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Importance of the Congonhas River for the conservation of the fish fauna of the Upper Paraná basin, Brazil

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Abstract. *Garcia DAZ, Vidotto-Magnoni AP, Costa ADA, Casimiro ACR, Jarduli LR, Ferraz JD, De Almeida FS, Orsi ML. 2019. Importance of the Congonhas River for the conservation of the fish fauna of the Upper Paraná basin, Brazil. Biodiversitas 20: 474-481.* The Upper Paraná River basin is among the most fragmented watersheds in the world. The Congonhas River belongs to this drainage system, which has its mouth in the Capivara Reservoir and can be considered the largest tributary free-from-dam, becoming important for the maintenance of fish species richness. In order to know more about the species present in this tributary, we aimed to provide an inventory of fish fauna of the Congonhas River and reproductive strategies to determine whether the river is used by migratory species and whether there is a longitudinal variation in the fish assembly. These findings will provide subsidies to contribute to the implementation of policies to protect biodiversity. Samplings occurred in the upper, middle and lower stretches of the Congonhas River during four periods between 1991 and 2011. Fishes were captured using gill nets from 2 to 14 cm mesh sizes between opposite knots and cast nets, identified and categorized according to their reproductive strategies. A total of 4,640 individuals belonging to 63 species, of which 79.4% consisted of Characiformes and Siluriformes were captured. Furthermore, 14% of fish were long-distance migratory species (e.g., *Piaractus mesopotamicus*, *Megaleporinus obtusidens*, *Prochilodus lineatus*, *Salminus brasiliensis*, *Pinirampus pirinampu*, and *Pseudoplatystoma corruscans*). In addition, there was an increase in the fish species richness from upstream to downstream. Management actions such as prohibition of fishing, rehabilitation of riparian vegetation, and protection of the basin against dam construction will reduce anthropogenic impacts on the ecosystem. The Congonhas River highlights the importance of preserving lotic environmental for the conservation of migratory and non-migratory Neotropical fish diversity into a heavily modified watershed.

Keywords: Freshwater, management, migratory species, Neotropical region, South America

INTRODUCTION

South America has the largest freshwater fish diversity in the world (Barletta et al. 2010; Reis et al. 2016; Vitule et al. 2017). The vast hydrographic system of Brazil also provides drainage to the Amazon and Paraná River basins, the largest in the Neotropical region (Langeani et al. 2007). The Upper Paraná River basin has been reported to support a rich fish diversity (Bonetto 1986; Galves et al. 2009; Lowe-McConnell 1999; Reis et al. 2003; Reis et al. 2016). However, only its main water bodies have been systematically studied in the past, and the lack of research on its tributaries may lead to underestimation of its species diversity (Langeani et al. 2007; Cavalli et al. 2018). Fish surveys have only been carried out in the smaller tributaries of this basin during the last decade, allowing better description of the diversity in the region and improving the information of fish distribution (Galves et al. 2007; Galves et al. 2009; Cunico et al. 2012; Cetra et al. 2012; Cioneck et al. 2012; Pagotto et al. 2012; Fagundes et al. 2015).

Paranapanema River is a major tributary of the Upper Paraná River that had its characteristics altered via the construction of 11 hydroelectric reservoirs. The Paranapanema River basin is a representative habitat in South America where the impacts of human activities, such as land use and introductions of non-native species, substantially change the composition of the fish fauna (Garcia et al. 2018). The Tibagi River is its largest tributary, with 151 currently-identified fish species, and is placed among the few rivers which belong to this basin in southern Brazil that has been intensively studied since the 1980s decade (Galves et al. 2009; Raio and Bennemann 2010). On the other hand, the Tibagi River has been targeted for the hydroelectric plants building, and a hydropower unit was recently built there (Mauá Dam, 2012) in addition to an ongoing project to build three new plants (Cebolão Médio, Limoeiro, and Telêmaco Borba dams) in its middle and upper stretches (Raio and Bennemann 2010; ANEEL 2018). These dams change the river flow and volume influencing the reproductive ability of fish species, in addition to promoting increased transparency of the water, maximizing the predation of eggs, larvae, and juveniles (Agostinho et al. 2007; Antonio et al. 2007). Furthermore, the current scenario of the

