ICTHYOFAUNA OF VACA AND ÁGUA AMARELA STREAMS AFLUENT OF RIO LONTRA (TOCANTINS BASIN), TOCANTINS, BRAZIL

ICTIOFAUNA DOS RIACHOS VACA E ÁGUA AMARELA AFLUENTES DO RIO LONTRA (BACIA DO TOCANTINS, TOCANTINS, BRASIL

ICTIOFAUNA DE LOS RIACHES VACA Y AGUA AMARELA DEL RÍO LONTRA (CUENCA TOCANTINS, TOCANTINS, BRASIL)

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ABSTRACT
This study was conducted in a preservation area of the Unidade de Medicina Veterinária e Zootecnia da Universidade Federal do Tocantins, Araguaína, TO, between May 2017 and January 2018, with monthly collection excursions. The objective was to inventory the ichthyofaunistic community of two streams: Corrégo da Vaca and Córrego da Água Amarela, the Lontra River tributaries, belonging to the Araguaia-Tocantins system, as well as to identify endemic species and new records. We collected 154 individuals belonging to five orders (Characiformes, Siluriformes, Gymnotiformes, Cichliformes, Cyprinodontiformes), distributed in 12 families and 30 species.

Keywords: Conservation, fish diversity, neotropical fish, species inventory

RESUMO

Este estudo foi conduzido em uma área de preservação da Unidade de Medicina Veterinária e Zootecnia da Universidade Federal do Tocantins, Araguaína, TO, entre maio de 2017 e janeiro de 2018, com excursões mensais de coleta. O objetivo foi inventariar a comunidade ictiofaunística de dois córregos: o Córrego da Vaca e o Córrego da Água Amarela, afluentes do Rio Lontra, pertencentes ao sistema Araguaia-Tocantins, bem como identificar espécies endêmicas e novos registros. Foram coletados 154 indivíduos pertencentes a cinco ordens (Characiformes, Siluriformes, Gymnotiformes, Cichliformes, Cyprinodontiformes), distribuídos em 12 famílias e 30 espécies.

Palavras-chave: *Conservação, Diversidade de peixes, peixes neotropicais, inventário de espécies.*

RESUMEN

Este estudio se realizó en un área de preservación de la Unidade de Medicina Veterinária e Zootecnia da Universidade Federal do Tocantins, Araguaína, TO, entre mayo de 2017 y enero de 2018, con excursiones de recolección mensuales. El objetivo fue inventariar la comunidad ictiofaunística de dos arroyos: Corrégo da Vaca y Córrego da Água Amarela, afluentes del río Lontra, pertenecientes al sistema Araguaia-Tocantins, así como identificar especies endémicas y nuevos registros. Se recolectaron 154 individuos pertenecientes a cinco órdenes (Characiformes, Siluriformes, Gymnotiformes, Cichliformes, Cyprinodontiformes), distribuidos en 12 familias y 30 especies.
Descriptores: *Conservación, diversidad de peces, peces neotropicales, inventario de espécies*.

INTRODUCTION

According to (Reis et al. 2016), the total diversity of freshwater and marine fish species for South America is approximately 9.100 species which would correspond to about 27% of all fish species in the world. In spite of this, the Neotropical Region has, approximately, 5.577 species of freshwater fish, which are primarily dominated by the two orders, Siluriformes and Characiformes; both correspond to 71% of all species that inhabit neotropical freshwater (Malabarba and Malabarba 2014). According to (Abell et al. 2008), Brazil has one of the richest freshwater ichthyofaunas and this might be related to the high rates of species and endemism. In this context, the Tocantins-Araguaia river basin is considered the fourth largest exclusively Brazilian hydrographic basin (Goulding et al. 2003) and its importance in terms of biodiversity and economic importance is immeasurable and it is estimated that the diversity of fish may exceed 600 species (Santos et al. 2004; (Lucinda et al. 2007), (Ferreira et al. 2011), (Akama 2017).

(Castro 1999) stated the importance of the studies of ichthyofauna that inhabit streams because the unequivocal absolute dominance, about 50% of ichthyofauna is composed by small fish. Several studies have been made in the Tocantins-Araguaia drainage, mainly in water bodies associated with hydroelectric developments, as Tucuruí Dam (Santos et al. 1984), Serra da Mesa Dam (Miranda and Mazzoni 2003), Lageado Dam (Lucinda et al. 2007) and Peixe Angical Dam (Soares et al. 2009). Despite the fact that the Araguaia river does not have hydroelectric projects, several authors pointed out that this region is very neglected in terms of biodiversity information and so impacted by anthropic actions (Agostinho, 2005, Nogueira et al, 2010, Giongo et al, 2011).

