

Fishes in first order stream in Ivaí River drainage basin, upper Paraná River Basin, Paraná state, Brazil

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ABSTRACT: Itiz Stream is a first order tributary of the Ivaí River basin, located in a rural area of Marialva municipality, Paraná state. Fish were sampled in October, November and December 2007, September 2008 and March 2009, using electrofishing and a sieve technique in three stretches along the stream. We collected 20 species belonging to 13 genera, seven families and three orders. Only *Poecilia reticulata* was considered non-native species and five are probably undescribed.

INTRODUCTION

The Neotropical region is the richest in fish species, where according to Reis *et al.* (2003), there are about 4475 valid species and 1550 undescribed species, giving over 6000 species in total for this region. Brazil, which has the largest river system in the world, is considered the richest, with more than 2500 species currently valid, but this number may be an underestimate (Abell *et al.*, 2008; Lévêque *et al.* 2008). In this region, the lack of species lists for different environments hinders estimates of biodiversity and more comprehensive studies of fish assemblages are necessary. The study of fish ecology in a vast and unexplored area as the Neotropical region is made even more difficult by the presence of so many species, several of which are very similar, making their identification difficult (Lowe-McConnell 1999; Aleixo 2009). The increasing degradation of habitats and the introduction of exotic species are having drastic consequences in aquatic environments (Araújo 1998; Bastos and Abilhoa 2004; Gomiero and Braga 2008; Aquino *et al.* 2009; Rodrigues *et al.* 2010), as well as influencing the distribution of species.

The Ivaí River basin is the second largest in the state of Paraná and the largest tributary of the upper Paraná River in this state, draining a largely agricultural and urban area of about 35,845 km². The small rivers that make up this basin and the Ivaí River itself have very heterogeneous geomorphological and hydrological characteristics, especially with regard to the presence of rocky beds, steep banks, and several waterfalls. These features contribute to the presence of a peculiar and restricted fish fauna, which together with the lack of studies in these environments result in underestimates of the diversity of fish in this basin (Maier *et al.* 2008; Viana *et al.* 2008).

Langeani *et al.* (2007) listed 50 probably new species from the upper Paraná River basin. Studies conducted by Maier *et al.* (2008) in the Barra Bonita River, a tributary

of the Ivaí River, indicated the presence of five additional new species. Such findings demonstrate that by increasing sampling efforts in the Upper Paraná River basin, new species could still be discovered, mainly in its tributaries. The present study thus aimed to provide a list of species in a rural first order stream in the Ivaí River basin. This list contributes to our knowledge of the ichthyofauna of non-urbanized headwater streams of the northwestern region of Paraná, and allows comparisons with other studies carried out in the same region using the same approach (Oliveira and Bennemann 2005; Cunico *et al.* 2006; Cunico *et al.* 2009).

