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Ichthyofauna from three streams of the lower Iguatemi River in the upper Paraná river basin, Brazil

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Abstract
The ichthyofauna from 3 streams (Água Boa, Perobão, and Santa Maria) to the lower Iguatemi River were inventoried, which is located in the upper Paraná river basin, in Mato Grosso do Sul state, Brazil. Sites in the upper, intermediate, and lower portions of each stream were quarterly electrofished from March to December 2008. All sampled fish (n = 6,816 individuals) represented 43 species of 5 orders, and 16 families. The most abundant species was *Phalloceros harpagos* (63.5%), followed by *Astyanax* aff. *paranae* (10.6%), *Hypostomus ancistroides* (5.9%), *Gymnotus inaequilabiatus* (3.4%), and *Knodus moenkhausii* (2.7%). Despite the high ichthyofauna richness in the lower portion of Iguatemi River, the need to implement and/or expand soil conservation practices and riparian forest restoration is of utmost importance to maintain these populations in the long term.

Keywords
Diversity; floodplain; freshwater fishes; preservation; re-establish.

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Introduction

The South American freshwater fish fauna is the most diverse on earth (Albert et al. 2011), with about 20 orders, 69 families, 739 genera, and 5,160 valid species (Reis et al. 2016). Of these, approximately 310 species, including both native and non-native species, are found in the upper Paraná river basin (Langeani et al. 2007). Small tributaries and streams of this basin harbor a great concentration of small-bodied species of fish (Castro 1999, Winemiller et al. 2008), with little or no commercial value, which correspond to around 50% of the richness of freshwater fish species in tropical regions (Lowe-McConnell 1999, Winemiller et al. 2008).

Despite the representativeness of Brazilian streams fish fauna in Neotropical biodiversity and its contribu-

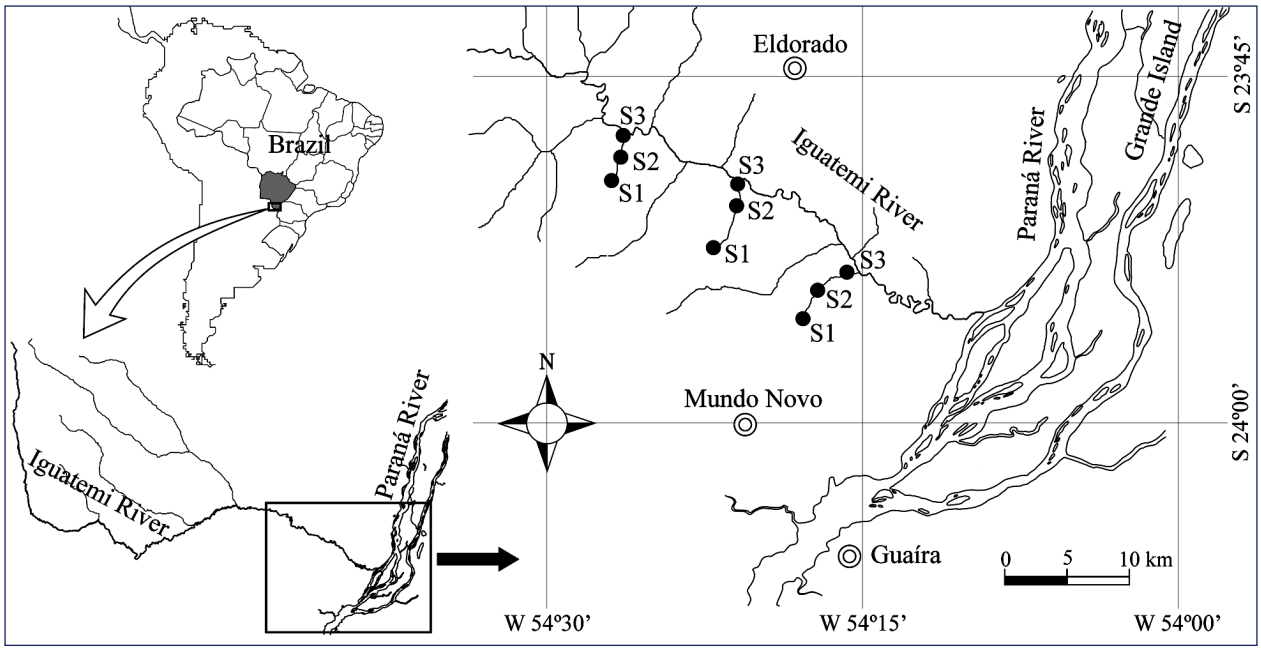

Figure 1. Location of Perobão, Água Boa and Santa Maria streams and sampled sites at each stream. S1 = site 1, upper portion; S2 = site 2, intermediate portion; S3 = site 3, lower portion.

tion to the functioning of ecosystems, the composition of fish species in Brazilian streams is still poorly reported in the literature (Castro et al. 2003, Langeani et al. 2007, Winemiller et al. 2008). Although relatively well known compared to elsewhere in South America, the ichthyofauna of the upper Paraná river basin also requires further investigations (Langeani et al. 2007). Such a lack of information on the species composition of fish assemblages is particularly pronounced at the lower portion of the Iguatemi River, a right bank tributary of the upper Paraná river basin (see Súarez and Petrere-Júnior 2003, 2005, 2006).

The Iguatemi River, mainly in its lower section, is located within the limits of the area of influence of flood pulses of the upper Paraná River floodplain. This area corresponds to an extensive floodplain, mainly in the Mato Grosso do Sul state, and represents a very dynamic ecosystem in biotic and abiotic terms (Agostinho et al. 2009), presenting a high environmental heterogeneity and importance for biodiversity maintenance (Thomaz et al. 2007). Since the knowledge on fish species living in a river basin is essential for any measure of management of fishery resources and/or water quality and habitats (Oliveira et al. 2014), we present a list of fish species for 3 first-order streams, tributaries to the Iguatemi River, within the limits of the upper Paraná River floodplain.

Methods

Study area. Água Boa, Perobão, and Santa Maria are first-order streams, which run for about 6.0, 4.3, and 5.3 km, respectively, in rural areas in southern Mato Grosso do Sul, Brazil. Only the headwater of the Santa Maria stream is located in the urban area of the municipality of Mundo Novo. All the 3 streams flow into the right bank of the Iguatemi River, upper Paraná river basin (Fig. 1). These streams are surrounded by poor arboreal riparian forest. The native vegetation is the Atlantic Forest biome (semi-deciduous forest), which has been largely replaced with agriculture and pasture. Deforestation is a remarkable characteristic of the history of regional occupation (Súarez and Petrere-Júnior 2003). Siltation is another anthropogenic stressor. The soil in the region is sandy and frequently impacted by gullies, intensifying the input of sediments into the streams; added to this, rural populations indiscriminately use the water from streams for livestock, which worsens the siltation process due to animal trampling (Mendonça et al. 2014). Garbage accumulation is another impact on the Santa Maria stream given its contact to urban areas.

Data collection. Samplings were conducted quarterly from March to November, 2008 (Brazilian license 146/2007, IBAMA/SISBIO) in the upper (Site 1), intermediate (Site 2) and lower (Site 3) portions of Água Boa, Perobão, and Santa Maria streams. Each sampling site shows distinct characteristics of width, depth, flow, streambed, and riparian vegetation (for more details, see Table 1). Fish were caught using electrofishing (portable generator TOYAMA 1600, 220V, DC). The sampling effort was standardized for each stream and the different months. Each sampled portion length was determined according to Fitzpatrick et al. (1998), wherein we took 5 width measurements in each portion (emphasizing the environmental heterogeneity including the regions of run, riffle, and pool). Later, we calculated the arithmetic mean of these measures and multiplied the result by 20. The length of the upper, intermediate, and lower portion sampled were 82 m, 71 m, and 50 m for the Água Boa stream, 94 m, 57 m, and 61 m for the Perobão stream, and

Table 1. Environmental features and sampled area at Água Boa, Perobão and Santa Maria streams. Site 1 = upper portion; Site 2 = intermediate portion; Site 3 = lower portion. Minimums and maximums are shown for width and depth.

