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Ichthyofauna of streams in Maringá municipality, Paraná, Brazil: an updated checklist, threats, and conservation perspectives

Ictiofauna dos riachos do município de Maringá, Paraná, Brasil: uma lista atualizada, ameaças e perspectivas de conservação

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Abstract: Aim: The following list aims to provide the most recent taxonomic surveying of fish species inhabiting the Ivaí and the Pirapó/Parapanema river basins from the Maringá municipality, using material from the Coleção Ictiológica do Nupélia (NUP) and the available literature. **Methods:** We compiled all the available records of fish species housed in the NUP from the SpeciesLink database, and compared them with those in a previously published study. **Results:** The total number of species identified was 81, distributed across 24 families and six orders. The richest order is Characiformes, comprising 34 species. The data analysed reveal that 11 species are recorded as non-native, highlighting the alarming case of introduced species, especially by aquarium keeping. Regarding the threat categories analysed by the IUCN, only one species, *Bryconamericus coeruleus*, is considered Near Threatened. Further, a noteworthy feature is the presence of seven putative new species, which underlines the necessity for further studies to be conducted to facilitate a more complete understanding and description of the ichthyofauna of the region. The results of this study show that the fish species composition in the streams of the Maringá municipality is diverse and taxonomically complex. **Conclusions:** Further investigation is needed to address the aforementioned issues regarding conservation and possible species description. Furthermore, more surveys are needed in the Ivaí River basin to expand the species registry, especially in urban streams. We hope that the list of freshwater fish species from Maringá municipality will be a useful source of information for people who make decisions and for people who want to create plans to manage and protect the fish in the region.

Keywords: fish; northern Paraná; non-native species; urban streams.

Resumo: Objetivo: A lista a seguir pretende fornecer o levantamento taxonômico mais recente das espécies de peixes que habitam as bacias hidrográficas dos rios Ivaí e Pirapó/Parapanema, no município de Maringá, utilizando material da Coleção Ictiológica do Nupélia (NUP) e a literatura disponível. **Métodos:** Compilamos todos os registros disponíveis de espécies de peixes alojadas no NUP, a partir do banco de dados do SpeciesLink e os comparamos com um estudo publicado anteriormente. **Resultados:** O número total de espécies identificadas foi de 81, distribuídas por 24 famílias e seis ordens. A ordem mais rica é a Characiformes, compreendendo 34 espécies. Os dados analisados revelam que 11 espécies estão registradas como não nativas, destacando o caso alarmante de espécies introduzidas, especialmente por aquarismo. Em relação às categorias de ameaça analisadas pela IUCN, apenas uma espécie, *Bryconamericus coeruleus*, é considerada Quase Ameaçada. Além disso, uma característica digna de nota é a presença de sete supostas espécies novas, o que embasa a necessidade de se realizarem mais estudos para facilitar uma compreensão e descrição mais completas da ictiofauna da região. Os resultados deste estudo mostram que a composição das espécies de peixes nos riachos do município de Maringá é diversa e taxonomicamente complexa. **Conclusões:** São necessárias mais investigações para abordar as questões acima mencionadas relativas à conservação e possível descrição das espécies. Além disso, são necessárias mais pesquisas na bacia do rio Ivaí para ampliar o registro de espécies, especialmente em córregos urbanos. Esperamos que a lista de espécies de peixes de água doce do município de Maringá seja uma fonte útil de informação para tomadores de decisão e para pessoas que desejam criar planos para gerenciar e proteger os peixes da região.

Palavras-chave: peixes; norte do Paraná; espécies não-nativas; riachos urbanos.