Paranapanema River fragmented by dams and the prediction in the Tibagi River, the fishes that need to perform reproductive displacements would be restricted to reservoirs and their tributaries. In the long term, populations of migratory species could be even more threatened (Lima et al. 2016), contributing to biodiversity loss.

The Congonhas River, one of the main tributaries of the Tibagi River, highlights as free-from-dam river in a heavily modified basin (Upper Paraná River, Agostinho et al. 2008; 2016). It has been suggested that this river may be used as a possible reproductive route for important rheophilic and migratory species inhabiting the Tibagi River basin (Orsi et al. 2004; Hoffmann et al. 2005; Orsi 2010). Tributaries that flows directly into reservoirs play a fundamental role in the maintenance of rheophilic species and provide ideal conditions for eggs and larvae drift (Nunes et al. 2015; Silva et al. 2017; Cavalli et al. 2018; Marques et al. 2018). Moreover, along with the course of such tributaries different physical conditions are found in the upper, middle and lower stretches, where populations of aquatic organisms adapt to habitat availability (Vannote et al. 1980; Garutti 1988). Therefore, preservation of undammed rivers is essential for the maintenance of richness and functional connectivity for migratory and non-migratory fish species that inhabit different stretches of the basin.

Given the above considerations, we aimed to evaluate if the Congonhas River is used by migratory fish species and if there is a longitudinal variation (upstream-downstream) in the fish assembly. In addition, we conducted a study about fish species richness dwelling in the Congonhas River, highlighting the reproductive strategies already known for the identified species. This study may provide an overview of the relevance of the Congonhas River to the Upper Paraná River basin in maintaining the diversity of Neotropical fishes.

MATERIALS AND METHODS

Study area

The Congonhas River is inserted in the state of Paraná, with its headwaters in the municipality of São Jerônimo da Serra and runs for 110 km until its mouth at the Tibagi River, in the municipality of Sertaneja (Maack 2002) (Figure 1). The upper stretch of the Congonhas River (P1: 23º26'20.40"S, 50º38'29.70"W) has strong rapids embedded into the riverbank, due to the characteristic undulating relief and steep slopes of the area. Undamaged vegetation areas can be found on its banks, composed just of shrubs and small trees along with an agricultural mosaic. The middle stretch (P2: 23º08'11.70"S, 50º48'15.40"W) has several backwaters and ponds of up to five meters deep. The marginal lagoons along this section, identified as essential components of the reproductive cycle of various fish species, are used as areas for fish growth and feeding (Orsi et al. 2002). This stretch of beds and banks presents a large quantity of gravel, agricultural activity there is incipient, and riparian vegetation extends along its marginal area. The lower stretch (P3: 22º59'10.37"S, 50º55'35.60"W) has lentic characteristics, due to the influence of the Hydroelectric Power Plant of the Escola de Engenharia Mackenzie (Capivara Dam), which has a flooded area of 576 km² (Duke Energy 2008). This area of vast dimensions alters the water flow of all the tributaries of the Tibagi River, including the Congonhas River mouth.