MATERIALS AND METHODS

Study area

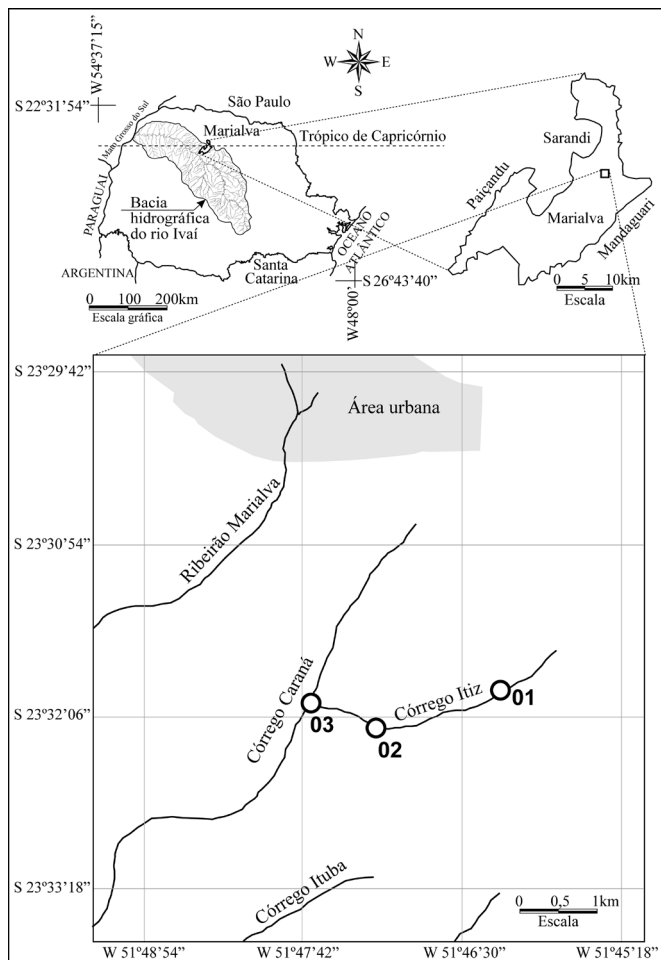
The present study was performed in Itiz Stream, at first order stretch (*sensu* Strahler 1957), located in Marialva municipality, Paraná state. This stream flows into other tributaries of Pinguim Stream, which flows into the Ivaí River. The Ivaí River watershed has a drainage area of 36,899 km², a total course of 675 km, and is considered the second largest basin and the second largest river in extension in the state of Paraná (Sudhersa 2009). This basin originates by the confluence of the Patos and São João Rivers, in the second plateau of Paraná state, in the region named Serra da Boa Esperança, bordering the municipalities of Prudentópolis and Ivaí, and flows into the Paraná River. It is located in the ecoregion known as the Upper Paraná, with a reported richness of 310 species and many endemic species.

Itiz Stream is situated in a rural area (Figure 1) in which the main economic activity is the cultivation of soybean, wheat, corn, sugarcane and grapes (Ipardes 2007).

The main physical characteristics and geographic coordinates of the three sampling stations along the stream are listed in Table 1 and Figure 1.

TABLE 1. Physical characteristics of the sampled sites in Itiz Stream, Ivaí River basin, Marialva municipality, Paraná state.

SITES	COORDINATES	WIDTH (m)	DEPTH (m)	PREDOMINANT SUBSTRATE	RIPARIAN VEGETATION	CHANNEL PHYSIOGRAPHY	OBSERVATIONS
1	23°31'49,9" S, 051°46'26.9" W	1.5 – 3.0	0.10 – 0.50	Gravel, pebble, sand, silt and litter	Range of trees and shrubs at or higher than 30 m in the margins	Rapids with mean depth of 0.20 m, and pools of up to 0.60 m in depth	There is a disabled weir besides the sampling station, and water is extracted from the middle of the sampled stretch to irrigate land nearby. Surrounding vegetation provides about 80% shading.
2	23°32'11,2" S, 051°46'59" W	1.5 – 4.5	0.10 – 0.20	Rock, gravel, pebble and some backwaters with sand and mud	Range of trees and shrubs at or higher than 30 m in the margins with little aquatic vegetation	Pools of 5 m in width and up to 1.20 m in depth; stretches with rapids of 0.10 to 0.20 m in depth; few backwater areas	1.5-m high waterfall upstream. Stretch with higher degree of conservation of riparian vegetation, with 90% shading.
3	23°32'02,6" S, 051°46'26.3" W	2.0 – 4.0	0.30 – 0.50	Rock, pebble, litter and sand	Range of trees lower than 10 m and invasive grasses	Most stretches consist of rapids	1.5-m high waterfall downstream; stretch with the lowest proportion of riparian vegetation and presence of tracks with a flow of people at the margins. About 50% shading.

