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Original Article

FISHES DIVERSITY IN A RESERVOIR OF SMALL HYDROELECTRIC POWER THAT SUFFERS INFLUENCE OF URBAN EVICTIONS, IN THE CITY OF ARAGUAÍNA, TOCANTINS STATE, BRAZIL

DIVERSIDADE DE PEIXES EM UM RESERVATÓRIO DE PEQUENO PODER HIDRELÉTRICO QUE SOFRE INFLUÊNCIA DE EVICÇÕES URBANAS, NA CIDADE DE ARAGUAÍNA, TOCANTINS, BRASIL

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ABSTRACT: The lake, formed by the SHP Corujão dam, installed on the River Lontra within the urban perimeter of Araguaína-TO, is an important recreation and supply center of the city, as well as a vast water mirror that make up the natural scenery of region. This lake is mainly supplied by the Lontra River and its tributaries. Meanwhile one of its tributaries, the Neblina stream, is a receiving body of urban effluents, and it imports taxpayer of this same lake. This environment is inserted in an urban area of Cerrado, which suffers the anthropic pressures of the expansion of the city, becoming a strategic area for the study of fish species and the effects of anthropization. The present study was carried out from March 2016 to December 2017, with different fishing gears, where 34 families were identified, belonging to the orders Characiformes, Clupeiformes, Siluriformes,

Gymnotiformes, Beloniformes, Synbranchiformes, Perciformes and Pleuronectiformes, in a total of 113 species identified.

Key words: Freshwater fish. Araguaia River. Hydroelectric dams. Bioindicators. Urban sprawl.

RESUMO: O Lago, formado pela Hidrelétrica Corujão, instalada no rio Lontra, no perímetro urbano de Araguaína-TO, é um importante centro de recreação e abastecimento da cidade, além de um vasto espelho d'água que compõe o cenário natural da região. Este lago é abastecido principalmente pelo rio Lontra e seus afluentes. Enquanto isso, um de seus afluentes, o córrego Neblina, é um corpo receptor de efluentes urbanos, contribuindo para a existência desse mesmo lago. Esse ambiente está inserido em uma área urbana do Cerrado, que sofre as pressões antrópicas da expansão da cidade, tornando-se uma área estratégica para o estudo de espécies de peixes e os efeitos da antropização. O presente estudo foi realizado no período de março de 2016 a dezembro de 2017, com diferentes artes de pesca, onde foram identificadas 34 famílias, pertencentes às ordens Characiformes, Clupeiformes, Siluriformes, Gymnotiformes, Beloniformes, Sinbranchiformes, Perciformes e Pleuronectiformes, sendo identificado um total de 113 espécies.

Palavras-chave: Peixe de água doce. Rio Araguaia. Barragens hidroelétricas. Bioindicadores. Expansão urbana.

INTRODUCTION

The northern region of Brazil is composed of a forest mosaic that includes the Amazon rainforest, Cerrado, Cocais forest and other floristic formations in less significant. Of these, the Amazon forest stands out, which covers more than 70% of this region and has a great biological diversity and microhabitats, making possible the existence of many species. However, it has influence of the other forest typologies, and these areas are called ecotones. In such a region, the lack of scientific studies makes it possible for many species to be discovered [1].

In this way, the North of Tocantins is inserted in an ecotone area, very singular, between Amazon forest, Cerrado forest and Cocais forest. Being that, the Araguaína city located to the North of the state and is inserted in the Cerrado biome, and where is located the lake of SHP (Small Hydroelectric Power) Corujão. This one, has its catchment basin, formed by many bedside rivers, which compose the Lontra river basin that, most of them are covered by Gallery Forest, typical of the biome [2].

However, regions such as the one mentioned, because they are inserted within or close to the urban area, suffer the anthropic processes of pollution and degradation, due to the disposal of waste and urban effluents. Which, in addition to contaminating the receiving water bodies, also damage and pollute the water table. Promoting, in this way, the trophic magnification that runs through the entire chain, from the

producer to the consumer, at a higher level [3].

