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Haematological and parasitological assessment of silver catfish *Rhamdia quelen* farmed in Southern Brazil

Monitoramento hematológico e parasitológico em jundiá *Rhamdia quelen* criado no Sul do Brasil

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Abstract

This study evaluated for two years the haematological parameters and the occurrence of gill parasites in silver catfish *Rhamdia quelen,* farmed in the state of Santa Catarina, southern Brazil. Between March 2010 and January 2012, a total of 137 fish were caught in a fish farm to compare the haematological and parasitological analysis, during hot and cold seasons. Simultaneously, water quality parameters were measured in the pond to analyze the relationship between environmental conditions and haematology and parasitism. During the hot season, there was an increase in water temperature, electrical conductivity and ammonia followed by a decrease in dissolved oxygen, pH, transparency and alkalinity. Two species of Monogenea were observed in the gills, *Aphanoblastella mastigatus* (Dactylogyridae) and *Scleroductus* sp. (Gyrodactylidae). Additionally, during this season, there was a significant increase ($p<0.05$) in the mean intensity of infection by Monogenea, as well as total leukocytes number, thrombocytes and lymphocytes, and a reduction in monocytes. The changes might be caused by parasitism and/or environmental variations between seasons.

Keywords: Siluriformes, parasitology, gills, haematology, blood, seasons.

Resumo

O presente estudo avaliou, durante dois anos, os parâmetros hematológicos e a ocorrência de parasitos branquiais em jundiá *Rhamdia quelen*, cultivado no Estado de Santa Catarina, Sul do Brasil. Entre março de 2010 e janeiro de 2012, um total de 137 jundiás foi coletado de uma piscicultura para comparar os parâmetros hematológicos e parasitológicos durante as estações quente e fria. Simultaneamente, foram medidos os parâmetros de qualidade da água do viveiro, para relacionar as condições ambientais com a hematologia e o parasitismo. Na estação quente, houve aumento da temperatura, condutividade elétrica e amônia, e redução do oxigênio dissolvido, pH, transparência e alcalinidade. Duas espécies de Monogenea foram observadas nas brânquias, *Aphanoblastella mastigatus* (Dactylogyridae) e *Scleroductus* sp. (Gyrodactylidae). Na estação quente, houve aumento significativo ($p<0,05$) da intensidade média de infecção por Monogenea, bem como dos valores de leucócitos totais, trombócitos e linfócitos, e redução significativa dos monócitos. As diferenças observadas podem ter sido causadas pelas variações ambientais entre as estações.

Palavras-chave: Siluriformes, parasitologia, brânquias, hematologia, sangue, estações.

Introduction

Silver catfish *Rhamdia quelen* (Quoy and Gaimard, 1824) is a Neotropical siluriforme fish found from southeastern Mexico to the south of Argentina (SILFVERGRIP, 1996). It has a great economic interest within freshwater fish cultures for presenting good adaptation to different environments and artificial diets, resistance to handling, and good commercial acceptance; thus being one of the most promising native species for intensive fish farming (ZANIBONI FILHO, 2004). Farmed in the south of Brazil, the silver catfish tolerates low temperatures and presents high growth rates in the warmer months (BARCELLOS et al., 2004).

With the development and intensification of fish farming, the greatest challenge is to reduce economic loss related to illnesses, since parasitic diseases constitute the main cause of production loss (MORAES; MARTINS, 2004). The illness condition arises at the moment in which there is a break in the host-parasite-environment balance (MARTINS et al., 2002). The climate of the Neotropical region allows the parasitic propagation to be constant and fast (THATCHER; BRITES-NETO, 1994), and the rearing environment offers adequate conditions for the transmission of

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parasites with direct life cycle (BARKER; CONE, 2000). In a parasitological study which examined fish reared in southeastern Brazil for a five-year period, Martins et al. (2000), found that monogeneans were the main group responsible for behavioral and mortality alterations in hosts. Lizama et al. (2007a, b) has also carried out parasitological monitoring for one year in Nile tilapia (*Oreochromis niloticus*) and pacu (*Piaractus mesopotamicus*), reared in the southeastern region, as well as Godoi et al. (2012) in tambaqui's (*Colossoma macropomum*) rearing in the northern region. They all reported the presence of monogeneans. These parasites belong to the phylum Platyhelminthes, class Monogenea, and are mainly found in the gills, body surface, nasal cavities, and urinary system (TAKEMOTO et al., 2004), feeding from the host's blood and tissue (LUPCHINSKI JR et al., 2006).