1. Introduction

The Upper Paraná River basin drains an area of approximately 880,000 km^2, representing 10.3% of Brazilian territory (Agostinho et al., 2007). It extends from the Planalto Central, near Brasília, southwards to the borders with Argentina and Paraguay. This region is characterized by numerous headwater streams and major tributaries that form a complex system of waterfalls and a diverse topography (Agostinho et al., 2004; Pagotto et al., 2012; Frota et al., 2016, 2021, 2022; Morais-Silva et al., 2018; Frota & Graça, 2025; Reis et al., 2025). Within the boundaries of Paraná State, the main tributaries of the Paraná River include the Paranapanema River – bordering São Paulo State and encompassing the Itararé, das Cinzas, and Pirapó sub-basins – as well as the Ivaí, Piquiri, and Iguaçu Rivers (Reis et al., 2020a).

Several researchers have documented fish species in the Paraná River basin (e.g. Graça & Pavanelli, 2007; Langeani et al., 2007; Cavalli et al., 2018; Frota et al., 2016, 2020; Ota et al., 2018; Jarduli et al., 2019; Reis et al., 2020a; Dagosta et al., 2024). These studies provided comprehensive compilations of freshwater fish species and discussed their geographic distribution, ecological characteristics, and taxonomic updates, while also proposed conservation policies. Despite these efforts, many headwater streams and small urban tributaries remain poorly studied or insufficiently understood.

Maringá is the third most populous municipality in the Paraná State and is notable for its numerous headwater streams, which originate within its boundaries. Moreover, the municipality is characterized by two major human activities that strongly influence urban watercourses. First, Maringá functions as an agro-industrial center, with a large proportion of soybean cultivation occurring within the municipality limits. Second, urbanization itself has an impact on watercourses. Both activities affect the environmental conditions of headwater streams, leading to alterations in their physical, chemical, and biological characteristics (Cunico et al., 2009; Pessoa et al., 2025). In this way, urban tributaries – especially first and second-order urban streams – are subject to anthropogenic impacts such as nutrients enrichment and channel modification, which favor the persistence of species tolerant to these altered conditions (Pessoa et al., 2025). These aforementioned issues can be designated collectively as 'the urban stream syndrome' (Walsh et al., 2005), which refers to streams exhibiting one or more of the following characteristics: elevated concentrations of contaminants and nutrients; changes in channel morphology; an altered hydrography; and a reduction in species richness and an increase in tolerant species.

In the context of environmental change, the introduction of non-native species represents a significant threat to native biodiversity (Vitule et al., 2009). This concern is supported by the findings of Cunico et al. (2009), who produced the first checklist of fish species from Maringá, documenting 38 species. The study reported the occurrence of non-native species, including *Poecilia reticulata* Peters, 1859, among the samples, suggesting the probable introduction of this and other non-native fish species. In that study, most voucher specimens were deposited in the Coleção Ictiológica do

Nupélia (NUP), allowing the information to be used for future research. More than fifteen years later, additional species have been recorded in the tributaries within the boundaries of Maringá, providing new data and the opportunity to produce an updated checklist. In this context, the present study aims to provide an inventory of fish species from streams in the municipality of Maringá, Paraná, Brazil, encompassing the Pirapó and Ivaí River basins.

2. Materials and Methods

2.1. Study area

The Pirapó River drainage area is situated within the third plateau of Paraná State, extending over an area of 5,076 km^2 (22°30' S/ 51°15' W; 23°30' S/ 52°15' W) (Maack, 2012). It encompasses the northern region within the state of Paraná. The river drains an area which is part of the Paranapanema sub-ecoregion, and is part of the Upper Paraná River System. The Ivaí River is a left bank tributary of the Paraná River in the Paraná State and has 35,845 km^2 drainage area, which is approximately 685 km in length (Maack, 2012). The drainage of this basin has a dense network with many tributaries that compose its watershed, being the second largest in the Paraná State (Maack, 2012). This river is formed in the municipality of Ivaí by the confluence of the rivers Patos and São João (Santos et al., 2008), both in the State Park of Serra da Esperança, the divide between the second and third plateau of the Paraná State (Maack, 2012). Both rivers have headwaters and streams that comprise the municipality of Maringá, being part of the northwest region of the Paraná State (Figure 1).