In the Amazon forest and the transitional biomes that compose this region of Cerrado, there is a lack of scientific studies that analyze the diversity of the ichthyofauna. The few works done in the region do not contemplate all the taxonomic groups of the fauna and the flora, thus having a gap in the scientific knowledge about some species of the region [1]. However, studies promoted in the region have been adding efforts to the knowledge and understanding of the composition of the species and their synergies have as their interaction with the environment[4]. Therefore, there is a great need to invest in the exploration and knowledge of the ichthyofauna of this region, which is formed by bed rivers, natural nurseries, and because they are part of the sources that supply the region and suffer from anthropic actions and habitat changes promoted by urban occupation [1], [5], [6], [7], [8].

Unlike the main channel of the Araguaia River, its tributaries and headwaters, which form the drainage basins that supply this river, are little explored scientifically, making it possible to meet new species and new geographical distributions [1], [9], [10].

Therefore, an assembly of fish that make up the wealth found in the bedside rivers, reflect the ichthyofauna existing in the Araguaia-Tocantins basin. Therefore, these studies make possible the understanding of the effects of anthropic alterations, promoted in the studied region. Where, the SHP Corujão Lake itself, is a disruption of de *continuum* course of de Lontra River, formerly a rapids area and is now a postwar region, wif depths and widths quite different from de previous one. However, the lake has existed for more than 20 years, allowing for an environmental stabilization in relation to the distribution of the ichthyofauna[11].

In this way, the present study aimed to promote the survey of the ichthyofauna existing within the area of the SHP Corujão Reservoir, in the urban perimeter of Araguaína-TO.

MATERIAL AND METHODS

The study area is located to the north of the state of Tocantins, in the municipality of Araguaína, contained within the urban area of the same municipality, composed of a mosaic of urban occupation and natural areas on the shores of Lake SHP Corujão in the Lontra River. Having as predominant climate in the region, the same described for the said state, being described as Tropical dry. Mainly conditioned by the wide latitudinal extension, consisting of fluvial plains and the proximity to the channel of two great rivers that drain to the North, the Araguaia River and the Tocantins River. In this way, the region has rainfall regime with two distinct seasons, one dry and one rainy. This very unique regime significantly influences the region's water regime. The study was carried out in the Lontra River Basin, tributary of the Araguaia River, in a hydroenergetic dam (Figure 01), inserted in an urban area in the city center of Araguaína - TO [12]. The region is marked by a characteristic river of the Cerrado areas, of the north of the country, composed of gallery forest, in an ecotone between the Amazon forest, Cerrado and Cocais forest.

The environmental characteristics of the region reflect that described for areas composed of a mixture of Amazonian Forest, Cerrado plants and characteristic plants of Cocais forest, with the presence of Babaçu (*Attalea speciosa*) and

Buriti (*Mauritia flexuosa*). Being the area of study quite characterized by Urban occupation and exploration for leisure, such as, water sports and sport fishing. However, it also receives effluents from lots and condominiums, on the banks of the lake, promoting a characteristic environment for opportunistic and quite plastic species [3], that support anthropization and urban pollution. In addition to this we have the increase with Amazon species from breeding sites as well as exotic species from other continents. Another preponderant factor is that the region undergoes a regime of rains with two distinct seasons, one dry and one rainy. These seasons drastically influence the region's water regime. In summary, the study was carried out in the Lontra River Basin, tributary of the Araguaia River [12] (Figures 02 e 03). The river Lontra is important for supplying the municipality of Araguaína and other municipalities where it passes. It is also formed by the main catchment and drainage basin in the region [2]. Where the present system of drainage that composes to the basin of the Araguaia, within the municipality of Araguaína, is formed mainly by the river Lontra and its tributaries [1], [13].