Stream	Site	Latitude (S)	Longitude (W)	Width (m)	Depth (cm)	Flow conditions	Stream bed	Riparian vegetation	Principal impacts
Água Boa	1	23°52′42.24″	054°21′55.37″	2.0–6.0	12–15	Backwaters	Clayey; abundant aquatic grasses	Marginal veg.: scattered trees, shrubs & grasses	Deforestation; grazing
	2	23°50′16.65″	054°20′55.54″	2.2–5.5	30–90	Backwaters alternating with rapids & pools	Rocky & sandy	Marginal veg.: small clusters of trees & pasture grasses	Recreational activities
	3	23°50′03.33″S	054°20′58.53″	2.2–2.7	30–63	Rapid water flow	Sandy	Marginal veg.: scattered trees, shrubs & grasses	Grazing; fish farming (natural course altered)
Perobão	1	23°49′25.26″S	054°26′43.30″	2.0–10.0	5–15	Backwaters	Clayey, slightly steep banks	Marginal veg.: mainly pasture grasses	Intense transit of cattle
	2	23°48′59.35″S	054°26′40.06″	1.0–4.5	10–50	Pools & rapids, rapids prevailing	Predominantly rocky & sandy; steep banks	Narrow band of riparian veg. & pasture grasses	Deforestation; grazing
	3	23°48′05.50″S	054°26′26.00″	2.0–3.6	26–45	Alternating backwaters, rapids & pools	Rocky & sandy; slightly sinuous, with steep bank & limited downstream by a waterfall (about 3 m)	Scarce marginal veg.: scattered trees & pasture grasses	Deforestation; grazing
Santa Maria	1	23°55′22.75″S	054°17′49.54″	0.7–1.2	12–19	Straight channel that receives culvert flow	Clayey; steep banks	Marginal veg.: scattered trees, shrubs & grasses	Deforestation; grazing
	2	23°54′29.17″S	054°17′14.49″	0.9–3.0	20–50	Rapid water flow	Clayey bed; somewhat steep banks	Marginal veg.: grasses & some shrubs	Deforestation; grazing
	3	23°53′52.44″S	054°16′13.55″	1.6–4.6	15–80	Straight channel next to fish farming; low flow	Rocky & sandy	Marginal veg.: grasses	Deforestation; grazing

19 m, 37 m and 63 m for the Santa Maria stream. Blocking nets were installed at the end of each portion (10 m × 2 m and mesh size of 0.5 cm between opposite nodes) to prevent fish from escaping. A single electrofishing pass was used to collect the fish in each portion.

The specimens were euthanized in benzocaine and fixed in 10% formalin. In the laboratory, specimens were sorted and placed in glass vials containing 70% alcohol. Identification followed Graça and Pavanelli (2007) and/or via specialist verification. Taxonomic classification followed Reis et al. (2003), Betancur et al. (2017), and Ferraris (2007) particularly for Siluriformes. Voucher specimens were deposited in the fish collection of the Nupélia (NUP: Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura), Universidade Estadual de Maringá, Maringá, Paraná (NUP 16119 to NUP 16122, NUP 16138 to NUP 16148, NUP 16151 to 16185, and NUP 16170). The species were categorized by their constancy of occurrence, which was calculated for each stream according to Dajoz (1983). Species with a frequency of occurrence up to 25% were classified as occasional, between 25 and 50% as an accessory, and above 50% as constant. In addition, the species were categorized into autochthonous and allochthonous, respectively, to distinguish native and introduced species to the upper Paraná river basin (Graça and Pavanelli 2007, Langeani et al. 2007, Júlio Júnior et al. 2009).

Results

The number of fish caught (n = 6,816 individuals) represented 43 species, in 5 orders, and 16 families (Table 2). Characiformes (Fig. 2) was the most representative order in number of species and families (22 species and 7 families), followed by Siluriformes (14 species and 4 families), Gymnotiformes (4 species and 3 families), Cichliformes (2 species and 1 family) and Cyprinodontiformes (1 species). Characidae (12 species), Loricariidae (6 species)

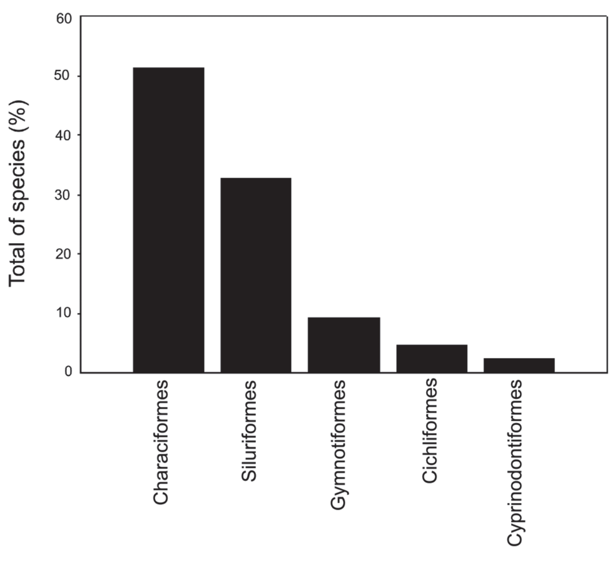

Figure 2. Percentages of the total number of sampled species in each order.

Table 2. List of fish species of Água Boa, Perobão and Santa Maria streams. N = total number of individuals collected, CO = constant, AC = accessory, OC = occasional, Auto = autochthonous, Allo = allochthonous, AB = Água Boa, PE = Perobão, SM = Santa Maria.

Species	Constancy				Origin	Voucher
	N	AB	PE	SM		
Characiformes						
Anostomidae						
Leporinus friderici (Bloch, 1794)	02	—	—	OC	Auto	NUP16161
Characidae						
Aphyocharax anisitsi Eigenmann & Kennedy, 1903	03	OC	—	—	Auto	NUP16143
Aphyocharax dentatus Eigenmann & Kennedy, 1903	02	OC	—	—	Auto	NUP16145
Astyanax aff. *fasciatus* (Cuvier, 1819)	01	—	—	OC	Auto	NUP16174
Astyanax aff. *paranae* Eigenmann, 1914	722	AC	CO	OC	Auto	NUP16121
Astyanax lacustris (Lütken, 1875)	135	CO	—	AC	Auto	NUP16175
Piabarchus stramineus (Eigenmann, 1908)	108	AC	—	CO	Auto	NUP16148
Knodus moenkhausii (Eigenmann & Kennedy, 1903)	187	AC	—	CO	Allo	NUP16172
Moenkhausia australe (Eigenmann, 1908)	31	AC	—	OC	Auto	NUP16167
Moenkhausia bonita Benine, Castro & Sabino, 2004	17	AC	—	AC	Auto	NUP16181
Oligosarcus pintoi Campos, 1945	03	—	—	OC	Auto	NUP16165
Piabina argentea Reinhardt, 1867	15	—	—	OC	Auto	NUP6171
Serrapinnus notomelas (Eigenmann, 1915)	107	AC	—	AC	Auto	NUP16177
Crenuchidae						
Characidium gomesi Travassos, 1956	01	—	—	OC	Auto	NUP16179
Characidium aff. *zebra* Eigenmann, 1909	14	AC	OC	OC	Auto	NUP16144
Curimatidae						
Cyphocharax modestus (Fernández-Yépez, 1948)	02	OC	—	—	Auto	NUP16142
Steindachnerina brevipinna (Eigenmann & Eigenmann, 1889)	04	OC	—	OC	Allo	NUP16155
Erythrinidae						
Hoplerythrinus unitaeniatus (Agassiz, 1829)	01	—	—	OC	Allo	NUP16156
Hoplias sp. 3	12	OC	AC	OC	Auto	NUP16160
Lebiasinidae						
Pyrrhulina australis Eigenmann & Kennedy, 1903	44	AC	—	—	Auto	NUP16147
Parodontidae						
Apareiodon affinis (Steindachner, 1879)	03	—	—	OC	Auto	NUP16183
Parodon nasus Kner, 1859	02	—	—	OC	Auto	NUP16169
Cyprinodontiformes						
Poeciliidae						
Phalloceros harpagos Lucinda, 2008	4329	AC	CO	AC	Auto	NUP16120
Gymnotiformes						
Gymnotidae						
Gymnotus inaequilabiatus (Valenciennes, 1839)	232	CO	—	AC	Allo	NUP16157
Gymnotus pantanal Fernandes, Albert, Daniel-Silva, Lopes, Crampton & Almeida-Toledo, 2005	07	—	—	AC	Auto	NUP16162
Hypopomidae						
Brachyhypopomus aff. *gauderio* Giora & Malabarba, 2009	01	—	—	OC	Allo	NUP16163
Sternopygidae						
Eigenmannia guairaca Peixoto, Dutra & Wosiacki, 2015	03	AC	—	—	Auto	NUP16151
Cichliformes						
Cichlidae						
Cichlasoma paranaense Kullander, 1983	50	OC	CO	—	Auto	NUP16222
Crenicichla britskii Kullander, 1982	23	CO	—	CO	Auto	NUP16221
Siluriformes						
Auchenipteridae						
Trachelyopterus galeatus (Linnaeus, 1766)	06	OC	—	—	Auto	NUP1885
Callichthyidae						
Callichthys callichthys (Linnaeus, 1758)	16	AC	—	OC	Auto	NUP16223
Corydoras aeneus (Gill, 1858)	71	AC	OC	CO	Auto	NUP16185
Hoplosternum littorale (Hancock, 1828)	04	—	—	OC	Auto	NUP16158
Heptapteridae						
Imparfinis schubarti (Gomes, 1956)	104	OC	AC	CO	Auto	NUP16168
Pimelodella avanhandavae Eigenmann, 1917	04	OC	—	—	Auto	NUP16139
Pimelodella gracilis (Valenciennes, 1835)	02	OC	—	—	Auto	NUP1874
Rhamdia quelen (Quoy & Gaimard, 1824)	36	AC	AC	CO	Auto	NUP16159
Loricariidae						
Farlowella hahni Meinken, 1937	15	AC	—	—	Auto	NUP16140

