Checklist and key for the identification of fish fauna of the Uberaba River, Upper Paraná River system, Brazil

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Abstract
The Uberaba River is an important right-bank tributary to the Grande River, in the Upper Paraná River system, Brazil, and the main water source for the public supply of the Uberaba city, Minas Gerais state. An inventory, an identification key, and photographs of the fish species of the Uberaba River are provided, based on samples made between 2012 and 2014 at 14 sampling sites in the river system. A total of 73 species was recorded from six orders, 20 families, and 49 genera. Characiformes and Siluriformes are the most speciose orders and Characidae and Loricariidae are the most commonly recorded families. Most species are autochthonous, nine are considered allochthonous, and two species are exotic. The Uberaba River has a diverse and heterogeneous ichthyofauna, typical of rheophilic environments, with endemic species and few non-native species.

Keywords
Brazilian Cerrado, freshwater fish, Neotropical Region, rheophilic environment, threatened species
Introduction

Approximately 34,797 species of fish have been formally described worldwide (Fricke et al. 2018), and recent estimates suggest that ca. 13,000 species are partially or exclusively freshwater (Nelson 2016). The Neotropical region has a unique and diverse freshwater fish fauna (Albert and Reis 2011), with 9,100 species exclusively distributed in South America (Reis et al. 2016), an impressive number when compared to the global estimates. Approximately 43% of the Neotropical fish diversity occurs in Brazil (Buckup et al. 2007), and the Amazon and La Plata river drainages bear the largest fish diversity in South America (Langeani et al. 2007).

With geological origin dating from the Mesozoic (Neocretaceous), the La Plata River has an estimated drainage area of ca. 3 million km² across five countries, Bolivia, Brazil, Paraguay, Argentina, and Uruguay, and is the second largest drainage in South America, with the main drainages the Paraná-Paraguay drainage and Uruguay River (Albert and Reis 2011). The Upper Paraná River system is a catchment above the Sete Quedas Falls, currently flooded by the Itaipu hydroelectric dam, located at the border between Brazil, Paraguay, and Argentina. In the Brazilian portion, the Upper Paraná River system drains the states of Goiás, Minas Gerais, São Paulo, Mato Grosso do Sul, and Paraná, comprising the subsystems of the Grande, Paranaíba, Tietê, and Paranapanema rivers (Souza-Filho and Stevaux 1997; Langeani et al. 2007).

The Upper Paraná River, according to Langeani et al. (2007), harbors approximately 360 of fish species. Subsequently, Fagundes et al. (2015) provide 46 new records for this system. Additionally, at least 28 new species have been described since the last twenty years (e.g., Silveira et al. 2008; Martins and Langeani 2011a, 2011b; Carvalho and Langeani 2013; Serra and Langeani 2015). The increased number of species recorded in the Upper Paraná River in the last decade reflects intense sampling carried out in the region. Some authors (e.g., Langeani et al. 2007; Oyakawa and Menezes 2011) report that the Upper Paraná River is among the most well-sampled Brazilian regions, especially the São Paulo state (Oyakawa and Menezes 2011), and is one of the most impacted by dams, which considerably altered the hydrological regime and natural environments, affecting the dynamics and recruitment in fish populations (Agostinho et al. 2004). Fagundes et al. (2015) carried out intense samplings in tributaries of the Paranaíba, Araguari, and Grande rivers in the state of Minas Gerais, northwest, east, and southeast of the Triângulo Mineiro region, contributing significantly to the knowledge on local fish faunas. However, despite the recent contributions to the Upper Paraná River system, some areas were poorly sampled (e.g., south and southwest of the Triângulo Mineiro region, northeast and south parts of the Minas Gerais state, most of the Mato Grosso do Sul and Goiás states) and information on fish fauna composition and distribution is still missing.

The Uberaba River is a right-bank tributary of the Grande River, in the Upper Paraná River system, Brazil, and it is the main water source for Uberaba city in Minas Gerais state. In the driest period, the water level of the Uberaba River is very low and it is not able to be the only source of public water supply to the Uberaba city. This problem becomes worse with the intensive anthropogenic impact on the environment which results in modifications of hydrological dynamics and associated biotic struc-
tures (Candido et al. 2010; Cruz 2003; Valera et al. 2016). A dam located in the middle section of the Uberaba River, designed to capture and treat water for human consumption, significantly altered the natural characteristics and self-depuration capacity of the river (Sousa et al. 2016), even more aggravated by the high loads of raw sewage released into some river sections (Cruz 2003).

The fish fauna of the Uberaba River is only partially known, with only few sections sampled and no seasonal investigations (see SEMEA 2004; Souza et al. 2016). In this paper, we present an inventory of the fish fauna of the Uberaba River based on samples from several sections of the river system. In addition, an identification key and photographs of some species are presented.

Materials and methods

Study area

The Uberaba River catchment area is located in the southeastern region of Minas Gerais state, Brazil, center-south of the Triângulo Mineiro region, 19°30’37”S – 20°07’40”S; 47°39’2”W – 48°34’34”W (Figure 1). The Uberaba River system covers an area of approximately 2,428.73 km² and is subordinated to the “Comité da Bacia Hidrográfica dos Afluentes Mineiros do Baixo Rio Grande (CBH-GD)”. The Uberaba River extends for 184.90 km, with a gap of approximately 554 m, and is supplied by 86 tributaries of diverse orders along its course. Its headwaters are located east of the municipality of Uberaba-MG, a hydromorphic field along the BR-262 road, at 1,014 m of altitude. The Uberaba River discharges in the right side of the Grande River in the municipality of Planura, Minas Gerais state, at 460 m of altitude (CODAU 2005). Along its route, the Uberaba River crosses five municipalities, Uberaba (1,198.75 km²), followed by Conceição das Alagoas (643.19 km²), Veríssimo (568.65 km²), Planura (33.39 km²), and Campo Florido (4.59 km²) (IGAM 2010).

The average annual precipitation in the region ranges between 1,300 mm and 1,700 mm, characterized by a rainy period of six to seven months (October to March) and the driest period (April to September) with less than 60 mm. The thermal regime is defined by an average annual temperature ranging from 20 to 24°C Celsius, with a minimum of 18°C in colder months (June/July). These climatic factors characterize two major seasons in the region, one, cold and dry, between autumn and winter, and the other, hot and rainy, between spring and summer (Gomes et al. 1982).

Data

The collections were carried out between 2012 and 2014 in 14 sampling sites (Figures 1, 2; Table 1) along the entire system. Permission for collecting was provided by IEF / DPBIO / GPFF No.44551-1156-2011. The samplings were performed both during the daytime and nighttime, using gill nets (2.5 to 120 mm mesh), dip nets (0.5 mm
Figure 1. Map of the Uberaba River drainage. A Upper Paraná River system highlighted in the Neotropical region B location of the Uberaba River drainage in the Upper Paraná River system C red triangles showing the sampling sites in the Uberaba River.

mesh), seines (1.5 mm mesh), and cast nets (2.5 to 100 mm mesh sizes). After sampling, the specimens were anesthetized in a solution containing 100 mg of eugenol by L⁻¹ previously dissolved in 100% ethanol in proportion of 1:1 v/v, fixed in 10% formalin buffered with sodium phosphate (pH 7.0 and 0.2 Mol) for 24 to 72 hours, and then transferred to 70% G.L. ethanol.

Specimens were identified using appropriate literature sources (e.g., Langeani et al. 2007; Langeani and Rêgo 2014; Castro et al. 2004; Ota et al. 2018) or by direct comparisons with specimens in museum collections. Vouchers are in the DZSJRP fish collection of the Departamento de Zoologia e Botânica do Instituto de Biociências, Letras
Figure 2. Sampling sites in the Uberaba River, Upper Paraná River system, Brazil. Detailed description of sites in Table 1.

e Ciências Exatas, Universidade Estadual Paulista 'Júlio de Mesquita Filho', São José do Rio Preto, SP, Brazil. Some groups are in need of a taxonomic revision, consequently the particle aff. (meaning “not the referred species, but very similar”) is used. The morphometric measurements were taken on the left side of the body, using a digital caliper with an accuracy of 0.01 mm. Lower-level taxonomy and species names follow Fricke et al. (2018) and suprageneric taxonomic groups are those listed in Betancur et al. (2017), except for Cynolebiidae and Bryconidae that follow van der Laan (2016). Allochthonous species are those with their origins from any other hydrographic system in South America outside the Upper Paraná River as defined above. Exotic species are those with origins from any other continent.
Table 1. Description of sampling sites (S1 to S14) of the Uberaba River, Upper Paraná River system, Brazil.

