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Hematological evaluation in commercial fish species from the floodplain of the upper Paraná River, Brazil

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ABSTRACT. In February 1994 and in March 1995 one hundred and forty-four four specimens of teleosts were analyzed. They belonged to the 20 most representative species from the Paraná River basin, state of Paraná and Mato Grosso do Sul, Brazil. Blood samples were collected from caudal peduncle to determine the number of erythrocytes (Er), hematocrit (Ht), hemoglobin rate (Hb) and differential percentage of leukocytes. Total hematometric indexes (mean corpuscle volume, mean corpuscle hemoglobin and mean corpuscular hemoglobin concentration) were estimated. Hematological parameters related to sex and gonadal maturation stages were undertaken for *Prochilodus lineatus* and *Schizodon borellii*. In these species significant differences between the gonadal maturation stages, with lowest values in the resting stage were found. Lymphocytes, monocytes, neutrophils, basophils, eosinophils, special granulocytic cells and immature cells were registered in the leukocyte differential count. As a general rule, neutrophil, followed by lymphocytes, was the most frequent cell recorded in the peripheral blood of most species. High percentage of eosinophils in the peripheral blood of some Siluriforms was observed.

Key words: fish hematology, commercial species, Paraná River, Brazil.

RESUMO. Avaliação hematológica de espécies de peixe de valor comercial da planície de inundação do rio Paraná, Brasil. Em fevereiro de 1994 e março de 1995, foram analisados 144 exemplares pertencentes a 20 espécies mais representativas da bacia do rio Paraná, Estado do Paraná e Mato Grosso do Sul, Brasil. Retirou-se sangue para as determinações de: número de eritrócitos; hematócrito; taxa de hemoglobina; contagem diferencial dos leucócitos e cálculo dos índices hematimétricos absolutos: volume corpuscular médio, hemoglobina corpuscular média e concentração de hemoglobina corpuscular média. Para *P. lineatus e S. borellii* foi possível fazer uma análise mais detalhada, considerando-se os sexos e os estádios de maturação gonadal. Para estas espécies, encontraram-se diferenças significativas entre os estádios de maturação gonadal, com valores mais baixos no estádio de repouso. Na contagem diferencial dos leucócitos, foram encontrados os seguintes leucócitos: linfócitos, monócitos, neutrófilos, basófilos, eosinófilos, célula granulocítica especial e algumas células de aspecto imaturo. De maneira geral, para a maioria das espécies, o neutrófilo é a célula mais freqüente, seguida pelo linfócito. Os eosinófilos estiveram presentes em maior porcentagem no sangue periférico de alguns Siluriformes.

Palavras-chave: hematologia de peixes, espécies comerciais, rio Paraná, Brasil.

The blood of fish has been studied under two aspects. It has been studied to determine the hematological picture of species in their natural environment so that values of each species could be standardized and so that factors that alter them could be verified. It has also been undertaken in fish living in captivity so that abnormalities occurring in the context of temperature variations, dissolved oxygen and other factors and in the context of diseases in confined fish could be detected.

It seems obvious that before one decides what may be considered normal, it is necessary to understand the variation amplitude of the normal situation. When sufficient data with regard to normality standards are available, variations over and above established poles may be considered abnormal (Saunders, 1966). In this context, the hematological situation of some species of fresh water fish captured in their natural environment has been studied by Ribeiro (1978), Ranzani-Paiva and Godinho (1983, 1985), Kavamoto *et al*. (1983, 1985), Silva (1987), Amadio (1985), Ranzani-Paiva and Eiras (1992) and Rodrigues (1999).

The present research aims at establishing hematological values of some species of commercial fish of the Paraná River basin, state of Paraná and Mato Grosso do Sul, Brazil. Its principal aim is to give more information for diagnosis, prevention and treatment of disease in fish, especially commercial species.

Material and methods

The Paraná River is one of the most important hydrographical basins in South America. According to Maack (1981), the Paraná River has a total length of 4,695 km from its source in the Paranaíba River to the Plata estuary. Although its principal bed consists of a big deep canyon, it has many areas subjected to floods or periodically flooded plains along its course, as, it is the case of the Paraná River basin, state of Paraná and Mato Grosso do Sul, Brazil (Bonetto *et al*., 1969).