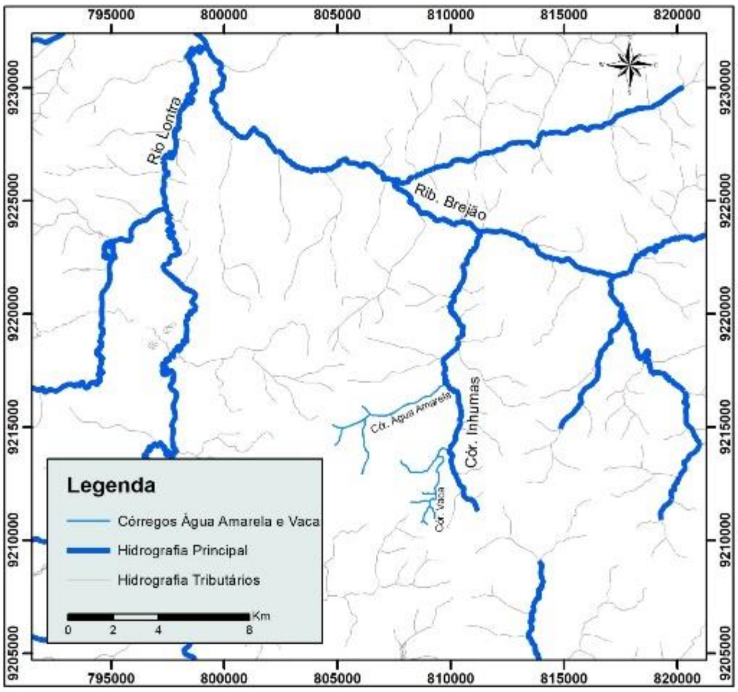
In that context, this study aims to inventory of ichthyofauna composition of the Vaca and the Água Amarela streams, both tributaries of the Lontra river, the Araguaia River basin, in the city of Araguaína, Tocantins State.

METHODS

Study area

The samples were collected in the Vaca (7º6'9.81"S, 48º11'52.79"W) and the Água Amarela streams (7º04'57.5"S, 48º12'23.4"W), an important environment because they are part of headwaters region of the Lontra River, tributary of the Araguaia River. The area has a considerable vegetal mosaic of phytophysiognomies (Sano and Almeida 1998), with two perennial streams characterized by gallery forest, riparian vegetation, pasture areas and, anthropized areas due to the construction of the Escola de Medicina Veterinária e Zootecnia, da Universidade Federal do Tocantins (EMVZ/UFT), located in Araguaína (Fig. 1).

Figure 1: Map of location, highlighting the Água Amarela and Vaca streams.



(Fonte: Authors, 2017)

The Vaca stream is about 2 meters wide and 60 centimeters of deep, while the Água Amarela stream is about 3,5 meters wide and 80 centimeters of deep, both have a moderate currents, bordered by gallery forests located in a transitional area between two Brazilian biomes - Cerrado and the Amazon Forest (Fig. 2 e Fig.3, respectively). The Água Amarela Stream is 6,680m long. It has 3 tributaries with: 2,021m, 563m, 517m. Nascent coordinates: 7º6'44.70 "S, 48º13'45.94 "W. The Vaca Stream is 4,656m long. It has 05 tributaries with: 121m, 884m, 653m, 2,293m, 695m. Nascent coordinates: 7º7'56.24 "S, 48º12'10.10 "W.

Figure 2: Part of the Vaca Stream studied.

(Fonte: Authors, 2017)

Figure 3: Part of the Água- Amarela Stream studied.

(Fonte: Authors, 2017)

Data collection

Nine collections events were carried out between May 2017 to January 2018. The methodology of inventory followed (Uieda and Castro 1999) with some modifications. It was also used gill nets and sieves in active captures in temporary puddles. The collections were performed alternately in daytime, twilight and night-time periods, all installed every four hours and remaining installed for 12 hours total. Along the streams, intervals of 100 meters were established between one point to another, three points in each area of the study. In some section of sampling points, the collections were carried out only with gill nets and sieves, due to the poor accessibility of environment.