| Site | Locality | Coordinates | Elevation | Characteristics |
|------|----------|-------------|-----------|-----------------|
| S1   | Serra do Grotão, headspring of the Uberaba River, on the margins of BR 262, Ponte Alta, MG | 19.40575S; 47.405430W | 1015 | Lentic environment; organic sediment and sand as substrate; clear and warm water, 1 m deep; abundant aquatic plants |
| S2   | Small stream (no name), unpaved road at BR262, tributary of Veríssimo River, Veríssimo, MG | 19.39538S; 48.181390W | 622 | Lotic environment, medium flow; clay as substrate; shallow water, less than 80 cm deep; few marginal plants |
| S3   | Small stream (no name), unpaved road at Mula Preta farm, tributary of the Lageado River, Uberaba, MG | 19.45312S; 47.484494W | 715 | Medium flow stream; sand and clay as substrate; turbid water; less than 1.5 m deep; riparian vegetation and open areas |
| S4   | Small stream (no name), into APP Vale encantado, tributary of the Saudade stream, Uberaba, MG | 19.33573S; 47.534852W | 901 | Lentic environment; organic sediment and sand as substrate; clear and warm water; 0.5 m depth; few aquatic plants |
| S5   | Alegria stream, unpaved road at Alegria farm, tributary of the Uberaba River, Uberaba, MG | 19.40224S; 47.522022W | 803 | Lotic environment, medium flow; clay soil as a substrate; shallow and turbid water, 1 m depth; dense riparian forest and pasture area |
| S6   | Small stream (no name), Rocinha farm, unpaved road at Pará Pereira Gomes road, tributary of the Lageado stream, Uberaba, MG | 19.41135S; 47.542032W | 778 | Lotic environment, medium flow; sand and leaves as substrate; shallow and crystalline waters, 30 cm deep; riparian forest sparse |
| S7   | Uberaba River, below of the PCH Monjolo, Veríssimo, MG | 19.41466S; 48.113035W | 632 | Lotic environment, fast flowing, several rapids and small backwaters, basaltic rocks and sand as substrate, riparian vegetation well preserved. |
| S8   | Uberaba River, Conceição das Alagoas, MG | 19.54288S; 48.23155W | 495 | Lotic environment, fast flowing, several rapids and small backwaters, basaltic rocks and sand as substrate, riparian vegetation well preserved, urban effluent present. |
| S9   | Ribeirão das Alagoas stream (or Eliezer stream), Eliezer farm, unpaved road at MG427, Conceição das Alagoas, MG | 19.58451S; 48.274545W | 495 | Medium-flow lotic environment; sand and clay as substrate; turbid waters, 1.5 m deep; degraded area |
| S10  | Small stream (no name), unpaved road at a sanitary landfill, tributary of the Uberaba River, Conceição das Alagoas, MG | 19.55268S; 48.233689W | 507 | Lotic environment, low flow, clay soil as a substrate, very shallow water, less than 30 cm deep; few marginal plants, very degraded area |
| S11  | Small stream (no name), 0.7 km at IFTM campus, affluent of the Uberaba River, Uberaba, MG | 19.67431S; 47.974856W | 779 | Medium flow stream, gravel and basaltic rocks as substrate; crystalline waters, 1 m deep, dense riparian vegetation |
| S12  | Uberaba River, Carijó farm, 4.5 km upstream from Gorfo waterfall, Conceição das Alagoas, MG | 19.92382S; 48.404833W | 490 | Lotic environment, fast flow, several rapids, basaltic rocks and gravel as a substrate, well preserved riparian vegetation, urban effluent present. |
| S13  | Ribeirão das Alagoas stream (or Eliezer stream), near the confluence with the Uberaba River, Conceição das Alagoas, MG | 19.97009S; 48.384722W | 506 | Lotic environment, medium flow, sand and clay as substrate, large basaltic rocks, turbid water, 1 m depth, degraded riparian vegetation |
| S14  | Small stream (no name), unpaved road at Conceição das Alagoas city, tributary of the Uberaba River, Conceição das Alagoas, MG | 19.91363S; 48.375123W | 516 | Lotic environment, low flow, loam and sand as substrate; shallow water, 70 cm deep; many marginal grasses, degraded area |
Results

In total, 2,722 specimens were collected and assigned to 49 genera and 73 species. The identified taxa are listed in Table 2. Most of the species in the Uberaba River are autochthonous (80.0%). Nine species (12.3%) have been recognized as allochthonous (Galeoccharax gulo (Cope), Metynnis lippincottianus (Cope), Knodus aff. moenkhausii (Eigenmann & Kennedy), Hoplerythrinus unitaeniatus (Spix & Agassiz), Gymnotus inaequilabiatus (Valenciennes), Trichomycterus brasiliensis Lütken, Megalechis thoracata (Valenciennes), Poecilia reticulata Peters, and Cichla piquiti Kullander & Ferreira), and only two (2.7%) species are exotic (Coptodon rendalli (Boulenger) and Oreochromis niloticus (Linnaeus)). Six orders were recognized, of which Characiformes and Siluriformes were the most representative (90.3%), with eight families and 33 species for the former and five families and 27 species for the latter. Gymnotiformes (two families and three spp.), Cichliformes (one family and seven spp.), Cyprinodontiformes (two families and three spp.), and Synbranchiformes (one sp.) together represent 9.7% of the groups collected (Figure 3). Characidae (48.8%) and Loricariidae (16.8%) correspond to the most abundant families (Figure 4) and occur

![Figure 3](image-url). Species richness for each fish order collected in Uberaba River, Upper Paraná River system, Brazil.

![Figure 4](image-url). Species richness of each fish family collected in Uberaba River, Upper Paraná River system, Brazil.
**Table 2.** List of fish species from the Uberaba River, Upper Paraná River system, Brazil. Vouchers and origin/status are provided.

| Taxa                        | Voucher                  | Origin         |
|-----------------------------|--------------------------|----------------|
| **CHARACIFORMES**           |                          |                |
| **Anostomidae**             |                          |                |
| 1 Leporinus amblyrhynchus   | DZSRP15809               | Autochthonous  |
| 2 Leporinus friderici       | uncataloged              | Autochthonous  |
| 3 Leporinus octofasciatus   | DZSRP16097               | Autochthonous  |
| 4 Leporinus striatus        | DZSRP21396               | Autochthonous  |
| 5 Schizodon nasutus         | DZSRP21388               | Autochthonous  |
| **Bryconidae**              |                          |                |
| 6 Brycon nattereri          | DZSRP17489               | Autochthonous/VU|
| **Characidae**              |                          |                |
| 7 Astyanax bockmanni        | DZSRP15819               | Autochthonous  |
| 8 Astyanax aff. fasciatus   | DZSRP15818               | Autochthonous  |
| 9 Astyanax lacustris        | DZSRP21399               | Autochthonous  |
| 10 Astyanax aff. paranae    | DZSRP17486               | Autochthonous  |
| 11 Astyanax paranae         | DZSRP15823               | Autochthonous  |
| 12 Bryconamericus turiuba   | DZSRP05533               | Autochthonous  |
| 13 Galeochromis gulo        | DZSRP16096               | Allochthonous  |
| 14 Hasemanua uberaba        | DZSRP18781               | Autochthonous  |
| 15 Hypsibrycon uaiso         | DZSRP18783               | Autochthonous  |
| 16 Knodus aff. moenkhauisi   | DZSRP15825               | Allochthonous  |
| 17 Oligosarcus pintoi       | DZSRP05553               | Autochthonous  |
| 18 Piabarchus stramineus    | DZSRP21383               | Autochthonous  |
| 19 Piabina argentea         | DZSRP17487               | Autochthonous  |
| **Serrasalmidae**           |                          |                |
| 20 Metynnis lippincottianus | DZSRP21397               | Allochthonous  |
| 21 Myloplus tiete           | DZSRP21398               | Autochthonous/EN|
| 22 Serrasalmus maculatus    | DZSRP21386               | Autochthonous  |
| **Curimatidae**             |                          |                |
| 23 Steindacherina insculpta | DZSRP15812               | Autochthonous  |
| **Erythrinidae**            |                          |                |
| 24 Hoplerythrinus unitaeniatus | DZSRP21402             | Allochthonous  |
| 25 Hoplias intermedius      | DZSRP21389               | Autochthonous  |
| 26 Hoplias aff. malabaricus | DZSRP10546               | Autochthonous  |
| **Parodontidae**            |                          |                |
| 27 Apareiodon affinis       | DZSRP21391               | Autochthonous  |
| 28 Apareiodon ibitiensis    | DZSRP15813               | Autochthonous  |
| 29 Apareiodon pinacicae     | DZSRP16100               | Autochthonous  |
| 30 Parodon nasus            | DZSRP21400               | Autochthonous  |
| **Crenuchidae**             |                          |                |
| 31 Characidium aff. zebra   | DZSRP17484               | Autochthonous  |
| 32 Crenuchidae              | DZSRP15806               | Autochthonous  |
| **Prochilodontidae**        |                          |                |
| 33 Prochilodus lineatus     | DZSRP21385               | Autochthonous  |
| **GYMNOTIFORMES**           |                          |                |
| **Sternopygidae**           |                          |                |
| 34 Eigenmannia trilineata   | DZSRP21392               | Autochthonous  |
| **Gymnotidae**              |                          |                |
| 35 Gymnotus inaequilabiatus | uncataloged              | Allochthonous  |
| 36 Gymnotus sylvius         | DZSRP16101               | Autochthonous  |
### Checklist and Key for the Identification of Fish Fauna of the Uberaba River