Morbid conditions are related to changes in haematological values, which prove the importance of studying blood parameters in reared animals (TAVARES-DIAS; MORAES, 2004). Furthermore, due to the direct contact with water, fish's blood characteristics are closely related to the animal's response to the environment (GABRIEL et al., 2004). Changes in haematological values may occur due to changes in the parameters of water quality, the presence of stressing factors such as high organic compounds, high stocking density, and handling procedures (BARCELLOS et al., 2004).

Environmental changes cause physiological transformations and may lead to homeostasis disruption, when the animal becomes susceptible to illnesses (SELYE, 1950). The host's immunological response is important regarding the link between the fish and the parasite (BUCHMANN; LINDENSTRØM, 2002). Several factors may interfere in the immunological capacity of fish farming, such as water quality (XU et al., 2007). In the south of Brazil, characterized by well-defined seasons and rigorous winters, Jerônimo et al. (2011) reported monogenean parasitism rates in farmed Nile tilapia (*O. niloticus*) during the different seasons of the year. Environmental changes caused by temperature variation throughout the year may cause stress and interfere in the reared fish's immunological capacity, reflecting on the haematological variables.

Despite the zootechnical advantages and the silver catfish's commercial importance, there are not previous studies involving long term monitoring of the parasitism, as well as haematological variables, in reared silver catfish. The knowledge of the annual distribution of agents causing parasitic diseases is important in order to develop adequate preventive techniques in rearing (SCHALCH; MORAES, 2005). The assessment of haematological indexes is also important, since it allows the implementation of handling techniques which avoid losses related to illnesses, during certain times of the year. This study's purpose was to analyze the haematological parameters and parasitological indexes of Monogenea in silver catfish *R. quelen* farmed in ponds located in the south of Brazil, during hot and cold seasons, for a two-year period.

Materials and Methods

A total of 137 silver catfish (*R. quelen*) were bimonthly collected in fish ponds, between March 2010 and January 2012, in Piscicultura Panamá ("Panamá fish farming"), located in the city of Paulo Lopes (27° 57' 43" S, 48° 41' 02" W), in the state of Santa Catarina, south of Brazil. The fish were always collected from the same pond (1000 m²), at a stocking density of 10 fish/m² and classified monthly by size. The water, coming from Travessão das Águas Férreas' stream, is renewed at a rate of 25% per day.

At the moment of collection, which took place in the mornings, the following water quality parameters were measured: water temperature and dissolved oxygen concentration with Hanna® HI9146 oximeter, hydrogen potential (pH) with Alfakit® AT310, electric conductivity with Bel Engineering® W12D conductivimeter, transparency by Secchi disc, and alkalinity, nitrite, nitrate, total ammonia and phosphorus with Alfakit® colorimetric method. Monthly data related to air temperature was informed by "Centro de Informações de Recursos Ambientais e de Hidrometeorologia de Santa Catarina (Ciram/SC)", measured at the weather station closest to the study region.

In order to analyze the effect caused by the time of the year, the "hot season" was defined by the months pertaining to the Brazilian spring and summer seasons (from October to March), and, the "cold season" was defined by the months pertaining to autumn and winter (from April to September). A number between 30 to 42 animals were collected by season, adding up to 60 animals in the hot season and 77 animals in the cold season. The fish were acclimated for five days, and kept in 100 L tanks with constant aeration. After this period, the fish were individually anesthetized with eugenol (75 $mg.L^{-1}$) to perform biometrics and haematological analysis. Approximately 1.0 mL of blood was removed by caudal vessel puncture, with syringes moistened with EDTA 10%. An aliquot was reserved for erythrocyte count in Neubauer chamber, after a 1:200 dilution in sodium chloride solution (0.65%). Another aliquot was used for determining hematocrit by the microhematocrit method and the mean corpuscular volume (MCV) calculated by the Ranzani-Paiva et al. (2013) methods. The remaining blood was used for smears stained with May-Grünwald-Giemsa (RANZANI-PAIVA et al., 2013), for differential leukocyte count, and total thrombocytes and leukocytes count. The total amount of thrombocytes and leukocytes in the blood were calculated by indirect method (ISHIKAWA et al., 2008).