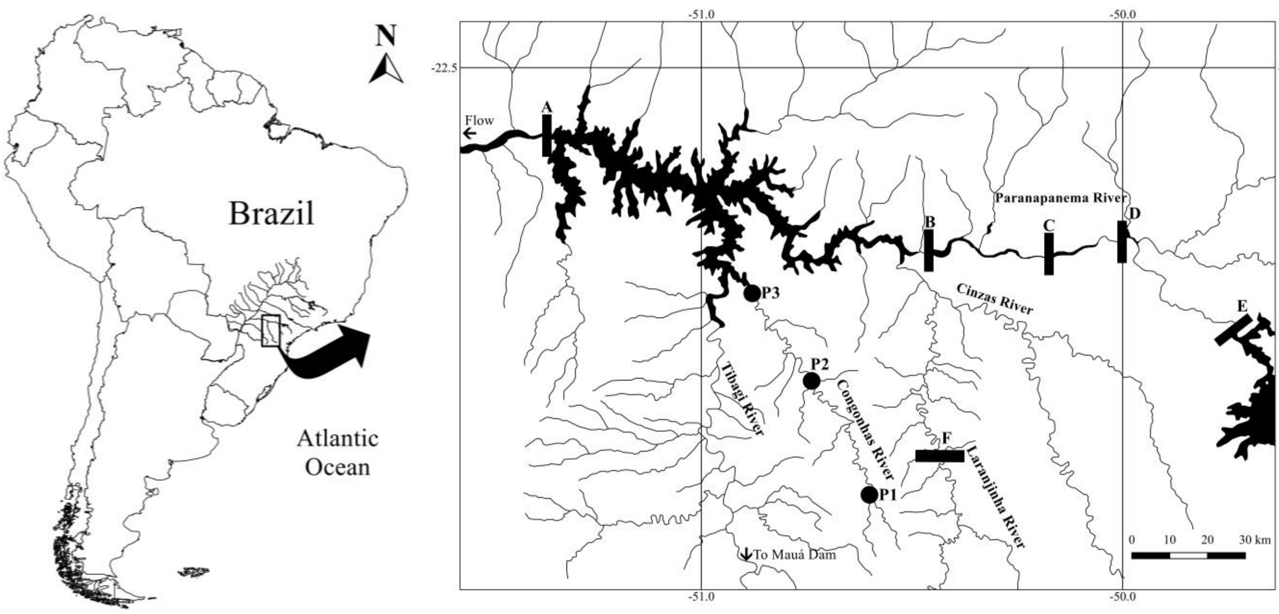

Figure 1. Left: location of the study area in the Upper Paraná River basin, Brazil. Right: map of the Paranapanema River stretch and the three sampling sites in the Congonhas River: P1 – Upper; P2 – Middle; P3 – Lower. The letters represent the locations of the dams: (A) Capivara; (B) Canoas I; (C) Canoas II; (D) Salto Grande; (E) Chavantes; (F) Corredeira

Procedures

Samplings were conducted in four periods (permit number 251610 issued by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, IBAMA). The first period consisted of seasonal samplings carried out between the years 1991 and 1996. The second period comprised monthly samplings from March 1997 to August 1998. The third comprised seasonal samplings occurred from 2001 to 2002 and the fourth was comprised of seasonal samplings from 2009 to 2011.

The samplings were carried out in the upper (P1), middle (P2) and lower (P3) stretch of the Congonhas River, with one kilometer of extension in each stretch and covering its different sections. Standardized sampling methodology was employed, using gillnets with 2, 3, 4, 5, 6, 8, 10, 12 and 14 cm mesh sizes between opposite knots and height from 0.8 to 4.2 m, involving a total amount of 1,200 m2 sampling area. The nets were arranged close to the margins for 24 hours with inspections every eight hours. In each section, standardized area of approximately 100 m was established for the use of cast nets, resulting in 8 m2 with 1 hour of sampling effort.

The sampled fish were anesthetized and euthanized in a saturated clove oil solution, fixed in 10% formalin and taken to the laboratory for identification following protocols approved by the Animal Ethics Committee of the Universidade Estadual de Londrina (CEUA n. 30992.2014.33). Subsequently, the fish were transferred to 70% alcohol, and specimens of each species were deposited in the Coleção de Peixes do Museu de Zoologia da Universidade Estadual de Londrina (MZUEL).