Two captures in February 1994 and in March 1995 were undertaken in the Porto Rico region (22° 40' to 22° 50'S and 53° 10' to 53° 40'W). The sampling stretch comprised the Paraná River and its right margin affluent, the Baía River, the marginal lakes and the channels derived from them. Fish belonging to the most representative species in number and from a commercial point of view were studied, according to orders:

Characiformes: *Schizodon borellii* (piava); *Prochilodus lineatus* (curimbatá); *Serrasalmus marginatus* (piranha); *Serrasalmus spilopleura* (pirambeba); *Hoplias malabaricus* (traíra); *Leporinus obtusidens* (piapara); *Raphiodon vulpinus* (dourado-cachorro); *Piaractus mesopotamicus* (pacu); *Leporinus lacustris* (piau); *Brycon orbignyanus* (piracanjuba);

Siluriformes: *Hypostomus* sp. (cascudo); *Pimelodus maculatus* (mandi); *Pseudoplatystoma corruscans* (pintado); *Loricariichthys platymetopon* (cascudo-chinelo); *Parauchenipterus galeatus* (cangati); *Hypostomus* aff. *derbyi* (cascudo); *Pimelodella gracilis* (mandizinho); *Pterodoras granulosus* (armado); *Pinirampus pirinampu* (barbado);

Perciform: *Cichla monoculus* (tucunaré).

Gill and trammel nets and boulters were used. Fishing apparatus was laid for three days with night-morning, day and night-evening visits.

Blood was collected through caudal puncture by syringe and disposable heparinized needles. Number of erythrocytes (Er) in Neubauer chamber; hematocrit (Ht) by the microhematometric method, according to Goldenfarb *et al*. (1971); hemoglobin rate (Hb) by the cyanometahemoglobin method, according to Collier (1944); leukocyte differential counts in blood extensions stained by May-Grünwald-Giemsa method, according to Rosenfeld (1947) were determined. Total hematimetrical indexes, or rather, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were calculated with the results obtained for number of erythrocytes (Er), hematocrit (Ht) and hemoglobin rate (Hb) (Wintrobe, 1934).

Data on total length (Lt), standard length (Ls), total weight (Wt), sex, stage of gonadal maturation were analyzed for each fish (Nikolsky, 1963). The last items were determined after median-longitudinal ventral incision and organ exposition.

Means and mean standard deviations of species captured with more than two representatives were calculated. Calculation of means with regard to sex and the stages of gonadal maturation in *S. borellii* and *P. lineatus* was possible.

Student's "t" test at 95% significance was employed to verify whether differences between male and female and between stages of gonadal maturation were significant (Pimentel Gomes, 1982).

Results and discussion

One hundred and forty-four (144) specimens out of 20 fish species were examined for blood analysis. Variation range, mean and standard deviation of mean blood parameters for each fish are shown in Tables 1 and 2. Values are within variation for other teleost species (Ribeiro, 1972; Ranzani-Paiva and Godinho, 1983, 1985; Ranzani-Paiva and Eiras, 1992).

Table 1 shows that the lowest values of hematological values (Ht, Hb and Er) may be found in the Siluriformes fish *P. granulosus, P. gracilis, Hypostomus* sp.*, L. platymetopon, H.* aff. *derbyi* and *P. corruscans.* High rate of MCV and MCH in *Hypostomus* sp. indicate that, although in a lesser quantity, cells have a larger volume and greater quantity of hemoglobin. For the Characiformes *R. vulpinus* the highest values in all species analyzed were registered. The two specimens of *C. monoculus,* Perciformes, showed very high hematocrit values, averaging 58.0 ± 1.0%, rarely found in fish. Highest values of red series have been registered in migratory fish (*P. lineatus, S. marginatus, P. maculatus*). Although *H. malabaricus* has sedentary habits, mean values were relatively high comparing with other fish species. The high values founded in *P. galeatus* and *S. spilopleura* could not be explained since there were few specimens analyzed.

Specimens of *P. gracilis* and *L. lacustris* showed very low values of Hb, MCH and MCHC. These values may indicate an anemic process. However, only one individual of each species was sampled.

