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LISTS OF SPECIES

Fish, Maringá Urban Streams, Pirapó river drainage, upper Paraná river basin, Paraná State, Brazil

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Abstract
The metropolitan area of Maringá, Paraná state (southeastern Brazil), has many small headwater streams that are affected by urban development. Checklists of fish species in these sites are important tools to learn about the biodiversity of impacted environments. Samples were taken every two months from July 2007 to June 2008 in three different sites along 10 small headwater streams in Maringá city within a gradient of urbanization. A total of 38 fish species ascribed to six orders, 12 families, and 27 genera were collected, including six non-native species, and 14 that are probably new species.

Introduction
The Pirapó river drainage is located in the upper drainage basin of the Paraná River and has an area of 5076 Km^2, into the third plateau of Paranean state (22°30' S/ 51°15' W; 23°30' S/ 52°15' W) (Maack 1968). The landscape of the drainage basin is a mosaic of agricultural and urban lands, especially in the metropolitan area of Maringá. Maringá city is an important agro-industrial center of the region, and the third most populous city of Paraná state with 325,968 inhabitants (IBGE 2007). Many small headwater streams (1st, 2nd and 3rd order, sensu Strahler 1957) sprout within the urban perimeter and are affected by urbanization, which in turn affects physical, chemical, and biological characteristics of these environments. The features of an urban stream include a flashier hydrography, high nutrient and contaminant concentrations, altered channel morphology and stability, reduced biotic richness, and dominance of tolerant species (Paul and Meyer 2001, Meyer et al. 2005). In order to understand the environmental changes caused by urban development, the research center "*Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura*" (Nupélia), *Universidade Estadual de Maringá* (UEM), carried out several fish samplings in the region throughout one year. Changes in fish assemblage structure in response to urbanization have been less studied compared to other stream biota, particularly invertebrates (Paul and Meyer 2001). The lack of information on fish assemblage structure in urban streams hinders our understanding about the vulnerability, tolerance and consequences of invasive fish species in this impacted environment (Oliveira and Bennemann 2005; Vieira and Shibatta 2007; Cunico et al. 2006). This study provides a checklist of fish species from 10 small urban headwater streams in Maringá, with information about native, non-native and probable new species as well.

Material and methods
Samples were taken every two months from July 2007 to June 2008 in three different sites along 10 small headwater streams (1st, 2nd and 3rd order, sensu Strahler 1957) within an urbanization gradient in Maringá city (Figure 1). Fishes were collected under license of *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* (IBAMA) (137/2006 DIFAP/IBAMA, Process IBAMA # 02040.000093/06-45).

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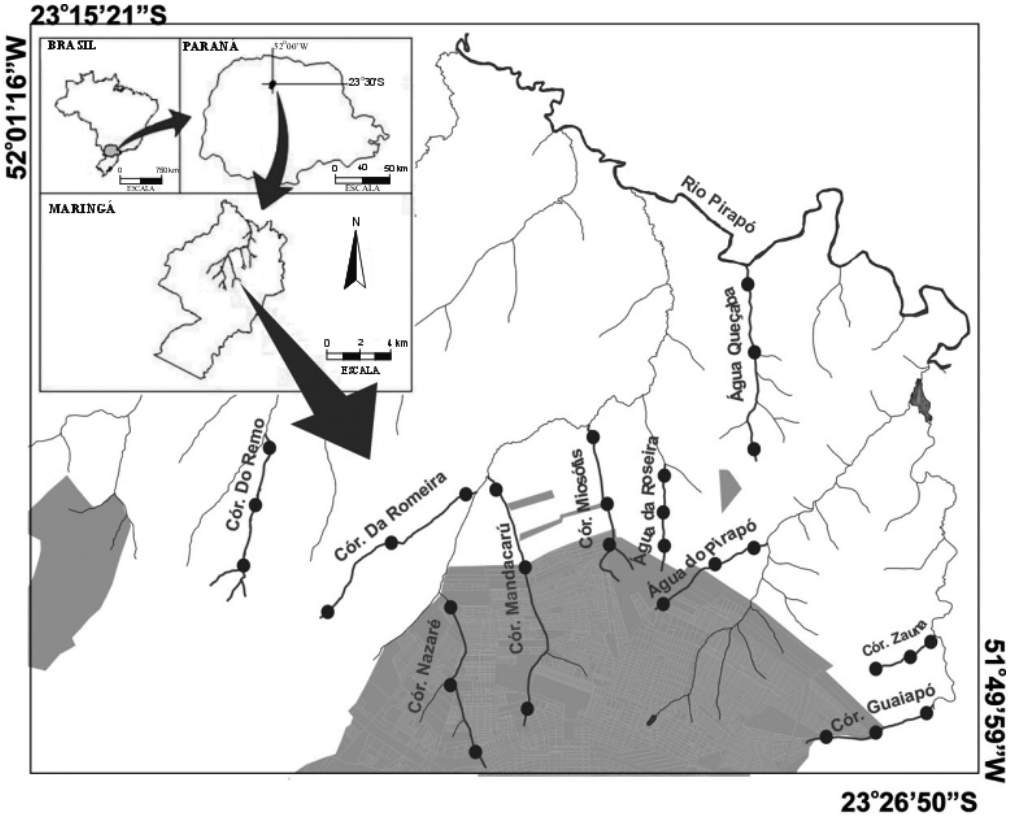