Data analysis

The capture rate was represented by the percentage of each species in relation to the total number of individuals (frequency of capture), while the longitudinal distribution pattern (independent variable) of species richness (dependent variable) was represented by linear regression. The species were characterized according to their reproductive strategies of fishes from the Upper Paraná River basin: short distance migratory or non-migratory (SDNM); long-distance migratory (LDM), migrate over than 100 km in the reproductive season; external fecundation (EF); internal fecundation (IF); parental care (PC); no parental care (NPC) (Agostinho et al. 2003).

RESULTS AND DISCUSSION

The captures comprised 4,640 individuals, belonging to six orders, 21 families and 63 species (Table 1). Characiformes and Siluriformes represented 79.4% of the species (50.8% and 28.6%, respectively). Cichliformes (9.5%), Gymntiformes (7.9%), Synbranchifomes (1.6%), and Perciformes (1.6%), together represented the remaining fish species. Families with highest species richness were Characidae (12 species), Anostomidae (seven species), Loricariidae and Cichlidae (six species). Amongst all the sampled individuals, 78.4% belonged to the Characiformes and 12.9% to the Siluriformes. The remaining orders represented less than 10% of the specimens caught. Furthermore, only six species presented capture frequencies above 5%, representing nearly 57% of the specimens sampled. These species were *Astyanax lacustris* (20.5%), *Steindachnerina insculpta* (10.0%), *Acestrorhynchus lacustris* (8.0%), *Plagioscion squamosissimus* (7.1%), *Moenkhausia intermedia* (5.6%), and *Apareiodon affinis* (5.5%).

Characiformes and Siluriformes are widely reported in the Neotropical region and display the highest species richness (Lowe-McConnell 1999; Reis et al. 2003; Reis et al. 2016). These orders encompass species with reproductive strategies adapted to diverse aquatic habitat (Orsi 2010), demonstrating the importance of the preservation of heterogeneous environments free-from-dams such as the Congonhas River. The high ratio of Characiformes and Siluriformes was also reported on studies in the Tibagi (Shibatta et al. 2002; 2006), Paranapanema (Castro et al. 2003), Grande (Castro et al. 2004), and Upper Paraná River basins (Casatti et al. 2001; Lemes and Garutti 2002; Graça and Pavanelli 2007; Langeani et al. 2007), which have fish fauna similar to the Congonhas River. However, many of these basins have a system of reservoirs in cascade in their mainstem and transformed environments, impeding the longitudinal connectivity. This indicates the importance of preserving the Congonhas River basin for fish conservation and mitigating the influence of the Capivara Reservoir.

Six species are considered the most exploited species by artisanal fisheries due to its commercial interest, i.e., *Piaractus mesopotamicus* (pacu, common name in Portuguese); *Megaleporinus obtusidens* (piapara); *Prochilodus lineatus* (curimbatá); *Salminus brasiliensis* (dourado); *Pinirampus pirinampu* (barbado); and *Pseudoplatystoma corruscans* (pintado) (Hoeinghaus et al. 2009; Novaes and Carvalho 2013). In addition, these species are long-distance migrators and represent about 29% of all migratory species of the Upper Paraná River basin (Agostinho et al. 2003). In this basin, *S. brasiliensis* and *P. corruscans* are rare and near-threatened to extinction (Abilhoa and Duboc 2004). Long-distance migratory species require habitat for spawning, development and growth, and thus complete their life cycles (Agostinho et al. 2008; Pelicice et al. 2015). Therefore, management actions should be taken to benefit these migratory species, such as prohibition of fishing, rehabilitation of riparian vegetation of critical areas (i.e., spawning and development habitat), and protection of the entire basin against dam construction.