2.2. Data collection

We compiled the records from the Maringá municipality housed in the Coleção Ictiológica do Nupélia (NUP), Maringá municipality, Paraná State, Brazil, available at SpeciesLink (2025) database, and compared them with the records of Cunico et al. (2009) for the same region (Figure 1). For each species, we cite its occurrence, specifying if it is native or non-native according to Reis et al. (2020a) or Ota et al. (2018), and the conservation status for each species uses the IUCN's (2025) categories: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU). A complete list is available in http://doi:10.48331/SCIELODATA.AP10VU.

Classification in taxonomic levels at family rank or higher ranks followed Fricke et al. (2025a). Modifications and updates in species names

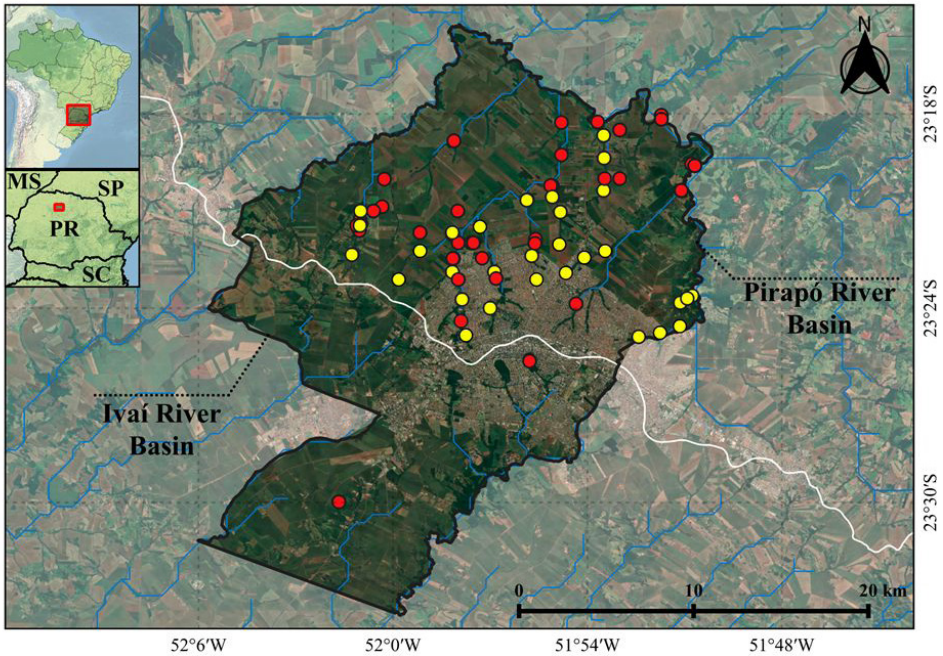

Figure 1. Partial map of South America highlighting Brazil, Paraná State, and the limits of the municipality of Maringá (black lines in the bigger map). Yellow circles represent lots recorded by Cunico et al. (2009); red circles represent lots that were further recorded in the study area. White lines represent the limits of the Ivaí and Pirapó River basins. Abbreviations: PR, Paraná State; MS, Mato Grosso do Sul State; SP, São Paulo State; SC, Santa Catarina State.

(as synonyms, validation) were accessed from Fricke et al. (2025b).

3. Results

The focus of collection in the Pirapó River basin within Maringá municipality over the last 30 years has yielded a total of 538 lots housed in the NUP fish collection at the University of Maringá, Paraná, Brazil. Maringá streams house a total of 81 species distributed into 24 families and six orders. Characiformes are the richest order with 34 species (41.98%), followed by Siluriformes with 32 species (39.51%). Other orders comprise 15 species, 18.52% of the total species recorded for the region (Table 1). Seven possible new species are presented in Figure 2, and eleven species are non-native (7.36%). No species are under any threatened category of the IUCN. However, *Bryconamericus coeruleus* Jerep & Shibatta, 2017 is considered Near Threatened (NT).