Figure 1. Location of the studied basin and the sampling sites. Areas in grey represent the urban limits. (●) – Sampling site.

The sampling reach lengths at each site were 20 times the mean wetted channel width. A minimum reach length of 40 m and a maximum reach length of 80 m were established. Fishes were caught while wading upstream, using a full-wave rectified pulsed DC electroshocker (2.5kW, 400 V, 2 A) operated through two anode dipnets. A stop net (2 mm diameter mesh) was placed at the up and downstream limit of each site. Because identification in field conditions was rarely possible, fish were anaesthetized (carnation oil) and fixed in 4% formalin. In the laboratory, fish species were identified in accordance with Graça and Pavanelli (2007). Species classification is presented according to Eschmeyer (2006) for superior categories and Reis et al. (2003) for Neotropical families. Voucher specimens of each species were deposited in "*Coleção Ictiológica do Nupélia" of Universidade Estadual de Maringá*, available at: http://www.nupelia.uem.br/colecao. In the appendix there is information about the order, species, number of lots, number of specimens, and range of standard length (SL) or total length (TL) in millimeters. Only *Crenicichla niederleinii* (Holmberg, 1891), has no voucher specimens, and just one specimen collected. Relationship between species richness and the number of samples was calculated by species-accumulation curve using Microsoft Office Excel version 2003.

Results and discussion

A total of 38 fish species ascribed to 27 genera, 12 families, and six orders (Table 1) were collected; five species were considered non-native, and 14 are probably new species. The most representative order was Siluriformes, with four families and 16 species, followed by Characiformes, with four families and 13 species, a common trend in Neotropical rivers (Lowe-McConnell 1999). The species-accumulation curve suggests no occurrence of more species in the sampled streams, except for the Miosótis stream (Figure 2).