Table 2. *Continued.*

Species	Constancy				Origin	Voucher
	N	AB	PE	SM		
Hypostomus iheringii (Regan, 1908)	47	AC	—	—	Auto	NUP16153
Hypostomus ancistroides (Ihering, 1911)	400	AC	CO	CO	Auto	NUP16184
Hypostomus strigaticeps (Regan, 1908)	34	AC	—	—	Auto	NUP16138
Otothyropsis polyodon Calegari, Lehmann & Reis, 2013	15	AC	—	OC	Auto	NUP16171
Rineloricaria sp.	01	—	—	OC	Auto	NUP16170

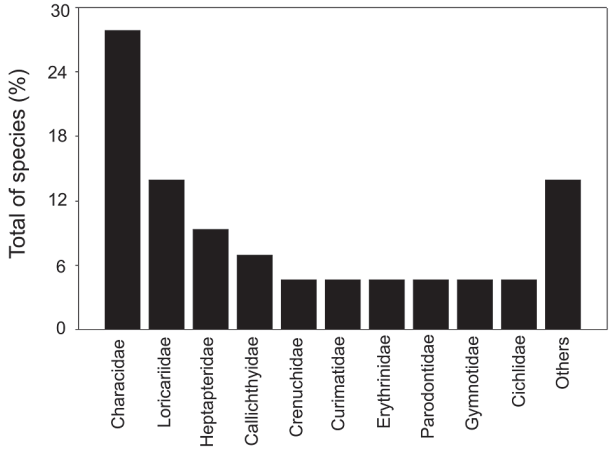

Figure 3. Percentages of the total number of sampled species in each family.

and Heptapteridae (4 species) presented higher richness, contributing together with 51.2% of all species (Fig. 3). *Phalloceros harpagos* Lucinda, 2008 (4,329 individuals), *Astyanax* aff. *paranae* Eigenmann, 1914 (722 individuals), *Hypostomus ancistroides* (Ihering, 1911) (400 individuals), *Gymnotus inaequilabiatus* (Valenciennes, 1839) (232 individuals), and *Knodus moenkhausii* (Eigenmann & Kennedy, 1903) (187 individuals) were the most abundant species, contributing with 86.1% of the collected individuals (Fig. 4). On the other hand, 19 species represented fewer than 10 individuals.

Regarding species richness, we identified 31 species (11 exclusive) at Água Boa stream, 31 (12 exclusive) at Santa Maria stream, and nine at Perobão stream (Table 2). As for constancy of occurrence, most species recorded at Água Boa stream were characterized as accessory (18 species among 31 captured), at Perobão stream as constant and accessory (4 among 9 captured), while at Santa Maria stream, fish fauna was mainly made up of occasional species (18 among 31 captured) (Table 2). In considering the origin of species, there was a predominance of autochthonous species (88.3%); only 5 were classified as allochthonous: *Brachyhypopomus* aff. *gauderio* Giora & Malabarba, 2009, *G. inaequilabiatus*, *Hoplerythrinus unitaeniatus* (Agassiz, 1829), *K. moenkhausii*, and *Steindachnerina brevipinna* (Eigenmann & Eigenmann, 1889). Short descriptions following Graça and Pavanelli (2007) and/or taxonomic revisions for all captured species are herein provided, as well as photographs of some captured species (Fig. 5).

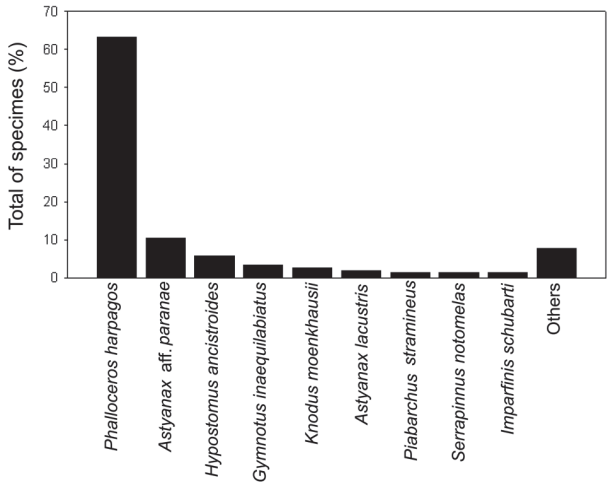

Figure 4. Percentages of number of specimens of each species with more than 100 individuals captured.

Order Characiformes
Family Anostomidae

***Leporinus friderici* (Bloch, 1794)**
Salmus friderici Bloch 1794: 94 [original description].
Leporinus friderici—Graça and Pavanelli 2007: 38, 41.

Material examined. Table 2; Figure 5A.

Elongated body; terminal mouth; premaxilla and dentary with 4 teeth, no maxillary teeth. Lateral line with 37–41 pored scales; transversal series above lateral line with 4–5½ scale rows and below with 4–5½ scale rows. Dorsal fin with 11 or 12, pectoral fin with 15–17, pelvic fin with 9, anal fin with 10 and caudal fin with 19, total rays (Garavello 1979). Ground color silvery to yellowish; dorsal portion of iris red; 3 dark-brown rounded or oval, horizontally elongated, blotches on flank; region of contact between flank scales below lateral line with orange or red spots, forming longitudinal series. Fins yellowish.

Family Characidae

***Aphyocharax anisitsi* Eigenmann & Kennedy, 1903**
Aphyocharax anisitsi Eigenmann and Kennedy 1903: 517 [original description]—Graça and Pavanelli 2007: 86, 87.

Material examined. Table 2.

Elongated body; terminal mouth; premaxilla with 4–8 teeth, dentary with 7–14, and maxilla with 1–4 teeth. Lateral line incomplete, with 7–10 pored scales; longitudinal series with 30-34 scales; transversal series above lateral line with 4–5 scale rows and below with 3½–5 scale rows. Dorsal fin with 9–11, pectoral fin with 9–12,