| Taxa                                      | Voucher       | Origin                  |
|-------------------------------------------|---------------|-------------------------|
| **SILURIFORMES**                          |               |                         |
| **Callichthyidae**                        |               |                         |
| 37 Aspidoras fuscoguttatus Nijssen & Isbrücker, 1976 | DZJRP18785   | Autochthonous           |
| 38 Corydoras diffusivittis Britto & Castro, 2002 | DZJRP15824   | Autochthonous           |
| 39 Megalechis thoracata (Valenciennes, 1840) | DZJRP21106   | Autochthonous           |
| **Heptapteridae**                         |               |                         |
| 40 Imparfinis borodini Mees & Cala, 1989  | DZJRP17488   | Autochthonous           |
| 41 Pimelodella avanhandavae Eigenmann, 1917 | DZJRP21105   | Autochthonous           |
| 42 Rhamdia quelen (Quoy & Gaimard, 1824)  | DZJRP16799   | Autochthonous           |
| 43 Rhamdia sp.                            | DZJRP15817   | Autochthonous           |
| **Loricariidae**                          |               |                         |
| 44 Curculionichthys insperatus (Britski & Garavello, 2003) | DZJRP21120   | Autochthonous           |
| 45 Hypostomus albopunctatus (Regan, 1908) | DZJRP21390   | Autochthonous           |
| 46 Hypostomus anciestroides (Ihering, 1911) | DZJRP15810   | Autochthonous           |
| 47 Hypostomus butantanis (Ihering, 1911)  | DZJRP16098   | Autochthonous           |
| 48 Hypostomus fluviatilis (Schubart, 1964) | DZJRP21114   | Autochthonous           |
| 49 Hypostomus aff. hermanni (Ihering, 1905) | DZJRP21107   | Autochthonous           |
| 50 Hypostomus marginifer (Regan, 1908)    | DZJRP20107   | Autochthonous           |
| 51 Hypostomus nigromaculatus (Schubart, 1964) | DZJRP16103   | Autochthonous           |
| 52 Hypostomus aff. paulinus (Ihering, 1905) | DZJRP21108   | Autochthonous           |
| 53 Hypostomus regani (Ihering, 1905)      | DZJRP21124   | Autochthonous           |
| 54 Hypostomus striaticeps (Regan, 1908)   | DZJRP21125   | Autochthonous           |
| 55 Hypostomus topawe (Godoy, 1969)        | DZJRP21098   | Autochthonous           |
| 56 Loricaria lentiginosa Isbrücker, 1979  | uncataloged | Autochthonous           |
| 57 Microlepdogaster dimorpha Martins & Langeani, 2012 | DZJRP18784   | Autochthonous           |
| 58 Proloricaria prolaxa (Isbrücker & Nijssen, 1978) | DZJRP16102   | Autochthonous           |
| 59 Rineloricaria latirostris (Boulenger, 1900) | DZJRP15811   | Autochthonous           |
| **Trichomycteridae**                      |               |                         |
| 60 Trichomycterus brasiliensis Lütken, 1874 | DZJRP21116   | Allochthonous           |
| 61 Trichomycterus candidus (Miranda-Ribeiro, 1949) | DZJRP15820   | Autochthonous           |
| **Auchenipteridae**                       |               |                         |
| 62 Tatia neivai (Ihering, 1930)           | DZJRP21111   | Autochthonous           |
| **CYPRINODONTIFORMES**                    |               |                         |
| **Cynolebiidae**                          |               |                         |
| 63 Melanorivulus giarettai Costa, 2008    | DZJRP18782   | Autochthonous           |
| **Poeciliidae**                           |               |                         |
| 64 Phalloceros harpagos Lucinda, 2008     | DZJRP17485   | Autochthonous           |
| 65 Poecilia reticulata Peters, 1859       | DZJRP17483   | Allochthonous           |
| **CICHLIFORMES**                          |               |                         |
| **Cichlidae**                             |               |                         |
| 66 Cichla piquiti Kulander & Ferreira, 2006 | DZJRP21401   | Allochthonous           |
| 67 Cichlasoma paranaense Kulander, 1983   | DZJRP21394   | Autochthonous           |
| 68 Captodon rendalli (Boulenger, 1897)    | DZJRP05549   | Exotic                 |
| 69 Crenicichla britskii Kulander, 1982    | DZJRP21393   | Autochthonous           |
| 70 Crenicichla jaguarensis Haseman, 1911  | DZJRP21387   | Autochthonous           |
| 71 Geophagus brasiliensis (Quoy & Gaimard, 1824) | DZJRP21395   | Autochthonous           |
| 73 Oreoichthys niloticus (Linnaeus, 1758)  | uncataloged  | Exotic                 |
| **SYNBRANCHIFORMES**                      |               |                         |
| **Synbranchidae**                         |               |                         |
| 73 Synbranchus marmoratus Bloch, 1795     | DZJRP21384   | Autochthonous           |
### Table 3. Species collected (X) in each site (S1 to S14) of the Uberaba River, Upper Paraná River system, Brazil.

| Species                                              | Sites          |
|------------------------------------------------------|---------------|
| Apareiodon affinis                                   | X X X X       |
| Apareiodon ibitiensis                                | X X X X       |
| Apareiodon piracicabae                               | X X X X       |
| Aspidoras fuscoguttatus                               | X X           |
| Astyanax bockmanni                                   | X X X X       |
| Astyanax aff. fasciatus                              | X X X X       |
| Astyanax lacustris                                    | X X X X       |
| Astyanax paranae                                      | X X X X       |
| Astyanax aff. paranae                                 | X             |
| Brycon nattereri                                      | X X           |
| Bryconamericus turiba                                | X X           |
| Characidium aff. zebra                                | X X           |
| Cichla piquiti                                        | X             |
| Cichlasoma paranase                                   | X X X X       |
| Coptodon rendalli                                     | X             |
| Corydoras diluviatilis                               | X X           |
| Crenicichla britskii                                  | X             |
| Crenicichla jaguarensii                               | X             |
| Crenuchidae (undescribed genus and species)           | X             |
| Curelioniichthys insperatus                           | X             |
| Eigenmannia trilineata                                | X             |
| Galeocaraux gulo                                      | X             |
| Geophagus brasiliensis                                | X X X X       |
| Gymnotus inaequaliatus                                | X             |
| Gymnotus sylvis                                       | X X X X       |
| Hasemania uberaba                                     | X             |
| Hoplopyrrhus unitaeniatius                            | X             |
| Hoplias intermedius                                   | X X           |
| Hoplias aff. malabaricus                              | X X X X       |
| Hypbosobrycon uaso                                    | X X X X       |
| Hypostomus albopunctatus                              | X X X X       |
| Hypostomus anciestroids                               | X X X X       |
| Hypostomus butantanii                                 | X X           |
| Hypostomus fluviatilis                                | X             |
| Hypostomus aff. hermani                               | X             |
| Hypostomus margaritifer                               | X             |
| Hypostomus nigromaculatus                             | X X X X       |
| Hypostomus aff. paulinus                              | X X           |
| Hypostomus regani                                     | X X           |
| Hypostomus strigaticeps                               | X X X X       |
| Hypostomus topavae                                    | X X X X       |
| Imparfinis borodini                                    | X             |
| Knodus aff. moenkhausii                               | X X           |
| Leporinus amblyrhynchus                               | X X X X       |
| Leporinus friderici                                   | X X X X       |
| Leporinus octofasciatus                               | X X X X       |
| Leporinus striatus                                    | X X           |
| Loricaria lentiginosa                                  | X X           |
| Megalechis thoracata                                   | X X           |
| Melanorivulus giarettai                               | X X           |
| Melanorivulus giarettai                               | X             |
| Metynnis lippincottianus                              | X             |
### Checklist and key for the identification of fish fauna of the Uberaba River...