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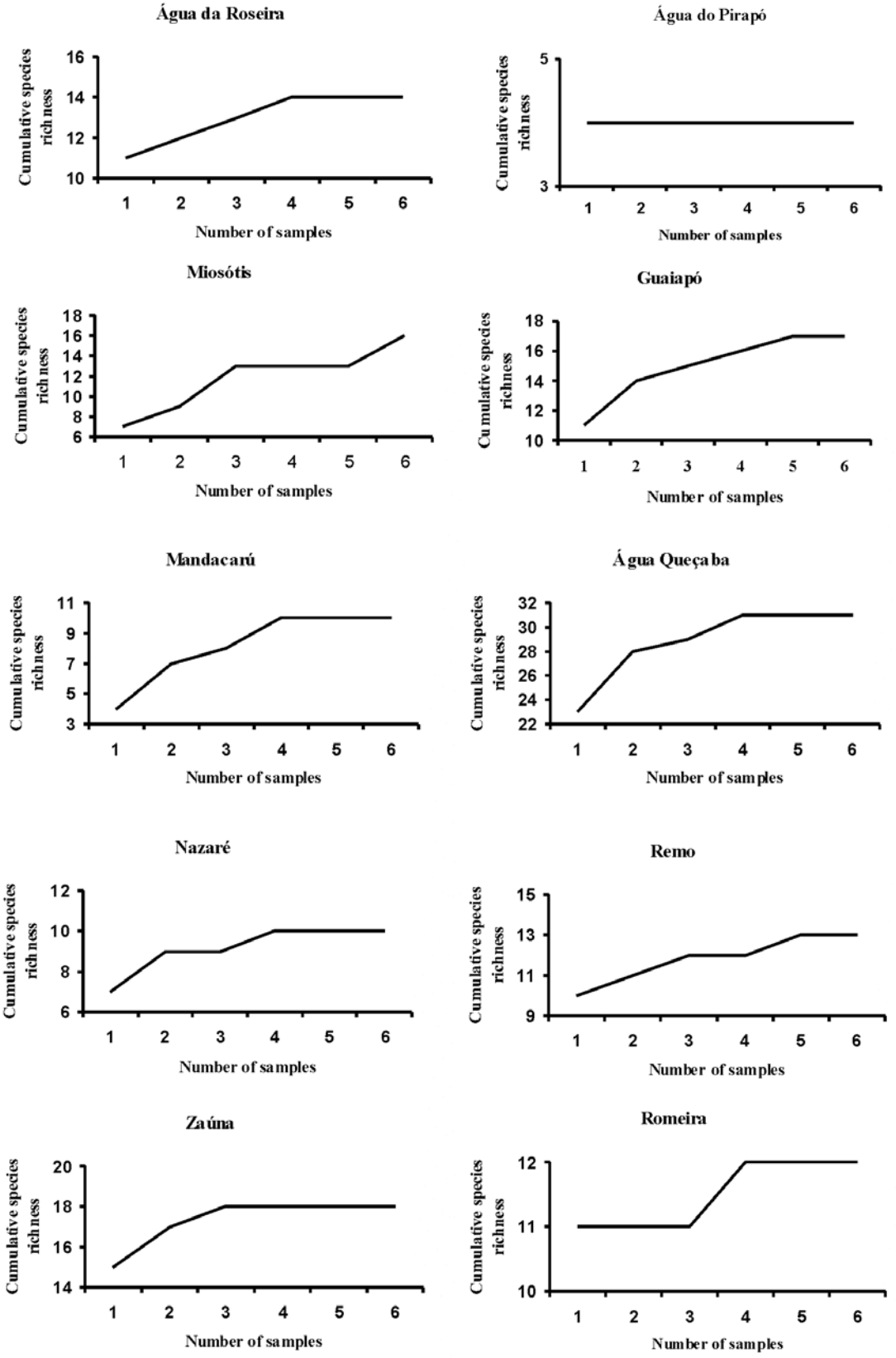

Figure 2. Species cumulation curve in 10 streams in Maringá metropolitan area, Paraná state, Brazil.

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The species with the higher number of specimens was *Poecilia reticulata* Peters, 1859 representing 64.9% of all collected individuals. Three other species represented more than 5% of the overall abundance - *Hypostomus* aff. *ancistroides* (Ihering, 1911) (8.7%), *Rhamdia quelen* (Quoy & Gaimard, 1824) (5.8%) and *Imparfinis mirini* Haseman, 1911 (5.4%). Cunico et al. (2006) studied the structure of fish assemblages in three small headwater urban streams in Maringá and found a similar abundance distribution, comprising 11 species and including one non-indigenous species (*Poecilia reticulata*).

Urban streams are susceptible to invasion by non-native fish species and are also associated with the increase of tolerant species (Vieira and Shibatta 2007; Onorato et al. 2000; Wang et al. 2000; Silva 1995). The non-native species captured in the samples, *Poecilia reticulata* and *Xiphophorus hellerii* Heckel, 1848, are originally from Venezuela and Mexico respectively (Lucinda 2003). These species had probably been carried by aquarists or introduced for controlling insects' larvae. *Oreochromis niloticus* (Linnaeus, 1758) is an African species and possibly was introduced by escapes from pisciculture tanks. *Erythrinus erythrinus* (Bloch & Schneider, 1801) from Amazon, Orinoco and Guianas basins is commonly used as live bait by fishers, what could explain their presence in sampled streams.

Native species listed in Table 1 with no Latin binomens are probably new species, which have been analyzed by specialists. Langeani et al. (2007) listed 50 probably new species from the upper drainage basin of Paraná River. However, our studies, along with Maier et al. (2008), indicated the presence of additional species to the upper drainage basin of Paraná River that have not been listed by those authors. Such findings demonstrate that increasing sampling efforts in the region could result in some new species, especially in its affluents.