There may be a certain relationship between hematological values and behavior in fish (Hall and Gray, 1929; Gray, 1946; Ranzani-Paiva and Godinho, 1985) since migratory and lotic environmental species have the highest values. Weels *et al*. (1980) stated that migratory fish have high hemoglobin rate which may be explained by the need for high energy waste. Val *et al*. (1985) compared assemblages of *Hypostomus regani* of lotic and lentic environments but no significant differences in Hb values have been recorded.

In the leukocytes differential counting the following cells were observed: lymphocytes, monocytes, neutrophils, eosinophils, special granulocytic cell, some apparently immature cells and other non-identified ones. Table 2 shows that all species had lymphocytes, neutrophils and monocytes. Neutrophil was the most frequent and lymphocyte came next. Similar results were obtained by Ranzani-Paiva and Eiras (1992) for other species captured in the Paraná River, Porto Rico region, PR, Brazil. Eosinophils in 11 species and at a higher percentage in the peripheral blood of *Hypostomus* sp. were reported. Immature cells were found in almost all species with the exception of *R. vulpinus* and *P. granulosus*. Basophils were absent in 14 out of 20 species, but occurred in a higher percentage in *L. lacustris* blood. It should be recalled that this was the same fish with lowest Hb, MCH and MCHC.

Table 1. Range (Ax), means ($\bar{x}$) and standard deviations of means ($S\bar{x}$) of blood parameters of teleost species captured in the Paraná River, Porto Rico region, PR, Brazil (n=number of specimens)

Species		Ht (%)	Hb (g/100ml)	Er (10^4/mm^3)	MCV (μm^3)	MCH (pg)	MCHC (%)
S. borellii	Ax	22,0 - 49,5	3,8 - 9,8	125,0 - 268,5	104,8 - 274,9	21,9 - 55,8	13,2 - 32,5
n = 42	$\bar{x} \pm S\bar{x}$	32,4 ± 0,8	7,5 ± 0,1	201,9 ± 5,2	164,3 ± 5,6	37,7 ± 0,9	23,6 ± 0,6
P. lineatus	Ax	22,0 - 56,5	4,7 - 14,9	155,5 - 314,0	108,9 - 221,6	30,5 - 158,2	17,2 - 104,0
n = 42	$\bar{x} \pm S\bar{x}$	40,1 ± 1,1	9,7 ± 0,2	234,4 ± 5,8	172,0 ± 3,8	41,3 ± 0,8	24,4 ± 0,5
S. marginatus	Ax	26,0 - 40,5	4,9 - 9,6	178,0 - 306,0	120,9 - 195,7	25,0 - 39,3	18,5 - 26,0
n = 12	$\bar{x} \pm S\bar{x}$	34,8 ± 1,2	7,6 ± 0,4	229,1 ± 10,5	154,3 ± 7,1	33,3 ± 1,2	21,8 ± 0,7
Hypostomus sp.	Ax	19,0 - 34,0	4,2 - 6,4	66,5 - 107,0	285,7 - 388,2	42,1 - 74,8	14,7 - 21,6
n = 11	$\bar{x} \pm S\bar{x}$	29,3 ± 1,6	4,8 ± 0,4	92,4 ± 4,4	325,2 ± 12,4	45,6 ± 7,0	16,5 ± 1,2
P. maculatus	Ax	29,0 - 43,5	4,0 - 9,2	136,5 - 258,0	131,8 - 221,0	28,7 - 46,1	13,8 - 24,1
n = 6	$\bar{x} \pm S\bar{x}$	36,3 ± 2,1	7,3 ± 0,8	204,5 ± 17,8	183,0 ± 15,8	35,7 ± 3,2	19,8 ± 1,5
P. corruscans	Ax	20,0 - 29,0	3,1 - 6,1	111,0 - 188,5	114,3 - 185,7	25,7 - 35,5	15,7 - 22,5
n = 5	$\bar{x} \pm S\bar{x}$	26,0 ± 2,9	4,9 ± 0,5	158,8 ± 14,0	165,2 ± 13,2	30,6 ± 1,7	18,8 ± 1,1
H. malabaricus	Ax	24,0 - 36,5	5,9 - 7,2	189,5 - 225,5	106,4 - 181,1	29,3 - 35,7	19,7 - 27,5
n = 4	$\bar{x} \pm S\bar{x}$	30,1 ± 2,8	6,6 ± 0,2	204,6 + 7,5	148,4 ± 16,0	32,2 ± 1,3	22,3 ± 1,8
L. platymetopon	Ax	17,0 - 30,5	3,1 - 6,8	82,0 - 141,0	176,0 - 216,4	35,8 - 48,2	18,4 - 23,1
n = 4	$\bar{x} \pm S\bar{x}$	21,4 ± 3,1	4,6 ± 0,8	106,8 ± 13,7	200,0 ± 9,4	42,3 ± 2,7	21,2 ± 1,0
P. galeatus	Ax	30,5 - 31,5	6,6 - 7,2	160,0 - 199,0	158,3 - 170,9	36,4 - 41,3	23,0 - 23,0
n = 3	$\bar{x} \pm S\bar{x}$	31,0 ± 0,4	7,0 ± 0,2	179,2 ± 19,5	164,6 ± 5,1	39,0 ± 1,4	23,0
S. spilopleura	Ax	32,0 - 38,5	7,7 - 9,2	193,0 - 249,0	128,5 - 199,5	36,9 - 39,9	20,0 - 28,8
n = 3	$\bar{x} \pm S\bar{x}$	34,8 ± 1,9	8,3 ± 0,5	216,7 ± 16,7	163,8 ± 20,5	38,4 ± 0,9	24,0 ± 2,5
H. aff. *derbyi*	Ax	30,0 - 34,5	7,5 - 9,8	118,5 - 182,5	189,0 - 253,2	53,5 - 63	24,9 - 28,3
n = 2	$\bar{x} \pm S\bar{x}$	32,3 ± 2,3	8,6 ± 1,1	150,5 ± 32,0	221,1 ± 32,0	58,3 ± 4,8	26,6 ± 1,7
C. monoculus	Ax	57,0 - 59,0	7,7 - 8,7	286,0 - 301,5	195,7 - 199,3	26,9 - 28,9	13,5 - 14,7
n = 2	$\bar{x} \pm S\bar{x}$	58,0 ± 1,0	8,2 ± 0,5	293,8 ± 7,8	197,5 ± 1,8	27,9 ± 1,0	14,1 ± 0,6
L. obtusidens n=1		38,0	8,2	221,0	171,9	37,1	21,6
R. vulpinus (n=1		44,0	9,8	311,0	141,5	31,4	22,2
P. gracilis n=1		16,5	3,1	122,0	135,2	25,7	19,0
P. granulosus n=1		19,0	4,9	81,5	233,1	60,5	25,9
P. mesopotamicus n=1		36,5	8,7	166,0	219,9	52,4	23,8
L. lacustris n=1		27,0	2,0	138,5	194,9	14,4	7,4
B. orbignyanus n=1		42,0	7,2	227,0	185,0	31,7	17,1
P. pirinampu n=1		35,0	7,7	223,0	157,0	34,6	22,0

