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Research paper

Ichthyofaunistic composition of Veadinho Brook, tributary of Lower Rio Grande River microbasin, Minas Gerais State, Brazil

Composição da ictiofauna do córrego Veadinho, microbacia afluente do Baixo Rio Grande, Estado de Minas Gerais, Brasil

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ABSTRACT: Anthropic actions can have negative effects on aquatic communities, such as changes in both the environment and in the composition of local communities. The aim of the current study is to investigate the ichthyofaunistic composition in a lower Rio Grande River tributary. Four regions distributed between two waterfalls were sampled. In order to do so, 50-minute samplings were carried out at each point, based on using 1.0 x 0.50-m sieves with 3-mm adjacent nodes. Subsequently, diversity indices (richness, abundance, dominance, Shannon-Winner, Simpson and Equitability parameters) were calculated in PAST® software for data analysis purposes. Shapiro-Wilker test was used to analyze data normality, whereas ANOVA test was adopted to analyze significant differences. In total, 1.926 individuals distributed among four orders, four families and six species were sampled. Cyprinodontiformes (49.01%) was the most abundant fish order; it was followed by Characiformes (48.75%), Cichliformes (1.30%) and Siluriformes (0.93%). Interpretive analyses did not indicate significant differences in this parameter, likely due to environmental homogeneity in the sampled regions. Thus, the herein investigated ichthyoaunistic composition may be linked to fish's adaptive plasticity.
Keywords: Ichthyofauna. Neotropical Region. Synanthropic Species.

RESUMO: *As ações antrópicas podem afetar negativamente as comunidades aquáticas. Esse fato pode implicar em mudanças no ambiente, bem como, na composição das comunidades locais. Objetivou-se realizar uma investigação da composição ictiofaunística em um afluente do baixo rio Grande. Foram amostradas quatro regiões distribuídas entre duas quedas d'águas. Para as coletas foram realizadas amostragens de 50 minutos em cada ponto com peneiras de 1,0 x 0,50 m com nós adjacentes de 3 mm. Posteriormente para as análises de dados foram calculados no software PAST® os índices de diversidade (parâmetros de riqueza, abundância, dominância, diversidade de Shannon- Winner, Simpson e Equitabilidade). Para a análise de normalidades dos dados foi realizado teste de Shapiro-Wilker, e posteriormente o teste ANOVA para testar às diferenças significativas. Foram amostrados 1.926 indivíduos distribuídos entre quatro ordens, quatro famílias e seis espécies. As mais abundantes foram Cyprinodontiformes (49,01%) seguida de Characiformes (48,75%), Cichliformes (1,30%) e Siluriformes (0,93%). As análises interpretativas não apontaram diferenças significativas, fato esse, que possa está relacionado com a homogeneidade ambiental nos trechos amostrados. Assim, a composição ictioaunistica pode estar atrelada a plasticidade adaptativa.*
Palavras-chave: *Ictiofauna. Região Neotropical. Espécie Sinantrópica.*

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INTRODUCTION

The South American continent has one of the largest water reserves in the world; it is also rich in freshwater ichthyofauna species (VARI; MALABARBA, 1998, REIS et al., 2016; ALBERT; TAGLIACOLLO; DAGOSTA, 2020). Species richness in the Neotropical region can reach more than 6,000 species (AGOSTINHO; THOMAZ; GOMES, 2005; REIS et al., 2016; ALBERT; TAGLIACOLLO; DAGOSTA, 2020). There are biases in the number of species sampled in small-order brooks, if one takes into consideration the small number of studies carried out in these regions (WINEMILLER; AGOSTINHO; CARAMASCHI, 2008). Thus, regions with smaller scope and economic influence are the ones presenting the most incomplete data; sometimes, these data are addressed in some studies (CASTRO et al., 2004; GALVES; SHIBATTA; JEREP, 2009; FAGUNDES et al., 2015; SOUZA et al., 2016; RIBEIRO et al., 2019; COSTA et al., 2023).

A significant fraction of the Neotropical biodiversity is found in the Amazonas River and Paraná River basins (LANGEANI et al.,2007). Paraná River basin is formed by sub-basins; the main ones (upper Paraná River) are Rio Grande, Paranaíba, Tietê and Paranapanema. Biodiversity in this region has representatives belonging to orders Characiformes, Siluriformes, Cichliformes and Cyprinodontiformes (CASTRO et al., 2004; LANGEANI et al., 2007; RIBEIRO et al., 2019). With respect to spatial representativeness, Siluriformes and Characiformes stand out for their adaptive plasticity; they can be found in both microbasins (e.g., drainage area smaller than 100 km^2) and sub-basins (e.g., drainage area bigger than 100 km^2 and smaller than 700 km^2) (LOWE-MCCONNELL, 1999; FAUSTINO, 1996; CASTRO et al., 2004; AGOSTINHO; GOMES; PELICICE, 2007; FAGUNDES et al., 2015).