Table 1. List of fish species and their respective abundances from Maringá's urban streams. Letters represent streams: A. Água da Roseira; B. Água do Pirapó; C. Água Queçaba; D. Guaiapó; E. Mandacaru; F. Miosótis; G. Nazaré; H. Remo; I. Romeira; J. Zaúna. Local vernacular names of each species are provided between quotation marks.

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
OSTEICHTHYES										
CHARACIFORMES										
Parodontidae										
Apareiodon ibitiensis Campos, 1944 – "canivete"						4				
Apareiodon piracicabae (Eigenmann, 1907) – "canivete"			1							
Apareiodon sp. – "canivete"			6							
Crenuchidae										
Characidium aff. *zebra* Eigenmann, 1909 – "mocinha"			291	94		3		81		71
Characidae										
Incertae sedis										
Astyanax altiparanae Garutti & Britski, 2000 – "tambiú"	1		188	132	17	32			116	3
Astyanax bockmanni Vari & Castro, 2007 – "lambari"	2		23							41

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Astyanax aff. *fasciatus* (Cuvier, 1819) – "lambari-rabo-vermelho"	119		243	42	21	4	35	653	135	182
Astyanax aff. *paranae* Eigenmann, 1914 – "lambari"	7			6			4	121	29	63
Bryconamericus stramineus Eigenmann, 1908 – "pequira", "lambari"	120		129			2				9
Piabina sp. – "pequira"	19		96					35		
Cheirodontinae										
Serrapinnus notomelas (Eigenmann, 1915) – "pequira"			16							
Erythrinidae										
Erythrinus erythrinus (Bloch & Schneider, 1801) – "jejú"							1			
Hoplias aff. *malabaricus* (Bloch, 1794) – "traíra"			3	5				1	2	
SILURIFORMES										
Trichomycteridae										
Trichomycterus diabolus Bockmann, Casatti & de Pinna, 2004 – "candiru"								34		
Callichthyidae										
Callichthys callichthys (Linnaeus, 1758) – "camboja", "tamboatá"			2							2
Corydoras aeneus (Gill, 1858) – "limpa-vidro"			375							
Loricariidae										
Hypoptopomatinae										
Hisonotus sp. – "cascudinho limpa-vidro"	1									
Hypostominae										
Hypostomus aff. *ancistroides* (Ihering, 1911) – "cascudo"	87	13	152	229	982	502	551	255	178	100
Hypostomus nigromaculatus (Schubart, 1964) – "cascudo"			60							2
Hypostomus aff. *strigaticeps* (Regan, 1908) – "cascudo"			31	1	2	37	74			8
Hypostomus sp. – "cascudo"			7				4			
Loricariinae										
Rineloricaria sp. – "cascudo-chinelo"			5	51						13
Neoplecostominae										
Neoplecostomus sp. – "cascudo"								1		
Heptapteridae										
Cetopsorhamdia iheringi	10		15	221	2	209	150		19	27

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Schubart & Gomes, 1959 – "bagrinho"										
Imparfinis borodini Mees & Cala, 1989 – "bagre-pedra"			15							24
Imparfinis mirini Haseman, 1911 – "bagrinho"	806	10	295	337		75			385	
Phenacorhamdia tenebrosa (Schubart, 1964) – "bagrinho"	11		32	12		1	1	25	147	237
Pimelodella avanhandavae Eigenmann, 1917 – "mandi-chorão", "chorãozinho"	1		33							
Rhamdia quelen (Quoy & Gaimard, 1824) – "bagre", "jundiá"	77	37	64	398	603	454	306	42	46	24
GYMNOTIFORMES										
Gymnotidae										
Gymnotus inaequilabiatus (Valenciennes, 1839) – "morenita", "tuvira"			51	6	1	3		8	3	1
Gymnotus sp. – "morenita", "tuvira"			3		1					
CYPRINODONTIFORMES										
Poeciliidae										
Poecilia reticulata Peters, 1859 – "barrigudinho", "guaru"	55	1307	72	3666	8966	2840	2038	1907	785	1162
Xiphophorus hellerii Heckel, 1848 – "espadinha"						8				
SYNBRANCHIFORMES										
Synbranchidae										
Synbranchus marmoratus Bloch, 1795 – "muçum"			13	3	5	2		10		
PERCIFORMES										
Cichlidae										
Crenicichla britskii Kullander, 1982 – "joaninha"			9							
Crenicichla niederleinii (Holmberg, 1891) – "joaninha"			1							
Geophagus aff. *brasiliensis* (Quoy & Gaimard, 1824) – "cará"			30	6		1			5	
Oreochromis niloticus (Linnaeus, 1758) – "tilápia do nilo"			2	9						10
Richness	**14**	**4**	**31**	**17**	**10**	**16**	**10**	**13**	**12**	**18**
Total abundance	**1316**	**1367**	**2263**	**5218**	**10600**	**41771**	**3164**	**3173**	**1850**	**1979**