4. Discussion

The fish fauna of streams in the municipality of Maringá exhibits relatively high species richness, especially considering that the sampled environments consist exclusively of low-order streams, in contrast to the broader Ivaí and Pirapó River basins. We recorded 81 species throughout all sampled rivers within the municipality of Maringá, whereas Frota et al. (2016) reported 118 species for the entire Ivaí River basin, and Pagotto et al. (2012) recorded 76 species for the Pirapó River basin. Moreover, our survey found 58 more species than those listed by Cunico et al. (2009) in tributaries of the Pirapó River drainage within the municipality of Maringá. Of the collected species, only *Bryconamericus* sp. was found exclusively in the tributaries of the Ivaí River basin in this study.

A detailed examination of the NUP fish collection revealed that some species were identical but listed under different names (see Table 1, third column). Conversely, five species reported by Cunico et al. (2009) were not confirmed in the NUP fish collection: *Apareiodon* sp., *Hisonotus* sp., *Hypostomus* aff. *ancistroides* (Ihering, 1911) (although *H. ancistroides* is on the current list, we did not find the proper lot could not be verified); *Hypostomus* aff. *strigaticeps* (Regan, 1908), *Hypostomus* sp. (specimens from Água Queçaba stream may correspond to *H. strigaticeps*). After excluding these five species and merging synonyms between the two lists, the most up-to-dated checklist of Maringá's ichthyofauna includes 51 new records. *Cyphocharax modestus* was recorded for the Pirapó River Basin by Pagotto et al. (2012) but has not yet been registered by Reis et al. (2020a), such as the *Bunocephalus hertzi* (a paratype for the species) recently described. Additionally, in contrast to Reis et al. (2020a), *Hoplosternum littorale* can be considered native to the basin, following Langeani et al. (2007) and Ota et al. (2018).

Among the recorded taxa, seven are considered potential new species requiring further taxonomic investigation. Some belong to species complexes (i.e., morphologically similar groups that are genetically, geographically, and/or ecologically distinct). These include: (1) *Characidium zebra*,

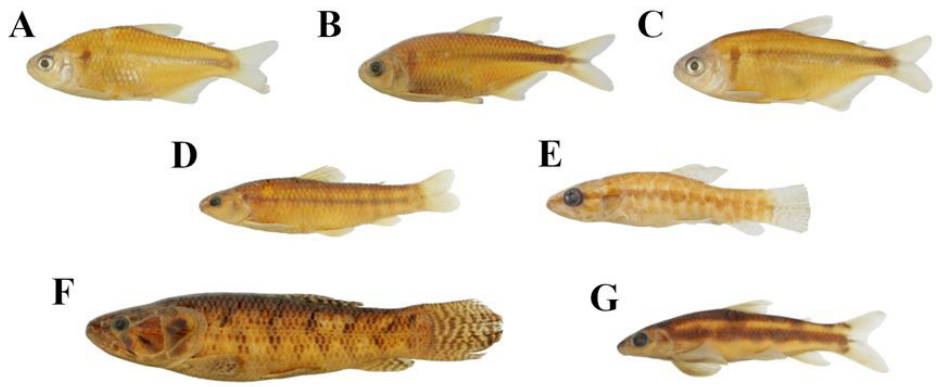

Figure 2. Probable new species from Maringá municipality streams: A) NUP 10585 *Bryconamericus* sp., 52.1 mm SL; B) NUP 6370 *Psalidodon* aff. *fasciatus*, 85.7 mm SL; C) NUP 13215 *Psalidodon* aff. *paranae*, 56.6; D) NUP 6007 *Characidium* aff. *zebra*, 59.2; E) NUP 5314 *Hoplias* aff. *malabaricus*, 30.3 mm SL; F) NUP 3833 *Hoplias* sp. 2, 157.7 mm SL; G) NUP 25206 *Apareiodon* aff. *vladii*, 47.5 mm SL.