| Species                        | Sites |
|-------------------------------|-------|
| **Species richness**          | 4 2 2 3 4 4 24 53 15 5 2 31 24 2 |

| Species          | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | S14 |
|------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|
| Microlepidogaster dimorpha | X  |    |    |    |    |    |    |    |    |     |     |     |     |     |
| Myloplus tiete    |    | X  |    |    |    |    |    |    |    |     |     |     |     |     |
| Oligosarcus pintoi|    |    | X  |    |    |    |    |    |    |     |     |     |     |     |
| Oreochromis niloticus |  |    |    | X  |    |    |    |    |    |     |     |     |     |     |
| Parodon nasus     |    |    |    | X  | X  | X  |    |    |    |     |     |     |     |     |
| Phalloceros harpagos |  |    |    |    | X  |    |    |    |    |     |     |     |     |     |
| Pseudobrycon stramineus |  |    |    |    |    | X  | X  |    |    |     |     |     |     |     |
| Poecilia argentea  |    | X  |    |    |    |    |    |    |    |     |     |     |     |     |
| Poecilia reticulata|    |    |    |    |    |    |    | X  | X  |     |     |     |     |     |
| Prochilodus lineatus|    |    |    |    |    |    |    |    |    |    | X  |    |    |     |
| Proloricaria prolifica|    |    |    |    |    |    |    |    |    |    |    | X  |    |     |
| Rhamdia quelen     |    |    |    |    |    |    |    |    |    |    | X  | X  | X  |     |
| Rhamdopsis sp.     |    |    |    |    |    |    |    |    |    |    |    |    |    | X  |
| Rineloricaria latirostris |  |    |    |    |    |    |    |    |    |     |     |     |     |     |
| Schizodon nasutus   |    |    |    |    |    |    |    |    |    |    |    | X  |    |     |
| Serrasalmus maculatus|    |    |    |    |    |    |    |    |    |    |    |    | X  |     |
| Steindachnerina inornata |  |    |    |    |    |    |    |    |    |     |     |     |     |     |
| Synbranchus marmoratus |  |    |    |    |    |    |    |    |    |     |     |     |     |     |
| Tatia neiva        |    |    |    |    |    |    |    |    |    |    |    |    | X  |     |
| Trichomycterus brasiliensis |  |    |    |    |    |    |    |    |    |     |     |     |     |     |
| Trichomycterus candidus |  |    |    |    |    |    |    |    |    |     |     |     |     |     |

**Figure 5.** Species richness along longitudinal gradient in Uberaba River, Upper Paraná River system, Brazil. Circle diameter corresponds to species richness.

in the entire river system. The species richness suggested a longitudinal gradient, with more species in the lower reaches whereas in the upper reaches the richness does not exceed ten species (Figure 5 and Table 3). The loricariids are mainly represented by *Hyphpostomus* species, up to 92% of the total loricariid number. The most abundant species is *Knodus aff. moenkhausii* with 507 collected specimens comprising 38% of all characiform species. All other species have already been recorded in the Upper Paraná River.
Key to fish species of the Uberaba River drainage

1 Single mid-ventral gill opening; eel-shaped body..... *Synbranchus marmoratus*  
   – Two laterally located gill openings; not eel-shaped body ...................... 2  
2 Dorsal and pelvic fins absent; anal-fin rays more than 100 ..................... 3  
   – Dorsal fin present; pelvic fin commonly present; anal-fin rays up to 50 .... 5  
3 Body uniformly clear with relatively inconspicuous longitudinal stripes; anal fin not reaching the tail end; terminal mouth, both jaws approximately equal................................................................. *Eigenmannia trilineata*  
   – Body dark with clear transverse bands; anal fin extending to the tail end; prognathous, lower jaw longer than upper jaw................................. 4  
4 Obliquely-oriented dark transversal bars fragmented, forming a pattern of irregular spots; anal-fin posterior membrane striped................................................. *Gymnotus inaequilabiatus*  
   – Obliquely-oriented dark transversal bars not fragmented; anal-fin posterior region darkly pigmented or translucent................................ *Gymnotus sylvius*  
5 Body naked or covered by bony plates ...................................................... 6  
   – Body covered by scales ..................................................................... 30  
6 Body covered by bony plates, at least partially......................................... 7  
   – Body covered by thick skin; bony plates absent .................................. 24  
7 Mouth forming a ventral oral disk; bony plates rows on flanks 3–5......... 8  
   – Mouth not forming ventral oral disk, with terminal or subterminal opening; bony plates rows on flank 2................................................................. 22  
8 Adipose fin absent ............................................................................... 9  
   – Adipose fin present .......................................................................... 12  
9 Caudal peduncle very elongate and depressed ...................................... 10  
   – Caudal peduncle rounded or elliptical in cross-section......................... 13  
10 Lips with small papillae, occasionally with short, thick, non-filamentous projections .......................................................... *Rineloricaria latirostris*  
   – Lips fringed, with filamentous projections ......................................... 11  
11 Head with dark brown spots, much smaller than the eye diameter........  
   ............................................................... *Loricaria lentiginosa*  
   – Head light brown without spots........................................ *Proloricaria prolixa*  
12 Scapular bridge fully exposed; well-developed and pointed odontodes on the anterior portion of the snout................................. *Curculionichthys insperatus*  
   – Scapular bridge exposed only laterally; small and spatulate odontodes on the anterior portion of the snout.......................... *Microlepidogaster dimorpha*  
13 Body light with dark spots .................................................................. 14  
   – Body dark with light spots or vermiculations .................................. 17  
14 Lateral keels on body present (three rows), with hypertrophied odontodes ...  
   ............................................................... *Hypostomus ancistroides*  
   – Lateral keels on body absent ............................................................. 15
15  Pectoral-fin spine claviform, with well-developed odontodes on distal portion; eyes small, 6–6.5 × in head length .......... *Hypostomus nigromaculatus*
   – Pectoral-fin spine not claviform, with subequal odontodes along entire spine; eyes large, 3.5–5 × in head length ..................... *Hypostomus fluviatilis*
16  Abdomen completely covered by plates; dentary angle more than 60°; bony plates between dorsal and adipose fins 5 pairs .............. *Hypostomus topavae*
   – Abdomen without plates on pelvic-fin region; dentary angle approximately 45°; bony plates between dorsal and adipose fins 4 pairs ................................................................. *Hypostomus aff. hermani*
17  Pectoral-fin spine equal to or shorter than pelvic-fin spine ................................................................. *Hypostomus albopunctatus*
   – Pectoral-fin spine longer than pelvic-fin spine ........................................... 18
18  Premaxillary and dentary with short and sturdy teeth (18–32), arranged in obtuse angle ................................................................. 19
   – Premaxillary and dentary with long and thin teeth (more than 35), arranged in acute angle ................................................................. 20
19  Body and fins with light spots, aligned longitudinally, but not forming continuous line ................................................................. *Hypostomus margaritifer*
   – Head and fins with light vermiculations, with four longitudinal yellow lines on flank, from dorsal fin to caudal-fin base .................. *Hypostomus butantanis*
20  Pectoral girdle covered with large plates; bony plates between anal and caudal fins 10 or 11; dentary teeth more than 140 ............ *Hypostomus aff. paulinus*
   – Pectoral girdle covered with very small plates or skin; bony plates between anal and caudal fins 12 or 13; dentary teeth up to 130 ........................................... 21
21  Mid-lateral plates series 28 or 29; snout-operculum distance greater than the width of the lips; dorsal fin large, reaching adipose fin; premaxillary and dentary teeth more than 65 ................................................................. *Hypostomus regani*
   – Mid-lateral plates series 25 or 26; snout-operculum distance equal to width of the lips; dorsal fin of moderate size, distant from adipose fin; premaxillary and dentary teeth up to 60 ................................................................. *Hypostomus strigaticeps*
22  Mental barbels absent; jaws teeth present; nuchal plate covered by skin; caudal fin truncated ................................................. *Megalechis thoracata*
   – Mental barbels present; jaws teeth absent; nuchal plate exposed; caudal fin forked ................................................................. 23
23  Supraoccipital long and reaching the nuchal plate; pectoral-fin rays anterior portion without posterior bone lamellae ............ *Corydoras difluviatilis*
   – Supraoccipital short, not reaching the nuchal plate; pectoral-fin rays anterior portion with posterior bone lamellae (more evident in the first rays) ................................................................. *Aspidoras fuscoguttatus*
24  Operculum and preoperculum with odontodes; dorsal-fin origin situated posterior the middle of the body ........................................... 25
   – Operculum and preoperculum without odontodes; dorsal-fin origin situated approximately at the middle of the body ................................................................. 26
25 Pelvic fin present.......................................................................................... Trichomycterus brasiliensis