Ht=hematocrit; Hb=hemoglobin rate; Er=erythrocytes number; MCV=mean corpuscular volume; MCH=mean corpuscular hemoglobin; MCHC=mean corpuscular hemoglobin concentration

Immature cells are frequent in the peripheral blood of fish. According to Ribeiro (1978), these cells would be the precursory cells of various cell strains which he called lymphoplasmocytoid and small hemoblast.

Tables 3 and 4 show means and standard deviation of means and "t" test results of blood of *Schizodon borellii* and *Prochilodus lineatus* considering sex. It may be seen that in the two species there is no difference between means of males and females. Present results agree with the others found in literature that changes in the fish blood are chiefly related to the type of life of the species (Hall and Gray, 1929; Gray, 1946; Val *et al.*, 1985), to the gonadal maturation stages (Ranzani-Paiva and Godinho, 1983, 1985; Ranzani-Paiva, 1995 a and b) and to pathological processes (Ranzani-Paiva *et al.*, 1997).

When the stages of gonadal maturity are taken into account, only individuals in the undifferentiated, immature, resting, mature and regression stages were collected. Most of them were in the resting stage.

The lowest mean hemocrit value in *S. borellii* was related in the resting stage (Table 5), significantly different from that in immature (p=0.03) and mature (p=0.01) stages. With regard to MCV, significant difference has been found between resting and mature stages (p=0.002), since mature individuals had a smaller number of cells with greater volume. In the case of leukocyte percentages (Table 6) significant differences were observed between the resting and the regression stages for lymphocytes (p=0.0001), neutrophils (p=0.01) and basophils (p=0.03). Individuals in regression showed higher percentage in lymphocytes and basophils and lower percentage in neutrophils when other stages are taken into account.

