by caudal puncture with disposable heparinized syringes. With regard to red series analysis, the number of erythrocytes (Er) was determined in Neubauer chamber; hematocrit (Ht) by the microhematocrit method (Goldenfarb *et al.*, 1971); hemoglobin rate (Hb) by the cyanometahemoglobin method (Collier, 1944). The hematimetric indexes MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin) and MCHC (mean corpuscular hemoglobin concentration) were also calculated, according to Wintrobe (1934). Blood extensions stained with May-Grünwald-Giemsa were used for differential counting of leukocytes (Rosenfeld, 1947).

Fish were put down by cerebral concussion, weighed (total weight, in grams) and measured (standard length, in cm). Means and mean standard deviation were calculated for each blood analysis, weight and standard length, whether specimens

were parasitized or not.

Kn value (relative condition factor which corresponds to the quotient between real weight and theoretically expected weight for a given length) of each individual was calculated according to Verani *et al.* (1997). Mean values were obtained and compared to standard Kn = 1.0 by Student's "t" test.

Comparison of blood values and of Kn in parasitized and non-parasitized individuals was undertaken by non-parametric statistical analysis (Mann-Whitney "U" test) (Siegel, 1979). Gills were removed and processed according to Amato *et al.* (1991) for the verification of occurrence and collection of parasites.

Each fish was eviscerated by a median-ventral incision for examination of body cavity. Internal organs were placed in Petri plates with 0.65 physiological solution and examined for parasites under a stereoscopic microscope. Snout cavities, eyes and the musculature of each individual were examined too. Parasites of each group were collected, counted and prepared routinely, according to Amato *et al.* (1991). Prevalence (P%), intensity of infection/infestation and mean intensity of infection/infestation (MII) were calculated (Bush *et al.*, 1997).

Results

Forty-two adult specimens of "piava" *Schizodon borellii* (standard length between 14.5 and 25.2 cm and total weight between 55.0 and 300.7 g) and 42 adult "curimbatá" *Prochilodus lineatus* (standard length between 6.2 and 28.5 cm and total weight between 6.7 and 700.0 g) were examined.

Nine out of 42 specimens of *S. borellii* were only infested with monogeneans Dactylogyridae Family in the gills (1 to 1,740); 16 showed only *Cucullanus pinnai* (Nematoda: Cucullanidae) in the intestine (1 to 9) and 6 were parasitized by Dactylogyridae with MII = 121.5 (2 and 360) and by *C. pinnai* with MII = 2.0 (1 and 4) (Table 1). No parasites were found in 11 specimens of *S. borellii*. Parasitized specimens of *S. borellii* did not show any changes in red series (Table 2).

Lymphocytes, neutrophils, monocytes, basophils and immature cells were found in all specimens of *S. borellii*. No significant change in percentage of leukocytes of parasitized specimens could be verified. However, individuals infested solely by Dactylogyridae were the only ones with special granulocytic cells and without any eosinophils in peripheral blood (Table 3).

Ten out of 42 specimens of *P. lineatus* showed between 1 and 239 Dactylogyridae on the gills; 6 showed only Ergasilidae on the gills (1 and 81); one had 16 *Neoechinorhynchus curemai* (Acanthocephala: Neoechinorhynchidae) in the intestine, but without any Dactylogyridae or Ergasilidae; 25 were not parasitized (Table 1).

Table 1. Prevalence (P%) and mean intensity of infection/infestation (MII) of parasites of *Schizodon borellii* and *Prochilodus lineatus* from Paraná River, Porto Rico region, PR, Brazil (N = number of examined specimens; ni = number of parasitized specimens)

	Schizodon borellii				*Prochilodus lineatus*			
	N	ni	P(%)	MII	N	ni	P(%)	MII
Dactylogyridae	42	9	21.4	278.3	42	10	23.8	86.9
Cucullanus pinnai	42	16	38.1	3.3	-----	-----	-----	-----
Dactylogyridae and *Cucullanus pinnai*	42	6	-----	-----	-----	-----	-----	-----
Ergasilidae	-----	-----	-----	-----	42	6	14.3	27.5
Neoechinorhynchus curemai	-----	-----	-----	-----	42	1	2.4	16