– Pelvic fin absent .......................................................................................... Trichomycterus candidus

26 Adipose fin short, shorter than anal fin length; nuchal plate reaching the pos
terior portion of head................................................................................... Tatia neivai

– Adipose fin long, approximately 2 × anal fin length; nuchal plate not reaching
the posterior portion of head ........................................................................ 27

27 Body very elongate, depth contained 8.0 × in standard length; 4 dark brown
dorsal transverse bands (first at vertical passing at pectoral fin, second at ver-
tical passing anterior portion of dorsal-fin base, third at vertical passing at
last third of dorsal-fin base, and the last one at vertical passing at adipose-fin
origin); eyes dorsally placed ...................................................................... 28

– Body short, depth contained up to 6.0 × in standard length; dark brown dor-
sal transverse bands absent; eyes laterally placed ........................................ 29

28 Body uniformly clear; longitudinal black stripe on flank present; maxillary
c Barbels long, and reaching or surpassing the anal-fin origin...................... Pimelodella avanhadavae

– Body with small dark spots or irregular vermiculations; longitudinal black
stripe on flank absent; maxillary barbels short, never reaching the anal-fin
origin ............................................................................................................... 30

29 Anal-fin rays up to 12; eyes large, approximately 5 × head length............. Rhamdia quellen

– Anal-fin rays more than 15; eyes small, more than 7.5 × head length .......... Rhamdiopsis sp.

30 Dorsal and anal fins anterior rays modified into spines; pelvic fin in thoracic
position, below of pectoral fin; lateral line divided into 2 branches, 1 anterior,
near the base of the dorsal fin and another posterior, along the middle portion
of the body and caudal peduncle; ctenoid scales........................................ 31

– Dorsal and anal fins anterior rays not modified into spines; pelvic fin posteri-
orly located, close to anal fin; lateral line not divided into 2 branches; cycloid
or spinoid scales .......................................................................................... 32

31 Dorsal-fin spines separate from soft rays by notch.............................. Cichla piquiti

– Dorsal-fin spines not separate from soft rays by notch.............................. 33

32 Body elongate (fusiform), 3.6–5.2 × in standard length; preoperculum poste-
rior margin serrated ...................................................................................... 34

– Body deep, more than 3.5 × in standard length; preoperculum posterior mar-
gin smooth .................................................................................................. 35

33 Scales in longitudinal series 33–40; flank with black transverse bands; dorsal
fin with XVI + 14 or 15 rays; anal fin with III + 9 or 10 rays; black humeral
blotch present ............................................................................................ Crenicichla britskii

– Scales in longitudinal series 41–50; flank without black transverse bands
(crossing the longitudinal stripe); dorsal fin with XIX–XXI + 10–12 rays;
anal fin with III + 7 or 8 rays; black humeral blotch absent....................... Crenicichla jaguarensis
34 Anterior lateral line with 19 or fewer scales; scales in longitudinal series 22–27; black lateral spot present

35 Anterior lateral line with 20 or more scales; scales in longitudinal series 28–35; black lateral spot absent

36 Posterior lateral line with 10–14 scales; scales in longitudinal series 24–27; dorsal fin with XV or XVI + 10–13 rays; black lateral spot on flank larger than the eye diameter. **Geophagus brasiliensis**

37 Scales in transverse series above the lateral line 3 or 3½; gill rakers in inferior branch of the first branchial arch 18 or more. **Oreochromis niloticus**

38 Top of head covered by scales; upper jaw protractile

39 Males with intense colored spots in life, black when preserved; females without spots; gonopodium with moderate size (3.2–3.6 × in standard length), with terminal portion almost straight. **Poecilia reticulata**

40 Teeth absent in adults. **Steindachnerina insculpta**

41 Teeth small, numerous and depressibly implanted in the lips. **Prochilodus lineatus**

42 Body fusiform or moderately compressed laterally; abdominal serrae absent...

43 Teeth incisiform (rabbit-like), truncated or cuspidate, premaxillary and dentary with 3 teeth each, premaxillary with 3 and dentary with 3 or 4 teeth, or premaxillary and dentary with 4 teeth each. **Schizodon nasutus**

44 Teeth cuspidate; flank silver in life, spots or bands absent; a conspicuous, horizontally elongate black spot at end of caudal peduncle extending to the median caudal-fin rays. **Schizodon nasutus**

45 Teeth truncated; body with large black spots or longitudinal stripes; horizontally elongate black spot on end of caudal peduncle absent...
| Step | Description |
|------|-------------|
| 45   | Premaxillary and dentary with 4 teeth each; 3 large black spots on flank (first bellow dorsal fin, second above the anal-fin base and third at the end of caudal peduncle) | \textit{Leporinus friderici} |
| –    | Premaxillary with 3 teeth; dentary with 3 or 4 teeth, body with longitudinal black stripes or transverse bars, large black spots on flank absent | \textit{Leporinus amblyrhynchus} |
| 46   | Premaxillary and dentary with 3 teeth each; black longitudinal stripe on flank present; dorsal dark transverse bars (but not reaching the longitudinal stripe) 10 or more; subterminal mouth; prominent snout | \textit{Leporinus friderici} |
| –    | Premaxillary with 3 teeth; dentary with 4 teeth; black dorsal transverse bars absent; terminal or subterminal mouth; non-prominent snout | \textit{Leporinus amblyrhynchus} |
| 47   | Body elongate, depth 4.1 × in standard length; four longitudinal black stripes on flank; fins usually hyaline or slightly red | \textit{Leporinus striatus} |
| –    | Body deep, depth 3.2 × in standard length; eight black transverse bars on flank; fins yellow, orange or red in life | \textit{Leporinus octofasciatus} |
| 48   | Premaxillary teeth in 1 row | \textit{Leporinus striatus} |
| –    | Premaxillary teeth in 2 or more rows | \textit{Leporinus octofasciatus} |
| 49   | Adipose fin absent; posterodorsal portion of head with straight margin; caudal fin rounded or truncate | \textit{Hoplias intermedius} |
| –    | Adipose fin usually present; posterodorsal portion of head convex or with a posterior projection; caudal fin forked or emarginate | \textit{Hoplias aff. malabaricus} |
| 50   | Dorsal-fin rays up to 11; pectoral, pelvic and anal fins without dark brown stripes; teeth canine on maxillary absent | \textit{Hoplogenys unitaeniatus} |
| –    | Dorsal-fin rays more than 12; pectoral, pelvic and anal fins with dark brown stripes; teeth canine on maxillary present | \textit{Hoplias aff. malabaricus} |
| 51   | Medial margin of dentary bones parallel in ventral view; denticles on tongue absent | \textit{Hoplias intermedius} |
| –    | Medial margin of dentary bones converging towards the symphysis in ventral view; denticles on tongue present | \textit{Hoplias aff. malabaricus} |
| 52   | Teeth on anterior portion of dentary absent; lower jaw anterior portion straight | \textit{Parodon nasus} |
| –    | Teeth on anterior portion of dentary present; lower jaw anterior portion rounded | \textit{Parodon nasus} |
| 53   | Dentary teeth present | \textit{Parodon nasus} |
| –    | Dentary teeth absent | \textit{Parodon nasus} |
| 54   | Black lateral stripe with broad projections above and below, giving a zig-zag appearance; body greenish in life | \textit{Apareiodon ibitiensis} |
| –    | Black lateral stripe without broad projections above and below; 6–8 transverse, rectangular or triangular black thin bars above; body silver in life | \textit{Apareiodon ibitiensis} |
| 55   | Scales in pre-anal series 29 or fewer; premaxillary teeth cusps up to 12 | \textit{Apareiodon piracicabae} |
| –    | Scales in pre-anal series 29½ or more; premaxillary teeth cusps 12–15 | \textit{Apareiodon affinis} |
Adipose fin absent; pectoral-fin unbranched rays 10–13; principal caudal-fin rays 16 ................................................. Crenuchidae (undescribed genus and species)

– Adipose fin present; pectoral-fin unbranched rays 3; principal caudal-fin rays 18 or 19 ............................................................... Characidium aff. zebra

57 Premaxillary teeth in three rows; teeth conical in the symphysis region present ................................................................. Brycon nattereri

– Premaxillary teeth in two rows; teeth conical in the symphysis region absent ................................................................. 58

Teeth on the palate present .................................................... Oligosarcus pintoi

– Teeth on the palate absent .................................................. 59

