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Ecophysiological interactions in species of peacock bass Cichla spp. from the Amazon

The peacock bass species Cichla spp. are economically important in the Amazon region, being used in food, sport fishing and the ornamental fish market. The aims of present study was investigate the ecophysiological interactions and the relationship to the physical parameters of the water. In order to compare and ecologically correlate the species of peacock bass (Cichla monoculus, Cichla temensis and Cichla vazzoleri) in Lake Balbina, Presidente Figueiredo. The total of 45 animals, 15 individuals of each species, was captured with rod and reel, hand line with natural and artificial bait. The animals blood was removed by means of caudal puncture and the hematological data were determined according to methodology previously described in the literature. The analysis of water physical properties was determined during the collections. The Principal Component Analysis (PCA) was used for observations of interactions (60.00%). The PCA of the erythrogram showed an interaction of 86.26%, the thrombogram and leukogram of the peacock bass species showed no interaction. The PCA of the plasma metabolites showed no interaction with a rate of 51.55%, however, there is a tendency in the x axis, where the species C. monoculos presents distinct ecophysiological patterns of C. temensis and C. vazzoleri. In the analysis of the physical properties of the water, was observed interaction 96.59%, where in the X axis the species C. monoculos and C. vazzoleri inhabit exclusive localities. It is possible to infer that C. monoculos presents a different pattern compared to other species.

Keywords: Blood; Association; Physiology; Fish.

Interações ecofisiológicas em espécies de tucunaré Cichla spp. da Amazônia

As espécies de tucunaré Cichla spp. são economicamente importantes na região amazônica, pois são utilizadas na alimentação, na pesca esportiva e no mercado de peixes ornamentais. O presente estudo tem como objetivo investigar as interações ecofisiológicas e as relações dos parâmetros físicos da água. Comparação e correlação entre as espécies de tucunaré (Cichla monoculus, Cichla temensis e Cichla vazzoleri) do Lago Balbina, Presidente Figueiredo. No total, 45 animais, 15 animais de cada espécie, foram capturados com vara, molinete e linha de mão com iscas naturais e artificiais. O sangue dos animais foi extraído por punção caudal e os dados hematológicos foram determinados de acordo com a metodologia previamente descrita na literatura. A análise das propriedades físicas da água foi determinada durante a amostragem. A análise de componentes principais (PCA) foi utilizada para observar interações (60,00%). O eritrograma do PCA mostrou 86,26% de interação, o trombograma e o leucograma das espécies de tucunaré não apresentaram interações. O PCA dos metabólitos plasmáticos também não apresentou interação, porém, existe uma tendência no eixo x das espécies de C. monoculos que mostrou diferenciação ecofisiológica de C. temensis e C. vazzoleri. Na análise das propriedades físicas da água, observou-se uma interação de 96,59%, onde no eixo X as espécies C. monoculos e C. vazzoleri, habitam locais exclusivos. Pode-se inferir que C. monoculos apresenta um padrão diferente em comparação com outras espécies de tucunarés investigadas.

Palavras-chave: Sangre; Associação; Fisiologia; Peixes.

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INTRODUCTION

Among the members of the Amazon peacock bass ichthyofauna *Cichla* spp. show great economic, ecological and social importance, because sport fishing that occurs in the Middle Negro River (Barcelos) and along the Uatumã River, including the Balbina Reservoir (CASTRO et al., 2020). The peacock bass are also appreciated for flavor, due to its organoleptic characteristics of your meat, considered being very tasty. In addition, these species also feature ornamental fish market attractiveness, as present large variations in their patterns of coloration.

The species of peacock bass feature great adaptability in reservoirs, as demonstrated over the years in the Balbina dam. In this location, three species are found, they are: *Cichla temensis, Cichla monoculos* and *Cichla vazzoleri*. The main differences between the species are the patterns of colors and sidelines differentiation. Individuals of *C. monoculus* showed relevant feature that facilitates your identification, which is the presence of a horizontal solid stain or even interrupted, at the height of the base of the pectoral fin (SANTOS et al., 2006). Feature a sideline discontinues on both sides, being the species with greater geographical distribution (KULLANDER et al., 2006).