Table 1. List of fish species from the streams of Maringá municipality. Records of native and non-native species use Reis et al. (2020a) fish species list. IUCN Red List categories (no species are threatened): Least Concern (LC) and Near Threatened (NT). Even if the species are presented without the particle aff. on the IUCN website, putative new species are considered not available (NA). Losangle (♦) shows the same species captured in Cunico et al. (2009), "New" are new records added in relation to Cunico et al. (2009) after our analysis.

Classification	Common name	Cunico et al. (2009)	IUCN category	Native/non-native species	Voucher
GYMNOTIFORMES					
Apteronotidae					
Apteronotus caudimaculosus de Santana 2003	Ituí	New	LC	Native	NUP 3854
Sternopygidae					
Sternopygus macrurus (Bloch & Schneider 1801)	Sarapó	New	LC	Native	NUP 3859
Gymnotidae					
Gymnotus inaequilabiatus (Valenciennes 1839)	Tuvira, Morenita	♦	LC	Non-native	NUP 6029
Gymnotus pantanal Fernandes, Albert, Daniel-Silva, Lopes, Crampton & Almeida-Toledo 2005	Tuvira, Morenita	New	LC	Non-native	NUP 6296
Gymnotus sylvius Albert & Fernandes-Matioli 1999	Tuvira, Morenita	New		Non-native	NUP 3850
CHARACIFORMES					
Crenuchidae					
Characidium aff. *zebra* Eigenmann 1909	Canivete	New	NA	Native	NUP 13159
Erythrinidae					
Erythrinus erythrinus (Bloch & Schneider 1801)	Jeju	♦	LC	Non-native	NUP 6032
Hoplias argentinensis Rosso, González-Castro, Bogan, Cardoso, Mabragaña, Delpiani & Díaz de Astarloa 2018	Traíra	New		Native	NUP 3894
Hoplias intermedius (Günther 1864)	Trairão	New	LC	Native	NUP 3881
Hoplias aff. *malabaricus* (Bloch 1794)	Traíra	♦	NA	Native	NUP 5314
Hoplias misionera Rosso, Mabragaña, González-Castro, Delpiani, Avigliano, Schenone et al. 2016	Traíra	New	NA	Native	NUP 19237
Hoplias sp. 2	Traíra	New	-	Native	NUP 13692
Parodontidae					
Apareiodon ibitiensis Amaral Campos 1944	Canivete	♦	LC	Native	NUP 6026
Apareiodon piracicabae (Eigenmann 1907)	Canivete	♦	LC	Native	NUP 5760
Apareiodon aff. *vladii* Pavanelli 2006	Canivete	New	NA	Native	NUP 25206
Parodon nasus Kner 1859	Canivete	New	LC	Native	NUP 3870
Serrasalmidae					
Serrasalmus maculatus Kner 1858	Piranha, Pirambeba	New	LC	Native	NUP 3867
Anostomidae					

Table 1. Continued...