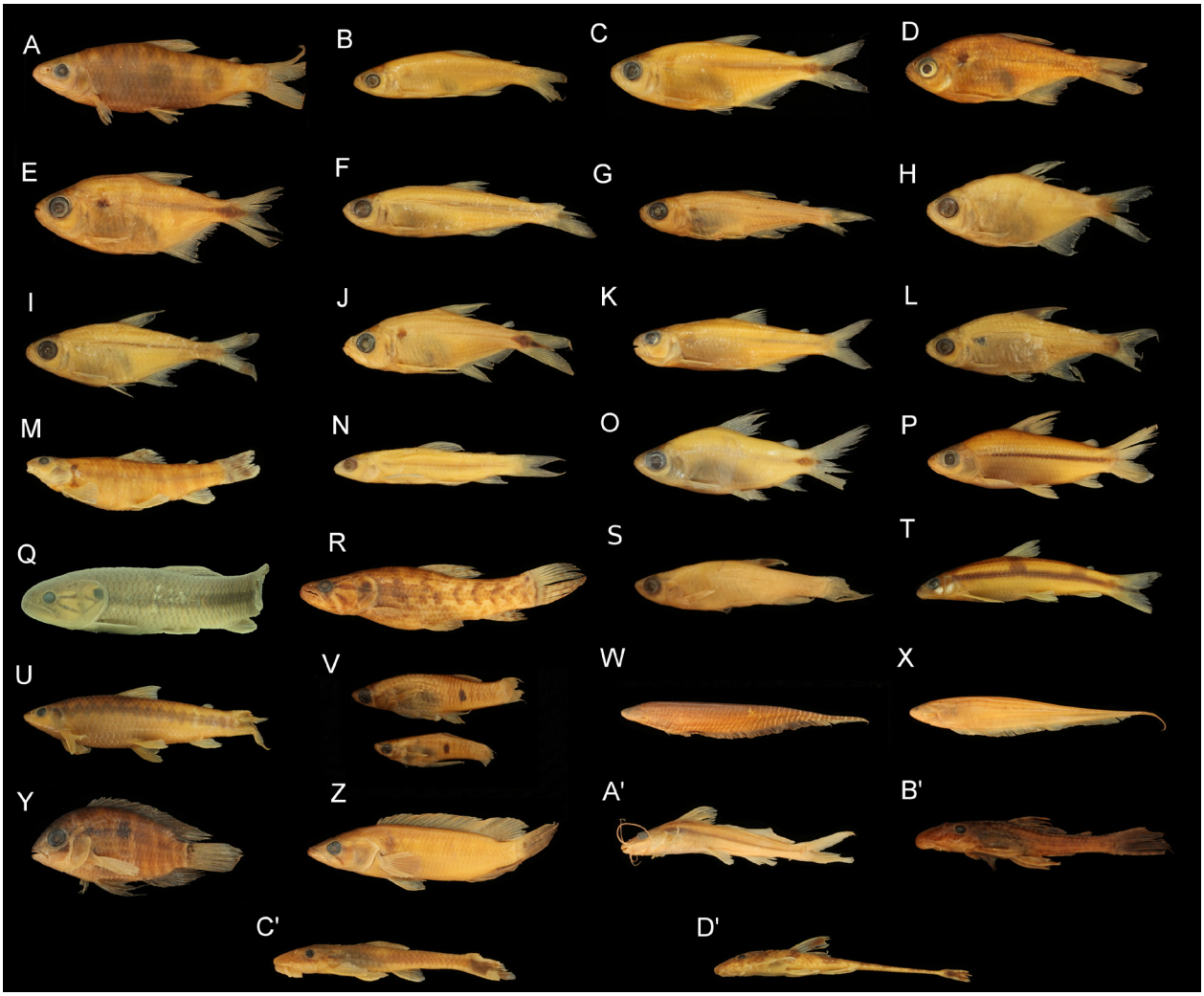

Figure 5. Some fish species from streams of the lower Iguatemi River in the upper Paraná river basin. **A.** *Leporinus friderici*, NUP 16161, 102.0 mm SL. **B.** *Aphyocharax dentatus,* NUP 16145, 36.8 mm SL. **C.** *Astyanax* aff. *fasciatus*, NUP 16174, 73.1 mm SL. **D.** *Astyanax* aff. *paranae*, NUP 16121, 40.3 mm SL. **E.** *Astyanax lacustris*, NUP 16175, 40.1 mm SL. **F.** *Piabarchus stramineus,* NUP 16148, 41.1 mm SL. **G.** *Knodus moenkhausii*, NUP 16172, 24.6 mm SL. **H.** *Moenkhausia australe*, NUP 16167, 28.1 mm SL. **I.** *Moenkhausia bonita*, NUP 16181, 43.2 mm SL. **J.** *Oligosarcus pintoi*, NUP 16165, 38.5 mm SL. **K.** *Piabina argentea*, NUP6171, 59.2 mm SL. **L.** *Serrapinnus notomelas*, NUP 16177, 22.1 mm SL. **M.** *Characidium gomesi*, NUP16179, 80.3 mm SL. **N.** *Characidium* aff. *zebra*, NUP 16144, 35.4 mm SL. **O.** *Cyphocharax modestus*, NUP16142, 43.0 mm SL. **P.** *Steindachnerina brevipinna*, NUP 16155, 73.2 mm SL. **Q.** *Hoplerythrinus unitaeniatus,* NUP 16156, 192.1 mm SL. **R.** *Hoplias* sp. 3, NUP16160, 113.2 mm SL. **S.** *Pyrrhulina australis,* NUP 16147, 26.1 mm SL. **T.** *Apareiodon affinis*, NUP16183, 70.1 mm SL. **U.** *Parodon nasus*, NUP 16169, 74.3 mm SL. **V.** *Phalloceros harpagos*, NUP 16120, 26.8 mm SL (female, below., 19.2 mm SL (male, above. **W.** *Gymnotus inaequilabiatus*, NUP 16157, 122.2 mm SL. **X.** *Brachyhypopomus* aff. *gauderio,* NUP 16163, 129.1 mm SL. **Y.** *Cichlasoma paranaense*, NUP 16222, 82.2 mm SL. **Z.** *Crenicichla britskii*, NUP 16221, 102.3 mm SL. **A'.** *Pimelodella avanhandavae*, NUP 16139, 112 mm SL. **B'.** *Hypostomus ancistroides*, NUP 16184, 51.5 mm SL. **C'.** *Otothyropsis polyodon*, NUP 18972, 38.8 mm SL. **D'.** *Rineloricaria* sp., NUP16170, 35.0 mm SL.

pelvic fin with 6–8, anal fin with 18–23, and caudal fin with 19, total rays (Lima 2003). Ground color silvery; no dark marks on body and fins. Reddish fins, except dorsal and adipose fins.

Aphyocharax dentatus Eigenmann & Kennedy, 1903

Aphyocharax dentatus Eigenmann and Kennedy 1903: 516 [original description]—Britski et al. 1999: 45; Graça and Pavanelli 2007: 86, 88.

Material examined. Table 2; Figure 5B.

Elongated body; terminal mouth, slightly prognathous; premaxilla with 4–8 teeth, dentary with 9–23, and maxilla with 8–17 teeth. Lateral line incomplete, with 8–13 pored scales; longitudinal series with 36–42 scales. Dorsal fin with 9–11, pectoral fin with 10–14, pelvic fin with 7–8, anal fin with 16–22, and caudal fin with 19, total rays (Lima 2003). Ground color silvery; diffuse, oval transversely elongated, humeral spot; no other dark marks on body and fin. Caudal fin red, other fins hyaline to yellowish.

Astyanax aff. *fasciatus* (Cuvier, 1819)

Chalceus fasciatus Cuvier 1819: 352, pl. 26 [original description].

Astyanax fasciatus—Castro et al. 2004: 32, fig. 4a, 5.

Astyanax aff. *fasciatus*—Graça and Pavanelli 2007: 54, 57; Bifi et al. 2017: 4, 5, fig. 2.5

Astyanax fasciatus—Hoffmann et al. 2015: 4, fig. A1.G.

Material examined. Table 2; Figure 5C.

Elongated body; terminal mouth; inner row of premaxilla with 5 teeth, outer with 4 or 5, dentary with 10–12, and maxilla with one tooth. Complete lateral line with 34–36 pored scales; transversal series above lateral line with 5 or 5½ scale rows and below with 5 scale rows. Dorsal fin with 11, pectoral fin with 15, pelvic fin with 9, anal fin with 24–28, and caudal fin with 19, total rays. Ground color silvery; dark vertically elongated humeral blotch; silvery longitudinal band on the flank (dark in fixed specimens) from humeral blotch to median caudal-fin rays, being larger on caudal peduncle and forming oval-shaped, horizontally elongated blotch. Reddish unpaired fins reddish and hyaline paired fins.

Astyanax aff. *paranae* Eigenmann, 1914

Astyanax scabripinnis paranae Eigenmann 1914: 47 [original description].

Astyanax aff. *paranae*—Graça and Pavanelli 2007: 54, 58; Bifi et al. 2017: 4, 5, fig. 2.7.

Astyanax paranae—Hoffmann et al. 2015: 4, fig. A1.H.

Material examined. Table 2; Figure 5D.

Elongated body; terminal mouth; inner row of premaxilla with 5 teeth, outer with 4 or 5, dentary with 8–13, and maxilla with 1 tooth. Complete lateral line with 38 or 39 pored scales; transversal series above lateral line with 5 or 5½ scale rows and below with 4 or 4½ scale rows. Dorsal fin with 11, pectoral fin with 15 or 16, pelvic fin with 9, anal fin with 17–23 and caudal fin with 19, total rays. Ground color silvery; dark vertically elongated humeral blotch followed by another similar dark humeral blotch, smaller than the first. Reddish fins.

Astyanax lacustris (Lütken, 1875)

Tetragonopterus lacustris Lütken 1875: 131 [original description].

Astyanax scabripinnis—Castro et al. 2004: 32, fig. 4a, 4.

Astyanax altiparanae—Graça and Pavanelli 2007: 54, 55; Hoffmann et al. 2015: 4, fig. A1.E.

Astyanax lacustris—Lucena and Soares 2016: 103, figs. 1, 6, 8, 9; Bifi et al. 2017: 4, 5, fig. 2.6.

Material examined. Table 2; Figure 5E.

Deep body; terminal mouth; inner row of premaxilla with 5 teeth, outer with 4 or 5, dentary with 8–16, and no maxillary teeth. Lateral line complete, with 33–41 pored scales; transversal series above lateral line with 6–8 scale rows and below with 4–8 scale rows. Dorsal fin with 12, pectoral fin with 12 or 13, pelvic fin with 8 or 9, anal fin with 22–34, and caudal fin with 19, total rays (Garutti and Britski 2000). Ground color silvery; 1 black rounded humeral blotch followed by another vertically elongated humeral blotch, silvery longitudinal band on the flank (dark in fixed specimens) from humeral blotch to median caudal-fin rays, being larger on caudal peduncle and forming oval-shaped, horizontally elongated blotch. Yellowish fins.

Piabarchus stramineus Eigenmann, 1908

Bryconamericus stramineus Eigenmann 1908: 105 [original description]—Castro et al. 2004: 32, fig. 4a–8; Graça and Pavanelli 2007: 60, 62; Hoffmann et al. 2015: 4, fig. A2.A.

Piabarchus stramineus—Thomaz et al. 2015: 20, fig. 10; Bifi et al. 2017: 4, 5, fig. 2.10.

Material examined. Table 2; Figure 5F.

Elongated body; terminal mouth; inner row of premaxilla with 4 teeth, outer row with 5 teeth; dentary with 9 or 10 teeth, and maxilla with 2 teeth. Lateral line with 36–38 pored scales; transversal series above lateral line with 4 rows and below with 3. Dorsal fin with 11 or 12, pectoral fin with 14 or 15, pelvic fin 9, anal fin with 20–22, and caudal with 19, total rays. Ground color silvery to yellowish; silvery longitudinal band (dark in preserved specimens), from humeral spot to caudal peduncle; black oval, vertically elongated, humeral spot. Caudal fin yellowish to orange; remaining fins hyaline, with dusky border *P. stramineus* is very similar to *Bryconamericus exodon* Eigenmann, 1907, except for its caudal-fin margin that is hyaline versus dark margin in the latter. *Piabarchus* was described by presenting a long anal fin and its origin opposite to/or slightly in front of the dorsal-fin origin. Recently, Thomaz et al. (2015) described the molecular phylogeny of the Stevardiinae and allocated *Bryconamericus stramineus* in *Piabarchus*. Therefore, *P. stramineus* can be distinguished from *P. analis* (Eigenmann, 1914) and from *P. torrenticola* Mahnert & Géry, 1988 by the origin of its anal fin being behind the dorsal-fin origin.