**FIGURE 1.** Map of Itiz Stream in the Ivaí River basin, state of Paraná, Brazil, indicating sampling sites.

Fish sampling

Fish were collected in October, November and December 2007, September 2008 and March 2009, in stretches of 50 meters at each of three sampling stations (station

1, 2 and 3), located in the upstream, intermediate and downstream regions (respectively), with an approximate distance of 1.2 km between each station. Sampling in October and November 2007 was carried out using sieves (three collectors), with sampling being carried out for 20 minutes in total, divided into a session of 15 minutes, followed by a break of 20 minutes, and then a further 5 minutes of sampling (additional attempts to capture remaining specimens). On the other sampling occasions, we used electrofishing with three passes of 30 minutes each, in each stretch of 50 meters. The electrofishing equipment was powered by a portable generator (Honda, 2.5 kW, 220 V, 3–4 A) connected to a DC transformer, with two electrified net rings (anode and cathode). Output voltage varied from 400 to 600 V. The collectors always wore electrically insulated overalls and gloves. For both types of sampling we installed blocking nets (mesh size 0.5 mm) at the ends of each stretch to prevent any fish escaping. After sampling, fish were anesthetized with benzocaine (250 mg/L) and fixed in 10% formalin. Fish were collected under the license of the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) (Process IBAMA number 11253-1/2007).

Specimens were identified in the laboratory according to Graça and Pavanelli (2007), and then preserved in 70% alcohol. Voucher specimens were deposited in the fish collection of Nupélia (Núcleo de Pesquisas em limnologia, Ictiologia e Aquicultura), of the State University of Maringá, Brazil (<http://peixe.nupelia.uem.br>).

RESULTS AND DISCUSSION

We collected 1547 specimens, belonging to 20 species, 13 genera, seven families and three orders (Table 2). Only *Poecilia reticulata* Peters, 1859 was considered non-native and five were probably new and undescribed. The most representative order was the Siluriformes (55%)

with 11 species, followed by Characiformes (40%) with eight species, both with three families (Table 2). Such dominance by Siluriformes and Characiformes (95%) is a common trend in rivers in the Neotropical region (Lowe-McConnell 1999) and has been reported for other headwater streams of the Upper Paraná River basin (Maier et al. 2008; Cunico et al. 2009). The families with the highest number of species sampled were Loricariidae and Characidae, accounting for 30% and 25%, respectively, of collected species.

The species with the largest number of individuals were *Poecilia reticulata* (28.1%), *Astyanax* aff. *paranae* Eigenmann, 1914 (14.0%) and *Trichomycterus* sp.2 (13.9%) (Table 2). *Poecilia reticulata* was also recorded in streams in the region, being an introduced species that is highly tolerant to adverse environmental conditions (Vieira and Shibatta 2007). It has been well documented in studies on urban streams by Cunico et al. (2006; 2009) in the Maringá Municipality, Gubiani et al. (2010) in the Toledo Municipality, and Bertaco (2009) in a coastal stream.

In this study, we observed many small-sized fish, typical of streams in South America, corroborating other studies performed in the Upper Paraná River basin (Gubiani et al. 2010). In accordance with Castro (1999), most species inhabiting small streams, mainly in the headwaters, are small and are almost completely restricted to this type of environment.

The number of species found herein may be considered high given that sampling was carried out in a first order stream. Casatti (2005) reported the presence of 18 species in a stream located in a conservation unit (Morro do Diabo, Parapanema River basin, São Paulo State). Furthermore, some studies carried out in second and third order streams, with higher sampling effort, reported lower species richness than that found in this survey, such as the study of Vieira and Shibatta (2007), who found 13 species during four samplings in a third order stream. It should also be noted that the stream sampled in the current study is located outside urban limits, and therefore is subject to lower levels of pollution, which certainly contributes to the higher richness of the fish fauna.

TABLE 2. List of fish and their respective abundances at sampling stations in Itiz Stream. The common regional name for species is provided between quotation marks. Taxonomic positions are consistent with Britski et al. (1999), Reis et al. (2003), and Graça and Pavanelli (2007). Asterisk indicates species not yet described in the literature.