Individuals of *C. temensis* stand out by size, reaching up to 80.0 cm and more than 11 Kg (SANTOS et al., 2006). This species presents distribution restricted to black water rivers and its tributaries (KULLANDER et al., 2006). The specie *C. vazzoleri* is the species with smaller geographic distribution, with presence in the State of Pará in the northern region (Oriximiná) at the mouth of the Cuminá River, the rivers Uatumã and Trombetas, as well as the Balbina (KULLANDER et al., 2006). Has coloration yellow gold, red eyes and black vertical bars. Adult individuals can reach 70 cm long and weigh about 7 kg of (KULLANDER et al., 2006).

Although the meristic and morphological differences exist between the species cited, there is no research on the interactions and differences between hematological aspects and the characteristics of the water of their natural occurrence. Thus, the aim of present work is elucidating the hematological profile (hematology, thrombogram and leukocyte count and plasma metabolites) in relation to the physical parameters of the water, comparing and correlating ecologically between the peacock bass *C. monoculus, C. temensis* and *C. vazzoleri.*

MATERIALS AND E METHODS

The Balbina Lake this study site is located in the municipality of President Figueiredo (Amazonas, Brazil). The Balbina Hydroelectric Power Plant was built in the decade of 1980 with the Uatumã River Dam the 155 km from the city of Manaus. In the year 1990, the Uatumã River Biological Reserve (REBIO) was created with the goal of protecting the flora and fauna of the rivers Uatumã and Jatapu. The REBIO is located on the left bank of the reservoir of Balbina, covering the municipalities of São Sebastião of Uatumã, Urucará and Presidente Figueiredo.

A total of 45 animals were catches using fishing rod, reel, line with natural bait and artificial. Were captured 15 individuals of *C. monoculos,* 15 of *C. temensis* and 15 from *C. vazzoleri*. After the capture the

blood was collected immediately through the caudal puncture. Was subsequently held biometrics determining the overall length (CT, cm) with the use of tape and the body weight (g) with the use of portable scales. After the procedures of handling the animals were returned to the environment.

The collection of blood was performed with the aid of disposable syringes containing heparin 5000 UI. With the blood samples were determined the hematocrit (Ht, %) through the microhematocrit method (capillary tubes containing heparin), the count of red blood cells (RBC, million/mm³), through the optical pickup in Neubauer Chamber in formalin-fixed specimens-citrate. The blood hemoglobin concentration (Hb, g/dL) was determined by the cianometahemoglobin method and hematological indices: mean corpuscular volume (MCV, fL), mean corpuscular hemoglobin (MCH, pg) and mean corpuscular hemoglobin concentration (MCHC, g/dL) were calculated in accordance with methodology of Wintrobe (1934). Blood extensions were prepared in field and stained in the laboratory to the total count of leukocytes and thrombocytes (DIAS, 2006), as well as for the differential leukocyte count based on 100 count leukocyte types and subsequent determination of the percentage of each cell type.

After the blood separation by centrifugation at 12000 G, plasma samples were immediately frozen in liquid nitrogen until the moment of laboratory testing. Glucose levels (g/dL), total protein (g/dL), triglycerides (mM/L), cholesterol (mM/L) and urea (mM/L) were determined with the use of enzymatic kits Labtest® and analyzed in spectrophotometer. Also the plasma metabolites were determined (mM/L), potassium (mM/L) and chlorides (mM/L), with the use of enzymatic kits labtest® and analyzed in spectrophotometer. Water samples for the evaluation of physical properties such as temperature (ºC), pH and dissolved oxygen (mg/L), were determined in capture locations using digital multi-parameter WTW-310i (WTW, Germany).

For investigation of hematological aspects and interactions of physical properties of water was employed multivariate exploratory statistics through Principal Component Analysis (PCA). These analyses were divided in hematology (6 variables), thrombogram and leukogram (6 variables), plasma metabolites (8 variables) and physical properties of water (3 variables), the interactions were considered to be significant when the sum of the X and Y axes were greater than or equal to 60.0%.