Knodus moenkhausii (Eigenmann & Kennedy, 1903)

Poecilurichthys moenkhausii Eigenmann and Kennedy 1903: 522 [original description].

Knodus moenkhausii—Graça and Pavanelli 2007: 66.

Material examined. Table 2; Figure 5G.

Elongated body; terminal mouth; inner row of premaxilla with 4, outer row with 4 or 5, dentary with 8 or 9 and maxilla with 2 or 3 teeth. Lateral line with 35–39 scales, transversal series above lateral line with 4½–5½ scales above and below with 3–4½ scale rows. Dorsal fin with 10, pectoral fin with 14 or 15, pelvic fin with 8 or 9, anal with 22–24, and caudal fin with 19, total rays. Ground color silvery to pale yellow; silvery longitudinal band (dark-brown in preserved specimens) from humeral spot to median caudal-fin rays; dark-brown crosswise elongated humeral spot. Yellowish fins but reddish during the reproductive period.

Moenkhausia australe (Eigenmann, 1908)

Moenkhausia australe Eigenmann 1908: 103 [original description].

Moenkhausia sanctaefilomenae—Reis et al. 2003: 150.

Material examined. Table 2; Figure 5H.

Deep body; terminal mouth; inner row of premaxilla with 5 teeth, outer with 3 or 4, dentary with 9–12 and maxilla with 1 or 2 teeth. Lateral line complete, with 19–26 pored scales; longitudinal series with 24–26 scales; transversal series above lateral line with 4, 4½ or 5 scale rows and below with 3, 3½ or 4 scale rows. Dorsal fin with 11, pectoral fin with 11–13, pelvic fin with 8, anal fin

with 24–27 and caudal fin with 19, total rays. Ground color silvery; scales with dark-brown border, conferring reticulated pattern to body; 1 dark-brown humeral spot; anterior half of caudal peduncle with light area. Hyaline fins, except caudal fin. *Moenkhausia australe* is morphologically similar to *M. forestii* and *M. sanctaefilomenae*, but can be distinguished from them by having lateral line completely pored, rarely disrupted (vs lateral line incompletely pored, in *M. forestii* and *M. sanctaefilomenae*).

Moenkhausia bonita Benine, Castro & Sabino, 2004
Moenkhausia bonita Benine et al. 2004: 68, fig. 1 [original description].
Hemigrammus marginatus—Graça and Pavanelli 2007: 63.

Material examined. Table 2; Figure 5I.

Elongated body; terminal mouth; inner row of premaxilla with 5 teeth, outer with 2–5, dentary with 4 and maxilla with 2 or 3 teeth. Lateral line complete, with 29–34 pored scales; transversal series above lateral line with 5 scale rows and below with 3 scale rows. Dorsal fin with 11, pectoral fin with 12–13, pelvic fin with 8, anal fin with 24–26 and caudal fin with 19, total rays (Benine et al. 2004). Ground color silvery to pale yellow; dark-brown longitudinal stripe from opercle (conspicuously from vertical through dorsal-fin origin) to median caudal-fin rays; distal portion of caudal-fin lobes equally dark brown.

Oligosarcus pintoi **Campos, 1945**
Oligosarcus pintoi Campos 1945: 456, fig. 9 [original description]—Graça and Pavanelli 2007: 69, 70.

Material examined. Table 2; Figure 5J.

Deep body; terminal mouth terminal; premaxilla with 10–12 teeth, dentary with 10–18, and maxilla with 15–23 teeth. Lateral line complete, with 36–40 pored scales; transversal series above lateral line with 7–9 scale rows and below with 6–8 scale rows. Dorsal fin with 12, pectoral fin with 14–17, pelvic fin with 9, anal fin with 28–33 and caudal fin with 19, total rays (Menezes 1987). Ground color yellowish to silvery; black rounded humeral spot with diffuse dorsal and ventral extensions, followed by second, inconspicuous humeral spot; silvery longitudinal stripe on flank (dark in preserved specimens).

Piabina argentea **Reinhardt, 1867**
Piabina argentea Reinhardt 1867: 50, fig. 1 [original description]—Graça and Pavanelli 2007: 71; Hoffmann et al. 2015: 4, fig. A2.E; Bifi et al. 2017: 4, fig. 2.11.

Material examined. Table 2; Figure 5K.

Elongated body; subterminal mouth; outer row of premaxilla with 2 or 3 teeth, median row with 2 and inner row with 4, dentary with 6 or 7 and maxilla with 2 or 3 teeth. Lateral line complete, with 37–39 pored scales; transversal series above lateral line with 5 scales above and below with 3 or 4 scale rows. Dorsal fin with 10, pectoral fin with 12–13, pelvic fin with 9, anal with 18–21, and caudal fin with 19, total rays (Vari and Harold 2001). Ground color silvery to pale yellow; black humeral spot, with irregular limits; dark-brown longitudinal band, from humeral spot to median caudal-fin rays. Hyaline fins.

Serrapinnus notomelas **(Eigenmann, 1915)**
Cheirodon notomelas Eigenmann 1915: 74 [original description].
Serrapinnus notomelas—Graça and Pavanelli 2007: 93; Bifi et al. 2017: 4, fig. 2.12.

Material examined. Table 2; Figure 5L.

Elongated body; terminal mouth; premaxilla with 4 or 5, dentary with 6 or 7 and maxilla with 1 or 2 teeth. Lateral line incompletely pored, with 5–7 pored scales; longitudinal series with 30-34 scales; transversal series above lateral line with 3½ or 4 scale rows and below with 3 or 3½ scale rows. Dorsal fin with 10 or 11, pectoral fin with 12 or 13, pelvic fin with 8 or 9, anal fin with 19–24 and caudal fin with 19, total rays. Ground color whitish; dark brown diffuse longitudinal stripe on flank, from pseudotympanum to caudal peduncle; black rounded blotch on posterior portion of caudal peduncle and caudal-fin base, not extended to median caudal-fin rays. Dorsal fin with dark chromatophores along two unbranched e first branched rays and proximal half of remaining; pectoral, pelvic, anal and caudal fins yellowish.

Family Crenuchidae

Characidium gomesi **Travassos, 1956**
Characidium gomesi Travassos 1956: 3, fig. 1 [original description]—Hoffmann et al. 2015: 4, fig. A2.F.

Material examined. Table 2; Figure 5M.

Elongated body; terminal mouth; premaxilla with 6 or 7, dentary with 8–10 and maxilla with no teeth. Isthmus without scales. Lateral line with 34 or 35 pored scales; transversal series above lateral line with 4 scale rows and below with 2 or 2½ scale rows. Dorsal fin with 11, pectoral fin with 11–13, pelvic fin and anal fin with 8 or 9, and caudal fin with 18, total rays. Ground color brown; 3 dark brown longitudinal stripes on dorsal region of body; dark brown stripe from tip of snout to orbit; dark brown longitudinal stripe on flank, from humeral spot caudal peduncle; dark brown transversal bars on flank, conspicuous on caudal peduncle; dark brown spot at base of median caudal-fin rays. Hyaline fins; dorsal fin with 2 dark brown oblique stripes; adipose fin with distal portion darkened; posterior half of pectoral, pelvic and anal-fin rays darkened; caudal fin with 2 dark-brown transversal bars.

Characidium **aff. *zebra* Eigenmann, 1909**
Characidium zebra Eigenmann 1909: 38 [original description]—Hoffmann et al. 2015: 4, fig. A2.H.
Characidium aff. *zebra*—Graça and Pavanelli 2007: 50, 51; Bifi et al 2017: 4, fig. 2.13.

Material examined. Table 2; Figure 5N.

Elongated body; terminal mouth terminal; isthmus covered by scales; premaxilla with 9, dentary with 10 or 11 teeth and no maxillary teeth. Lateral line with 34–37

pored scales; transversal series above lateral line with 4 scale rows and below with 3½–4 scale rows. Dorsal fin with 11, pectoral fin with 13 or 14, pelvic fin with 9, anal fin with 9 rays, and caudal fin with 18 or 19, total rays. Ground color pale yellow; dark-brown longitudinal stripe from humeral spot to caudal peduncle; 8 to 10 dark brown transversal bars on flank; black spot on the base of median caudal-fin rays; hyaline fins.

Family Curimatidae

***Cyphocharax modestus* (Fernández-Yépez, 1948)**

Curimatorbis modestus Fernández-Yépez 1948: 43, fig. 21 [original description].

Cyphocharax modestus—Graça and Pavanelli 2007: 31.

Material examined. Table 2, Figure 5O.