Orders Characiformes and Siluriformes were recorded in tributary brooks of Grande River in São Paulo State, as well as in tributary rivers in Minas Gerais State (e.g., Uberaba and Araguari rivers) (CASTRO et al., 2004; SOUZA et al., 2016; RIBEIRO et al., 2019).

It is known that anthropic actions are one of the worst threats to aquatic biodiversity. (ALVES; VONO, 1997; LIMA, 2001; AGOSTINHO; THOMAZ; GOMES, 2005; BIFI et al., 2006; SOUZA et al., 2013; CAMARGO; SOUZA; SILVA, 2022). According to Agostinho, Thomaz and Gomes (2005), factors like pollution, dams' construction and predatory fishing have been strongly linked to the disruption of fish communities. These anthropic activities change the environment and affect the composition of biological communities; consequently, they lead to population decline and increase vacant niches, a fact that favors invasion processes by allochthonous species (ELTON, 1958; AGOSTINHO; THOMAZ; GOMES, 2005; CASATTI; PAULA; CARVALHO, 2009).

Thus, the survey carried out by Alves and Vono (1997) in a small tributary brook (i.e., Gameleira Stream) of Rio Grande River has pointed out that anthropic activities (e.g., industrial effluent discharge) have influenced the richness decrease observed in fish communities.

Another example of anthropic action lies on the introduction of exotic species, as reported by Souza et al. (2016), who evidenced the presence of Cyprinodontiformes (i.e., *Poecilia reticulata*) – which is an allochthonous species native to Northern South America - in Brazilian basins, where they were introduced to help controlling mosquito larvae (LUCINDA, 2017).

Therefore, anthropogenic influence, such as pollution, changes in water flow and

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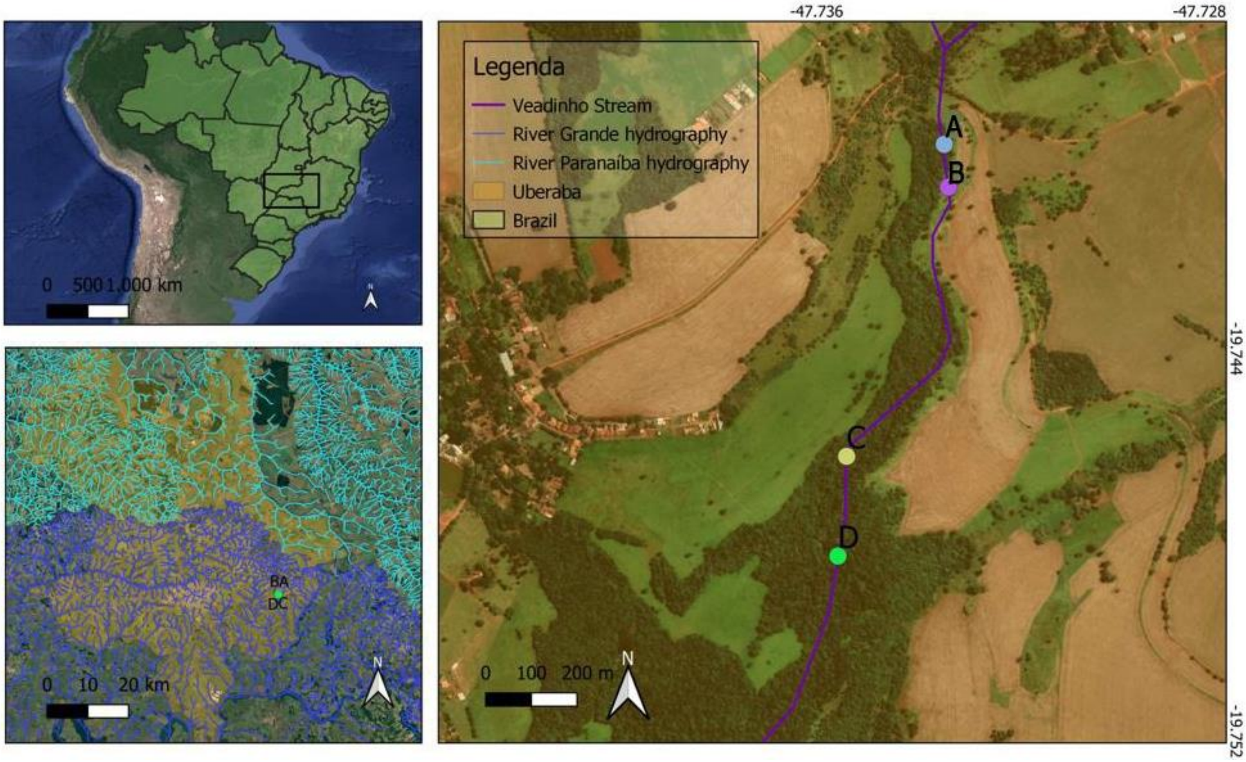
exotic species' introduction, can put pressure on native species (SOUZA et al., 2013; GANASSIN et al., 2020). In light of the foregoing, the aim of the current study was to investigate the ichthyofaunistic composition of Veadinho Brook, which is part of the tributary microbasin of Lower Rio Grande Basin. Thus, the present research can help improving knowledge about fish communities associated with small-order brooks and conservation strategies.