The study area has a perimeter of 23 km, and a water mirror of 2.2 km² and depths between 1.5m, upstream and 6m in the spillway of the aforementioned dam, quite silted, characteristic due to the strong rainy period added to unfavorable roadway structures within the catchment basin. Being inserted in an urban area, surrounded by farms and lots, as well as, some preserved areas in the urban environs of the municipality of Araguaína [13]. This lake, remained for more than 20 years being used to feed the hydroenergetic production of the SHP Corujão. However, in 2014, it was totally drained to clean the banks and in 2016 it was again full. And today it receives attention of the municipal government, with the urbanization of the margins for sports activities and construction of an artificial island inside the referred lake.

Study area is inserted in the urban perimeter of Araguaína formed by SHP Corujão lake which is inserted in an ecotonal region influencing biomes such as Cerrado, Cocais Forest and Amazon Rainforest. Being that in all its extension and in both margins exists the formation and Typical gallery forest for the Cerrado biome, composed mainly plants of the cerrado and plants of the biome Forest Amazon. and in the landscape as well as in the floristic composition the Buriti, Arecacea of amphibian habitats is very widespread, both in the Amazon Forest and in the cerrado forest (Figure 04). however, the tributaries that supply the lake, some are under pressure from urban sprawl and others come from rural areas where there is exploitation for livestock and agriculture. And more conspicuously, this lake is mainly supplied by the headwaters of the Lontra River and Jacuba River, however it receives a heavy load of effluents, coming from the urban area of Araguaína, through the Neblina stream. Manancial, this one, which has its catchment basin, from mouth to head, all inserted in an urban area in the Araguaína city, receiving domestic effluents, urban waste and effluents in general, generated by hospitals and companies located in this region.

Figure 1 - Front view of the SHP Corujão Dam, in Araguaína - TO (Source: Authors, 2018).

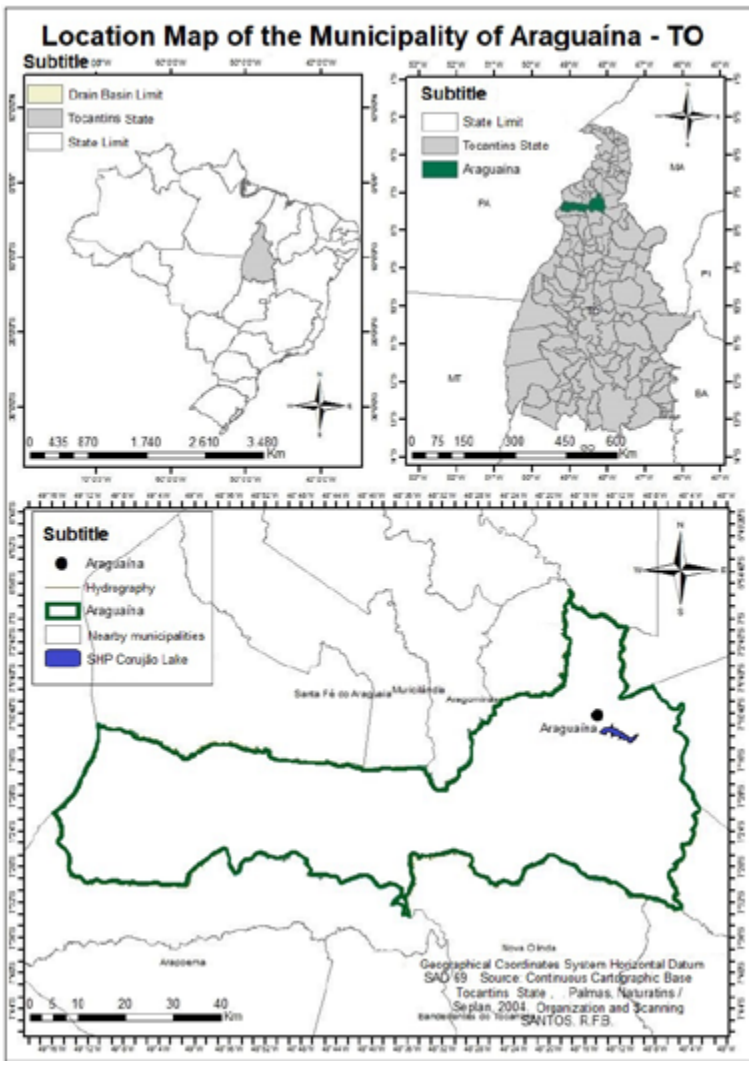


Figure 2- Geographical location of the municipality of Araguaína, indicating the position of the Lake of SHP Corujão (Source: Adapted from SAVIATO et al., 2017).

