Haematology of *Mugil curema* from the north coast estuary of Santa Catarina state, Brazil*

Hematologia de *Mugil curema* em estuário no litoral norte do estado de Santa Catarina, Brasil

Juliano Santos Gueretz,** Maurício Laterça Martins,*** Antonio Pareira de Souza****

**Instituto Federal Catarinense - IFC, Campus Araquari, Araquari, SC, Brasil.
***Laboratório AQUOS – Sanidade de Organismos Aquáticos - Universidade Federal de Santa Catarina - UFSC, Florianópolis, SC, Brasil.
****Programa de Pós-Graduação em Ciência Animal – Universidade do Estado de Santa Catarina – UDESC, Lages, SC, Brasil.

Introduction

*Mugil curema* Valenciennes, 1836 is a teleost fish popularly known as “tainha” and “tainha-sajuba” in the north and northeast and as “parati” in the southeast and south of Brazil. Mugilid fish are abundant in coastal, estuarine and lagoon regions, even for its dietary characteristics, which is scavenger. It is a catadromous fish that adapts to the variations of water salinity, it survives in both sea and fresh water environment. It is more abundant from October to April, a time period that, partly, coincides to its spawning which is from August to January (Albieri et al. 2010, Fonsêca et al., 2000, Menezes, 1983, Menezes et al., 2015).

The hematology and possible alterations in benchmark hematological patterns, as well as the morphological disorder in blood cells may be used to help monitoring fish and environment health. The blood parameters may be used as biological indicators in monitoring the fish welfare, using it as a tool for diagnosing the animal stress due to the environmental imbalance or due to the presence of infectious agents (Silva et al., 2012). Hematological...
characteristics in fish vary according to the species, age, gender, diet and environment which they are exposed. Therefore, they are important characteristics to be analyzed when those animals are exposed to stress (Ghiraldelly et al., 2006).

The aim of this study was to verify the hematological profile of the *M. curema* along 18 months in estuary waters from the north coast of the state of Santa Catarina in the south of Brazil.

**Material and methods**

The studied site was Parati river located in the city of Araquari, Santa Catarina state, Brazil, within the geographic coordinates 26°23'07.0" S 48°45'07.0" W and 26°21'31.8" S 48°42'51.7" W. From March 2016 to August 2017, the fish were captured by gillnet with a five to seven centimeters net between knots, two meters in height and 150 m in length, thrown from a power-driven boat, which both the boat and the pilot were properly registered and qualified by the “Capitania dos Portos”, Brazil navy, from Sào Francisco do Sul, SC. After captured, the fish were transported in a plastic container with water of the river, constantly aerated by a portable aerator powered by a 1.5 W battery.

Blood samples were collected by puncturing the caudal vessel with 3 mL disposable syringes and 0.7 x 25 mm hypodermic needles, previously soaked in a Ethylenediamine Tetra acetic Acid (EDTA 10%) as anticoagulant. After puncture 2 mL of blood were placed in a 10 mL test tube and sent to the hematological laboratory for hematological analyses.

Blood samples were collected by puncturing the caudal vessel with 3 mL disposable syringes and 0.7 x 25 mm hypodermic needles, previously soaked in a Ethylenediamine Tetra acetic Acid (EDTA 10%) as anticoagulant. After puncture 2 mL of blood were placed in a 10 mL test tube and sent to the hematological laboratory for hematological analyses.

Erythrocyte, leukocyte, thrombocyte, hemocrit, MCHV, MCHC, MCV, and MCH were determined by the microhematocrit method and expressed in a blood extension in microscope slide. The hemocrit was measured and total plasma protein was obtained by refractometer. For leukocyte, the differential count was determined using a Neubauer chamber, in which the erythrocyte was expressed in cells x 10⁶ mL⁻¹ and the leukocyte in unit mL⁻¹ and in percentage. For leukocyte, the differential count was determined using a blood extension in microscope slide. The hematocrit was determined by the microhematocrit method and expressed in percentage. Total plasma protein was obtained by refractometer.

Using the hemoglobin dosage, expressed in g dL⁻¹, the number of erythrocyte and the hemocrit, the mean corpuscular volume (MCV) was calculated and expressed in FL; the mean corpuscular hemoglobin (MCH) was expressed in pg and the mean corpuscular hemoglobin concentration (MCHC) expressed in g dL⁻¹ (Ranzani-Paiva et al., 2013).

For statistical analyses, the data were submitted initially to the Shapiro-Wilk test in order to verify the distribution type, its standardization or not. The considered normal data, in its distribution, were submit to variance analysis, and in case it showed difference the Tukey test was applied to check which set, or sets were different. In case of the Shapiro-Wilk test resulted in non-standard data, the set was submitted to standardization using the logarithmic transformation or box-cox type. For the considered non-standard sets, even after the transformation, the Kruskel-Wallis and Mann-Whitney test were applied. In order to assist those analyses the statistical softwares Past and R were utilized (Andrade e Ogliari, 2013, Hammer et al, 2001, Petrie e Watson, 2009, R Core Team, 2017). The scientific investigation project that led to this study was approved by the Comissão de Ética no Uso de Animais (CEUA) of the Instituto Federal Catarinense - Campus Araquari, certificate 0107/2015 and by the Instituto Chico Mendes de Conservação e Biodiversidade – ICMBio, authorization for scientific purpose activities – SISBIO 48661.