Table 2. Mean values, standard deviation (sd) and variation ranges (Ax) of hematological variables of *Schizodon borellii* from Paraná River, Porto Rico region, PR, Brazil

	without parasites	Dactylogyridae on gills	*Cucullanus pinnai* in intestine	Dactylogyridae and *Cucullanus pinnai*
Ht ± sd	34.5 ± 2.44	32.8 ± 2.64	30.4 ± 4.16	33.2 ± 4.97
(Ax)	(25.5-49.5)	(29.0-37.5)	(22.0-38.5)	(29.5-42.5)
Hb ± sd	7.7 ± 0.97	7.4 ± 1.52	7.4 ± 0.90	7.5 ± 0.83
(Ax)	(6.6-9.8)	(3.8-8.9)	(5.9-9.1)	(6.5-8.7)
Er ± sd	209.1 ± 23.68	212.3 ± 33.94	187.6 ± 27.91	211.3 ± 53.49
(Ax)	(169.5-248.0)	(153.0-266.5)	(144.0-254.0)	(125.5-268.5)
MCV ± sd	166.6 ± 39.88	157.9 ± 27.22	164.9 ± 30.71	168.2 ± 60.02
(Ax)	(104.8-236.8)	(116.3-209.2)	(114.0-216.7)	(114.2-274.9)
MCH ± sd	36.9 ± 3.35	34.9 ± 6.88	40.0 ± 5.31	37.5 ± 9.63
(Ax)	(32.6-45.1)	(21.9-43.1)	(30.9-50.4)	(30.0-55.8)
MCHC ± sd	23.1 ± 4.45	22.3 ± 4.14	24.7 ± 3.64	23.3 ± 4.66
(Ax)	(16.6-32.5)	(13.2-26.0)	(20.3-32.0)	(15.2-26.9)

Ht = hematocrit (%); Hb = hemoglobin rate (g/100 ml); Er = number of erythrocytes (10^4/mm^3); MCV = mean corpuscular volume (μ^3); MCH = mean corpuscular hemoglobin (ppg); MCHC = mean corpuscular hemoglobin concentration (%)

Table 3. Mean values of leukocytes percentages in peripheral blood of *Schizodon borellii* from Paraná River, Porto Rico region, PR, Brazil

	Without parasites	Dactylogyridae on the gills	*Cucullanus pinnai* in the intestine	Dactylogyridae and *Cucullanus pinnai*
Lymphocytes	31.08	27.43	31.41	29.90
Neutrophils	45.76	56.30	54.88	61.45
Monocytes	14.36	8.66	9.93	6.52
Basophils	0.29	0.41	0.15	0.23
Eosinophils	2.69	0.00	0.14	0.33
SCG	0.00	0.10	0.00	0.17
Immature cells	5.56	6.89	3.49	2.90
Other cells	0.23	0.33	0.00	0.00

SGC = Special granulocytic cells

It seems that the presence of Dactylogyridae on the gills of *P. lineatus* decreases hemoglobin

percentage (Table 4) but does not change the percentage of leukocytes in the peripheral blood (Table 5). Significant differences were obtained when Hb values of individual parasitized by Dactylogyridae were compared with those of non-parasitized specimens (p=0.02). Significant differences were also verified when Hb values (p=0.01) and Ht (p=0.04) of fish parasitized by Dactylogyridae were compared with those of fish infested by Ergasilidae.

Table 4. Mean values, standard deviations (sd) and variation ranges (Ax) of hematological variables of *Prochilodus lineatus* from Paraná River, Porto Rico region, PR, Brazil

	Without parasites	Dactylogyridae on the gills	Ergasilidae on the gills	*Neoechinorhynchus curemai* in the intestine
Ht ± sd (Ax)	39.4 ± 7.37 (22.0-56.5)	37.3 ± 5.49 (25.0-44.5)	44.2 ± 5.98 (35.0-52.5)	53.0
Hb ± sd (Ax)	9.7 ± 1.74 (4.7-14.9)	8.7 ± 0.89 (7.5-10.6)	10.5 ± 1.04 (9.2-12.2)	11.2
Er ± sd (Ax)	233.1 ± 35.85 (155.5-292.5)	221.7 ± 31.51 (186.5-287.5)	253.4 ± 35.58 (218.5-314.0)	306.5
MCV ± sd (Ax)	169.3 ± 21.89 (132.4-207.7)	170.9 ± 31.75 (108.9-204.2)	175.3 ± 20.13 (141.7-194.8)	172.9
MCH ± sd (Ax)	41.6 ± 5.66 (30.5-52.9)	39.9 ± 5.38 (32.5-50.3)	41.6 ± 4.31 (33.8-45.4)	36.5
MCHC ± sd (Ax)	24.78 ± 3.25 (17.2-31.3)	23.87 ± 4.52 (18.5-34.8)	23.8 ± 1.56 (21.8-26.3)	21.1

Ht = hematocrit (%); Hb = hemoglobin rate (g/100 ml); Er = number of erythrocytes (10^4/mm^3); MCV = mean corpuscular volume (μ^3); MCH = mean corpuscular hemoglobin (ppg); MCHC = mean corpuscular hemoglobin concentration (%)