After blood collection, fish were euthanized by concussion for parasitological analysis, in accordance to the ethical procedures of the Ethic Committee on the Use of Animals (CEUA/UFSC PP00756). The gill arches were removed and kept in recipients containing water at 55 °C. After shaking the bottle, its content was fixed in 5% formalin. The parasites were then quantified in stereomicroscope. Some specimens were mounted in Hoyer's medium for sclerotized structures observation, while others were stained with Gomori trichrome in order to study the internal structures. The parasites were identified according to Suriano et al. (1986), Kritsky et al. (2000), Mendoza-Franco et al. (2007), Carvalho et al. (2009) and Mendoza-Palmero et al. (2012).

The prevalence rates (P%), mean abundance (MA), and mean intensity of infection (MII) were calculated by Quantitative Parasitology® 3.0 software (REICZIGEL; RÓZSA, 2005). The parasitological descriptors are in accordance with Bush et al. (1997).

The data was analyzed by Student's t-test, at a significance level of 5%, to test the differences in averages between the seasons. Pearson's correlation coefficients were calculated for parasitological and haematological values in each season. Mean prevalences of Monogenea were compared by chi-square analysis, at a significance level of 5%.

Results

Fish presented an average total length of 18.89 ± 0.53 cm, and an average weight of 82.00 ± 0.04 g (Table 1). The average rates of the environmental parameters were divided according to the season of the year (Table 2). Air and water temperatures were significantly higher ($p<0.05$) in the hot season, while transparency was significantly higher ($p<0.05$) in the cold season. The remaining environmental parameters did not show significant differences between the seasons ($p\geq0.05$).

Regarding the haematological parameters, there was no significant difference ($p\geq0.05$) in the hematocrit, erythrocytes, mean corpuscular volume (MCV) and neutrophils values between the seasons. The number of thrombocytes, total leucocytes and lymphocytes were significantly higher in the hot season, whereas the monocytes were higher in the cold season ($p<0.05$) (Table 3).

In the parasitological analysis, two monogenean species were observed, *Aphanoblastella mastigatus* (Suriano, 1986) (Dactylogyridae), and a non-identified species of the genus *Scleroductus* (Gyrodactylidae). The average prevalence was 92.21% in the cold season, and 93.33% in the hot season, presenting no significant difference between the seasons ($p\geq0.05$). The mean prevalence of Monogenea did not show significant difference between the seasons, while mean abundance and mean intensity of infection were significantly higher ($p<0.05$) in the hot season (Table 4). Mean abundance of Monogenea, erythrocytes, total leukocytes and lymphocytes showed significant ($p<0.05$) positive correlation with water temperature (Monogenea: r=0.38, erythrocytes: r=0.35, total leukocytes and lymphocytes: r=0.38) (Table 5). These parameters also showed significant ($p<0.05$) positive correlation with air temperature (Monogenea: r=0.74, erythrocytes: r=0.29, total leukocytes: r=0.32, lymphocytes: r=0.31) (Table 5). Thrombocytes' number presented significant positive correlation ($p<0.05$) with mean abundance of Monogenea (r=0.31) (Table 5).

Positive correlation ($p<0.05$) between the mean abundance of Monogenea and lymphocytes (r=0.57) and significant negative correlation with monocytes (r= –0.50) in cold season (Table 6) were found. In hot season, mean abundance of Monogenea showed no significant correlation with the blood parameters (Table 7). Significant correlations between the hematological parameters were observed in each season (Tables 6 and 7).

Discussion

In both seasons, the parameters' average values for water quality were kept within the tolerance limits for silver catfish (*R. quelen*) (GOMES et al., 2000). The parasites found in the present study were already observed in wild *R. quelen* (AZEVEDO et al., 2010). The parasite fish fauna responds to changes in the physical-chemical characteristics of the water environment, as well as environmental temperature and modifications in the host's physiological conditions (DOGIEL, 1970). However, the annual fluctuations may interfere in different parasites' species' population (TAVARES-DIAS et al., 2001).

Monogenean ectoparasites, which remain in direct contact with nature, are sensitive to changes regarding water quality (ZARGAR et al., 2012), and their proliferation is directly related to the increased concentration of organic matter (GHIRALDELLI et al., 2006), ammonia (SKINNER, 1982), and temperature (REPULLÉS-ALBELDA et al., 2013) and electric

Table 1. Mean values ± standard error of the total length (cm) and weight (g) of silver catfish *Rhamdia quelen* farmed in Paulo Lopes, Santa Catarina state, Southern Brazil, by season. n: number of analyzed fish.