Figure 3- Geographic Location of collection points within the SHP Corujão Lake in the municipality of Araguaína (Source: Authors, 2018 / GoogleEarth).

Figure 04 – Images of the study area illustrating A) vegetation cover and environmental quality in the studied region of both margins; B) left margin of the urbanization over the ciliary band; C) area within the studied region with construction of the Bridge over the Lake and D) preserved area of ciliary forest on the right bank. (Source Authors 2018).

In order to collect the fish in this study, 22 field trips were carried out between March 2016 and December 2017, monthly, with different fishing gear, such as tarrafa (2m Ø and 5mm mesh), puçá and sieve (3mm mesh). Where the material was collected during the daytime, twilight and night, and in some stretches it is possible to make collections with drag trawl type (30m x 3.5m and 5mm mesh). The collected animals were stored in plastic bags, and euthanized *in situ* with 10% formaldehyde, then taken to the Biology Laboratory (SESI / Araguaína School), for analysis and identification, and after 48 hours the formaldehyde was replaced with 70% alcohol, the specimens deposited and listed, in the biological collection of the same institution. However, some field trips were based on the knowledge of the popular and the riverside that promote fishing activities within the study area [14], [15]. The Microsoft Office ™ Excel program was used during tabulation and table conversion, it is a qualitative work, because only the species found will be presented.

RESULTS AND DISCUSSION

Considering the sample effort for the proposed study, we found results consistent with the expected fish assembly for the Araguaia-Tocantins Basin region. This assembly consists mainly of fish of the order Caraciformes, followed by the order Siluriformes, which, in this context, account for more than 50% of the species captured, as mentioned in studies carried out in the regions near the municipality of Araguaína [1], [6], [16],[17], [18].

In this way, it can be understood that the fish found for this study make up a quite distinct assembly that reflects the species richness expected for the Araguaia Tocantins basin, a basin that despite the environmental exploitation is still given as one of the most diverse South America [1], [18], [19], [20], [21].

Therefore, the species richness of this region is given by the sum of specimens hidden in 34 families (Acestrorhynchidae, Achiridae, Anostomidae, Aspredinidae, Auchenipterinidae, Belonidae, Bryconidae, Characidae, Chilodontidae, Cichlidae, Crenuchidae, Curimatidae, Cynodontidae, Doradidae, Erythrinidae, Gymnotidae, Hemiodontidae, Heptapteridae, Hypopomidae, Iguanodectidae, Lebiasinidae, Loricariidae, Parodontidae, Pimelodidae, Potamotrygonidae, Pristigasteridae, Prochilodontiade, Pseudopimelodidae Rhamphichthyidae,Serrasalmidae,Sternopygidae, and Synbranchidae Trichomycteridae) totaling 113 identified species.

Despite interruption of the flow of the river by the hydroelectric dam the richness of fish found region reflect the composition expected for the headwaters of the Araguaia River Basin. However, given the magnitude of Rio and the reports of older residents, some species were not considered in this study and there is a possibility that they are no longer present in this environment, thus providing a local extinction and a decrease in the region's environmental wealth (Table 01).

Table 01 - Species listed and collected for this study classified by order, family and species (Source: Authors, 2019).