Table 5. Mean values of leukocytes percentages in peripheral blood of *Prochilodus lineatus* from Paraná River, Porto Rico region, PR, Brazil

	Without parasites	Dactylogyridae in the gills	Ergasilidae on the gills	*Neoechinorhynchus curemai* in the intestine
Lymphocytes	38.2	29.2	22.0	11.3
Neutrophils	42.8	44.5	63.9	38.7
Monocytes	9.6	18.4	5.6	42.5
Basophils	0.9	0.5	0.0	0.0
Eosinophils	0.5	0.3	0.2	0.0
SCG	0.5	0.0	0.0	0.0
Immature cells	6.4	6.5	7.2	7.5
Other cells	1.1	0.6	1.1	0.0

SGC = Special granulocytic cells

Lymphocytes, neutrophils, monocytes, basophils, eosinophils, special granulocytic cells (SGC) and immature cells were found in individuals of *P. lineatus*. It seems that the presence of Ergasilidae on gills does not cause any changes in the red blood series (Table 4), but affects the leukocyte series (Table 5). Parasitized fish showed significant differences in percentage of neutrophils (p=0.03) when compared with non-parasitized individuals. Lower percentage of lymphocytes and a higher percentage of monocytes were also verified. Differences were not statistically significant.

Table 6. Mean values of relative condition factor (Kn), total weight (Wt) and standard length (Ls) with respective confidence intervals (CI) and results of Student's "t" test for specimens of *Schizodon borellii* from Paraná River, Porto Rico region, PR, Brazil, with or without parasites (N=number of specimens)

	Without parasites	Dactylogyridae	*Cuculannus pinnai*	Dactylogyridae and *Cuculannus pinnai*
Kn ± CI (range)	0.98 ± 0.15 (0.62-1.16)	0.92 ± 0.17 (0.10-1.11)	1.02 ± 0.05 (0.80-1.16)	0.98 ± 0.09 (0.86-1.04)
N	8	12	15	5
"t" Test. H_0:Kn=1.0	0.72	0.30	0.51	0.54
Wt ± CI (range)	168.13 ± 48.29 (55.00-221.90)	179.28 ± 32.15 (111.50-283.10)	192.19 ± 29.49 (115.20-300.70)	184.38 ± 86.71 (111.50-283.10)
Ls ± CI (range)	20.1 ± 1.85 (14.5-25.2)	19.8 ± 0.95 (18.1-23.0)	20.3 ± 1.02 (17.2-23.9)	19.8 ± 2.13 (18.1-23.0)

Table 7. Means values of condition factor (Kn), total weight (Wt) and standard length (Ls) with respective confidence intervals (CI) and results of Student's "t" test for specimens of *Prochilodus lineatus* from Paraná River, Porto Rico region, PR, Brazil, with or without parasites (N=number of specimens)

	without parasites	Dactylogyridae	Ergasilidae
Kn ± CI (range)	1.01 ± 0.09 (0.44-1.31)	0.91 ± 0.14 (0.61-1.09)	1.00 ± 0.11 (0.89-1.13)
N	22	8	5
"t" Test. H_0:Kn=1.0	0.89	0.18	0.98
Wt ± CI (range)	336.43 ± 72.73 (6.70-700.00)	301.95 ± 74.93 (217.50-505.40)	402.22 ± 114.59 (300.00-550.00)
Ls ± CI (range)	22.9 ± 1.80 (6.2-28.4)	23.8 ± 1.79 (20.5-27.4)	25.5 ± 2.29 (22.0-28.5)

The *P. lineatus* specimen with 16 *N. curemai* individuals in the intestine had a low percentage of lymphocytes and a high percentage of monocytes in periphery blood when compared with all the other specimens (Table 5). No basophils, eosinophils or SGC were found.

It has been verified by analysis of relative condition factor (Kn) that in the two species studied the presence of parasites did not significantly affect the hosts' condition. Total weight of non-parasitized and parasitized specimens was close to the theoretically expected weight (Kn=1.0) (Tables 6 and 7).

Discussion

The undeniable characteristic of parasitism is the harm done to the host, even if it cannot be quantified. Changes in environmental factors beyond certain limits, which may vary from fish to fish, may predispose fish to parasite attacks or may propitiate other illnesses. Parasites decrease the oxygen uptake and thus the performance of fish (Tort and Torres, 1988).