Period	Season	N	Length (cm)	Weight (g)
Mar/2010-Sept/2010	Cold	42	20.29 ± 0.63	66.54 ± 4.48
Oct/2010-Mar/2011	Hot	30	18.85 ± 0.16	72.00 ±3.71
Apr/2011-Sept/2011	Cold	35	17.79 ± 1.36	79.20 ±11.16
Oct/2011-Jan/2012	Hot	30	21.83 ± 0.59	94.7- ± 6.43
Total	-	137	18.89 ± 0.53	82.00 ± 0.04

Table 2. Air temperature and water quality parameters in the growth ponds of silver catfish *Rhamdia quelen* farmed in Paulo Lopes, Santa Catarina state, Southern Brazil, in different seasons.

Environmental parameters	Hot season	Cold season
Air temperature (°C)	23.3 ± 1.8[a]	19.8 ± 3.2[b]
Water temperature (°C)	23.0 ± 3.6[a]	18.8 ± 2.2[b]
Dissolved oxygen ($mg.L^{-1}$)	8.0 ± 1.4[a]	8.7 ± 0.8[a]
pH	6.5 ± 0.1[a]	7.0 ± 0.9[a]
Transparency (cm)	21.0 ± 4.0[a]	27.0 ± 2.5[b]
Electrical conductivity ($\mu S.cm^{-1}$)	38.0 ± 13.0[a]	19.0 ± 12.0[a]
Alkalinity ($mg.L^{-1}$)	40.0 ± 9.0[a]	55.0 ± 15.0[a]
Total ammonia ($mg.L^{-1}$)	0.38 ± 0.18[a]	0.13 ± 0.18[a]
Nitrite ($mg.L^{-1}$)	0.01 ± 0.00[a]	0.01 ± 0.00[a]
Nitrate ($mg.L^{-1}$)	0.1 ± 0.0[a]	0.0 ± 0.0[a]
Phosphate ($mg.L^{1}$)	0.025 ± 0.00[a]	0.025 ± 0.0[a]

Different letters indicate significant differences by Student's t-test ($p<0.05$).

Table 3. Haematological parameters (average ± standard error) in silver catfish *Rhamdia quelen* farmed in Paulo Lopes, Santa Catarina state, Southern Brazil, in different seasons.

Haematological parameters	Hot season (n=60)	Cold season (n=77)
Hematocrit (%)	33.74 ± 1.10[a]	31.91 ± 1.12[a]
Erythrocytes ($10^6.\mu L^{-1}$)	1.77 ± 0.12[a]	1.62 ± 0.07[a]
MCV (fL)	295.44 ± 46.25[a]	198.10 ± 16.27[a]
Thrombocytes ($10^3.\mu L^{-1}$)	34.29 ± 3.93[a]	29.55 ± 3.58[b]
Total leukocytes ($10^3.\mu L^{-1}$)	51.55 ± 5.81[a]	34.19 ± 6.34[b]
Lymphocytes ($10^3.\mu L^{-1}$)	37.68 ± 4.46[a]	18.66 ± 1.83[b]
Neutrophils ($10^3.\mu L^{-1}$)	8.30 ± 1.16[a]	7.89 ± 0.69[a]
Monocytes ($10^3.\mu L^{-1}$)	2.25 ± 0.33[a]	3.30 ± 0.68[b]

Different letters indicate significant differences by Student's t-test ($p<0.05$).

Table 4. Parasitological indexes of silver catfish *Rhamdia quelen* farmed in Paulo Lopes, Santa Catarina state, Southern Brazil. PF: parasitized fish, AF: analyzed fish, SE: standard error.

Parasitological indexes	Hot season	Cold season
PF/AF	56/60	71/77
Prevalence (%)	93.33[a]	92.21[a]
Mean abundance ± SE	22.17 ± 3,20[a]	12.15 ± 3.44[b]
Mean intensity ± SE	23.75 ± 3,44[a]	14.02 ± 3.50[b]
Range of variation (min-max)	(1-517)	(1-186)

Different letters indicate significant differences by chi-square test for prevalence and Student's t-test ($p<0.05$) for mean abundance and intensity.

Table 5. Pearson's correlation coefficients between hematological parameters, mean abundance (MA) of Monogenea and temperature values.