Table 1. List of fish species collected, absolute abundance at the three sites and frequency of capture in the Congonhas River, state of Paraná, Brazil. Taxonomic classification is based on Eschmeyer et al. (2018) and Eschmeyer and Fong (2018)

Name	Upper (P1)	Middle (P2)	Lower (P3)	Frequency of capture (%)	Reproductive strategies	Voucher
Characiformes						
Crenuchidae						
Characidium zebra Eigenmann 1909	6	0	0	0.13%	SDNM, EF, NPC	MZUEL 923
Erythrinidae						
Hoplias malabaricus (Bloch 1794)	34	21	48	2.22%	SDNM, EF, PC	MZUEL 1104
Parodontidae						
Apareiodon affinis (Steindachner 1879)	1	79	178	5.56%	SDNM, EF, NPC	MZUEL 1094
Apareiodon piracicabae (Eigenmann 1907)	12	16	21	1.06%	SDNM, EF, NPC	MZUEL 1174
Serrasalmidae						
Metynnis lippincottianus (Cope 1870)*	0	14	128	3.06%	SDNM, EF, NPC	MZUEL 1485
Piaractus mesopotamicus (Holmberg 1887)	0	1	3	0.09%	LDM, EF, NPC	MZUEL 3311
Serrasalmus maculatus Kner 1858	0	79	50	2.78%	SDNM, EF, PC	MZUEL 1572
Anostomidae						
Leporellus vittatus (Valenciennes 1850)	3	0	20	0.50%	SDNM, EF, NPC	MZUEL 1381
Leporinus friderici (Bloch 1794)	0	32	52	1.81%	LDM, EF, NPC	MZUEL 1153
Leporinus octofasciatus Steindachner 1915	0	6	3	0.19%	SDNM, EF, NPC	MZUEL 1473
Leporinus striatus Kner 1858	0	8	0	0.17%	SDNM, EF, NPC	MZUEL 1066
Megaleporinus obtusidens (Valenciennes 1837)	0	33	92	2.69%	LDM, EF, NPC	MZUEL 1154
Schizodon intermedius Garavello & Britski 1990	0	19	13	0.69%	SDNM, EF, NPC	MZUEL 1092
Schizodon nasutus Kner 1858	2	47	77	2.72%	SDNM, EF, NPC	MZUEL 1146
Curimatidae						
Cyphocharax modestus (Fernández-Yépez 1948)	1	1	18	0.43%	SDNM, EF, NPC	MZUEL 1691
Steindachnerina insculpta (Fernández-Yépez 1948)	2	237	228	10.06%	SDNM, EF, NPC	MZUEL 1366
Prochilodontidae						
Prochilodus lineatus (Valenciennes 1837)	0	20	39	1.27%	LDM, EF, NPC	MZUEL 1465
Triportheidae						
Triportheus nematurus (Kner 1858)*	0	5	11	0.34%	SDNM, EF, NPC	MZUEL 1365
Bryconidae						
Salminus brasiliensis (Cuvier 1816)	0	9	2	0.24%	LDM, EF, NPC	MZUEL 1636
Acestrorhynchidae						
Acestrorhynchus lacustris (Lütken 1875)	1	208	163	8.02%	SDNM, EF, NPC	MZUEL 1091
Characidae						
Aphyocharax anisitsi Eigenmann & Kennedy 1903	2	4	85	1.96%	SDNM, EF, NPC	MZUEL 1173
Astyanax bockmanni Vari & Castro 2007	2	0	0	0.04%	SDNM, EF, NPC	MZUEL 2429
Astyanax fasciatus (Cuvier 1819)	0	16	2	0.39%	SDNM, EF, NPC	MZUEL 1303
Astyanax lacustris (Lütken 1875)	8	396	550	20.56%	SDNM, EF, NPC	MZUEL 1573
Cheirodon stenodon Eigenmann 1915	0	0	13	0.28%	SDNM, EF, NPC	MZUEL 2397
Galeocharax gulo (Cope 1870)	6	10	9	0.54%	SDNM, EF, NPC	MZUEL 984
Hemigrammus marginatus Ellis 1911	4	0	0	0.09%	SDNM, EF, NPC	MZUEL 1715
Hyphessobrycon eques (Steindachner 1882)*	0	11	72	1.79%	SDNM, EF, NPC	MZUEL 2264
Moenkhausia intermedia Eigenmann 1908	0	186	74	5.60%	SDNM, EF, NPC	MZUEL 1150
Piabarchus stramineus (Eigenmann 1908)	18	0	0	0.39%	SDNM, EF, NPC	MZUEL 1783
Piabina argentea Reinhardt 1867	17	0	0	0.37%	SDNM, EF, NPC	MZUEL 2720
Serrapinnus notomelas (Eigenmann 1915)	0	11	42	1.14%	SDNM, EF, NPC	MZUEL 683
Gymnotiformes						
Gymnotidae						
Gymnotus inaequilabiatus (Valenciennes 1839)	0	1	7	0.17%	SDNM, EF, NPC	MZUEL 1103
Gymnotus sylvius Albert & Fernandes-Matioli 1999	1	10	9	0.43%	SDNM, EF, NPC	MZUEL 2349
Sternopygidae						
Sternopygus macrurus (Bloch & Schneider 1801)	0	0	3	0.06%	SDNM, EF, NPC	MZUEL 1547
Apteronotidae						
Apteronotus albifrons (Linnaeus 1766)	0	2	1	0.06%	SDNM, EF, NPC	MZUEL 853
Eigenmannia virescens (Valenciennes 1836)	0	2	9	0.24%	SDNM, EF, NPC	MZUEL 2276
Siluriformes						
Auchenipteridae						
Ageneiosus militaris Valenciennes 1835	0	0	2	0.04%	SDNM, IF	MZUEL 1699
Tatia neivai (Ihering 1930)	0	4	8	0.26%	SDNM, IF	MZUEL 1906
Doradidae						
Rhinodoras dorbignyi (Kner 1855)	0	2	33	0.75%	SDNM, EF, NPC	MZUEL 1770
Heptapteridae						
Pimelodella avanhandavae Eigenmann 1917	1	32	10	0.93%	SDNM, EF, NPC	MZUEL 1756