RESULTS AND DISCUSSION

The results of the total length and body weight are shown in Table 1. The Table 1 demonstrate that individuals of the species *C. monoculos* have smaller total length and greater body weight.

Table 1: Biometrics (mean ± standard deviation) of three species of peacock bass *Cichla* spp. from Balbina Lake, Presidente Figueiredo, Amazon.

Variables	*C. monoculos*	*C. temensis*	*C. vazzoleri*
Total length (cm)	26.20 ± 1.42	29.30 ± 4.27	28.20 ± 6.83
Weight (g)	448.93 ± 113.88	408.33 ± 183.24	446.80 ± 289.71

The erythrogram PCA (Figure 1) of peacock bass species showed an interaction of 74.27% (axis x = 39.84%, y = 34.43%). In relation to X axis, can be observed that *C. temensis* and *C. vazzoleri* are species closer to *C. monoculos*. When the Y axis is analyzed the same characteristic of the X axis in which the concentrated "cloud" pattern is marked in *C. monoculos*, different from *C. temensis* and *C. vazzoleri* that have more

expansive distribution. It is observed that the oxygen demand between a three species of peacock bass is differentiated. The specie *C. monoculos* has respiratory capacity differentiated from *C. temensis* and *C. vazzoleri*, although these species inhabit the same localities within the same ecosystem. In a study with elasmobranchs conducted by Oliveira et al. (2017) it is possible to observe that *Potamotrygon wallacei* has lower index of the red series when compare with *Paratrygon aiereba* stingray. In the other hand *Potamotrygon motoro* is a kind of intermediate patterns of red series, varied between the two species, but with greater similarity to the species *P. aireba* (OLIVEIRA et al., 2017). In study of Dias et al. (2011) with *C. temensis* from fish farms was described that the erythrogram analysis is associated with the respiratory capacity of fish.

The PCA of thrombogram and leukogram (Figure 2) of peacock bass species showed no interaction represented by only 50.73% (x axis = 29.31%, y = 21.42%). The PCA of thrombogram and leukogram showed no interaction ecophysiological, however, there is a trend in the x-axis of differentiation where *C. monoculos* is different from the other two species, but it is not possible to state that *C. monoculos* has a different immune system from the other two species. This trend may have been caused by some endogenous factor not considered in the present study. In a PCA investigated with freshwater stingrays, no interaction of the thrombogram and leukocytes (57.43%) was observed in the immune system of the *P. wallacei, P. motoro* and *P. aiereba* stingrays (OLIVEIRA et al., 2017).

The PCA of the plasma metabolites (Figure 3) showed no interaction 51.55% (axis x = 29.01%, y = 22.54%). The PCA of the plasma metabolites showed no interaction, however, there is a tendency in the x-axis where *C. monoculos* seems to be a species with different ecophysiological patterns from *C. temensis* and *C. vazzoleri*. These characteristics are not confirmed since the three species of peacock bass are carnivorous, feeding mainly on fish (SANTOS et al., 2006; KULLANDER et al., 2006) and the plasma ion patterns are similar to other species of Amazonian fish.

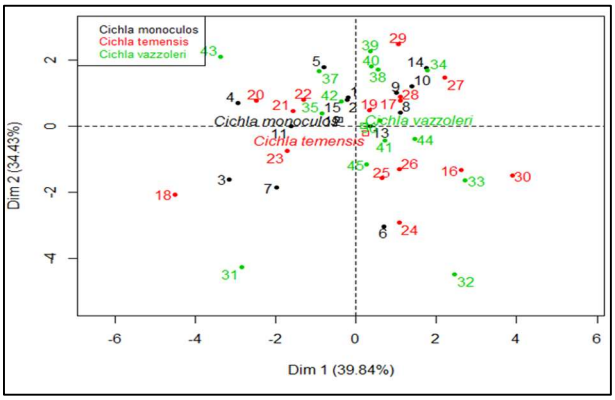

Figure 1: PCA Analysis of three species of peacock bass *Cichla* spp. erythrogram from Balbina Lake, Presidente Figueiredo, Amazon.