Variables	Monogenea (MA)	Air temperature (°C)	Water temperature (°C)
Hematocrit (%)	0.01 ^{NS}	0.22 ^{NS}	0.20 ^{NS}
Erythrocytes ($10^6.\mu L^{-1}$)	0.20 ^{NS}	0.29 *	0.35 *
Thrombocytes ($10^3.\mu L^{-1}$)	0.31 *	0.25 ^{NS}	0.22 ^{NS}
Total leukocytes ($10^3.\mu L^{-1}$)	0.04 ^{NS}	0.32 *	0.38 *
Lymphocytes ($10^3.\mu L^{-1}$)	0.06 ^{NS}	0.31 *	0.38 *
Neutrophils ($10^3.\mu L^{-1}$)	–0.08 ^{NS}	0.00 ^{NS}	0.07 ^{NS}
Monocytes ($10^3.\mu L^{-1}$)	0.06 ^{NS}	–0.20 ^{NS}	–0.14 ^{NS}
Monogenea (MA)	1.00	0.74 *	0.63 *

* = Significant correlation ($p<0.05$), NS = non-significant correlation ($p\geq0.05$).

Table 6. Pearson's correlation coefficients between hematological parameters and mean abundance (MA) of Monogenea in cold season. Ht: hematocrit (%), RBC: erythrocytes ($10^6.\mu L^{-1}$), Thromb: thrombocytes ($10^3.\mu L^{-1}$), WBC: total leukocytes ($10^3.\mu L^{-1}$), Lymph: lymphocytes ($10^3.\mu L^{-1}$), Neut: neutrophils ($10^3.\mu L^{-1}$), Mono: monocytes ($10^3.\mu L^{-1}$), MA: mean abundance of Monogenea.

Variables	Ht	RBC	Thromb	WBC	Lymph	Neut	Mono	MA
Ht	1.00	0.34 *	0.42 *	0.36 *	0.67 *	–0.71 *	0.22 ^{NS}	–0.27 ^{NS}
RBC		1.00	0.06 ^{NS}	0.01 ^{NS}	0.19 ^{NS}	–0.15 ^{NS}	–0.04^{NS}	–0.18 ^{NS}
Thromb			1.00	0.44 *	0.26 ^{NS}	–0.55 *	–0.70 *	0.08 ^{NS}
WBC				1.00	0.33 *	–0.45 *	0.23 ^{NS}	–0.27 ^{NS}
Lymph					1.00	–0.89 *	–0.02^{NS}	0.57 *
Neut						1.00	–0.42 *	0.29 ^{NS}
Mono							1.00	–0.50 *
Monogenea								1.00

* = Significant correlation ($p<0.05$), NS = non-significant correlation ($p\geq0.05$).

conductivity decrease (GARCIA et al., 2003). These factors, jointly, may be closely related to the increase in the intensity of parasitism in the hot season. Eiras (1994) said most monogenean species present well-defined intra-annual parasitism pattern, with increased intensity in the hotter months and decreased intensity in the colder months, ratifying the significant positive correlation between temperature and the Monogenea's mean abundance on the gills.

Haematological variables allow estimating the magnitude of the pathogen's influence on the host's health (EINSZPORN-ORECKA; WIERZBICKA, 1974). Previous studies showed that the blood values may also be influenced by environmental matters, such as

Table 7. Pearson's correlation coefficients between hematological parameters and mean abundance (MA) of Monogenea in hot season. Ht: hematocrit (%), RBC: erythrocytes ($10^6.\mu L^{-1}$), Thromb: thrombocytes ($10^3.\mu L^{-1}$), WBC: total leukocytes ($10^3.\mu L^{-1}$), Lymph: lymphocytes ($10^3.\mu L^{-1}$), Neut: neutrophils ($10^3.\mu L^{-1}$), Mono: monocytes ($10^3.\mu L^{-1}$), MA: mean abundance of Monogenea.

Variables	Ht	RBC	Thromb	WBC	Lymph	Neut	Mono	MA
Ht	1.00	0.32 *	0.21 NS	–0.22 NS	0.21 NS	–0.29 NS	0.01 NS	0.23 NS
RBC		1.00	0.37 *	0.05 NS	0.21 NS	0.17 NS	–0.16 NS	0.01 NS
Thromb			1.00	0.02 NS	0.08 NS	–0.02 NS	–0.13 NS	–0.14 NS
WBC				1.00	–0.39 *	0.36 *	0.18 NS	–0.19 NS
Lymph					1.00	–0.87 *	–0.59 *	0.13 NS
Neut						1.00	0.14 NS	–0.14 NS
Mono							1.00	–0.04 NS
Monogenea								1.00

* = Significant correlation ($p<0.05$), NS = non-significant correlation ($p\geq0.05$).

changes in water quality parameters and seasonality (TAVARES-DIAS; MORAES, 2004).