After collections, all specimens were fixed in formaldehyde 10% and preserved in ethanol 70%. The specimens were identified using available bibliography on the Tocantins-Araguaia basin. This article used: Santos et al., 2004; Ferreira et al., 2011; Bartolette et al., 2017 and; Saviato et al., 2017.

All specimens were deposited at Coleção de Peixes do Laboratório de Ictiologia Sistemática da Universidade Federal do Tocantins (UNT). The material was collected under authorization of the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) (Process number: 7025986).

Material examined

In this study, we do not take morphometric measurements and morphological attributes or use dissection methodologies. The main objective was to conduct an ichthyofaunistic survey of an area that has not yet been studied and of great ecological importance for the region. The specimens were identified based on morphological characteristics and places of occurrence, based on the articles cited in the item “data collection”.

Data Analysis

The data obtained were tabled and analyzed using spreadsheets and the PAST version 2.17c program (HAMMER et al. 2001).

RESULTS

During the study all the environments of the described collection spots were investigated, from small temporary puddles, permanent puddles and lotic environments within the Vaca and the Água Amarela streams. We collected 152 fish specimens, belonging to five orders: Characiformes, Siluriformes, Gymnotiformes, Cichliformes and Cyprinodontiformes. These are distributed in 13 families (Acestrorhynchidae, Characidae, Cichlidae, Curimatidae, Erythrinidae, Gymnotidae, Heptapteridae, Hypopomidae, Loricariidae, Rhamphichthyidae, Rivulidae, Serrasalmidae and Sternopygidae), totaling 30 species. (Table 1).

Table 1: List of species of fish that occur in the studied area.

Species
Characiformes
Curimatidae
Curimatella dorsalis (Eigenmann & Eigenmann, 1889)
Characidae
Aphyocharax dentatus Eigenmann & Kennedy, 1903
Astyanax microlepis (Eigenmann, 1913)
Astyanax abramis (Jenyns, 1842)
Cynopotamus tocantinensis (Menezes, 1987)
Hemigrammus stegemanni (Géry, 1961)
Moenkhausia aff. *collettii* (Steindachner, 1882)
Moenkhausia cf. *oligolepis* (Günther, 1864)
Poptella compressa (Günther, 1864)
Iguanodectinae
Bryconops melanurus (Bloch, 1794)
Serrasalmidae
Serrasalmus gibbus (Castelnau, 1855)
Acestrorhynchidae
Acestrorhynchus falcatus (Bloch, 1794)
Erythrinidae
Hoplerythrinus unitaeniatus (Spix & Agassiz, 1829)
Hoplias malabaricus (Bloch, 1794)
Siluriformes
Loricariidae
Ancistrus hoplogenys (Günther, 1864)
Hypostomus sp.
Callichthyidae
Hoplosternum littorale (Hancock, 1828)
Corydoras xinguensis (Nijssen, 1972)
Heptapteridae
Pimelodella lateristriga (Müller & Troschel, 1849)
Pimelodella cristata (Müller & Troschel, 1849)
Gymnotiformes
Sternopygidae
Eigenmannia limbata (Schreiner & Miranda Ribeiro, 1903)
Sternopygus macrurus (Bloch & Schneider, 1801)
Rhamphichthyidae
Gymnorhamphichthys petiti (Géry & Vu-Tân-Tui, 1964)
Hypopomidae
Microsternarchus bilineatus (Fernández-Yépez, 1968)
Gymnotidae
Electrophorus electricus (Linnaeus, 1766)
Cichliformes

Cichlidae	
Cichlasoma araguaiense (Kullander, 1983)	
Crenicichla labrina (Spix & Agassiz, 1831)	
Satanoperca acuticeps (Heckel, 1840)	
Cyprinodontiformes	
Rivulidae	
Melanorivulus zygonectes (Myers, 1927)	
Rivulus sp.	

DISCUSSION

Characiformes were the one that stood out the most in this work (46%), showing the expected pattern for headwaters in the Neotropical region (Langeani et al. 2007). The most representative family for the Vaca Stream was Iguanodectidae with 17% and the most abundant species was *Bryconops melanurus*. In the Água Amarela Stream, the occurrence of this species was slightly lower with 12%, with *Melanorivulus zygonectes* 14%, *Moenkhausia oligolepis* 13%, being the most abundant species and *Cichlasoma araguaiense* 14%. The most representative families were Characidae, with eight species, and Loricariidae with four species. Small species such as *Astyanax microlepis*, *A. abramis* and *Bryconops melanurus* were collected predominantly by active fishing (gill net).