Table 2. Range (Ax), means ($\bar{x}$) and standard deviation of means (S $\bar{x}$) of leukocytes differential counts of teleost species captured in the Paraná River, Porto Rico region, PR, Brazil

Species		Lf (%)	Nt(%)	Mn(%)	Bs(%)	Es(%)	SCG(%)	Imat(%)	Ot(%)
S. borellii	Ax	7,3 - 93,3	0,0 - 87,8	0,0 - 65,4	0,0 - 2,7	0,0 -27,0	0,0 - 1,0	0,0 - 22,8	0,0 - 2,0
n = 42	$\bar{x} \pm S\bar{x}$	30,3 ± 19,8	53,7 ± 21,6	10,3 ± 12,2	0,3 ± 0,6	0,8 ± 4,2	4,7 ± 5,2	0,1 ± 0,4	0,04 ± 0,2
P. lineatus	A	2,4 - 78,6	6,0 - 89,4	0,0 - 43,3	0,0 - 7,4	0,0 - 2,0	0,0 - 3,4	0,0 - 24,9	0,0 - 14,2
n = 39	$\bar{x} \pm S\bar{x}$	30,9 ± 2,9	48,5 ± 3,4	12,1 ± 2,1	0,6 ± 0,2	0,3 ± 0,1	6,5 ± 1,0	0,9 ± 0,4	0,3 ± 0,1
S. marginatus	Ax	13,3 - 79,6	4,8 - 58,0	7,6 - 48,2	0	0,0 - 1,7	0,0 - 12,9	0,0 - 25,2	0
n = 12	$\bar{x} \pm S\bar{x}$	38,7 ± 5,7	34,8 ± 5,4	18,2 ± 3,6	0	0,1 ± 0,1	1,8 ± 1,1	6,4 ± 2,2	0
Hypostomus sp.	Ax	10,0 - 72,6	0,0 - 72,5	0,0 - 15,8	0	0,0 - 87,8	0	0,0 - 3,8	0
n = 11	$\bar{x} \pm S\bar{x}$	23,6 ± 5,5	10,1 ± 6,7	3,1 ± 1,4	0	62,8 ± 9,7	0	0,7 ± 0,4	0
P. maculatus	Ax	7,5 - 72,2	8,5 - 82,1	1,5 - 50,9	0,0 - 0,9	0,0 - 1,0	0,0 - 4,0	0,0 - 12,9	0
n = 6	$\bar{x} \pm S\bar{x}$	29.9 ± 9,5	51,4 ± 12,0	13,1 ± 7,7	0,2 ± 0,2	0,2 ± 0,2	0,8 ± 0,6	4,5 ± 0,6	0
P. corruscans	Ax	6,7 - 44,3	17,1 - 68,9	0,0 - 60,0	0	0,0 - 8,1	0,0 - 11,7	0,9 - 5,7	0,0 - 8,8
n = 5	$\bar{x} \pm S\bar{x}$	28,8 ± 6,4	40,0 ± 10,0	18,6 ± 11,1	0	2,2 ± 1,5	5,8 ± 2,4	2,8 ± 0,8	1,8 + 1,7
H. malabaricus	Ax	27,4 - 72,1	19,9 - 67,2	2,5 - 8,0	0	0	0,0 - 1,0	0,0 - 10,1	0
n = 4	$\bar{x} \pm S\bar{x}$	43,4 ± 10,3	48,1 ± 10,1	4,5 ± 1,3	0	0	0,3 ± 0,2	3,9 ± 2,1	0
L. platymetopon	Ax	36,6 - 63,8	0,0 - 42,8	0,9 - 6,5	0,0 - 1,0	0,0 - 59,4	0	0,0 - 3,7	0
n = 4	$\bar{x} \pm S\bar{x}$	52,5 ± 5,9	28,4 ± 9,6	2,3 ± 1,4	0,3 ± 0,3	14,9 ± 14,9	0	1,7 ± 0,8	0
P. galeatus	Ax	14,4 - 47,1	48,0 - 81,7	1,4 - 1,6	0	0,0 - 2,4	0	0,4 - 2,4	0
n = 3	$\bar{x} \pm S\bar{x}$	26,3 ± 10,4	70,1 ± 11,0	1,5 ± 0,05	0	0,8 ± 0,8	0	1,2 ± 0,6	0
S. spilopleura	Ax	16,7 - 36,2	49,5 - 57,6	10,0 - 14,3	0	0,0 - 1,0	0,0 - 2,0	0,0 - 14,8	0
n = 3	$\bar{x} \pm S\bar{x}$	26,0 ± 5,6	54,0 ± 2,4	11,7 ± 1,3	0	0,3 ± 0,3	0,7 ± 0,7	7,3 ± 4,3	0
H. aff *derbyi*	Ax	7,4 - 8,5	87,5 - 91,1	1,5	0	0	0	0,0 - 2,5	0
n = 2	$\bar{x} \pm S\bar{x}$	8,0 ± 0,6	89,3 ± 1,8	1,5	0	0	0	1,3 ± 1,3	0
C. monoculus	Ax	31,7 - 86,7	6,7 - 57,4	4,8 - 6,9	0	0	0	1,9 - 4,0	0
n = 2	$\bar{x} \pm S\bar{x}$	59,2 ± 27,5	32,1 ± 25,4	5,9 ± 1,1	0	0	0	3,0 ± 1,1	0
L. obtusidens n=1		28,7	62,2	1,4	2,9	0	0	4,8	0
R. vulpinus n=1		40,2	57,8	2,0	0	0	0	0	0
P. gracilis n=1		44,8	42,9	6,7	0	0	0	5,7	0
P. granulosus n=1		10,4	88,1	1,5	0	0	0	0	0
P. mesopotamicus n=1		54,5	33,2	4,7	0	3,3	1,9	2,4	0
L. lacustris n=1		33	55,1	1,8	6,6	0	0	3,5	0
B. orbignyanus n=1		71,3	10,9	10,9	0	0	0	5,9	1
P. pirinampu n=1		65,3	20,8	2	0	5,9	2	4	0