Deep body; terminal mouth; premaxilla, dentary and maxilla without teeth. Lateral line with 31–36 pored scales; transversal series above lateral line with 5½–7 scale rows and below with 4½–6 scale rows. Dorsal fin with 11 or 12, pectoral fin with 14–16, pelvic fin with 9 or 10, anal fin with 8 or 9 and caudal fin with 19, total rays (Vari 1992). Ground color silvery; dark brown inconspicuous longitudinal band along lateral line to distal margin of median caudal-fin rays, larger on caudal peduncle; hyaline fins.

***Steindachnerina brevipinna* (Eigenmann & Eigenmann, 1889)**

Curimatus gilberti brevipinnis Eigenmann and Eigenmann 1889: 424 [original description].

Steindachnerina brevipinna—Graça and Pavanelli 2007: 32, 33.

Material examined. Table 2; Figure 5P.

Elongated body; terminal mouth; premaxilla, dentary, and maxilla without teeth; palate with irregular glomerular projections. Lateral line with 33–37 pored scales; transversal series above lateral line with 5½–6½ scale rows and below with 4½–5½. Dorsal fin with 10–12, pectoral fin with 11–14, pelvic fin with 9, anal fin with 9 or 10, and caudal fin with 19, total rays (Vari 1991). Ground color silvery; black conspicuous longitudinal stripe along lateral line to distal margin of median caudal-fin rays, larger on caudal peduncle; yellowish fins; dorsal-fin black blotch on the base of median rays, sometimes little conspicuous.

Family Erythrinidae

***Hoplerythrinus unitaeniatus* (Agassiz, 1829)**

Hoplerythrinus unitaeniatus—Graça and Pavanelli 2007: 10, 102, 233.

Material examined. Table 2; Figure 5Q.

Elongated and cylindrical body; terminal mouth; premaxilla with 8–10, dentary with 35–38, and maxilla with 32–36 teeth. Lateral line with 35–39 pored scales; transversal series above lateral line with 3½ scale rows and below with 3 scale rows. Dorsal fin with 11, pectoral fin with 14 or 15, pelvic fin with 8, anal fin with 13 or 14, and caudal fin with 19, total rays. Brown ground color with dorsal regions darker than the ventral ones; dark brown rounded blotch on opercle; dark brown longitudinal band from opercle to caudal-fin base; dark fins; without adipose fin.

***Hoplias* sp. 3**

Hoplias sp. 3—Graça and Pavanelli 2007: 106.

Material examined. Table 2; Figure 5R.

Elongated body; terminal mouth; premaxilla with 8–10; dentary with 30–35; maxilla with 32–36 teeth. Lateral line with 40–42 pored scales; series between lateral lines with 113 scale rows. Dorsal fin with 13, pectoral fin with 13 or 14, pelvic fin with 8, anal fin with 8–11 rays and caudal fin with 19, total rays. Ground color pale brown; dark-brown longitudinal band, from opercle to caudal peduncle; several dark-brown irregular transversal bars. Fins with dark-brown spots, sometimes forming dark brown stripes parallel with fin base. This species is predatory to small fish. It lives in habitats structured mainly by macrophytes, exhibiting sedentary habits and parental care.

Family Lebiasinidae

***Pyrrhulina australis* Eigenmann & Kennedy, 1903**

Pyrrhulina australe Eigenmann and Kennedy 1903: 508 [original description].

Pyrrhulina australis—Graça and Pavanelli 2007: 107.

Material examined. Table 2; Figure 5S.

Elongated body; terminal mouth; inner row of premaxilla with 9–12 and outer row with 4–6 teeth, inner row of dentary with 8–12 and outer row with 4–5, and maxilla with 1 or 2 teeth. Lateral line absent; longitudinal series with 20–25 scales; transversal series with 6–8 scale rows. Dorsal fin with 9 or 10, pectoral fin with 11 or 12, pelvic fin with 9 or 10, anal fin with 10 or 11, and caudal fin with 19, total rays. Ground color pale brown; dark brown longitudinal stripe from the anterior portion of the dentary, through orbit, to opercle; yellowish fins; black irregular blotch on the dorsal fin. Some specimens can present few or many dark blotches on body.

Family Parodontidae

***Apareiodon affinis* (Steindachner, 1879)**

Parodon affinis Steindachner 1879: 20 [original description].

Apareiodon affinis—Graça and Pavanelli 2007: 26, 27.

Material examined. Table 2; Figure 5T.

Elongated body; subterminal mouth; premaxilla with 4 or 5, maxilla with 2 or 3 and dentary with no teeth. Lateral line with 39–46 pored scales; transversal series above lateral line with 4½ or 5 scale rows and below with 3 or 4½ scale rows. Dorsal fin with 10–13, pectoral fin with 11–14, pelvic fin with 7–9, anal fin with 7 or 8 rays and caudal fin with 18 or 19, total rays (Pavanelli 1999). Ground color silvery to pale yellow; black longitudinal band along lateral line, from opercle to median caudal-

fin rays, without adjacent dark blotches downwards; 6–8 dark brown transversal bars above longitudinal band; hyaline fins or with few scattered dark cromathophores.

***Parodon nasus* Kner, 1859**

Parodon nasus Kner 1859: 167, φig. 17 [original description]—Graça and Pavanelli 2007: 30; Bifi et al. 2017: 4, fig. 2.2.

Material examined. Table 2; Figure 5U.

Elongated body; subterminal mouth; premaxilla with 4, dentary with 2–4 and maxilla with 2 teeth. Lateral line with 35–39 pored scales; transversal series above lateral line with 4½ scale rows and below with 3 or 3½ scale rows. Dorsal fin with 11 or 12, pectoral fin with 13–16, pelvic fin with 8 or 9, anal fin with 8 or 9 and caudal fin with 19, total rays (Pavanelli 1999). Ground color pale brown dorsally and pale yellow ventrally; black longitudinal band along lateral line, from opercle to median caudal-fin rays, with projections upwards and downwards, conferring zigzag pattern; hyaline or yellowish fins.

Order Cyprinodontiformes
Family Poeciliidae

***Phalloceros harpagos* Lucinda, 2008**

Phalloceros sp. n—Lucinda and Reis 2005.
Phalloceros aff. *caudimaculatus*—Graça and Pavanelli 2007: 196.
Phalloceros harpagos Lucinda 2008: 134, 135; fig. 27 [original description]—Hoffmann et al. 2015: 4, fig. A5.A; Bifi et al. 2017: 4, fig. 2.27.

Material examined. Table 2; Figure 5V.

Elongated body; superior mouth, dentary prognathous; premaxilla and dentary with several small teeth. Longitudinal series with 26–32 scales and transversal series with 7–9 scale rows. Dorsal fin with 7–9, pectoral fin with 11–13, pelvic fin with 5 or 6, and anal fin with 8–10 (males) or 10–12 rays (females) (Lucinda 2008). Adult males with gonopodium. Ground color yellowish-brown; dark brown vertically elongated lateral spot; scales with dark brown border, conferring a reticulate pattern to the body.

Order Gymnotiformes
Family Gymnotidae

***Gymnotus inaequilabiatus* (Valenciennes, 1839)**

Carapos inaequilabiatus Valenciennes (1839): 14 [original description].
Gymnotus inaequilabiatus—Graça and Pavanelli 2007: 178, 179; Bifi et al. 2017: 4, 6, fig. 2.26.

Material examined. Table 2; Figure 5W.

Elongated and compressed body; superior mouth, dentary prognathous; one or two conical teeth on the premaxilla and dentary. Transversal series above lateral line with 6–8 scale rows. Pectoral fin with 13–16 and anal fin with 170–260, total rays. Ground color pale brown; body with light transversal bars alternating with dark brown transversal bars, visible in specimens with less than 250 mm total length (TL); in larger specimens stripes can be broken or disappear, resulting in color pattern with dark-brown rounded or irregular blotches, especially on dorsal region of body; dark-brown bars wider than light bars. Hyaline fins, with scattered dark-brown spots. Body with 21 or 22 pairs of obliquely dark bands from the tail tip to nape. Pectoral and anal fins are uniformly dark gray, and the posterior part of the anal fin is pale.

***Gymnotus pantanal* Fernandes, Albert, Daniel-Silva, Lopes, Crampton & Almeida-Toledo, 2005**

Gymnotus pantanal Fernandes et al. 2005: 4, Fig. 1 [original description]—Graça and Pavanelli 2007: 178, 180.

Material examined. Table 2

Elongated and subcilindrical body; superior mouth, dentary prognathous. Pectoral fin with 16–18 and anal fin with 256–270, total rays; transversal series above lateral line with 7 or 8 scale rows (Fernandes et al. 2005). Ground color brown; body with seven to 25 light transversal stripes, spaced apart; hyaline fins or light, with scattered dark brown spots.

Family Hypopomidae

***Brachyhypopomus* aff. *gauderio* Giora & Malabarba, 2009**

Brachyhypopomus sp.—Giora et al. 2008: 167.
Brachyhypopomus cf. *pinnicaudatus*—Graça and Pavanelli 2007: 188.
Brachyhypopomus gauderio Giora and Malabarba 2009: 63, 64, Figs. 1, 2 [original description].

Material examined. Table 2; Figure 5X.