Anal-fin branched rays more than 30; spinoid scales ........ Galeocharax gulo

– Anal-fin branched rays up to 29; cycloid scales .................. 60

Lateral line incomplete .................................................................................. 61

– Lateral line complete ............................................................................. 62

Adipose fin present ................................................................. Hypessobrycon uaiso

– Adipose fin absent ............................................................................. Hasemania uberaba

Internal series of premaxillary with 4 teeth; body relatively elongate, depth 3.0–4.2 × in standard length ..................................................... 63

– Internal series of premaxillary with 5 teeth; body relatively deep, depth 1.8–3.6 × in standard length ................................................. 66

Upper jaw projecting anteriorly; premaxillary teeth misaligned ................................................................................. Piabina argentea

– Upper and lower jaws of equal size; premaxillary teeth aligned ................................................................. 64

Supraorbital groove present; caudal-fin lobes covered by small scales ........................................................... Knodus aff. moenkhausii

– Supraorbital groove absent; scales only at the caudal-fin base .................................................................................. 65

Dorsal stripe broad, extending from the supraoccipital crest to the caudal-fin base, with a gap at the region of the adipose fin; humeral spot conspicuous ............................................. Bryconamericus turiuba

– Dorsal stripe narrow, continuous, extending from the supraoccipital crest to the caudal-fin base; humeral spot inconspicuous or absent .... Piabarchus stramineus

Maxillary teeth absent; humeral spot clearly defined, horizontally elongate associated with two diffuse vertical black stripes; fins yellow in life .................................................. Astyanax lacustris

– Maxillary teeth present; humeral spot absent or inconspicuous; fins orange or red in life ...................................................... 67

Flank with a silvery longitudinal stripe; scales on abdomen without chromatophores on distal portion ........................................ Astyanax aff. fasciatus

– Flank without silvery longitudinal stripe; scales on abdomen with black chromatophores on distal portion ......... 68

Body relatively deep, up to 3.0 × in standard length; anal-fin rays 22 or more ................................................................. Astyanax bockmanni

– Body relatively elongate, more than 3.1 × in standard length; anal-fin rays 20 or fewer .................................................. 69
69 Eye with light iris, silver in life; pelvic-fin tip reaching anal fin………………
……………………………………………………………………………………………………Astyanax aff. paranae
– Eye with dark iris, gold or brown in life; pelvic-fin tip not reaching anal fin……
……………………………………………………………………………………………………Astyanax paranae

70 Teeth tricuspid present; premaxilla and dentary teeth in 1 row………………
……………………………………………………………………………………………………Serrasalmus maculatus
– Teeth tricuspid absent; premaxilla and dentary teeth in 2 rows (the inner
dentary row represented by 2 small conical teeth)………………………………..71

71 Adipose-fin base longer than taller; dorsal-fin rays 20 or fewer; pre-dorsal
spine present……………………………………………………………………………….Metynnis lippincottianus
– Adipose-fin base taller than longer; dorsal-fin rays 20 or more; pre-dorsal
spine absent……………………………………………………………………………….Myloplus tiete

Discussion

The diversity recorded in the Uberaba River (73) is slightly greater than in similar tributaries of the Grande River in São Paulo state, in which 64 species have been recorded in the tributaries of the Pardo, Turvo, and Sapucaí rivers (Castro et al. 2004). Our data increase the number of species previously recorded for the Uberaba River by 44, which corresponds to an increase of 150% of the species referred so far in the region (see more details in SEMEA 2004; Souza et al. 2016). However, these figures may reflect the differences in sampling methods used by us and the previous authors as well as a larger area investigated in this study. Estimates of species richness and diversity considerably depend on methods used as discussed by Oliveira et al. (2014).

The number of species (73) recorded in the Uberaba River comprises ca. 19% of the total species number known in the Upper Paraná River system when compared to the data in Langeani et al. (2007). The ichthyofauna of the Uberaba River is composed mainly of autochthonous species, few allochthonous species and only two exotic species. The autochthonous origin of some of these species in the Upper Parana River still needs further research. For example, the scarcity of data on the origin or taxonomic status of some putative species such as Knodus aff. moenkhausii, Trichomycterus brasiliiensis or Megalechis thoracata, does not allow to reasonably hypothesize on their origin.

Some species recorded in the Uberaba River potentially correspond to new species and some considerations are provided. Astyanax fasciatus (Cuvier) is described for the São Francisco River basin and it is widely distributed in the Paraná-Paraguay drainage and coastal drainages of eastern of Brazil. However, based on the definitions by Eigenmann (1921) it is possible to infer the existence of a "A. fasciatus species complex" in the Paraná-Paraguay and other coastal drainages. Thus, the name A. fasciatus should be used strictly for the São Francisco River lineage (Melo and Buckup 2006). In the La Plata drainage, the Hoplias malabaricus species group is constantly corroborated by morphological, cytotgenetic and molecular evidence, and a recognition and taxonomic delineating of new entities is currently in progress (Rosso et al. 2018). Additionally, the nominal
species name *Hoplias malabaricus* (Bloch) should be applied exclusively to the Guiana shield lineage (Rosso et al. 2018). Similarly, some authors (see Buckup 1992) suggest that populations of *Characidium zebra* Eigenmann throughout South America represent more than one species. *Characidium zebra* was described in tributaries of the Branco River (Negro River system) in the Amazon. Recent evidence suggests that *C. zebra* popu-
lations in the San Francisco and Paraná rivers correspond to the same species (Serrano et al. 2018) distinct from the \textit{C. zebra} populations of the Amazon drainage.

\textit{Astyanax} \textit{aff. paranae} Eigenmann collected from the Uberaba River may represent a distinct species in the complex “\textit{Astyanax scabripinnis} species complex” sensu Moreira-Filho and Bertollo (1991), a group with an underestimated diversity (Bertaco and Malabarba 2001) as it differs by a number of features (e.g., eye coloration and some measurements). \textit{Knodus moenkhausii} (Eigenmann & Kennedy) was described from the Arroyo Trementina in the Paraguay River system. The specimens from the Upper Paraná River and identified so far as \textit{K. moenkhausii} apparently represents an undescribed species (F. R. Carvalho pers. comm.).

The taxonomic boundaries of the \textit{Hypostomus} species are unclear. Some species of the genus \textit{Hypostomus} are highly variable morphologically and widely distributed. In addition, some important diagnostic characters, such as color pattern, cannot be seen at present in type specimens collected more than 100 years ago, making identification of the species difficult (Zawadzki et al. 2004). For example, \textit{Hypostomus hermanni} Ihering is widely dis-

\textbf{Figure 7.} Siluriformes (Loricariidae absent), Gymnotiformes, Cichliformes, Cyprinodontiformes, and Synbranchiformes collected in the Uberaba River. \textit{1} Megalechis thoracata \textit{2} Tafina neivai \textit{3} Trichomycterus candidus \textit{4} Trichomycterus brasiliensis \textit{5} Imparfinis borodini \textit{6} Rhamdiopsis sp. \textit{7} Corydoras difluviatilis \textit{8} Aspidoras fuscoguttatus \textit{9} Rhamdia quelen \textit{10} Pimelodella avanhadavai \textit{11} Eigenmannia trilineata \textit{12} Gymnotus sylvius \textit{13} Gymnotus inaequilabiatus (uncataloged) \textit{14} Crenichla jaguarensis \textit{15} Crenichla britskii \textit{16} Cichla piquiti \textit{17} Geophagus brasiliensis \textit{18} Coptodon rendalli \textit{19} Oreochromis niloticus (uncataloged) \textit{20} Cichlasoma paranense \textit{21} Phalloceros harpagos (female above and male below) \textit{22} Poecilia reticulata (female above and male below) \textit{23} Melanorivulus giarettai (male above and female below) and \textit{24} Synbranchus marmoratus. Photographs are of specimens presented in Table 2. Scale bar: 10 mm.
Figure 8. Loricariidae, genus *Hypostomus* collected in the Uberaba River (dorsal, lateral, and ventral photographs). 1 *Hypostomus ancistroides* 2 *Hypostomus albopunctatus* 3 *Hypostomus strigaticeps* 4 *Hypostomus margaritifer* 5 *Hypostomus butantanis* 6 *Hypostomus regani* 7 *Hypostomus aff. paulinus* 8 *Hypostomus topavae* and 9 *Hypostomus nigromaculatus*, Photographs are of specimens presented in Table 2. Scale bar: 10 mm.

Distributed within the Upper Paraná River system. A comparison of the specimens collected in the Uberaba River with specimens from other locations revealed a discrepancy in some meristic and color traits. The Uberaba specimens are especially different from specimens from the Piracicaba River, the type locality of *H. hermanni*. It has been also shown that
different populations of *Hypostomus paulinus* (Ihering) are effectively reproductively isolated and characterized by a high degree of inbreeding (Zawadzki et al. 2004).