**Results**

The hematological parameters of the *M. curema* captured in Parati river from April 2016 to July 2017 are shown in Table 1.

**Table 1**: Hematology, average and standard deviation of *Mugil curema* captured in Parati river, Araquari SC, from Mach 2016 to August 2017

| Parameter                  | Female                | Male                  | Indeterminate gender | Total                  |
|----------------------------|-----------------------|-----------------------|----------------------|------------------------|
| Erythrocytes (x 10⁶ mL⁻¹) | 3.53±1.05±(32)        | 3.96±1.57±(26)        | 3.36±1.39±(67)       | 3.53±1.36±(125)        |
| HTC (%)                    | 43.63±5.48±(32)       | 39.85±5.72±(26)       | 39.56±6.88±(73)      | 40.61±6.53±(131)       |
| Hemoglobin (g dL⁻¹)        | 15.58±2.04±(25)       | 14.30±1.78±(24)       | 14.77±2.04±(53)      | 14.86±2.01±(102)       |
| MCV (FL)                   | 135.6±47.02±(32)      | 118.1±59.23±(26)      | 141.7±74.43±(67)     | 135.2±65.52±(125)      |
| MCH (pg)                   | 44.08±13.28±(25)      | 38.63±17.29±(24)      | 43.56±19.62±(51)     | 42.51±17.65±(100)      |
| MCHC (%)                   | 36.10±4.84±(25)       | 35.85±1.93±(24)       | 36.37±1.93±(53)      | 36.18±2.91±(102)       |
| TPP (g dL⁻¹)               | 6.2±3.7±(32)          | 5.8±0.7±(26)          | 5.8±0.9±(72)         | 6.0±0.8±(130)          |
| Leukocytes (x 10³ mL⁻¹)    | 28.3±26.43±(30)       | 28.1±20.94±(26)       | 29.1±24.43±(68)      | 28.7±24.07±(124)       |
| Neutrophils (x 10³ µL⁻¹)   | 10.2±8.5.71±(17)      | 7.9±6.71±(18)         | 11.5±8.44±(43)       | 10.45±7.60±(78)        |
| Lymphocytes (x 10³ µL⁻¹)   | 6.7±8.8.4±(17)        | 10.7±8.10.0±(18)     | 12.5±12.00±(43)      | 12.06±11.63±(67)       |
| Thrombocytes (x 10⁵ µL⁻¹)  | 44.8±40.75±(14)       | 39.5±20.70±(14)       | 40.23±31.02±(44)     | 41.00±31.13±(44)       |

(1) number size; **a,b,c** = p<0.05. HTC: hematocrit, MCV: mean corpuscular volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration, TPP: total plasmatic protein.

**Discussion**

There was no significant difference between the hematological variables when compared by gender, in a study with *Mugil platanus* in 1995, in Cananéia SP, Brazil (RANZANI-PAIVA, 1995). Mugilidae with parasites, also in Cananéia SP, in 2002, when assessed by erythrogram did not show difference in the erythrocyte number between males, females and indefinite gender, although the male hematocrit was higher than the female and indefinite gender fish (p<0.05) (Ranzani-Paiva e Tavares-Dias, 2002). In this study there was no significant difference (P<0.05) in the erythrocyte count between the fish gender. Contrarily to that found in 2002 in Cananéia, in the present study...
there was difference, in the hematocrit, between male fish and the indefinite gender fish. However, it should be noted that the species are different in both studies, although the belong to the same family. Also, it is important to mention that the geographic and time are different.

_Piaractus mesopotamicus_ hematology, from intensive culture, presented different values than those mentioned by the literature, differences attributed to factors such as seasonality, reproduction, diet habits, metabolic needs of each species, besides the ecophysiological conditions. Such individual variations may be considered expected, because the biological parameter in fish do not present a normal distribution (Tavares-Dias e Mataqueiro, 2004). However, this pattern is not established, as it already is for mammals, in this regard, this study is a collaboration to the establishment of a hematomal parameters for _M. curema_. More studies regarding the growth and reproduction of this juvenile fish and in natural and controlled environment are needed.

The time scale influence was observed in the hematomal parameters values of _M. curema_, in a study carried out in the estuary waters of Santos and Juréia, both localized at the coast of São Paulo state, Brazil. The mentioned relative difference was attributed to the distance between both estuaries and its different water qualities, considering that in Santos the water is more polluted. In this study, $7.52\pm2.24$ and $9.62\pm2.75 \times 10^6$ mL$^{-1}$ of erythrocytes were registered in the summer and winter, respectively, in Santos, SP and $2.26\pm1.05$ and $2.58\pm8.27 \times 10^6$ mL$^{-1}$ in the summer and winter, respectively, in Juréia, SP (Cicero, 2015). The difference between the erythrocyte values in the Parati river study supports the conclusions mentioned above and may be awarded to the time conditions, in other words, the time scale influence. Although the time may be considered short between both studies, the geographic conditions, weather, kind of estuary, anthropogenic action and others, are completely different and possible each of these conditions acts in a different way in the fish physiology.