MATERIAL E METHODS

Study area

The herein sampled region is located in Uberaba City, Minas Gerais State. Sampling campaigns took place from September 2017 to June 2018, at four different points (**A, B, C and D**) between two natural waterfalls (**Figure 1**). The investigated waterbody is called "Córrego Veadinho" [Veadinho Brook] and it is part of the tributary microbasin of Lower Rio Grande River.

Figure 1. Map of Brazil (A). Sampling region in Uberaba City, MG (B). Points sampled in Veadinho Brook (A, B, C and D)



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Environmental characterization

According to the featuring process carried out by Camargo et al. (2021), **Point A** is located upstream the investigated waterfalls, at the following coordinates: 19°44’23”'S 47°44’00”'W (**Figure 1**).

The aforementioned site is partly shaded; its bed presents sandy composition with many decomposing leaves, as well as prevalent water flow deriving from pools. Both banks (right and left) present narrow riparian forest (approximately 2-m wide). The right bank is formed by a 2-m high ravine, with small amount of litter. The left bank, in its turn, is formed by a basaltic outcrop with small amount of litter; it presents a 1.5-m high ravine with a large number of exposed roots, as well as erosive processes.

Point B is located downstream the first waterfall, at coordinates 19°44’20”'S 47°44’01”W (**Figure 1**). This site is partly shaded by riparian forests and presents sandy bed. Water flow in it mostly derives from pools, although it also has some backwater regions. The right bank presents riparian forest – which is wider (approximately 60-m wide) than that observed in Point A – with significant litter amount. On the other hand, the left bank presents riparian forest similar to that of Point A, (approximately 2-m wide). This site is undergoing erosion process.

Point C is located upstream the second waterfall, at coordinates 19°44’53”S 47°44’09”W (**Figure 1**). Its bed is formed by both basaltic rocks and sandy sections with many decomposing leaves. This site is fully shaded by riparian forests. The right bank is covered by vegetation (approximately 80-m wide) grown in stony ground with significant litter amount. It also presents basaltic outcrop (approximately 15-m high). Vegetation on the left bank is wider (approximately 140-m wide) and more spaced than that on the right bank; the left bank also presents erosion and significant litter amount.

Point D is located downstream the second waterfall, at the following coordinates: 19°44’54”S 47°44’08”W (**Figure 1**). Its bed is mostly formed by sand. This site also features riparian forests on both banks. Point D is fully shaded, and its bed is interspersed in rocky and sandy regions. The right bank presents dense riparian forest (approximately 140-m wide), as well as soil with significant litter amount and no erosion, at all. Vegetation on the left bank has medium density and is approximately 300-m wide. Soil is mostly rocky with significant litter amount; it also presents erosion.

Ichthyological sampling

Collections were carried out upon license issued by the Biodiversity Authorization and Information System – also known as Sisbio (number 33448-1). A 100-m transect was defined at each collection point, where 50-minute sampling effort triplicates were performed, for biological sampling purposes. A 1.0 x 0.50m sieve, with 3-mm adjacent nodes, was used to do so. Individuals were anesthetized with benzocaine and the collected material was stored in plastic bags filled with 34% paraformaldehyde. Material identification process was carried out in laboratory environment, based on using Bel Photonics stereomicroscope, in compliance with the methodology by OTA et al. (2018). Subsequently, the collected material was transferred to 70% alcohol and deposited at the Aquatic Ecology Laboratory (LEA - Laboratório de Ecologia Aquática) of Federal University of Triângulo Mineiro.