The occurrence of *Metynnis lippincottianus* may be a result of accidental introduction (Ota 2015). Among the allochthonous species, *Poecilia reticulata* was introduced to control mosquito larvae (Ota et al. 2018). *Cichla piquiti* was probably introduced for sport fishing (Langeani et al. 2007; Ota et al. 2018), and *Gymnotus inaequilabiatus* originally from the Lower Paraná River, Paraguay and Uruguay rivers (Maxime and Albert 2014), colonized the upper reaches of the Paraná River after the construction of the Itaipu hydroelectric dam in the 1980s. Ota et al. (2018) suggested that the occurrence of *Hoplerythrinus unitaeniatus* in the Upper Paraná River can be associated with its introduction as a live bait or after inundation of the Sete Quedas Falls after the construction of the Itaipu dam. *Galeocharax gulo* is widely distributed in almost all Upper Amazon River systems, also in the Orinoco, Oyapok, Araguaia-Tocantins, and Paraná rivers (Giovannetti et al. 2017). The occurrence of this species in the Upper Paraná system may be a result of natural dispersion. *Coptodon rendalli* and *O. niloticus* probably represent results of escapes from fish farms (Langeani et al. 2007; Ota et al. 2018) and the populations of both species are probably established in the region as they have been regularly registered since long ago. Finally, Souza et al. (2016) report the occurrence of *Cyphocharax nagelii* (Steindachner) and *Steindachnerina brevipinna* (Eigenmann & Eigenmann) in the system, but we could not confirm these data and refrained from including them in the species list.
New taxa have been described from the Uberaba River system over the past decade, e.g., *Hasemania uberaba* (Serra and Langeani 2015), *Hyphessobrycon uaiso* (Carvalho and Langeani 2013), and *Microlepidogaster dimorpha* (Martins and Langeani 2011). These newly described species are only known from their type localities or from a few localities corroborating several examples of endemism in the Upper Paraná River, previously indicated by some authors (e.g., Langeani et al. 2007). This clearly demonstrates the importance of inventories and consequent conservation measures. Two species registered in the Uberaba River are definitely threatened: *Brycon nattereri* Günther and *Myloplus tiete* (Eigenmann & Norris) are assigned to “Vulnerable” (VU) and “Endangered” (EN) respectively, on the IBAMA Red List of Endangered Species (ICMBio 2015). The main threats to the local fauna are related to changes in hydrological cycles and the loss of riparian vegetation, as well as overexploitation of natural stocks (Lima et al. 2008; Lima et al. 2015). In addition, the presence of migratory rheophilic species such as *Prochilodus lineatus* (Valenciennes), *Leporinus friderici* (Bloch), *B. nattereri*, and *M. tiete*, is because these species use local resources, at least partially, to complete their life cycle, as suggested by Carolsfeld et al. (2003). Considering all the factors discussed above, the Uberaba River contains a diverse and heterogeneous fish fauna, with two endemic species, *H. uberaba* and an undescribed crenuchid (a description is in the process by Ribeiro et al.) and a low number of allochthonous and exotic species. The Uberaba River has undergone several anthropogenic actions over the last decades, such as the increase of the area destined to grazing, resulting in only 17.7% of native vegetation remains (Valle-Junior et al. 2010) and the reduction of the lotic environments due to damming. The impact of human-induced environmental change is dramatic on the structure and composition of the local fauna. Development of management plans on conservation areas such as the implementation of “Area de Proteção Ambiental Rio Uberaba – APA-Rio Uberaba” project (SEMEA 2004) is necessary to mitigate the effects and help the sustainable use of local natural resources.

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References

Albert JS, Reis RE (2011) Historical biogeography of neotropical freshwater fishes. University of California Press, London, 388 pp. https://doi.org/10.1525/california/9780520268685.001.0001

Agostinho AA, Gomes LC, Veríssimo S, Okada EK (2004) Flood regime, dam regulation and fish in the Upper Paraná River: effects on assemblage attributes, reproduction and recruitment. Reviews in Fish Biology and Fisheries 14: 11–19. https://doi.org/10.1007/s11160-004-3551-y

Bertaco VA, Malabarba LR (2001) Description of new species of Astyanax (Teleostei: Characidae) from headwater streams of Southern Brazil, with comments on the “A. scabripinnis species complex”. Ichthyological Exploration of Freshwaters 12(3): 221–234. https://doi.org/10.11646/zootaxa.3700.2.2

Betancur RR, Wiley EO, Arratia G, Acero A, Bailly N, Miya M, Lecointre G, Ortí G (2017) Phylogenetic classification of bony fishes. BMC Evolutionary Biology 17(162): 1–40. https://doi.org/10.1186/s12862-017-0958-3

Britski HA (1992) Conhecimento atual das relações filogenéticas de peixes neotropicais. In: Agostinho AA, Benedito-Cecílio E (Eds) Situação atual e perspectivas da ictiologia no Brasil. Editora da Universidade Estadual de Maringá, Maringá, 43–57.

Buckup P, Menezes N, Ghazzi M (2007) Catálogo das espécies de peixes de água doce do Brasil. Editora do Museu Nacional, Rio de Janeiro, 149 pp.

Candido HG, Galbiatti JA, Pissarra TCT, Martins-Filho MV (2010) Degradação ambiental da bacia hidrográfica do River Uberaba: uma abordagem metodológica. Engenharia Agrícola Jaboticabal 30(1): 179–192. https://doi.org/10.1590/S0100-69162010000100019

Carolsfeld J, Harvey B, Ross C, Baer A (2003) Migratory fishes of South America: biology, fisheries and conservation status. International Bank for Reconstruction and Development. World Fisheries Trust, Victoria, Canada, 380 pp. https://doi.org/10.1596/1-5525-0114-0

Carvalho FR, Langeani F (2013) Hyphessobrycon uaiso: new characid fish from the rio Grande, upper rio Paraná basin, Minas Gerais State (Ostariophysi: Characidae), with a brief comment about some types of Hyphessobrycon. Neotropical Ichthyology 11(3): 525–536. https://doi.org/10.1590/S1679-62252013000300006

Casatti L, Castro RMC (1998) A fish community of the São Francisco River headwaters riffles, southeastern Brazil. Ichthyological Exploration Freshwater 9(3): 229–242.

Casatti L, Castro, RMC, Langeani F (2001) Peixes de riocho do Parque Estadual Morro do Diabo, bacia do alto Rio Paraná, SP. Biota Neotropica 1(1): 1–15. https://doi.org/10.1590/S1676-06032001000100005

Castro RMC, Casatti L, Santos HF, Melo ALA, Martins LSF, Ferreira MK, Gibran FC, Benine RB, Carvalho M, Ribeiro AC, Abreu TX, Bockmann FA, Pelição GZ, Stopiglia R, Langeani F (2004) Estrutura e composição da ictiofauna de riachos da bacia do River Grande no estado de São Paulo, sudeste do Brasil. Biota Neotropica 4(1): 1–39. https://doi.org/10.1590/S1676-06032004000100006

CODAU [Codau-Centro Operacional De Desenvolvimento E Saneamento De Uberaba] (2005) Relatório de avaliação ambiental do Projeto de Recuperação Ambiental da Bacia...
Checklist and key for the identification of fish fauna of the Uberaba River...

...do River Uberaba e revitalização do sistema de abastecimento de água – Projeto Água Viva. CODAU, Uberaba, 416 pp. http://www.uberaba.mg.gov.br/portal/acervo/agua_viva/arquivos/avaliacao_ambiental/Relatorio%20Ambiental%202.pdf [accessed in 3 August 2018]

Cruz LBS (2003) Diagnóstico ambiental da bacia hidrográfica do River Uberaba – MG. Tese de Doutorado, Campinas, São Paulo, Brasil, Faculdade de Engenharia Agrícola, Universidade Estadual de Campinas, 182 pp.

Eigenmann CH (1921) The American Characidae. Memoirs of the Museum of Comparative Zoology 23(3): 209–310.