Classification	Common name	Cunico et al. (2009)	IUCN category	Native/non-native species	Voucher
Leporinus amblyrhynchus Garavello & Britski 1987	Piau	New	LC	Native	NUP 3837
Leporinus friderici (Bloch 1794)	Piau-três-pintas	New	LC	Native	NUP 3865
Schizodon nasutus Kner 1858	Ximborê, Piau-bosteiro	New	LC	Native	NUP 3836
Curimatidae					
Cyphocharax modestus (Fernández-Yépez 1948)	Saguiru	New	LC	Native	NUP 3780
Steindachnerina brevipinna (Eigenmann & Eigenmann 1889)	Saguiru	New	LC	Non-native	NUP 3838
Steindachnerina insculpta (Fernández-Yépez 1948)	Saguiru	New	LC	Native	NUP 3841
Bryconidae					
Salminus brasiliensis (Cuvier 1816)	Dourado	New	LC	Native	NUP 3863
Stevardiidae					
Bryconamericus coeruleus Jerep & Shibatta 2017	Lambari	New	NT	Native	NUP 19231
Bryconamericus exodon Eigenmann 1907	Piava, piaba	New	LC	Non-native	NUP 13201
Bryconamericus sp.	Lambari	New	NA	Native	NUP 10585
Bryconamericus turiuba Langeani, Lucena, Pedrini & Tarelho-Pereira 2005	Lambari	New	LC	Native	NUP 5575
Piabarchus stramineus (Eigenmann 1908)	Pequira	♦ *Bryconamericus stramineus* Eigenmann 1908	LC	Native	NUP 5298
Piabina argentea Reinhardt 1867	Piaba	♦ *Piabina* sp.	LC	Native	NUP 20114
Characidae					
Galeocharax gulo (Cope 1870)	Dentudo	New	LC	Native	NUP 3868
Serrapinnus notomelas (Eigenmann 1915)	Piabinha	♦	LC	Native	NUP 6025
Acestrorhamphidae					
Astyanax lacustris (Lütken 1875)	Lambari-do-rabo-amarelo	♦ *Astyanax altiparanae* Garutti & Britski, 2000	LC	Native	NUP 19232
Moenkhausia bonita Benine, Castro & Sabino 2004	Lambari-de-cauda-listrada	New	LC	Native	NUP 3869
Oligosarcus paranensis Menezes & Géry 1983	Peixe-cachorro	New	LC	Native	NUP 19230
Psalidodon bockmanni (Vari & Castro 2007)	Lambari	♦ *Astyanax bockmanni* Vari & Castro, 2007	LC	Native	NUP 19229
Psalidodon aff. *fasciatus* (Cuvier 1819)	Lambari-do-rabo-vermelho	♦ *Astyanax* aff. *fasciatus* (Cuvier, 1819)	LC	Native	NUP 6370
Psalidodon aff. *paranae* (Eigenmann 1914)	Lambari	♦ *Astyanax* aff. *paranae* Eigenmann, 1914	NA	Native	NUP 13161
Psalidodon schubarti (Britski 1964)	Lambari-do-rabo-amarelo	New	LC	Native	NUP 24129

Table 1. Continued...

Classification	Common name	Cunico et al. (2009)	IUCN category	Native/non-native species	Voucher
SILURIFORMES					
Trichomycteridae					
Cambeva diabola (Bockmann, Casatti & de Pinna 2004)	Bagrinho, Cambeva, Candiru	♦ *Trichomycterus diabolus* Bockmann, Casatti & de Pinna, 2004	LC	Native	NUP 6015
Callichthyidae					
Callichthys callichthys (Linnaeus 1758)	Tamboatá	♦	LC	Native	NUP 3853
Hoplosternum littorale (Hancock 1828)	Tamboatá	New	LC	Native	NUP 13691
Osteogaster aenea (Gill 1858)	Limpa-vidro	♦ *Corydoras aeneus* (Gill, 1858)	LC	Native	NUP 5296
Loricariidae					
Hypostomus albopunctatus (Regan 1908)	Cascudo	New	LC	Native	NUP 22968
Hypostomus ancistroides (Ihering 1911)	Cascudo	New	LC	Native	NUP 13160
Hisonotus francirochai (Ihering 1928)	Cascudinho	New	LC	Native	NUP 20087
Hypostomus hermanni (Ihering 1905)	Cascudo	New	LC	Native	NUP 13468
Hypostomus nigromaculatus (Schubart 1964)	Cascudo	♦	LC	Native	NUP 24917
Hypostomus paulinus (Ihering 1905)	Cascudo	New	LC	Native	NUP 3992
Hypostomus strigaticeps (Regan 1908)	Cascudo	New	LC	Native	NUP 4924
Hypostomus aff. *tietensis* (Ihering 1905)	Cascudo	New	NA	Native	NUP 13467
Hypostomus topavae (Godoy 1969)	Cascudo	New	DD	Native	NUP 13465
Neoplecostomus yapo Zawadzki, Pavanelli & Langeani 2008	Cascudinho	♦ *Neoplecostomus* sp.	LC	Native	NUP 14735
Otothyropsis biamnicus Calegari, Lehmann A. & Reis 2013	Cascudinho	New	LC	Native	NUP 4760
Proloricaria prolixa (Isbrücker & Nijssen 1978)	Rapa-canoa	New	LC	Native	NUP 10615
Rineloricaria latirostris (Boulenger 1900)	Cascudo-chinelo	♦ *Rineloricaria* sp.	LC	Native	NUP 5299
Rineloricaria pentamaculata Langeani & de Araujo 1994	Cascudo-chinelinho	New	LC	Native	NUP 10983
Aspredinidae					
Bunocephalus hertzi Esguícero, Castro & Pereira 2020	Bagre-banjo	New	NA	Native	NUP 17492
Auchenipteridae					
Tatia neivai (Ihering 1930)	Bagrinho	New	LC	Native	NUP 3799
Heptapteridae					
Cetopsorhamdia iheringi Schubart & Gomes 1959	Bagrinho	♦	LC	Native	NUP 20109
Heptapterus longicauda (Borodin 1927)	Bagre-pedra	♦ *Imparfinis borodini* Mees & Cala, 1989	NA	Native	NUP 6028