(n=number of specimens; Lf=lymphocytes; Nt=neutrophils; Mn=monocytes; Bs=basophils; Es=eosinophils; SCG=special granulocytic cells; Im=immature cells; Ot= other cells)

It has generally been verified that during gonadal maturation of this species a decrease in the number of erythrocytes occurred together with an increase in their volume and in the quantity of hemoglobin in each of them.

The same trend has been recorded in P. lineatus, but with decrease of hemoglobin concentration in the erythrocytes. Similar data have been registered by Ranzani-Paiva and Godinho (1985) and these values may be related to the migratory activity of the species.

No significant differences between percentages of different cell types, between immature and resting stages were registered for leukocytes of peripheral blood of *P. lineatus*. Mature and undifferentiated individuals had very high percentages of neutrophil when compared to those of other stages. Ranzani-Paiva and Godinho (1983) recorded the neutrophil as the most frequent leukocyte in the blood of *P. lineatus*.

Table 3. Means ($\bar{x}$), standard deviations of means (S $\bar{x}$) and Student's "t" test results (P) of hematological parameters of *S. borellii* and *P. lineatus* collected in the Paraná River, Porto Rico region, PR, Brazil (P>0,05).

Species	Sex		Hematological parameters					
			Ht (%)	Hb (g/100 ml)	Er (10^4/mm^3)	MCV (μ^3)	MCH (ppg)	MCHC (%)
S. borellii	M (n = 13)	Ax	22,0 - 38,5	3,8 - 9,1	125,5 - 266,5	102,4 - 306,8	21,9 - 55,8	13,2 - 32,0
		$\bar{x}$	31.7	7.5	196.5	168.4	39.4	23.7
		S $\bar{x}$	0.7	0.4	10.8	7.1	2.1	1.2
	F (n = 29)	Ax	27,5 - 49,5	5,9 - 9,8	153,0 - 268,5	104,8 - 225,5	30,0 - 44,6	15,2 - 32,5
		$\bar{x}$	32.7	7.3	196.5	161.9	36.8	22.8
		S $\bar{x}$	1.2	0.2	7.8	8.6	1.4	1.0
		P	0.58	0,92	0,49	0,63	0,26	0,87
P. lineatus	Indifferenciated	n =1	22.0	4.7	155.5	141.5	30.5	21.5
	M (n = 23)	Ax	25,0 - 53,0	7,5 - 12,2	175,0 - 314,0	108,9 - 221,6	31,2 - 52,9	21,1 - 34,8
		$\bar{x}$	39.7	9,5	230.7	173.5	41,5	24,6
		S $\bar{x}$	1.4	0,2	7.9	5.5	1,1	0.8
	F (n = 18)	Ax	33,5 - 56,5	7,9 - 14,9	186,5 - 292,5	132,4 - 207,7	32,5 - 52,3	21,6 - 31,3
		$\bar{x}$	41.6	10.1	243.4	171.8	41.6	24.2
		S $\bar{x}$	1.4	0.4	7.0	5.0	1.1	0.6
		P	0,34	0,63	0,24	0,82	0,39	0,37