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Data analysis

Past® software (Hammer, 2001) was used to calculate diversity rates of parameters, such as richness, abundance, dominance; Shannon-Winner diversity, Simpson diversity and equitability of sampled points. Statistic 7 software was used to check data distribution based on Shapiro-Wilker normality test. The herein analyzed data met the normality assumptions. Subsequently, analysis of variance (ANOVA) was carried out to test whether there were significant differences in mean values recorded for the sampled points.

RESULTAS AND DISCUSSION

In total, 1,926 individuals distributed into four orders, four families and six species were collected (**Figure 2**). Fish orders comprised Characiformes, Cyprinodontiformes, Cichliformes and Siluriformes. Cyrpinodontiformes (49.01%) and Characiformes (48.75%) were the most representative orders. Orders Cichliformes and Siluriformes recorded representativeness lower than 2% - 1.30% and 0.93%, respectively (**Table 2**).

Poeciliidae was the most abundant family; it was represented by species *Poecilia reticulata*, which recorded 944 individuals (49.01%). Characidae, on the other hand, presented greater species richness; it was represented by species *Psalidodon eigenmanniorum* (917 individuals - 47.61%), *Hoplias* sp. (12 individuals - 0.62%) and *Astyanax lacustris* (10 individuals - 0.52%). Finally, the least represented families comprised Cichilidae, which was represented by species *Geophagus iporangensis* (25 individuals - 1.30%); and Heptapteridae, which was represented by species *Rhamdia quelen* (24 individuals - 0.93%) (**Table 2**).

With respect to communities' metrics at temporal and spatial scale, no significant differences were observed ($p>0.05$) for the following parameters: Dominance $p=0.8120$; Abundance $p=0.5962$; Equitability $p=0.4583$; Richness $p=0.6912$; Shannon-Winner diversity $p=0.8789$; Simpson's diversity $p=0.8120$. This finding can be explained by environmental homogeneity resulting from proximity to the analyzed points. An example of it lies on habitat similarities (e.g., pools, backwater and water rapids, sandy bed, rocky bed, and riparian forest on both banks). Although riparian forests present fragmented sections, the preserved ones contribute to the composition of, and to similarities in, the community living in them, a fact that was observed in the current study.

Based on the current results, Cyprinodontifomes and Characiformes were the orders recording the greatest representativeness (abundance). Characiformes are often referred to in the literature as one of the most abundant orders in Neotropical regions (LOWE-MCCONNELL, 1999; INGENITO et al., 2004; BIFI et al., 2008; PAULA; AKAMA; MORAIS, 2012; FAGUNDES et al., 2015; RIBEIRO et al., 2019). According to these authors, order Siluriformes also stands out for its representativeness; however, this order recorded low abundance in the present study (**Table 2**).

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Figure 2. Fish species sampled in "Veadinho Brook", in the tributary microbasin of Lower Rio Grande River