The Shannon-Wiener diversity index is one of the most used in diversity studies. In this study we can verify that in both samples, the index is high, with 2.855 for the Água Amarela Stream and 2.621 for the Vaca Stream, which shows that, although they are nearby streams and tributaries of the same river, they have distinct species. Through the Margalef index, which measures the wealth of species, we also obtained close results: 4.96 for the Vaca Stream and a slight increase for the Água Amarela Stream, 5.36. The use of Simpson's index to verify dominance is low (less than one), being 0.899 for the Vaca Stream and 0.9285 for the Água Amarela Stream, which proves that there is no species dominance, but a great diversity in both samples (Table 2).

Table 2. Diversity indexes for the Vaca and the Água Amarela Streams.

	Vaca	**Amarela**	**B(eq)**	**Perm p(eq)**
Rate S	22	25	0.46	0.551
Individuals	71	88	0	0
Dominance	0.10 1	0,07154	0.051	0.018

Shannon H	2.62 1	2,855	0.142	0.128
Simpson	0.89 9	0,9285	0.051	0.018
Margalef	4.92 6	5,36	0.605	0.567
Equitability J	0.84 81	0,887	0.146	0.116

Acoording to Saviato *et al*. 2017, it is possible to identify that the fish assembly is within the expected for the region. However, new occurrences are presented in this study, possibly due to the few scientific explorations of ichthyofauna in this region, proving the lack of studies on the ichthyofauna of the headwaters that form the Araguaia-Tocantins basin. Sampling methods can provide representative data of the communities. In streams, the number of species is extremely variable and depends in part on the geographical region, sampled local type and the position of the sampling location related to headwaters (MATTHEWS, 1998. The wealth of species found for the two streams was 30 species in total, reinforcing the need and methodological suitability of the sampled locations. It is important to highlight that, due to constant extinctions and local invasions, long-term continuous sampling may add new species to the existing ones (Gotelli and Colwell 2001).

The diversity indices for the streams contemplated by the study (Table 2) illustrate a subtle difference in the number of species and the quantities shown. These environments were quite equitable among themselves, similar and with a well balanced species distribution. According to (Shibata and Cheida 2003), the occurrence of small species in streams like these studied ones is already expected, mainly due to their physiographic characteristics, such as low depth and width, for example the small ones, with the exception of *Hoplerythrinus unitaeniatus* and *Hoplias malabaricus* which are predators.

According to the collections, it was possible to identify which fish assembly from these places (the Vaca Stream and the Água Amarela Stream) is composed mainly by species of the Characidae family, with these ones to be important forages and components of the group that is the basis of the food chain in these places. Likewise, the subfamily Iguanodectidae was the most abundant group in number of individuals by species in the two streams, represented by the species Bryconops melanurus, with 17% for the Vaca Stream and 10% for the Água Amarela Stream. In addition to this abundance, there are the species of the genera *Astyanax* and *Moenkhausia* (Table 1), which were also dominant by numbers of individuals and by species from these streams samples.

However, Erythrinidae was poorly represented, in abundance level and relative frequency, as well as low representativity in number of individuals per species (*Hoplias malabaricus* and

Hoplerythrinus unitaeniatus) with a rate of 1% and a relative frequency of 1.44 for both streams (Table 2.). The Erythrinidae family low sampling is influenced by the fact that this group has the predatory habit and the top of the food chain, unlike the forage species, the basis of this chain, which are represented in greater number in headwaters streams.

The Curimatidae family, which represents the *Curimatella dorsalis*, species, which are small in size, is known as detritivorous fish or iliophages, because they feed mainly on algae and debris (ARANGUREN, 2002). This species was absent in the Vaca Stream. In the Água Amarela Stream, the occurrence was 12%, indicating the need for more collections.

The Cichlidae species showed a higher dominance in the Água Amarela Stream, with a frequency of 12.04 against 1.44, in the Vaca Stream (Table 2). This difference in richness can be caused by the use of different collection devices or by the dimensions of the creeks, since the Água Amarela Stream has greater dimension and depth than the Vaca Stream. According to some authors, the fish of this family dominate the South American waters, and it is widely distributed, occupying different environments, such as lakes, wetlands and rivers (Malabarba and Malabarba 2014).