The mugilid _M. curema_ and _Mugil incilis_ captures in Fortaleza, Ceará state, Brazil did not show strong differences between the species, albeit the sampling may be considered small, 12 _M. curema_ and nine _M. incilis_. For erythrocyte they have found the average of 3.50 thousand cells by mm$^3$, with a 2.60 to 4.40 thousand cells by mm$^3$ range (Pitombeira et al., 1969). The number of erythrocytes by mm$^3$ in the Parati river study was relatively close to the one found in Fortaleza. However, the range differed considerably, in which the variation in the cell numbers by mm$^3$ in the fish studied in Parati river was relatively high, mostly if compared to the Fortaleza, CE, Northeast Brazil study. Once more, the time scale and the fish species, _M. incilis_, may substantiate those differences between both studies. Supporting such hypothesis, it was noted that the mugilid hematomal characteristics, _M. platanus_, grown in different environments, fresh water and estuary did differ in hematomal characteristics (Ranzani-Paiva e Ishikawa, 1996).

**Conclusion**

The local population of the studied fish has a proper behavior in hematomal descriptors, which is different from other Brazilian coast studies with the same fish species. Hematomal results of _M. curema_, from the Parati river, Araquari, SC, Brazil, highlight the importance of future studies to report the effects of the estuary and the anthropic action around the Parati river, besides the behavior and physiology of the studied species and compare it to close regions.

**References**

ALBIEI, R.J.; ARAÚJO, F.G.; UEARA, W. Diferenças em reprodutivo estratégias entre dois osso-cocentes Mugil Valencianes 1836 and Mugil liza Valencianes 1836 (Mugilidae) in a tropical bay. Tropical Zoology, v.23, n.1, p.51-62, 2010.

ANDRADE, D.F.; OGLIARI, P.J. Estatística para ciências agrárias e biológicas: com noções de experimentação. 3 ed. rev. amp. Florianópolis: Ed. Da UFSC, 2013, 478p.

CICERO L.H. Avaliação das alterações da série vermelha do sangue de _Mugil curema_ (Mugiliformes: Mugilidae) em distintas condições ambientais. 2015. 43p. Dissertação (Mestrado em Sustentabilidade de Ecossistemas Costeiros e Marinhos (ECOMAR), Universidade Santa Cecília, Santos, SP, 2015.

FONSEÇA F.T.B.; PARANAGUÁ, M.N.; AMADO M.A.M. Copepoda parasitas de peixes mugilídeos mantidos em diferentes condições de manejo e alimentação no Estado de Santa Catarina, Brasil. Acta Scientiarum. Biological Sciences, v.28, n.4, p.319-325, 2006.

HAMMER Ø.; HARPER D.A.T.; RYAN P.D. PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica. v.4, n.1, p.1-9, 2001.

H. M. ZEREZ M.; NORTON, H.; YAMASHITA, M.M.; JERÔNIMO, G.T. Hematologia de _Oreochromis niloticus_ (Cichlidae) and _Cyprinus carpio_ (Cyprinidae) mantidos em diferentes condições de manejo e alimentação no Estado de Santa Catarina, Brasil. Boletim do Instituto de Pesca, v.22, n.1, p.1-22, 1995.

R. bras. Ci. Vet., v. 27, n. 3, p. 146-149, jul./set. 2020
RANZANI-PAIVA M.J.T.; ISHIKAWA C.M. Haematological characteristics of freshwater-reared ano wilo mullet, Mugil platanus Günther (Osteichthyes, Mugilidae). *Revista Brasileira de Zoologia*, v.19, n.3, p.807-818, 1996.

RANZANI-PAIVA M.J.T.; TAVARES-DIAS, M. Eritrograma, relação viscero-somática, hepatosomática e esplenosomática em tainhas Mugil platanus Günther (Osteichthyes, Mugilidae) parasitadas. *Revista Brasileira de Zoologia*, v.19, n.3, p.807-818, 2002.

RANZANI-PAIVA, M.J.T.; PÁDUA, S.B.; TAVARES-DIAS, M.; EGAMI, M.I. *Métodos para análise hematológica em peixes*. Maringá: Eduem, 2013, 140p.

SILVA, A.S.E.; LIMA, J.T.A.X.; BLANCO, S.B. Hematologia em peixes. *Revista Centauro*, v.3, n.1, p.24-32, 2012.

TAVARES-DIAS M.; MATAQUEIRO, M.I. Características hematológicas, bioquímicas e biométricas de *Piaractus mesopotamicus* Holmberg, 1887 (Osteichthyes: Characidae) oriundos de cultivo intensivo. *Acta Scientiarum. Biological Sciences*, v.26, n.2, p.157-162, 2004.