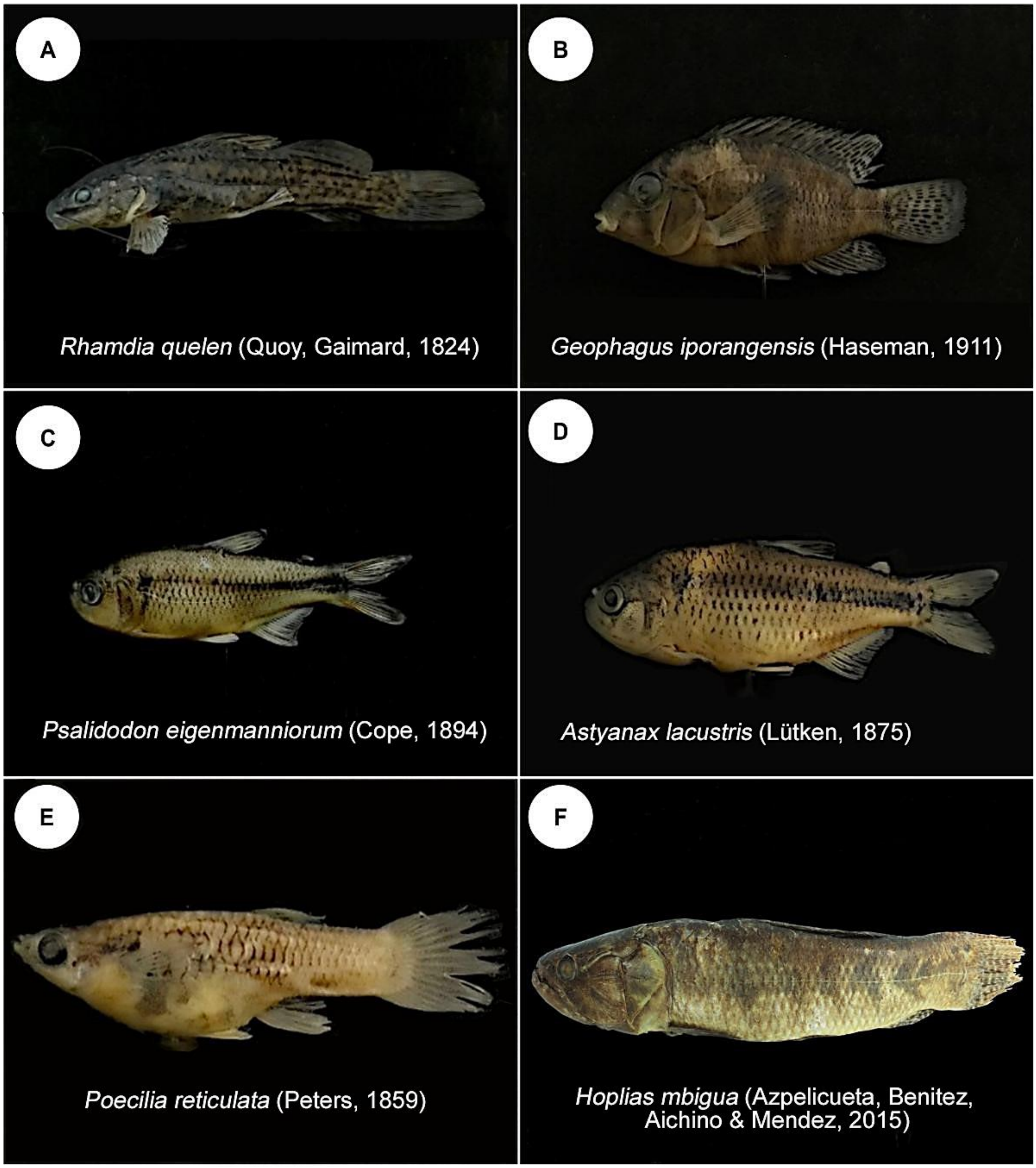

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Table 2. Species composition list associated with “Veadinho Brook”, in the tributary microbasin of Lower Rio Grande River

Taxa	**A point**				
	Sep/17	**Dec/17**	**Mar/18**	**Jun/18**	**Total**
CHARACIFORMES					
Characidae					
Psalidodon eigenmanniorum Cope, 1894	9	70	47	126	252
Astyanax lacustris Lütken, 1875	-	-	3	3	6
Hoplias mbigua Azpelicueta, Benitez, Aichino & Mendez, 2015	2	2	-	1	5
CYPRINODONTIFORMES					
Poeciliidae					
Poecilia reticulata Peters, 1859	132	61	48	-	241
CICHLIFORMES					
Cichlidae					
Geophagus iporangensis Haseman, 1911	-	6	-	1	7
SILURIFORMES					
Heptapteridae					
Rhamdia quelen Quoy, Gaimard, 1824	-	4	2	-	6
	B point				
	Sep/17	**Dec/17**	**Mar/18**	**Jun/18**	**Total**
CHARACIFORMES					
Characidae					
Psalidodon eigenmanniorum Cope, 1894	-	38	55	55	148
Astyanax lacustris Lütken, 1875	-	-	-	-	0
Hoplias mbigua Azpelicueta, Benitez, Aichino & Mendez, 2015	-	-	-	4	4
CYPRINODONTIFORMES					
Poeciliidae					
Poecilia reticulata Peters, 1859	-	94	32	68	194
CICHLIFORMES					
Cichlidae					
Geophagus iporangensis Haseman, 1911	1	3	-	-	4
SILURIFORMES					
Heptapteridae					
Rhamdia quelen Quoy, Gaimard, 1824	-	-	-	3	3
	C point				
	Sep/17	**Dec/17**	**Mar/18**	**Jun/18**	**Total**
CHARACIFORMES					
Characidae					
Psalidodon eigenmanniorum Cope, 1894	2	*178*	68	58	306
Astyanax lacustris Lütken, 1875	-	-	2	1	3