Táxon
BELONIFORMES

Belonidae

Potamorrhaphis guianensis (Jardine, 1843)

CHARACIFORMES

Acetrorhynchidae

Acestrorhynchus falcatus (Bloch, 1794)

Acestrorhynchus microlepis (Jardine, 1841)

Anostomidae

Abramites cf. hypselonotus (Günther, 1868)

Anostomus ternetzi Norman, 1926

Leporinus friderici (Bloch, 1794)

Leporinus taeniatus Lütken, 1875

Parodontidae

Apareiodon machrisii Travassos, 1957

Bryconidae

Brycon cf. falcatus Müller & Troschel, 1844

Iguanodectidae

Bryconops caudomaculatus (Günther, 1864)

Iguanodectes spilurus (Günther, 1864)

Characidae

Aphyocharax dentatus Eigenmann & Kennedy, 1903

Astyanax abramis (Jenyns, 1842)

Astyanax fasciatus (Cuvier, 1819)

Astyanax microlepis Eigenmann, 1913

Chalceus cf. macrolepidotus Cuvier, 1818

Deuterodon sp.

Hemigrammus cf. melanochrous Fowler, 1913

Hemigrammus cf. *stictus* (Durbin, 1909)

Hemigrammus hyanuary Durbin, 1918

Hemigrammus levis Durbin, 1908

Hyphessobrycon cf. copelandi Durbin, 1908

Knodus heteresthes (Eigenmann, 1908)

Knodus sp.

Moenkhausia chrysargyrea (Günther, 1864)

Moenkhausia collettii (Steindachner, 1882)

Moenkhausia oligolepis (Günther, 1864)

Odontostilbe nareuda Bührnheim & Malabarba, 2006

Phenacogaster microstictus Eigenmann, 1909

Poptella compressa (Günther, 1864)

Serrapinnus kriege (Schindler, 1937)

Tetragonopterus chalceus Spix & Agassiz, 1829

Thayeria boehlkei Weitzman, 1957

Triportheus elongatus (Günther, 1864)

Triportheus trifurcatus (Castelnau, 1855)

Chilodontidae

Caenotropus labyrinthicus (Kner, 1858)

Crenuchidae

Ammocryptocharax sp.

Characidium etheostoma Cope, 1872

Curimatidae

Curimatella dorsalis (Eigenmann & Eigenmann, 1889)

Cyphocharax cf. gouldingi Vari, 1992

Cynodontidae

Hydrolycus scomberoides (Cuvier, 1819)

Erythrinidae

Hoplias curupira Oyakawa & Mattox, 2009

Hoplias malabaricus (Bloch, 1794)

Hoplerythrinus unitaeniatus (Spix & Agassiz, 1829)

Hemiodontidae

Bivibranchia fowleri (Steindachner, 1908)

Hemiodus goeldii Steindachner, 1908

Hemiodus microlepis Kner, 1858

Hemiodus tocantinensis Langeani, 1999

Lebiasinidae

Nannostomus cf. eques Steindachner, 1876

Pyrrhulina cf. brevis Steindachner, 1876

Prochilodontidae

Prochilodus nigricans Spix & Agassiz, 1829

Semaprochilodus brama (Valenciennes, 1850)

Serrasalmidae

Colossoma macropomum (Cuvier, 1818)

Metynnis lippincottianus (Cope, 1870)

Myloplus arnoldi Ahl, 1936

Myloplus cf. rubripinnis (Müller & Troschel, 1844)

Pygocentrus natereri Kner, 1858

Serrasalmus geryi Jégu & Santos, 1988

Serrasalmus gibbus Castelnau, 1855

CLUPEIFORMES

Pristigasteridae

Pellona castelnaeana Valenciennes, 1847

GYMNOTIFORMES

Gymnotidae

Electrophorus electricus (Linnaeus, 1766)

Hypopomidae

Brachyhypopomus brevirostris (Steindachner, 1868)

Microsternarchus bilineatus Fernández-Yépez, 1968

Rhamphichthyidae

Gymnorhamphichthys petiti Géry & Vu, 1964

Sternopygidae

Eigenmannia limbata (Schreiner & Miranda Ribeiro, 1903)

Sternopygus xingu Albert & Fink, 1996

MYLIOBATIFORMES

Potamotrygonidae

Potamotrygon motoro (Müller & Henle, 1841)

OSTEOGLOSSIFORMES

Osteoglossidae

Osteoglossum bicirrhosum

PERCIFORMES

Cichlidae

Apistogramma sp.