Table 1. Continued...

Classification	Common name	Cunico et al. (2009)	IUCN category	Native/non-native species	Voucher
Imparfinis mirini Haseman 1911	Bagrinho	♦	LC	Native	NUP 5297
Imparfinis schubarti (Gomes 1956)	Bagrinho	New	LC	Native	NUP 13163
Phenacorhamdia tenebrosa (Schubart 1964)	Bagrinho	♦	LC	Native	NUP 20113
Pimelodella avanhandavae Eigenmann 1917	Bagre	♦	LC	Native	NUP 13180
Pimelodella gracilis (Valenciennes 1835)	Mandi-chorão	New	LC	Native	NUP 5307
Rhamdia quelen (Quoy & Gaimard 1824)	Jundiá	♦	LC	Native	NUP 19236
Pimelodidae					
Pimelodus maculatus Lacepède 1803	Mandi-amarelo	New	LC	Native	NUP 3795
Iheringichthys labrosus (Lütken 1874)	Mandi-bicudo	New	LC	Native	NUP 3862
Pimelodus microstoma Steindachner 1877	Mandi	New	LC	Native	NUP 19235
Pseudopimelodidae					
Rhyacoglanis paranensis Shibatta & Vari 2017	Bagre-abelha	New	LC	Native	NUP 3844
SYNBRANCHIFORMES					
Synbranchidae					
Synbranchus marmoratus Bloch 1795	Mussum	New	LC	Native	NUP 6041
CYPRINODONTIFORMES					
Poeciliidae					
Phalloceros harpagos Lucinda 2008	Barrigudinho	New	LC	Native	NUP 3848
Poecilia reticulata Peters 1859	Barrigudinho	♦	LC	Non-native	NUP 13188
Xiphophorus hellerii Heckel 1848	Espadinha	♦	LC	Non-native	NUP 6030
CICHLIFORMES					
Cichlidae					
Cichlasoma paranaense Kullander 1983	Acará	New	LC	Native	NUP 3858
Coptodon rendalli (Boulenger 1897)	Tilápia-do-Congo	New	LC	Non-native	NUP 8964
Crenicichla jaguarensis Haseman 1911	Jacundá	♦ *Crenicichla niederleinii* (Holmberg, 1891)	LC	Native	NUP 3864
Geophagus iporangensis Haseman 1911	Acará-iporanga	♦ *Geophagus* aff. *brasiliensis* (Quoy & Gaimard, 1824)	LC	Native	NUP 19228
Oreochromis niloticus (Linnaeus 1758)	Tilápia-do-Nilo	♦	LC	Non-native	NUP 3794
Saxatilia britskii (Kullander 1982)	Jacundá	♦ *Crenicichla britskii* Kullander, 1982	LC	Native	NUP 6003