Ht= hematocrit; MCV= mean corpuscular volume; Hb= hemoglobin rate; MCH= mean corpuscular hemoglobin; Er= number of erythrocytes; MCHC= mean corpuscular hemoglobin concentration; M= male; F= female; n=number of specimens

Table 4. Means ($\bar{x}$), standard deviation of means (S $\bar{x}$) and Student's "t" test results (P) of percentages of leukocytes in the peripheral blood of *S. borellii* and *P. lineatus* collected in the Paraná River, Porto Rico region, PR, Brazil, separated by sex. (P>0,05)

Specie	Sex		Leukocytes							
			Lf (%)	Nt (%)	Mn (%)	Bs (%)	Es (%)	Im (%)	Ot (%)	SGC (%)
S. borellii	M (n = 13)	Ax	8,8 - 81,4	0,0 - 77,1	0,0 - 39,0	0,0 - 1,9	0,0 - 0,5	0,0 - 21,0	0,0 - 2,0	0,0 - 0,9
		$\bar{x}$	33,3	53,1	9,4	0,2	0,0	4,4	0,2	0,1
		S $\bar{x}$	5,9	7,0	3,0	0,2	0,0	1,7	0,2	0,1
	F (n = 29)	Ax	7,3 - 93,3	4,3 - 87,8	0,0 - 65,4	0,0 - 2,4	0,0 - 27,0	0,0 - 22,8	0,0 - 1,7	0,0 - 1,0
		$\bar{x}$	27,4	48,6	9,6	0,3	1,0	4,3	0,1	0,04
		S $\bar{x}$	3,7	4,5	2,3	0,1	0,8	0,9	0,1	0,03
		P	0,51	0,90	0,75	0,83	0,43	0,83	0,33	0,62
P. lineatus	Indifferenciated n = 1		14,1	84,9	0,0	0,0	0,0	1,0	0,0	0,0
	M (n = 24)	Ax	9,1 - 67,6	6,0 - 89,0	0,0 - 43,3	0,0 - 7,4	0,0 - 1,9	0,9 - 24,9	0,0 - 4,7	0,0 - 2,0
		$\bar{x}$	29,2	48,1	13,0	0,8	0,2	8,1	0,3	0,2
		S $\bar{x}$	3,5	4,6	2,9	0,4	0,1	1,5	0,2	0,1
	F (n = 18)	Ax	2,4 - 78,6	10,2 - 9,4	0,0 - 40,4	0,0 - 2,7	0,0 - 2,0	0,0 - 15,0	0,0 - 14,2	0,0 - 3,4
		$\bar{x}$	33,9	46,8	11,6	0,4	0,4	4,8	1,7	0,3
		S $\bar{x}$	5,1	4,9	2,9	0,2	0,2	1,1	0,9	0,2
		P	0,46	0,86	0,76	0,42	0,30	0,11	0,11	0,62

Lf= Lymphocytes; Nt = Neutrophils; Mn = Monocytes; Bs = Basophils; Es = Eosinophils; Im = Immature cells; Ot = Others cells; SGC = Special granulocytic cells; M = male; F = female; n=number of specimens

Table 5. Means ($\bar{x}$) and standard deviation of means (S $\bar{x}$) of blood parameters of *Schizodon borellii* and *Prochilodus lineatus* from Paraná River by gonadal maturation stages