Fagundes DC, Leal CG, Carvalho DR, Junqueira NT, Langeani F, Pompeu PS (2015) The stream fish fauna from three regions of the Upper Parana River basin. Biota Neotropica 15(2): 1–8. https://doi.org/10.1590/1676-06032015018714

Fricke R, Eschmeyer WN, Van der Laan R (2018) Catalog of fishes: genera, species, references. Electronic version. http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp [accessed in 3 August 2018]

Garavello JC, Garavello JP (2004) Spatial distribution and interaction of four species of the catfish genus Hypostomus Lacépède with bottom of River São Francisco, Canindé do São Francisco, Sergipe, Brazil (Pisces, Loricariidae, Hypostominae). Brazilian Journal of Biology 64(3b): 103–141. https://doi.org/10.1590/S1519-69842004000400006

Giovannetti V, Toledo-Piza M, Menezes NA (2017) Taxonomic revision of Galeocharax (Characiformes: Characidae: Characinae). Neotropical Ichthyology 15(1): 1–32. https://doi.org/10.1590/1982-0224-20160040

Gomes IA, Palmieri F, Baruqui AM, Motta PEF, Naime UJ (1982) Levantamento de reconhecimento de média intensidade dos solos e avaliação da aptidão agrícola das terras do Triângulo Mineiro (1ª ed.). EMBRAPA, CNLCS, Rio de Janeiro, 526 pp.

Graça WJ, Pavanelli CS (2007) Peixes da planície de inundação do alto rio Paraná e áreas adjacentes. EDUEM, Maringá, 241 pp.

ICMBio (2015) Lista Nacional Oficial de Espécies da Fauna Ameaçada de Extinção. http://www.icmbio.gov.br/portal/faunabrasileira/lista-de-especies/6175-%Especie-6175%0A [Accessed in 03 August 2018]

IGAM [Instituto Mineiro de Gestão das Águas] (2010) Rio Uberaba. http://www.igam.mg.gov.br/ [Accessed in 03 August 2018]

Langeani F, Castro RMC, Oyakawa OT, Shibatta OA, Pavanelli CS, Casatti L (2007) Diversidade da ictiofauna do Alto rio Paraná: composição atual e perspectivas futuras. Biota Neotropica 7(3): 181–198. https://doi.org/10.1590/S1676-06032007000300020

Langeani F, Régo A (2014) Guia ilustrado dos peixes da bacia do River Araguari. Grupo de Mídia Brasil Central, Uberlândia, 195 pp.

Lima FCT, Albrecht MP, Pavanelli CS, Vono V (2008) Threatened fishes of the world: Brycon nattereri Günther, 1864 (Characidae). Environmental Biology of Fishes 83(2): 207–208. https://doi.org/10.1007/s10641-007-9319-1

Lima FCT, Albrecht M, Pavanelli CS, Volney V, Shibatta O (2015) Brycon nattereri. In: Machado ABM, Martins CS (Ed.) Livro Vermelho da Fauna Ameaçada de Extinção do Brasil. Biodiversitas, Belo Horizonte, 278 pp.
Martins FO, Langeani F (2011a) *Rhinolekos*, a new genus with three new species of Hypoptopomatinae (Siluriformes: Loricariidae) from upper rio Paraná. Neotropical Ichthyology 9(1): 65–78. https://doi.org/10.1590/S1679-62252011000100004

Martins FO, Langeani F (2011b) *Microlepidogaster dimorpha*, a new species of Hypoptopomatinae (Siluriformes: Loricariidae) from the upper rio Paraná system. Neotropical Ichthyology 9(1): 79–86. https://doi.org/10.1590/S1679-62252011000100005

Maxime EL, Albert JS (2014) Redescription of the Tuvião, *Gymnotus inaequilabiatus* Valenciennes, 1839, Using High-Resolution X-ray Computed Tomography. Copeia 2014(3): 462–472. https://doi.org/10.1643/CI-13-054

Melo FAG, Buckup PA (2006) *Astyanax henseli*, a new name for *Tetragonopterus aeneus* Hensel, 1870 from the southern Brazil (Teleostei: Characiformes). Neotropical Ichthyology 4(1): 45–52. https://doi.org/10.1590/S1679-62252006000100003

Moreira-Filho O, Bertollo LAC (1991) *Astyanax scabripinnis* (Pisces, Characidae): a species complex. Revista Brasileira de Genética 14: 331–357.

Nelson JS (2016) Fishes of the World. John Wiley & Sons, Hoboken, Nova Jersey, 651 pp.

Oliveira AG, Gomes LC, Latini JD, Agostinho AA (2014) Implications of using a variety of fishing strategies and sampling techniques across different biotopes to determine fish species composition and diversity. Natureza & Conservação 12(2): 112–117. https://doi.org/10.1016/j.ncon.2014.08.004

Ota RR, Deprá GC, da Graça WJ, Pavanelli CS (2018) Peixes da planície de inundação do alto River Paraná e áreas adjacentes: revised, annotated and updated. Neotropical Ichthyology 16(2): 1–111. https://doi.org/10.1590/1982-0224-20170094

Oyakawa OT, Menezes NA (2011) Checklist of fresh water fishes from São Paulo State, Brazil. Biota Neotropical 11(1a): 19–31. https://doi.org/10.1590/S1676-06032011000500002

Rosso JJ, González-Castro M, Bogan S, Cardoso YP, Mabraga E, Delpiani M, Astarloa JMD (2018) Integrative taxonomy reveals a new species of the *Hoplias malabaricus* species complex (Teleostei: Erythrinidae) Ichthyological Exploration of Freshwaters 28(3): 1–18. http://dx.doi.org/10.23788/IEF-1076

Santos AC, Gonçalves CC, Carvalho FR (2017) Ichthyofauna of the "Cachoeira de São Roberto" and fishes of lower Preto River, upper Paraná River basin, Brazil. Biota Neotropica 17(1): 1–10. https://doi.org/10.1590/1676-0611-bn-2016-0196

SEMEA [Secretaria Municipal de Meio ambiente] (2004) Diagnóstico Ambiental APA do Rio Uberaba. Prefeitura Municipal de Uberaba, Uberaba, 127 pp. http://www.uberaba.mg.gov.br/portal/acervo/meio_ambiente/arquivos/agenda_branca/diagnostico_apa.pdf [Accessed in 03 august 2018]
Serra JP, Langeani F (2015) A new Hasemania Ellis from the upper River Paraná basin, with the redescription of Hasemania crenuchoides Zarske & Géry (Characiformes: Characidae). Neotropical Ichthyology 13(3): 479–486. https://doi.org/10.1590/1982-0224-20140107

Serrano EA, Melo BF, Freitas-Souza D, Oliveira MLM, Utsunomia R, Oliveira C, Foresti F (2018) Species delimitation in Neotropical fishes of the genus Characidium (Teleostei, Characiformes). Zoologia Scripta 49(1): 69–80. https://doi.org/10.1111/zsc.12318

Silveira LGG, Langeani F, Graça WJ, Pavanelli CS, Buckup PA (2008) Characidium xanthopterum (Ostariophysi: Characiformes: Crenuchidae): a new species from the Central Brazilian Plateau. Neotropical Ichthyology 6(2): 169–174. https://doi.org/10.1590/S1679-62252008000200003

Souza-Filho EE, Stevaux JC (1997) Geologia e geomorfologia do complexo rio Baía, Curutuba, Ivinheima. In: Vazzoler AEAM, Agostinho AA, Hahn NS (Eds) A Planície de inundação do Alto rio Paraná: aspectos físicos, biológicos e socioeconômicos. EDUEM, Maringá, 3–46.

Souza F, Leitão MLC, Rocha BGA, Hiroki KAN, Pelli A (2016) Estrutura Ictiofaunística do River Uberaba: A Influência dos Barramentos na Dinâmica Ecológica das Comunidades de Peixes. Biota Amazônia 6(4): 87–93. https://doi.org/10.18561/2179-5746/biotaamazonia.v6n4p87-93

Valera CA, Valle-Junior RF, Varandas SGP, Fernandes LF, Pacheco FAL (2016) The role of environmental land use conflicts in soil fertility: A study on the Uberaba River basin, Brazil. Science of The Total Environment 562: 463–473. https://doi.org/10.1016/j.scitotenv.2016.04.046

Valle-Junior RF, Galbiatti JA, Martins-Filho MV, Pissarra TCT (2010) Potencial de erosão da bacia do River Uberaba. Revista Engenharia Agrícola 30(5): 897–908. https://doi.org/10.1590/S0100-69162010000500012

van der Laan R (2016) Freshwater fish list: an alphabetic scientific name list of the world's freshwater fishes and an overview of the scientific names used in the aquarium literature. 18th ed. Almere, The Netherlands, 996 pp.

Zawadzki CH, Renesto E, Paiva S, Lara-Kamei MCS (2004) Allozyme differentiation of four populations of Hypostomus (Teleostei: Loricariidae) from Ribeirão Keller, a small stream in the upper Rio Paraná basin, Brazil. Genetica 121(3): 251–257. https://doi.org/10.1023/B:GENE.0000039852.65610.4f