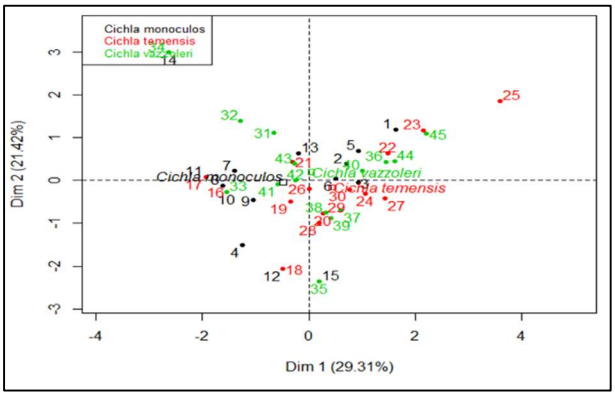

Figure 2: PCA Analysis of three species of peacock bass *Cichla* spp. thrombogram and leukogram from Balbina Lake, Presidente Figueiredo, Amazon.

In the PCA of the plasmatic biochemistry of Oliveira et al. (2017) we observed an ecophysiological interaction (64.67%) where it is observed that the species *P. aiereba* is a differentiated species of *P. motoro* and *P. wallacei*. According to the authors, this difference is caused by eating habits. For the ions, these values

have not reached the minimum level for the analysis (50.62%) (OLIVEIRA et al., 2017).

In PCA analysis of physical properties of water (Figure 4) the interaction of 96.59% were observed (x axis = 63.29%, y = 33.30%). In PCA analysis of physical properties of water the interaction of 96.59%, we can see that the species *C. monoculos* and *C. vazzoleri* inhabit different localities. In other hand, overlaps were found with respect to water properties for the three peacock bass species described in the present study. The PCA of water properties of the places where the stingrays were caught, there was showing differentiation of 68.57% mainly along the X-axis (49.44%). These values indicate that the species *P. motoro* is distributed broadly across the environment, while the species *P. aiereba* interacts more narrowly over the positive portion of the X-axis (OLIVEIRA et al., 2017). In the present study the interactions in the y axis show that the species *C. vazolleri* is more generalist than the other species.

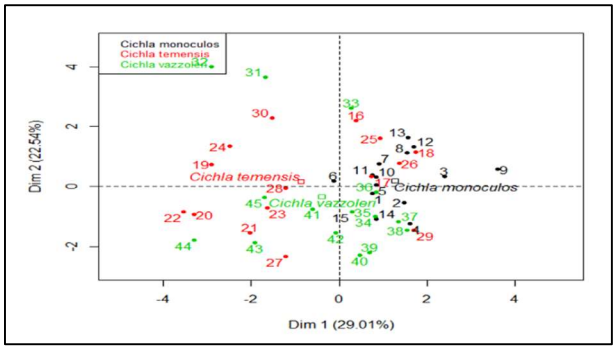

Figure 3: PCA Analysis of three species of peacock bass *Cichla* spp. plasma metabolites from Balbina Lake, Presidente Figueiredo, Amazon.

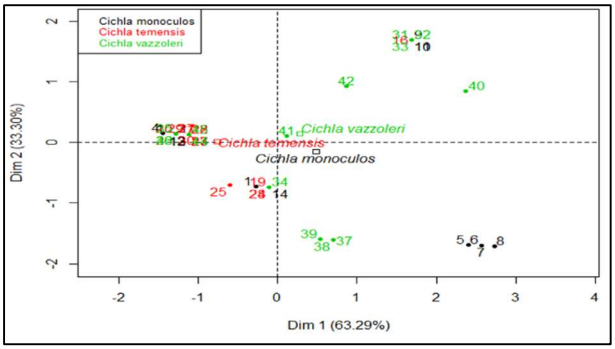

Figure 4: PCA analysis of of three species of peacock bass *Cichla* spp. water physical properties of from Balbina Lake, Presidente Figueiredo, Amazon.

CONCLUSIONS

According to the data collected and the PCA analyzes developed in the present study we can infer that the *C. monoculos* presents a different ecophysiological patterns when compare with the species *C. temensis* and *C. vazzoleri*. Thus, the specie *C. monoculos* should be managed and conserved under conditions differentiated from the other species described in the present study.

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