Pimelodella meeki Eigenmann 1910	2	8	0	0.22%	SDNM, EF, NPC	MZUEL 1039
Rhamdia quelen (Quoy & Gaimard 1824)	0	6	3	0.19%	SDNM, EF, NPC	MZUEL 1642
Pimelodidae						
Iheringichthys labrosus (Lütken 1874)	0	35	24	1.27%	SDNM, EF, NPC	MZUEL 1088
Megalonema platanum (Günther 1880)	0	1	0	0.02%	LDM, EF, NPC	MZUEL 1763
Pimelodus maculatus Lacepède 1803	0	121	76	4.25%	LDM, EF, NPC	MZUEL 859
Pinirampus pirinampu (Spix & Agassiz 1829)	0	16	42	1.25%	LDM, EF, NPC	MZUEL 1147
Pseudoplatystoma corruscans (Spix & Agassiz 1829)	0	0	2	0.04%	LDM, EF, NPC	MZUEL 1525
Callichthyidae						
Hoplosternum littorale (Hancock 1828)	0	12	13	0.54%	SDNM, EF, PC	MZUEL 2353
Loricariidae						
Hypostomus albopunctatus (Regan 1908)	0	2	0	0.04%	SDNM, EF, PC	MZUEL 2560
Hypostomus ancistroides (Ihering 1911)	7	32	12	1.10%	SDNM, EF, PC	MZUEL 1939
Hypostomus regani (Ihering 1905)	0	0	16	0.34%	SDNM, EF, PC	MZUEL 1605
Loricariichthys platymetopon Isbrücker & Nijssen 1979*	0	8	47	1.19%	SDNM, EF, PC	MZUEL 1726
Megalancistrus parananus (Peters 1881)	0	0	5	0.11%	SDNM, EF, PC	MZUEL 2619
Proloricaria prolixa (Isbrücker & Nijssen 1978)	2	16	0	0.39%	SDNM, EF, PC	MZUEL 1370
Synbranchiformes						
Synbranchidae						
Synbranchus marmoratus Bloch 1795	0	0	2	0.04%	SDNM, EF, PC	MZUEL 104
Cichliformes						
Cichlidae						
Cichla kelberi Kullander & Ferreira 2006*	0	2	8	0.22%	SDNM, EF, PC	MZUEL 1882
Cichlasoma paranaense Kullander 1983	1	8	9	0.39%	SDNM, EF, PC	MZUEL 2350
Crenicichla britskii Kullander 1982	0	18	8	0.56%	SDNM, EF, PC	MZUEL 2271
Crenicichla jaguarensis Haseman 1911	0	2	6	0.17%	SDNM, EF, PC	MZUEL 998
Geophagus brasiliensis (Quoy & Gaimard 1824)	3	0	3	0.13%	SDNM, EF, PC	MZUEL 1982
Oreochromis niloticus (Linnaeus 1758)*	0	10	5	0.32%	SDNM, EF, PC	MZUEL 1040
Perciformes						
Sciaenidae						
Plagioscion squamosissimus (Heckel 1840)*	0	150	179	7.09%	SDNM, EF, NPC	MZUEL 1155