The hematocrit percentage, the number of erythrocytes and the mean corpuscular volume (MCV) did not present significant differences between the seasons. On the other hand, Tavares-Dias and Moraes (2004) argued it is common for the parameters regarding the red series to increase in hotter periods, explaining this increase as a compensatory mechanism against the lower saturation of dissolved oxygen in water. This is evidenced by the significant positive correlation between the number of erythrocytes and the air and water temperature. Parasitic infection can also lead to anaemia (TAVARES-DIAS et al., 2002a); however, in this study the intensity of infection was not high enough to reduce the erythrocytes number.

Total leukocytes' and thrombocytes numbers were significantly lower in the cold season, and the total leukocytes number was significantly correlated with temperature. It is possible that this reduction in the cold season was due to immunosuppression, a characteristic of periods marked by lower temperatures (DEXIANG; AINSWORTH, 1991). Even though the temperatures were maintained within the range tolerated by silver catfish, the seasonal fluctuations may have caused immunosuppression, since the adequate temperature for growth may be different from the adequate temperature for immunological response (LANGSTRON et al., 2002). Another hypothesis is that the number of leukocytes and thrombocytes in the hot season has increased by intensified parasitism, due to the increased production of immune cells to fight against some stressor, as reported by Sopińska (1985) while studying carp (*Cyprinus carpio*) parasitized by *Bothriocephalus acheilognathi* (Cestoda). This is demonstrated by the significant positive correlation between the number of thrombocytes and the Monogenea's mean abundance, without considering the season.

The differential leukocyte count was characterized by lymphocytes as the most abundant cells, followed by neutrophils and monocytes, in accordance to the proportion reported by other authors for siluriform fishes (TAVARES-DIAS et al. 2002b; MABILIA; SOUZA, 2006; JERÔNIMO et al., 2009).

The number of lymphocytes was significantly lower in the cold season, coinciding with the decrease in water temperature. Studies suggest that lower temperatures induce immunosuppression by causing negative impact on the lymphocytes' population (DEXIANG; AINSWORTH, 1991), and this hypothesis is supported by the significant correlation between temperature and the number of lymphocytes. On the other hand, the positive correlation between the number of lymphocytes and parasitism in the cold season corroborates the findings of Alexandrino et al. (1995) in pacu (*P. mesopotamicus)* parasitized by Monogenea and *Henneguya* sp. who reported higher proportion of lymphocytes in the blood. Thus, variations in the amounts of this cell can be related to a defense response against the parasite.

The neutrophils, on the other hand, did not present a significant seasonal variation, ratifying the observations of Ainsworth et al. (1991), which reported that these cells seem to be more resistant to variations on water temperature. Therefore, in reduced temperatures, fish can intensify some defense mechanisms as a way of preparing to hold out infections (TAVARES-DIAS; MORAES, 2004). This would explain the significant monocytes increase in the cold season. Monocytes play an important role in host defense against parasites, by infiltrating the damaged tissue and by adhering to the pathogen (NAKAYASU et al., 2005). Considering the negative correlation between the number of monocytes and parasitism by Monogenea in cold season, it can be assumed that this relationship is due to the migration of monocytes to the injured site when parasitism increases.

For a long period of observation, it can be concluded that the hematological parameters and parasitism by Monogenea showed clear relationship with the season. Higher intensities of parasitism occur in the warmer periods, however, a possible immunosuppression frame was observed during the cold season. Therefore, this is a time when mechanisms related to disease prevention should be intensified, as well as avoiding handling procedures which cause stress.

Conclusions

Environmental changes between the seasons possibly influenced the parasitism by Monogenea. Although the parasites observed in this study are not compulsorily notifiable, according to the World Organization for Animal Health (OIE), they can cause losses to the producer when in large number. The knowledge of the dynamics of variation in parasitological indexes throughout the seasons is important for disease prevention, since it allows the producers to take appropriate preventive measures in each season. Furthermore, meeting the biological requirements of the cultivated species, the management procedures and preventive techniques

must be adapted to the particularities of each region, allowing more effective control of the pathogens and avoiding economic losses related to illness. This is the first register of haematological and parasitological study for two years in a fish farm destined to silver catfish's commercialization, being an important result for the development of the activity and the application of prophylactic techniques.

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