Biotodoma cupido (Heckel, 1840)

Caquetaia spectabilis (Steindachner, 1875)

Cichla kelberi Kullander & Ferreira, 2006

Cichlasoma araguaiense Kullander, 1983

Crenicichla labrina (Spix & Agassiz, 1831)

Crenicichla lugubris Heckel, 1840

Crenicichla strigata Günther, 1862

Geophagus proximus (Castelnau, 1855)

Heros efasciatus Heckel, 1840

Laetacara araguaiae Ottoni & Costa, 2009

Mesonauta acora (Castelnau, 1855)

Retroculus lapdifer (Castelnau, 1855)

Satanoperca acuticepis (Heckel, 1840)

SILURIFORMES

Aspredinidae

Bunocephalus coracoideus (Cope, 1874)

Auchenipteridae

Centromochlus sp.

Tatia cf. neivai (Ihering, 1930)

Trachelyopterus galeatus (Linnaeus, 1766)

Doradidae

Oxydoras niger (Valenciennes, 1821)

Heptapteridae

Mastiglanis cf asopos Bockmann, 1994

Phenacorhamdia cf. somnians (Mees, 1974)

Pimelodella cristata (Müller & Troschel, 1849)

Pimelodella lateristriga (Müller & Troschel, 1849)

Rhamdia cf. muelleri (Günther, 1864)

Loricariidae

Ancistrus hoplogenys Günther, 1864)

Farlowella smithi Fowler, 1913

Hemiodontichthys acipenserinus (Kner, 1853)

Hypoptopoma gulare Cope, 1878

Hypostomus faveolus Zawadzki, Birindelli & Lima, 2008

Hypostomus sp.

Otocinclus sp.

Panaque nigrolineatus (Peters, 1877)

Sturiosoma sp.

Pimelodidae

Pimelodus blochii Valenciennes, 1840

Pseudoplatystoma cf. fasciatum (Linnaeus, 1766)

Sorubim lima (Bloch & Schneider, 1801)

Zungaro zungaro (Humboldt, 1821)

Pseudopimelodidae

Microglanis sp.

Pseudopimelodus schutzi (Dahl, 1955)

Trichomycteridae

Ituglanis sp.