However, the order Cyprinodontiformes, quite different from other fish groups, living in temperate and tropical regions, usually in freshwater environments, have distinct adaptations to live in very extreme conditions like swamps and temporary pools (Malabarba and Malabarba 2014). In this study, the species *Melanorivulus zygonectes* had a significant sampling for the Vaca Stream, with a relative frequency of 14.49 and *Rivulus sp*. - 13.04. These fish live and have complete life cycle in these unique environments, for approximately one year, where the eggs can survive buried in the substrate and with embryonic development suspended (Wourms 1972); (Porciuncula et al. 2007)). From the rains on and the return of the water to the environment, the eggs develop rapidly during the flood periods and later, as the body of water begins to dry out, the adult individuals reproduce and lay resistance eggs in the substrate, which will only be able to hatch in the following year's flood (COSTA 2002). However, the representatives of this family have little ecological plasticity, generally living in headland and riparian forest environments, which are often impacted by anthropogenic actions, such as: deforestation, pollution and landings, which provide drastic environmental changes, promoting exclusion and even local extinctions, due to changes in water cycles and floristic composition, as well as habitat destruction (FONTANA et al. 2003). These groups of fish are commonly found in less altered environments, sensitive to these changes, and are also the first to head the list of endangered fish. As these changes progress, stream fish ecological measures become necessary (JUNQUEIRA 2011).

Although wealth found throughout the study is within the expected standards for a stream environment, it was found that there is a great difference in the abundance of the species among the streams that were studied. While some species were abundant during the sampling period, others were rare, and few individuals were collected from each, as for Serrasalmus sp, Eletrophorus electricus which had a low sampling frequency (1.2 and 2.4) in relation to the other species, with the two species occurring only in the Agua Amarela stream (Table. 2). Although they were in different orders, the first in the most abundant order and the second in a little different one, both were represented by few individuals, considered rare, since they are non-gregarious predators, which are already expected to meet few animals per sample area.

The species Moenkhausia oligolepis showed great abundance in the Água Amarela stream 15%, (12.04), and the Vaca Stream 13% with a reference value of (12.67), showing well equal in both streams. This dominance was also observed in other studies in different basins with the species of the Characidae, *Knodus moenkhausii*, in streams of the Upper Paraná basin (Castro et al. 2005); (Casatti et al. 2006). *Moenkhausia oligolepis* is very opportunistic and this characteristic guarantees it permanent sources of energy, a large part of which is allocated for reproduction, allowing its occurrence even in impacted environments (Ceneviva-Bastos and Casatti 2007).

Despite its wide distribution along the streams, *Astyanax abramis* has a greater abundance in the headwaters, where it had a greater abundance in the Água Amarela stream 11%. In general, this species has a small size, which restricts its distribution to specific micro-habitats, isolating populations, and sometimes favoring alopatric speciation (Castro 1999).

We hope that in some way, these results can influence environmental protection measures for these important streams. Therefore, the study of fish ecology in such a large, remote and little studied area as the tropical region is not an easy task considering the great species diversity, and still very similar to each other, making their identification so difficult, a fact that explains the presence of some not identified species in this study (LOWE-McCONNELL 1987).

CONCLUSION

From the results, it can be concluded that both streams are very similar due to their geographical proximity. Likewise, the study revealed a high rate of individuals, composed mainly by species of the Characidae. The richness presented in the study was very representative in relation to the size of the area that was sampled, reflecting the fishing tactics employed in these streams, while measuring the size of the water body and the sampling effort which was used. However, it is important to point out that with a larger extension of the collection area and the fishing gear employed, we will possibly find a richer ichthyofauna for this region, because some common species such as *Leporinus affinis* (piau) and

Prochilodus nigricans (curimatã) were not collected in this research and have already been reported by local residents. Thus, alongside with the results that were obtained and discussed here, it is inferred that they considerably enrich the ichthyofauna of this transition region between biomes.

With this paper, a path is opened for new studies of conservation and preservation of creeks in the middle Araguaia River region, especially in headwaters streams, priority areas for the conservation of biodiversity in watersheds that harbor great biological diversity, such as fish. Even with the strong anthropic pressure, these environments still remain quite preserved. The two headwaters streams studied here need more information that can show more data on species richness and total composition.

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