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Hoplias mbigua Azpelicueta, Benitez, Aichino & Mendez, 2015	-	*1*		-	1
CYPRINODONTIFORMES					
Poeciliidae					
Poecilia reticulata Peters, 1859	25	*256*	59	35	375
CICHLIFORMES					
Cichlidae					
Geophagus iporangensis Haseman, 1911	-	*5*	-	6	11
SILURIFORMES					
Heptapteridae					
Rhamdia quelen Quoy, Gaimard, 1824	5	*2*	-	2	9
			D point		
	Sep/17	**Dec/17**	**Mar/18**	**Jun/18**	**Total**
CHARACIFORMES					
Characidae					
Psalidodon eigenmanniorum Cope, 1894	11	52	80	68	211
Astyanax lacustris Lütken, 1875	-	-	1	-	1
Hoplias mbigua Azpelicueta, Benitez, Aichino & Mendez, 2015	-	-	-	2	2
CYPRINODONTIFORMES					
Poeciliidae					
Poecilia reticulata Peters, 1859	53	39	10	32	134
CICHLIFORMES					
Cichlidae					
Geophagus iporangensis Haseman, 1911	-	2	-	1	3
SILURIFORMES					
Heptapteridae					
Rhamdia quelen Quoy, Gaimard, 1824	2	1	-	3	6

The herein observed abundance of Cyprinodontiformes is attributed to the notable presence of *Poecilia reticulata* in the investigated environment, since this species is often found in drainage regions from Venezuela to La Plata River basin - it is an exotic species in Brazilian basins (OTA et al., 2018). Thus, the aforementioned species may have advantages (SOUZA et el., 2013; GANASSIN et al., 2020), such as competition, in interspecies relationships taking place outside its natural geographical area due to its generalist habit (ALVES; VONO, 1997; ARAÚJO et al., 2009; SOUZA et al., 2013; GANASSIN et al., 2020). In fact, based on the current results, the composition of the herein analyzed community may be linked to food plasticity, in association with seasonality periods in these environments, a fact that favors its generalist condition, as previously mentioned. This factor can change the relative abundance of the used resource and, consequently, affect specialist communities and provide better conditions to generalist species, such as *P. reticulata* (ABELHA et al., 2006; GANASSIN et al., 2020).

Although Cyprinodontiformes were abundant in the investigated environment, Characiformes also recorded strong density, which was represented by species *P. eigenmanniorum*. This condition may be associated with its distribution in Brazilian basins,

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as well as with environmental features observed in Neotropical streams, a fact that explains its presence in “Veadinho Brook” (AGOSTINHO et al., 1997; REIS et al. 2003). This species is a great competitor, since it is omnivorous and tends to herbivore habits (ESTEVES; GALETTI- JR, 1994; CASTRO et al., 2004; ABELHA et al., 2006; KAVALCO; PAZZA 2007). This feature enables it to adapt to trophic conditions associated with oscillations in seasonal periods. Furthermore, fish belonging to species *P. eigenmanniorum* are excellent swimmers, with wide adaptive spectrum. This plasticity conditions helps them to survive in oligotrophic environments (NASCIMENTO et al., 2014).

P. reticulata and *P. eigenmanniorum* present significant performance in environments subjected to anthropic impacts, such as regions undergoing alluviation (e.g., caused by lack of riparian forest), and the practice of agricultural and livestock activities, which are harmful to fish communities (ARAÚJO et al., 2009; OTA et al., 2018; SENE et al., 2021). The aforementioned anthropic impacts were observed in “Veadinho Brook” (personal observation). *P. reticulata* and *P. eigenmanniorum* adaptability can be attributed to their relative abundance in the aforementioned brook, due to anthropogenic pressure. Therefore, these species are often used for environmental biomonitoring purposes due to their high tolerance to environmental changes (SOUZA et al., 2013).

CONCLUSION

It is possible inferring that the composition of the fish community found in “Veadinho Brook” may be associated with species’ adaptive plasticity (i.e., *P. reticulata* and *P. eigenmanniorum*). The current results helped improving the ichthyofaunistic knowledge about the investigated region, as well as emphasized the importance of carrying out ichthyological inventories to help developing conservationist strategies focused on both its species and landscape. Moreover, this research type can help improving geographic, biogeographical and macroevolutionary historical knowledge, as well as elaborating environmental education programs, since the investigated region is used as tourist spot linked to the dinosaur museum in Peirópolis district, Uberaba City, Minas Gerais State, with emphasis on the recreational use of local waterfalls.

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