Vandellia sanguínea Eigenmann, 1917

SYNBRANCHIFORMES

Synbranchidae

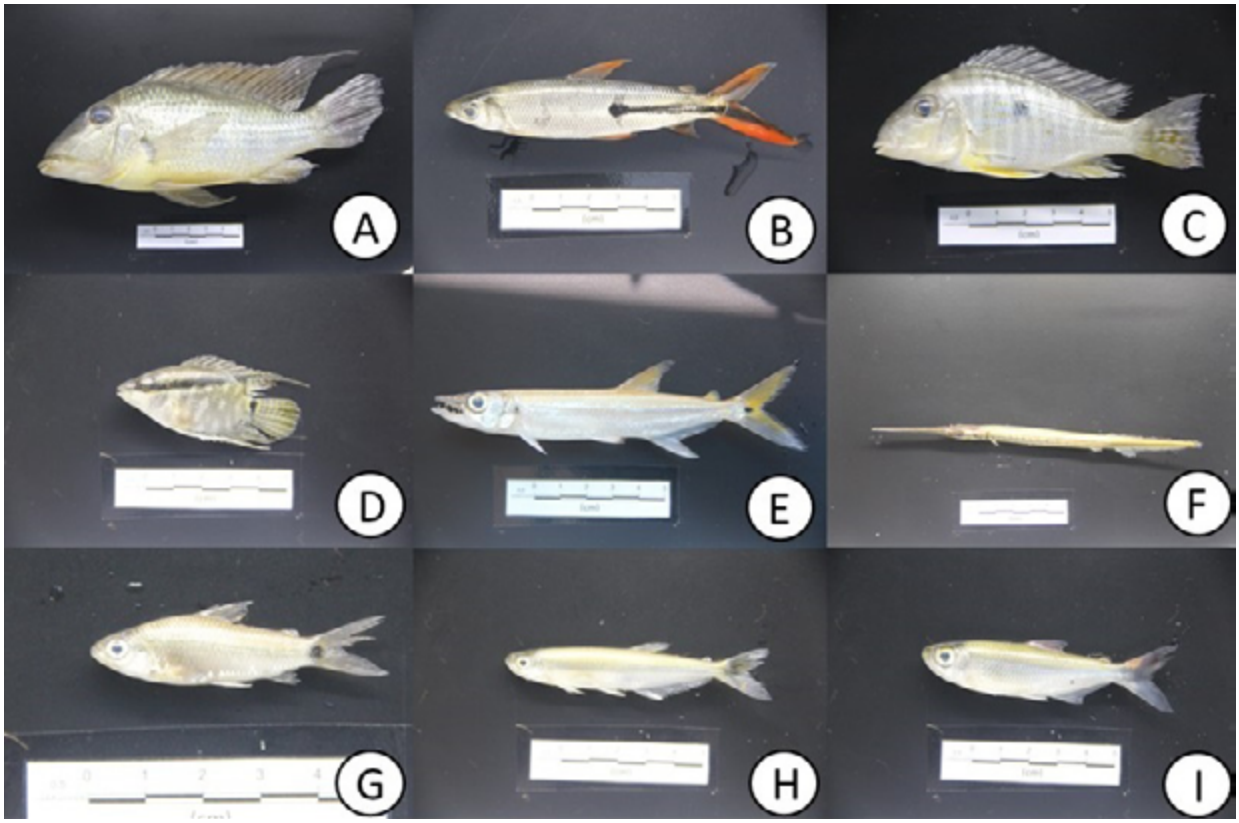
Synbranchus cf. marmoratus Bloch, 1795

PLEURONECTIFORMES

Achiridae

Hypoclinemus mentalis (Günther, 1862)

As expected the largest order found for the region is Characiformes, which has representatives of all food guilds, from grazers (*Curimatella dorsalis*) to top-chain predators (*Hydrolycus scomberoides*). in this way it represents a very biodiverse group with characteristics expected for a region where there is an equity in the distribution of the species (Figure 05).