			Ht	Hb	Er	MCV	MCH	MCHC
S. borellii	Immat. n=6	$\bar{x}$	35,6	7,9	202,0	180,8	40,0	22,7
		S $\bar{x}$	2,9	0,4	17,8	16,2	2,0	1,4
	Rest. n=30	$\bar{x}$	30,8	7,4	203,3	154,2	36,8	24,3
		S $\bar{x}$	0,7	0,2	5,7	5,1	1,0	0,8
	Mat. n=4	$\bar{x}$	37,8	7,7	185,4	211,2	43,0	20,8
		S $\bar{x}$	3,7	0,7	21,3	27,2	4,8	1,7
	Reg. n=2	$\bar{x}$	36,5	7,3	214,3	173,2	34,7	20,0
		S $\bar{x}$	2,0	0,5	22,3	27,3	6,0	0,3
P. lineatus	Undif. n=1		22,0	4,7	155,5	141,5	30,5	21,5
	Immat. n=5	$\bar{x}$	36,8	15,3	243,3	151,4	62,8	41,4
		S $\bar{x}$	1,9	5,9	13,5	3,2	23,9	15,6
	Rest. n=34	$\bar{x}$	41,0	9,8	233,1	172,2	42,3	24,3
		S $\bar{x}$	1,1	0,2	5,8	4,1	0,9	0,6
	Mat. n=1		37,5	8,7	233,5	160,6	37,3	23,2
	Reg. n=1		44,5	10,6	314,0	141,7	33,8	23,8

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 (%); Immat. = immature; Rest. = resting; Mat. = mature; Undif. = undiferentiated; n=number of specimens

Table 6. Means ($\bar{x}$) and standard deviation of means (S $\bar{x}$)of leukocytes of *Schizodon borellii* and *Prochilodus lineatus* from Paraná River by gonadal maturation stages

			Lf (%)	Nt (%)	Mn (%)	Bs (%)	Es (%)	SGC (%)	Imt (%)	Ot (%)
S. borellii	Immat. n =6	$\bar{x}$	37,2	54,2	4,9	0,2	0,0	0,0	3,4	0,2
		S $\bar{x}$	9,4	9,0	0,9	0,2	0,0	0,0	0,9	0,2
	Rest. n=30	$\bar{x}$	25,1	58,0	10,7	0,2	1,1	0,1	4,8	0,1
		S $\bar{x}$	2,7	3,5	1,7	0,1	0,9	0,1	2,5	0,1
	Mat. n=4	$\bar{x}$	36,3	38,3	20,1	0,0	0,2	0,0	7,1	0,5
		S $\bar{x}$	9,2	11,7	15,1	0,0	0,2	0,0	4,9	0,5
	Reg. n=2	$\bar{x}$	75,7	19,1	2,1	1,4	0,0	0,0	1,8	0,0
		S $\bar{x}$	17,7	14,7	0,3	1,3	0,0	0,0	1,2	0,0
P. lineatus	Undif. n=1		14,1	84,9	0,0	0,0	0,0	0,0	1,0	0,0
	Immat. n=5	$\bar{x}$	37,9	44,0	6,6	0,4	0,0	0,4	7,6	3,0
		S $\bar{x}$	11,0	14,3	2,1	0,4	0,0	0,4	2,2	2,8
	Rest. n=34	$\bar{x}$	31,3	46,5	13,7	0,6	0,4	0,3	6,5	0,7
		S $\bar{x}$	3,1	3,3	2,5	0,3	0,1	0,1	1,2	0,3
	Mat. n=1		2,4	89,4	2,4	0,0	0,0	0,0	5,8	0,0
	Reg. n=1		29,4	53,2	9,2	0,0	0,9	0,0	7,3	0,0

Lf= Lymphocytes; Nt = Neutrophils; Mn = Monocytes; Bs = Basophils; Es = Eosinophils; Im = Immature cells; Ot = Others cells; SGC = Special granulocytic cells; Immat. = immature; Rest. = resting; Mat. = mature; Undif.= undiferentiated; n=number of specimens

In conclusion it was found that the lowest hematological values of fish of the Paraná River, Porto Rico region, were registered among the Siluriform fish, while species with migratory habits tended to have the highest. Neutrophils were the most frequent leukocytes in the peripheral blood of most of the fish studied. Changes found in the hemogram of *S. borellii* and *P. lineatus* were chiefly due to the stages in gonadal maturation.

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