Note: *Non-native species. SDNM = short distance migratory or non-migratory; EF = external fecundation; NPC = no parental care; PC = parental care; IF = internal fecundation; LDM = long-distance migratory

Seven non-native species were captured (*Metynnis lippincottianus*, *Triportheus nematurus*, *Hyphessobrycon eques*, *Loricariichthys platymetopon*, *Cichla kelberi*, *Oreochromis niloticus*, and *Plagioscion squamosissimus*), resulting in 11.1% of the total species. Non-native species in the Congonhas River basin were introduced due to different vectors, such as escapes from fish farming (*Metynnis lippincottianus* and *Oreochromis niloticus*) (Orsi and Agostinho 1999; Britton and Orsi 2012), aquarium dumping (*Hyphessobrycon eques*), and geographical barrier transposition (*Triportheus nematurus* and *Loricariichthys platymetopon*) (Graça and Pavanelli 2007; Júlio Júnior et al. 2009). In the cases of *Cichla kelberi* and *P. squamosissimus*, the introduction occurred for fishing and recreation purposes (Langeani et al. 2007; Britton and Orsi 2012). The deliberate introduction of non-native species is considered one of major global changes caused by humans in the last decades (Gozlan et al. 2010), generally carried out for economic benefits and lacking possible ecological impacts (Vitule 2009). Introduction of non-native fishes may cause changes in habitat and community, such as hybridization, trophic alterations, introduction of pathogens and fauna homogeneity (Vitule et al. 2009; Orsi and Britton 2014; Daga et al. 2015). Therefore, the presence of non-native fishes in the Congonhas River represents a real threat and jeopardize its biodiversity.

The species richness along the river increased from the upper to the lower stretch ($y = 15.5x + 11.33$, $r2 = 0.845$). Seven species were presented only in the lower stretch, *Cheirodon stenodon*, *Sternopygus macrurus*, *Ageneiosus militaris*, *Pseudoplatystoma corruscans*, *Hypostomus regani*, *Megalancistrus parananus*, and *Synbranchus marmoratus*. The increase in species richness from the headwaters to the mouth occurs primarily in temperate streams (Vanotte et al. 1980), and has been observed in Neotropical rivers (Braga and Andrade 2005; Greathouse and Pringle 2006; Costa et al. 2013). The richness increment probably occurs due to the increase in the waterbody size and a gradient of physical conditions is formed to which aquatic organisms adapt (Braga and Andrade 2005). The development of environmental complexity provides more niches and habitat availability (Garutti 1988), and affects the structure and functioning of the fish assemblages that occur along river courses (Uieda and Barreto 1999). Although the Congonhas River basin is considered only of the second order, it was able to host large migratory species in its downstream stretches, which indicates its great biological importance.