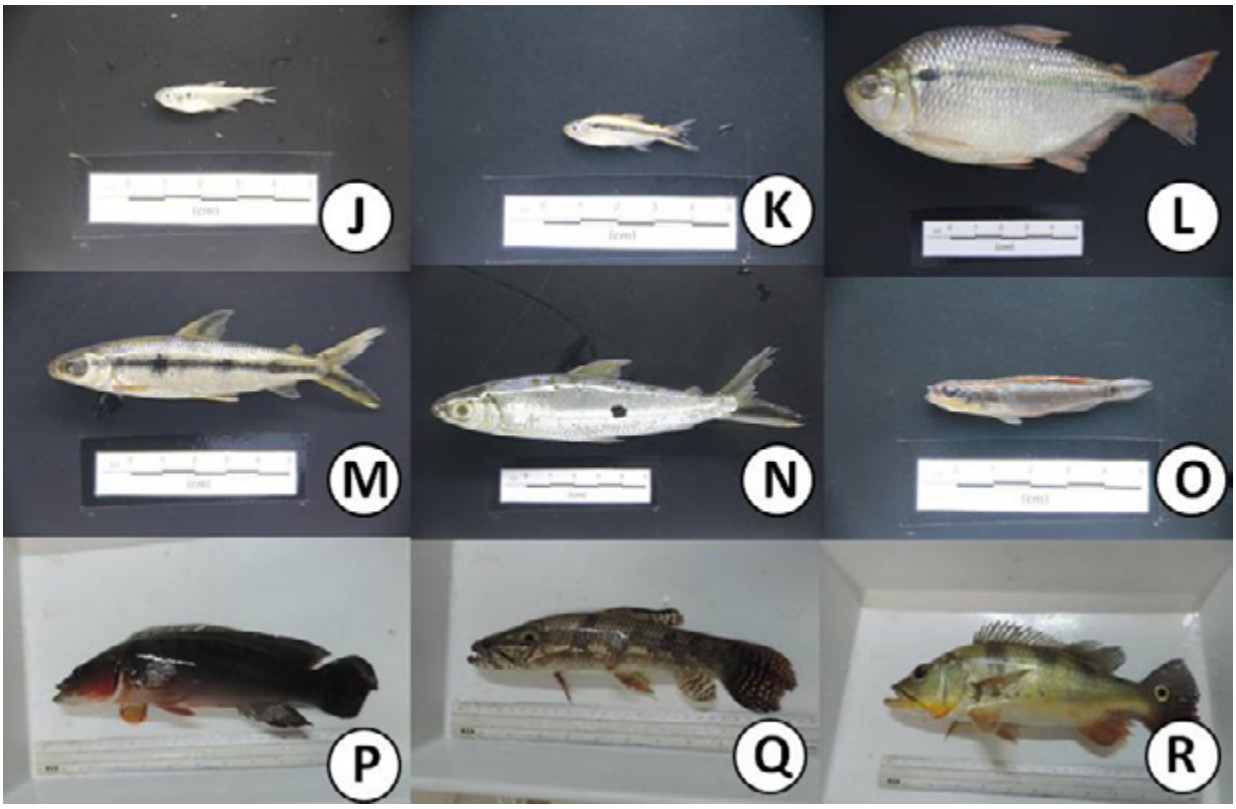


Figure 05 - Representative specimens of fish species of conservation interest for the region studied; A) *Satanoperca acuticeps,* B) *Hemiodus Goeldi,* C) *Geophagus proximus,* D) *Mesonauta acoura,* E) *Acestrorhynchus falcatus,* F) *Potamorhaphis guianensis,* G) *Cyphocharax dorsalis,* H) *Iguanodectes spilurus,* L) *Bryconops caudomaculatus,* J) *Hyphessobrycon cf. copelandi*, K) *Thayeria boehlkei ,* L) *Astyanax abramis,* M) *Hemiodus tocantinenses,* N) *Hemiodus microlepis,* O) *Crenicichla labrina,* P) *Crenicichla lugubris,* Q) *Hoplias malabaricus,* e R) *Cichla kelberi* (Source authors 2019).

According to studies carried out in the region, as well as, with some investigations carried out in the same basin, the results for these studies are consistent with the lists of fish species described for the Araguaia-Tocantins basin, and also in agreement with the other studies carried out in the region [22]. However, the richness found for this region denotes the sum of the species expected for the Amazon Forest and the Cerrado, thus composing a unique and diversified ichthyofauna. Being the reflection, the pertinent environmental configuration and the environmental stability, installed after the construction of the studied dam [23], [24].

It is important to raise the fact that, even the present study, can be complemented with the wider exploration within the studied area, and the use of other methodologies, more conclusive, with a longer sampling time. In this way, increasing the richness found and emphasizing the singularity of the studied environment, a basin of headwaters, inserted in an important ecotone, between Amazon Forest and Cerrado, with richness and abundance intrinsic of this phytosociological and

geographic formation.

CONCLUSION

The present study provided the identification of a large number of fish species, as expected for a river of fourth magnitude, located in the headwaters of Araguaia, within the region comprising the Brazilian Amazon. This wealth, cited in this work, demonstrates the accredited for the evaluated environment. However, with the increase of the sampling effort and the use of other capture methodologies, it is possible to increase species to the region and also to confirm some local extinctions.

However, this study presents a fish assemblage consistent with the environments preserved in the Headwaters of the Araguaia Tocantins Basin. This fact happens because it is a river of Cerrado where the anthropized environment is confused with the natural one, undergoing few alterations upstream of said lake. And because of these data, it is possible to infer that there is no apparent influence on the composition of the ichthyofauna due to the discharge of urban waste. However, the physiological effects of these wastes on the fish that compose the ichthyosis of the study area were not included in these results.

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