Elongated and compressed body; terminal mouth. Pectoral fin with 14–17 and anal fin with 179–226, total rays; transversal series above lateral line with 7 or 8 scale rows (Giora and Malabarba 2009). Ground color varies from yellowish to pale brown; dorsal region and lower half of the body with dark brown transversal and irregular bars; anal fin is hyaline with dark brown spots.

Family Sternopygidae

***Eigenmannia guairaca* Peixoto, Dutra & Wosiacki, 2015**

Eigenmannia guairaca Peixoto et al. (2015): 394, Fig. 9 [original description].

Material examined. Table 2.

Elongated and compressed body; terminal mouth; premaxilla with 9 or 10 teeth distributed in two rows. Lateral line complete, with 110–143 pored scales; transversal series above lateral line with 9–11 scale rows. Pectoral fin with 12 or 13 and anal fin with 151–170, total rays (Peixoto et al. 2015). Ground color pale brown; four dark-brown longitudinal stripes on flank (one superior medial, one lateral line, one inferior medial and one at anal-fin base).

Order Cichliformes
Family Cichlidae

***Cichlasoma paranaense* Kullander, 1983**

Cichlasoma paranaense Kullander 1983: 241, Fig. 1 [original description]—Graça and Pavanelli 2007: 203; Bifi et al. 2017: 4, Fig. 2.29.

Material examined. Table 2; Figure 5Y.

Deep body; terminal mouth; premaxilla with 2 or 3 and dentary with 3 or 4 teeth rows. Upper lateral line with 14–17 pored scales, lower lateral line with 5–8 pored scales and longitudinal series with 22–23 scales. Transversal series above upper lateral with 2½–4 and below lower lateral line with 5–7 scale rows. Dorsal fin with XIII–XV, 10–15, pectoral fin with 12–13, pelvic fin with I,6 and anal fin with III, 8–10 total rays (Kullander 1983). Ground color iridescent green; dark brown transversal bars; dark-brown rounded blotch, slightly below upper lateral line; dark brown blotch on superior portion of caudal peduncle.

***Crenicichla britskii* Kullander, 1982**

Crenicichla britskii Kullander 1982: 642, fig. 7 [original description]—Graça and Pavanelli 2007: 204, 205; Bifi et al. 2017: 4, fig. 2.30.

Material examined. Table 2; Figure 5Z.

Elongated body; terminal mouth; premaxilla and dentary with arranged in several teeth rows. Upper lateral line with 20–22 pored scales, lower lateral line with 7–9 pored scales and longitudinal series with 33–40 scales. Transversal series above upper lateral with 3–4½ and below lower lateral line with 7–9 scale rows. Dorsal fin with XVI, 14–16, pectoral fin with 14 or 15, pelvic fin with I,5 and anal fin with III, 9–11 total rays (Kullander, 1983). Ground color greyish to greenish; dorsum with dark transversal bars; dark suborbital stripe; dark brown discontinuous longitudinal band, sometimes inconspicuous, from snout to caudal peduncle; black rounded humeral blotch; black rounded ocelli on caudal-fin base. Dorsal, anal and caudal fins with light spots; pectoral and pelvic fins yellowish or hyaline.

Order Siluriformes
Family Auchenipteridae

***Trachelyopterus galeatus* (Linnaeus, 1766)**

Parauchenipterus galeatus—Graça and Pavanelli 2007: 175.
Trachelyopterus galeatus—Costa et al. 2017: 44, fig. 2C.

Material examined. Table 2

Deep body; terminal mouth terminal with dentigerous tooth plates in both premaxilla and dentary. Dorsal fin with I,6, pectoral fin with I,7, pelvic fin with 7 or 8 and anal fin with 21–24, total rays. Adipose fin present. Ground color pale yellow to orange with several dark-brown irregular blotches as well as fins.

Family Callichthyidae

***Callichthys callichthys* (Linnaeus, 1758)**

Callichthys callichthys—Graça and Pavanelli 2007: 112; Hoffmann et al. 2015: 4, fig. A3.I.

Material examined. Table 2.

Elongated body; terminal mouth. Lateral line with 4 pores on upper series of plates. Dorsolateral series with 26–29 and ventrolateral series with 24–27 plates. Dorsal fin with I,7 or 8, pectoral with I,6, pelvic and anal fins with 6, total rays. Ground color pale brown to dark grey; dark fins with dark spots. Coracoid bone, between pectoral fins, covered by skin.

***Corydoras aeneus* (Gill, 1858)**

Hoplosoma aeneum Gill 1858: 403 [original description].
Corydoras aeneus—Graça and Pavanelli 2007: 113; Hoffmann et al. 2015: 4. fig. A3.J; Bifi et al. 2017: 4, fig. 2.19.

Material examined. Table 2.

Deep body deep and elliptical; inferior mouth. Lateral line with 4–6 pores on upper series of plates. Dorsolateral series with 20–23 and ventrolateral series with 19–22 plates. Dorsal fin with I,7 or 8, pectoral with I,8–10, pelvic fin with 6 and anal fin with 6–8, total rays. Ground color dark grey dorsally and yellowish ventrally; large dark regular spot in anterior region of flank; dark fins, without spots. Coracoid bones exposed; maxillary barbel short, not reaching pectoral-fin base; dorsal-fin spine approximately the same size as its first unbranched ray.

***Hoplosternum littorale* (Hancock, 1828)**

Callichthys littoralis Hancock 1828: 244, pl. 32, fig. 1 [original description].
Hoplosternum littorale—Graça and Pavanelli 2007: 115.

Material examined. Table 2.

Elongated body; terminal mouth. Lateral line with 4–6 pores on upper series of plates. Dorsolateral series with 25–27 and ventrolateral with 22–24 plates. Dorsal fin with I,7, pectoral with I,9 or 10, pelvic fin with 6 and anal fin with 8, total rays (Reis 1997). Ground color dark gray, lighter ventrally; dark fins. Coracoid bone exposed; maxillary barbel long, surpassing gill opening; dorsal-fin spine short, smaller than half of its first unbranched ray; caudal fin bifurcated; maxillary barbel not reaching pelvic-fin base.

Family Heptapteridae

***Imparfinis schubarti* (Gomes, 1956)**

Nannorhamdia schubarti Gomes 1956: 404, fig. 1 [original description].
Imparfinis schubarti—Graça and Pavanelli 2007: 142, 144.

Material examined. Table 2.

Elongated body; terminal mouth; premaxilla and dentary with several diminute and viliform teeth. Dorsal fin with 7, pectoral fin with 8–11, pelvic fin with 6 and anal fin with 11–14, total rays. First dorsal fin ray shorter than the second one; adipose-fin base short, not extending to caudal fin. Ground color beige; few scattered dark brown on body, except on ventral region of head and abdomen; dark brown transversal bars on dorsum; dark brown conspicuous longitudinal stripe along lateral line; yellowish or hyaline fins.

***Pimelodella avanhandavae* Eigenmann, 1917**

Pimelodella avanhandavae Eigenmann 1917: 240, pl. 29; fig. 3 [original description]—Graça and Pavanelli 2007: 145, 146.

Material examined. Table 2; Figure 5A′.

Elongated body; terminal mouth; premaxilla and dentary with several small and villiform teeth. Dorsal fin with I,6; pectoral fin with I,9 or 10; pelvic fin with 6 and anal fin with 12–14, total rays. Ground color beige; 2 dark brown longitudinal bands, 1 along the lateral line and another slightly below the dorsal fin; light fins.

***Pimelodella gracilis* (Valenciennes, 1835)**

Pimelodus gracilis Valenciennes 1835: pl. 2, fig. 5 [original description].

Pimelodella gracilis—Graça and Pavanelli 2007: 145, 147; Hoffmann et al. 2015: 4, fig. A3.B.

Material examined. Table 2.

Elongated body; terminal mouth; premaxilla and dentary with several diminute and viliform teeth. Dorsal fin with I,6, pectoral fin with I,9 or 10, pelvic fin with 6 and anal fin with 12–14, total rays. Ground color beige; dark brown longitudinal band along lateral line; light fins.

***Rhamdia quelen* (Quoy & Gaimard, 1824)**

Rhamdia quelen—Graça and Pavanelli 2007: 149; Hoffmann et al. 2015: 4, fig. A3.C; Bifi et al 2017: 4, fig. 2.16.

Material examined. Table 2.

Elongated body; terminal mouth; premaxilla and dentary with several diminute and viliform teeth. Dorsal fin with 7, pectoral fin with 8–10, pelvic fin with 6 and anal fin with 14–15, total rays. Ground color beige to brown; some specimens can present scattered dark brown chromatophores on body; dark fins.

Family Loricariidae

***Farlowella hahni* Meinken, 1937**

Farlowella hahni Meinken 1937: 77, fig. 2 [original description].

Farlowella aff. *amazona*—Graça and Pavanelli 2007: 119.

Material examined. Table 2.

Depressed body; inferior mouth; premaxilla with 15–17 and dentary with 13–18 teeth. Mid-lateral series with 32, predorsal series with 7, series between pectoral and pelvic fins with 5 and abdomen series with 3 plates. Dorsal and pectoral fins with I,6, pelvic fin with i,4 or 5 and anal with 6, total rays. Ground color brown; dark brown longitudinal band from base of snout to caudal peduncle; hyaline fins with few dark brown spots, caudal fin with discontinuous dark brown longitudinal band in upper lobe.