TAXON	COMMON NAME	1	2	3	TOTAL	VOUCHER
CHARACIFORMES						
Crenuchidae						
<i>Characidium</i> aff. <i>zebra</i> Eigenmann, 1909	"mocinha"	34	11	16	61	NUP 11817
Characidae						
<i>Astyanax</i> aff. <i>fasciatus</i> (Cuvier, 1819)	"lambari-do-rabo-vermelho"	39	31	25	95	NUP 11797
<i>Astyanax</i> aff. <i>paranae</i> Eigenmann, 1914	"lambari"	62	98	57	217	NUP 11794
<i>Astyanax bockmanni</i> Vari and Castro, 2007	"lambari"	36	10	7	53	NUP 11793
<i>Bryconamericus</i> aff. <i>iheringi</i> (Boulenger, 1887)	"lambarizinho"	12	46	18	76	NUP 11791
<i>Bryconamericus stramineus</i> Eigenmann, 1908	"pequira", "lambari"	3	15	5	23	NUP 11818
<i>Oligosarcus paranensis</i> Menezes and Géry, 1983	"saicanga"		1		1	NUP 11788
Erythrinidae						
<i>Hoplias</i> sp. 2 *	"traíra"	1	1		2	NUP 11828
SILURIFORMES						
Trichomycteridae						
<i>Trichomycterus</i> sp. 1*	"candiru"	14	15	7	36	NUP 11800
<i>Trichomycterus</i> sp. 2*	"candiru"	94	75	46	215	NUP 11811
Loricariidae						
<i>Hisonotus</i> sp. *	"cascudinho limpa-vidro"	22	18	17	57	NUP 11808
<i>Rineloricaria</i> aff. <i>pentamaculata</i> Langeani and de Araújo, 1994	"cascudo-chinelo"	48	20	34	102	NUP 11815
<i>Hypostomus ancistroides</i> (Ihering, 1911)	"cascudo"	28	29	31	88	-----
<i>Hypostomus</i> cf. <i>strigaticeps</i> (Regan, 1908)	"cascudo"		1	1	2	NUP 11814
<i>Hypostomus</i> sp. *	"cascudo"		2	3	5	NUP 11804
Heptapteridae						
<i>Cetopsorhamdia iheringi</i> Schubart and Gomes, 1959	"bagrinho"	5	7		12	NUP 11816
<i>Imparfinis mirini</i> Haseman, 1911	"bagrinho"	1	1	1	3	NUP 11796
<i>Imparfinis schubarti</i> (Gomes, 1956)	"bagrinho"	2	13	2	17	NUP 11799
<i>Rhamdia quelen</i> (Quoy and Gaimard, 1824)	"bagre", "jundiá"	24	13	10	47	NUP 11805
CYPRINODONTIFORMES						
Poeciliidae						
<i>Poecilia reticulata</i> Peters, 1859	"barrigudinho", "guaru"	202	114	119	435	NUP 11807
Total number		627	521	399	1547	
Richness		17	20	17	20	

In general, the pattern of species found in the present study is typical of streams, including several species of 'lambaris', made up by the genera *Astyanax* and *Bryconamericus*, as well as loricariids (*Hypostomus*), which are widely distributed in basins such as the Upper Paraná River (Castro *et al.* 2003; Ferreira and Casatti 2005; Casatti 2005; Suárez and Lima-Junior 2009) and Tibagi River (Oliveira and Bennemann 2005; Galves *et al.* 2007). Coupled with this, the hydrological and geomorphological features of Itiz Stream, particularly the presence of rocky rapids, waterfalls, and pools, provide microhabitats that favor this species composition.

Comparison of species recorded here with other locations of the Ivaí River basin is hampered by the lack of ichthyofaunistic surveys and even ecological studies in such places. Additionally, many species collected in such small water bodies have not yet been described (Maier *et al.* 2008); and that in this study were represented by five species (*Hisonotus* sp., *Hoplias* sp.2, *Hypostomus* sp., *Tricomys* sp.1, and *Tricomys* sp.2) that are being analyzed by experts. This justifies the need for further sampling effort in these headwater streams, mainly in non-urbanized environments, in order to record additional new species in the Ivaí River basin.

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