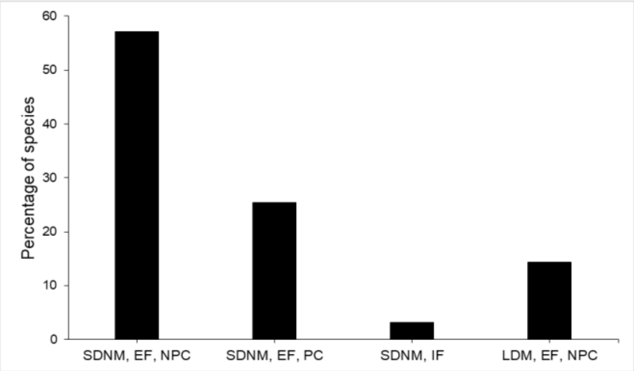

Figure 2. Frequency of species for reproductive strategies of fishes captured in the Congonhas River from 1991 to 2011. SDNM = short distance migratory or non-migratory; EF = external fecundation; NPC = no parental care; PC = parental care; IF = internal fecundation; LDM = long distance migratory

Two reproductive strategies could be distinguished: long-distance migratory species (14.28%) and short distance migratory or non-migratory species (85.72 %). In addition, only 3.18% of the species presented internal fertilization, and 25.4% of the total amount have some form of parental care (Figure 2, Table 1). The presence of migratory species in the Congonhas River indicates that this river can perform an alternative migration route. In other stretches of the Upper Paraná River basin, it was evidenced that migratory fishes are able to find new breeding pathways (Agostinho et al. 2007; Antonio et al. 2007; Affonso et al. 2015; Da Silva et al. 2015; Marques et al. 2018). The Tibagi, Cinzas and Laranjinha rivers have similar characteristics with the Congonhas River and already holds built dams in their mainstem (ANEEL 2018). Therefore, the Congonhas River is the largest tributary of this stretch of the basin that is still out of dams (Figure 1).

The impacts caused by the Mauá Dam building in the Tibagi River are still unknown, but the long-term changes in the fish fauna of Capivara Reservoir have been reported (Orsi and Britton 2014). Furthermore, the building of two dams in the Cinzas River and three in the Laranjinha River are in progress (ANEEL 2018), showing an imminent fragmentation of this stretch of the Paranapanema River basin. It is noteworthy that the Congonhas River has its mouth in the lower stretch of the Tibagi River. The use of this lower section for the reproduction of migratory and rheophilic species has been previously indicated as a migratory route, which enables the maintenance of fish populations (Orsi 2010). The nearest areas to impoundments present lower fish diversity due to the transformed environments (Hoffmann et al. 2005), decreasing over time (Lima et al. 2016). Tributaries that present lotic features and directly flows into reservoirs, such as the Congonhas River, are important for the maintenance of species diversity (Affonso et al. 2015; Marques et al. 2018). Thus, the future scenario of fragmentation of this stretch of the Tibagi River basin highlights the importance of preserving lotic environmental of the Congonhas River and favors the high fish diversity.

Despite the impacts caused by anthropogenic activities (i.e., damming rivers and introductions of non-native fishes), we believe that the Congonhas River still maintains adequate conditions that favor the conservation of fish diversity, including native and migratory species. Due to its richness and taxonomic composition, the Congonhas River basin requires preservation measures that restrict human activities to studies and recreational fishing associated with environmental monitoring. Furthermore, an official prohibition about the building of the dams must be proposed, since the occurrence of migratory fishes highlights the role of the Congonhas River in the conservation of threatened species. The efforts for conservation also may consider the identification of functional free stretches for the maintenance of migratory species with the prohibition of their fragmentation.

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