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Acknowledgements

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Appendix

Characiformes- Parodontidae- NUP 5605 *Apareiodon ibitiensis*, 1 (79.0 SL); NUP 5760 *Apareiodon piracicabae*, 1 (32.9 SL); NUP 6026 *Apareiodon* sp., 4 (44.2-55.3 SL); Crenuchidae- NUP 5555 *Characidium* aff. *zebra*, 5 (34.0-60.9 SL); Characidae- NUP 5615 *Astyanax altiparanae*, 3 (64.9-69.7 SL); NUP 5626 *Astyanax bockmanni*, 5 (47.1-62.1 SL); NUP 5580 *Astyanax* aff. *fasciatus*, 8 (28.5-48.7 SL); NUP 6037 *Astyanax* aff. *paranae*, 14 (44.4-76.6 SL); NUP 5765

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Bryconamericus stramineus, 3 (54.4-61.8 SL); NUP 5578 *Piabina* sp., 5 (51.2-61.0 SL); NUP 6025 *Serrapinnus notomelas*, 5 (23.1-43.3 SL); Erythrinidae- NUP 6032 *Erythrinus erythrinus*, 1 (120.4 SL); NUP 6042 *Hoplias* aff. *malabaricus*, 1 (205.4 SL). **Siluriformes**- Trichomycteridae- NUP 5579 *Trichomycterus diabolus*, 2 (46.0-72.7 SL); Callichthyidae- NUP 5633 *Callichthys callichthys*, 1 (65.1 SL); NUP 5559 *Corydoras aeneus*, 10 (32.6-39.4 SL); Loricariidae- NUP 3950 *Hisonotus* sp., 14 (30.7-38.5 SL); NUP 6047 *Hypostomus* aff. *ancistroides*, 8 (51.5-142.2 SL); NUP 5561 *Hypostomus nigromaculatus*, 2 (50.0-62.3 SL); NUP 5283 *Hypostomus* aff. *strigaticeps*, 3 (32.9-117.6 SL); NUP 5759 *Hypostomus* sp., 3 (34.9-84.7 SL); NUP 5577 *Neoplecostomus* sp., 1 (46.7 SL); NUP 5761 *Rineloricaria* sp., 2 (45.5-54.6 SL); Heptapteridae- NUP 5556 *Cetopsorhamdia iheringi*, 5 (31.9-66.5 SL); NUP 6010 *Imparfinis borodini*, 1 (101.7 SL); NUP 5628 *Imparfinis mirini*, 11 (33.9-67.3 SL); NUP 5607 *Phenacorhamdia tenebrosa*, 8 (31.7-70.0 SL); NUP 5632 *Pimelodella avanhandavae*, 1 (80.4 SL); NUP 6048 *Rhamdia quelen*, 20 (31.2-107.7 SL); **Gymnotiformes**- Gymnotidae- NUP 6043 *Gymnotus inaequilabiatus*, 6 (58.3-201.9 TL); NUP 6044 *Gymnotus* sp., 2 (120.0-173.6 TL). **Cyprinodontiformes**- Poeciliidae- NUP 3452 *Poecilia reticulata*, 15 (17.3-32.9 SL); NUP 6030 *Xiphophorus hellerii*, 3 (49.2-53.5 SL). **Synbranchiformes**- Synbranchidae- NUP 6041 *Synbranchus marmoratus*, 2 (350.5-414.8 TL). **Perciformes**- Cichlidae- NUP 6003 *Crenicichla britskii*, 1 (108.8 SL); NUP 6002 *Geophagus* aff. *brasiliensis*, 2 (70.9-71.0 SL); NUP 5316 *Oreochromis niloticus*, 4 (30.3-37.7 SL).