***Hypostomus iheringii* (Regan, 1908)**

Plecostomus iheringii Regan 1908: 795, pl. 47, fig. 1 [original description].

Hypostomus sp.—Graça and Pavanelli 2007: 136.

Material examined. Table 2.

Deep body; inferior mouth; teeth bifid; premaxilla with 32–41 and dentary with 35–42 teeth. Mid-lateral series with 24–27 plates, predorsal series with 3, and dorsal-fin base series with 8 plates. Dorsal fin with I,7, pectoral fin with I,6, pelvic fin with i,5, and anal fin with 6, total rays. Ground color brownish; dark brown blotches, occasionally inconspicuous.

***Hyspostomus ancistroides* (Ihering, 1911)**

Plecostomus ancistroides Ihering 1911: 396 [original description].

Hypostomus ancistroides—Oyakawa et al. 2005: 4, 10, 11, 12; fig. 4; Graça and Pavanelli 2007: 126, 128; Hoffmann et al. 2015: 4, fig. A4.C; Bifi et al. 2017: 4, fig. 2.22.

Material examined. Table 2; Figure 5B′.

Deep body; inferior mouth; teeth bifid; premaxilla with 24–33 and dentary with 23–35 teeth. Mid-lateral series with 27 or 28 plates, predorsal series with 3, and dorsal-fin base series with 8 or 9 plates. Dorsal fin with I,7; pectoral fin with I,6; pelvic fin with i,5; and anal fin with 6, total rays. Brown ground color; dark brown blotches on body, especially on the dorsal region; dark fins with dark brown spots.

***Hypostomus strigaticeps* (Regan, 1908)**

Plecostomus strigaticeps Regan 1908: 796, pl. 48, fig. 1 [original description].

Hypostomus cf. *strigaticeps*—Graça and Pavanelli 2007: 126, 134.

Hypostomus strigaticeps—Hoffmann et al. 2015: 4, fig. A4.E; Bifi et al. 2017: 4, fig. 2.23.

Material examined. Table 2.

Deep body; inferior mouth; teeth bifid; premaxilla with 49–54 and dentary with 49–55 teeth. Mid-lateral series with 24–26 plates, predorsal series with 3, and dorsal-fin base series with 8 plates; abdomen with plates concentrated on its central portion. Dorsal fin with I,7, pectoral fin with I,6, pelvic fin with i,5 and anal fin with 6, total rays. Ground color brown; light blotches on body, smaller on head; dark fins with light spots.

***Otothyropsis polyodon* Calegari, Lehmann & Reis, 2013**

Otothyropsis polyodon Calegari et al. 2013: 133, fig. 3 [original description].

Material examined. Table 2, Figure C′.

Elongated body; inferior mouth; premaxilla and dentary with 14–21 teeth. Lateral line series with 24 or 25 plates. Dorsal fin with I,7, rarely 8, pectoral fin with I,6, pelvic fin with 6 and anal fin with 6, total rays (Calegari et al. 2013). Ground color brown; dark brown longitudinal stripe from snout to caudal fin; hyaline fins, with dark brown spots; upper caudal-fin lobe with dark brown spot close to its tip; lower caudal-fin lobe dark, with hyaline portion on its lower portion, frequently with small dark brown spots.

***Rineloricaria* sp.**

Rineloricaria sp.—Graça and Pavanelli 2007: 124.

Material examined. Table 2, Figure D′.

Depressed body; inferior mouth; premaxilla and dentary with 6 teeth. Mid-lateral series with 28 plates. Dorsal fin with I,7, pectoral fin with I,6, pelvic fin with i,5 and anal with 6 total rays. Ground color brownish; dark brown transversal bars on flank; hyaline fins with few dark brown spots, sometimes forming irregular stripes.

Discussion

The taxonomic composition of the 3 studied streams was not different from the pattern described for the South America freshwater fish fauna, given the predominance of Characiformes and Siluriformes orders (Albert et al. 2011, Hulsey and López-Fernández 2011), which included 83% of the captured species. In addition, the record of 18 of the 34 families listed by Buckup (1999) for Brazilian streams draws attention to the high richness of the Iguatemi river fish fauna, considering that only 3 streams were sampled. The families with the highest number of species in our study (Characidae, Heptapteridae, and Loricariidae) were also reported by Langeani et al. (2007) as the most species-rich in the upper Paraná river basin. Similarly, several studies have indicated the prevalence of these families in other streams of this basin (Casatti et al. 2001, Cunico et al. 2009, Súarez and Lima-Júnior 2009, Felipe and Súarez 2010, Pereira et al. 2014, Frota et al. 2016, Bifi et al. 2017). In addition, the most representative species in number of individuals, *P. harpagos*, *A.* aff. *paranae*, *H. ancistroides*, *G. inaequilabiatus*, and *K. moenkhausii*, were also numerically important in other surveys conducted in streams of the upper Paraná river basin (Casatti et al. 2001, Castro et al. 2004, Casatti 2005, Ferreira 2007, Daga et al. 2012, Mendonça et al. 2014).

It is also important to emphasize that the species richness of Água Boa and Santa Maria streams (both with 31 species) are well above those recorded in other streams of the upper Paraná river basin (see Casatti 2004, Rocha et al. 2009, Felipe and Súarez 2010), even including pristine streams (see Casatti et al. 2001). This finding once again highlights the role of the Iguatemi river basin in harboring a diverse fish fauna in its streams. In fact, the number of species recorded in the three streams inventoried here, accounts for 29% of the representativeness of ichthyofauna of the upper Paraná River floodplain presented by Graça and Pavanelli (2007), and 15% of the species of the Mato Grosso do Sul state recorded by Froehlich et al. (2017). Therefore, we advocate that the sampled area is intimately associated with maintaining the biodiversity of fish species in the floodplain, serving as refuges, and encompassing a good percentage of fish species of the state within a small area.

The high fish species richness of streams could be related to 3 main factors. The first concerns about the small body size of individuals inhabiting streams; the speciation rate is assumed to be inversely related to body size (Marzluff and Dial 1991, Brown 1995). These habitats may contain more niches for small organisms than large ones; therefore, in principle, small-bodied species would be less prone to extinction (Purvis et al. 2003). The second factor is related to the environmental complexity of streams (Castro et al. 2003, Copatti and Copatti 2011) as the mosaic of pools, runs, and riffles clearly delimit different combinations of flow, depth, and substrate (Angermeier and Schlosser 1989); thus, it is expected that every mesohabitat hold unique species given the resources and conditions available. The third factor has to do with the degree of conservation of riparian vegetation, as fish species richness is positively associated with surrounding vegetation integrity (Ferreira and Casatti 2006). The deleterious effects caused by the removal of this vegetation bordering streams include: increased solar radiation and consequent rise in water temperature, reducing fish tolerance to toxic gases such as ammonia; development of toxic Cyanophyceae; the silting-up of the bed; reduced leaf, trunk, and branch inputs that shelter and provide substrate for the development of organisms consumed by the fish (Pusey and Arthington 2003, Casatti 2010). These impacts can substantially alter the composition and abundance of fish assemblages inhabiting streams (Agostinho et al. 2007, Casatti et al. 2010). Whereas the riparian vegetation surrounding these streams is poor, due to anthropogenic action, the fish assemblages may already be under such deleterious effects.

This conception of constancy of species can illustrate the spatial occupation of fish assemblages (Begon et al. 2007), discriminating migrant and resident populations (Dajoz 1983, Langeani et al. 2005). The greatest number of accessory and occasional species recorded in Água Boa and Santa Maria suggests a high exchange of species between these streams and Iguatemi River, as long as fish may use these environments in the search for resources. Súarez and Petrere-Júnior (2006) drew similar inferences for Jogui region, Iguatemi river basin and Viana et al. (2013) for Bonito region, Ivaí river basin.

In addition, the fish fauna of the sampled streams was primarily composed of autochthonous species, following the pattern described for the species of the upper Paraná River (Langeani et al. 2007). Regarding the 5 allochthonous species, we may report that *K. moenkhausii* and *S. brevipinna* reached the upper Paraná river basin after the construction of Itaipu Reservoir (Júlio-Júnior et al. 2009). In turn, *B.* aff. *gauderio* and *H. unitaeniatus* were introduced by fishing activities, possibly as live bait, while the origin of *G. inaequilabiatus* in the basin is unknown (Langeani et al. 2007). Therefore, the presence of these 5 species in the streams highlights their dispersal abilities and success in the occupation of low order rivers.

In general, our study shows that streams of the lower portion of the Iguatemi river basin encompass a diverse fish fauna, in contrast to the anthropogenic impacts affecting the microbasins. This calls the attention to the urgency of primary management measures in the studied microbasins, such as the implementation and/or extension of soil conservation practices and riparian vegetation restoration, to help the maintenance of fish populations.

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Authors' Contributions

All authors contributed to the drafting and editing of the manuscript. AF took the photographs. WJG identified the specimens. VFBS, EALK, and MCFA participated in the data collection.

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