In the two fish species under analysis prevalence of parasitism by Dactylogyridae was practically the same. However, MII in *S. borellii* was higher than that in *P. lineatus.* Only *P. lineatus* presented significantly lower mean values of hemoglobin rate in parasitized fish. This fact may be related to difference in animal response to the same pathogenic agent. Monogeneans superficially attach the gill epithelium and could cause some harm to fish. However, some non-pathogenic species may induce an excessive production of mucus through the filaments and thus reduce the breathing capacity of the hosts. Ranzani-Paiva *et al.* (1997) did not find any significant difference in mean values of blood variables in *Mugil platanus* infested by monogeneans.

Eosinophils are extremely rare or totally absent in the fish blood. According to Pitombeira (1972), this leukocyte is more abundant in intestine submucus, peritoneal fluid and gills. This cell frequency increased in *C. carpio* infested by *Argulus* sp. and decreased after treatment with organophosphorus (Ranzani-Paiva *et al.*, 1997). Saunders (1966) found eosinophils in 70 fish species out of 610 studied. The same author infers that it is very difficult to relate the presence of this cell with disease or parasitism in fish. In this research the highest percentage of eosinophils was found in non-parasitized *S. borellii*.

In fish infested by copepods, Ranzani-Paiva *et al.* (1997) recorded a significant increase in MCHC related to the increase of infestation intensity.

According to Einzporn-Orecka (1970), parasite copepods of fish damage the respiratory epithelium of the gill filaments, especially by their swimming appendixes. According to Thatcher and Boeger (1983) and Thatcher (1991), ergasilids cause epithelial hyperplasia, metaplasia and lamellar fusion in the gill filaments of their host. Thus, they reduce blood circulation in the filaments and cause necrosis. Natarajan and Felix (1987) registered a drastic decrease in Er, Hb and Ht and an increase in MCV, MCH and MCHC in *Mystus gulio*, infested with many parasites, including *Ergasilus* sp. when compared with non-infested fish. At the start of infestation there is an increase in values of hematological variables. In total leukocytes counts and in their relative frequency an increase of lymphocytes in parasitized fish and a great number of granulocytics in non-parasitized ones occurred. Changes in red series were not registered in specimens of *P. lineatus* of the Paraná River parasitized by ergasilids. However, these specimens had a lower percentage of lymphocytes and monocytes and a higher percentage of neutrophils than those found in non-parasitized ones. Similar results were obtained by Silva-Souza *et al.* (1999, in press) in *Schizodon intermedius* infested by *Lernaea cyprinacea*.

Nematodes frequently found in the fish intestines cause serious ulceration, oedema and spoliation. Damages in hosts are caused by attack and feeding activities of the parasite, by competition for food between parasites and host or, perhaps, by toxic effect of the parasite's metabolic remains. In the present research, nematodes do not seem to affect the hosts' blood condition. Sakanari *et al.* (1984) registered that fish infected by nematodes *Anisakis* spp. had significant lower hematocrit values than that in non-parasitized ones.

Infection by acanthocephalans is low in neotropical fish. Some species insert their proboscis in the intestine wall and cause localized inflammatory reactions (Thatcher, 1991). The *P. lineatus* with 16 specimens of *N. curemai* in the intestine showed a high percentage of monocytes when compared with the other individuals and data found by Ranzani-Paiva and Godinho (1983) for the same species in the Mogi-Guaçu River. This fact may be related to the fixation hooks of the acanthocephalans proboscis.

Damage from parasite infections are not easily found in natural populations. The individual's "comfort" parameter commonly used to establish such relationships has been the condition factor (K) of Le Cren (1951). Accordingly, the factor is totally dependent on the length and weight of analyzed animals (Verani *et al.*, 1997). Due to this item, the relative condition factor (Kn) defined by Le Cren (1951) and applied by Eckmann (1984) was chosen to evaluate the influence of parasitism in the general health state of the specimens studied. Measurements and standard deviation of Kn give a better foundation for statistical comparisons than tests comparing *a* and *b* values of weight/length relationship. Besides, the method allows the statistical comparison of estimated Kn values with centralizing value 1.0 (Verani *et al.*, 1997).

With regards to Kn, it has been verified that all analyzed fish had total weight close to that expected for each standard length. This means that fish parasitized by different groups of parasites do not show any condition change. Opposite results were given by Silva-Souza (1998) for specimens of *Plagioscion squamosissimus* infected by metacercariae of *Diplostomum (Austrodiplostomum) compactum.*

In conclusion, all parasitized and non-parasitized animals of the *Schizodon borellii* species studied showed a relatively altered blood condition

which made the establishment of any relationship with parasitism difficult. However, in the case of *Prochilodus lineatus*, blood changes were caused by dactylogyrid monogeneas and ergasilids on the gills and by acanthocephalans in the intestine.

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