originally described from the Ireng River, Guyana (Eigenmann, 1909). Because of its general morphology common to species of the genus, having wide vertical bars along the side of the body, and a scaled isthmus. *Characidium zebra* complex occurs across several South American basins and probably complies several new species (Stabile pers. Comm.), and here we treated the population from the Upper Paraná River basin as *C.* aff. *zebra*. Similarly, (2) *Hoplias malabaricus*, whose type locality is probably in Suriname (Oyakawa, 2003), presents a broad distribution range and remarkable morphotypes variation throughout South American rivers. Bifi (2013) recognized a morphotype as *H.* cf. *malabaricus* for the Upper Paraná River basin, and here we treated it as *H.* aff. *malabaricus*. (3) *Psalidodon paranae*, described from the Tibagi River from Castro, in the Paraná State, Brazil [see Garutti & Britski (2000)], is known to display substantial variation in meristic characters commonly employed in species diagnoses within the genus. For this reason, we refer to highly variable specimens that retain the species' diagnostic body pattern (*ie.*, elongated shape, two humeral spots, and maximum body depth located one scale anterior to the origin of the dorsal fin) as *P.* aff. *paranae*; (4) *Psalidodon fasciatus*, with its type locality in the São Francisco River, differs from *P.* aff. *fasciatus* by the presence of an elongated dorsal fin on the first dorsal-fin ray of mature males (Melo, 2005; Melo & Buckup, 2006). The latter species complexes are found here (5) *Apareiodon vladii*, with its type locality in the Piquiri River basin (Pavanelli, 2006), not far from the sample points in this paper. Despite this, we considered the species as *A.* aff. *vladii* due to variation in premaxillary dentition, specifically the absence of pronounced median cusps.

In addition to these species complexes, we also identified (6) *Hoplias* sp. 2, which differs from members of the *H. malabaricus* group by presenting rounded margins formed by the scales at the base of the caudal peduncle, along with an abrupt reduction in scale size through mid to the tips of caudal-peduncle (Ota et al., 2018); and (7) *Bryconamericus* sp., distinguished from *Bryconamericus* species from the region by the body shape and height, the presence and configuration of the humeral blotch, and the dentition pattern of the premaxilla.

The introduction of non-native species into rivers already impacted by urbanization and physical alterations, poses as a major threat, as such degraded environments are often more vulnerable to biological invasions (Ricciardi, 2007, 2013; Simberloff et al., 2013; Daga et al., 2016; Garcia et al., 2018; Bueno et al., 2021). Non-native species are often found in urbanized areas, with introductions frequently linked to human activities (Esmaeili et al., 2010; Larentis et al., 2019). In many cases, this phenomenon reflects disregardless about the ecological consequences. A prominent example involves species associated with the aquarium trade or those intentionally released for mosquito control, such as *Poecilia reticulata* and *Xiphophorus hellerii* (Azevedo-Santos et al., 2017; Ota et al., 2018; Larentis et al., 2019).

Other examples include *Steindachnerina brevipinna* and *Bryconamericus exodon*, both non-native in the Upper Paraná River basin. The former appears to be associated with the construction and flooding of the Itaipu Reservoir, that submerged the Sete Quedas Falls, while the latter may have spread through the opening of the Piracema Channel (Júlio Júnior et al., 2009; Ota et al., 2018). Both species are now captured in tributaries far upstream from their probable points of introduction and are widespread elsewhere in the basin.

In addition, several non–native species are suspected to have been released in the rivers as live bait (e.g., *Gymnotus inaequilabiatus*, *G. pantanal*, *G. sylvius*, and *Erythrinus erythrinus*), while others likely escaped from fishponds or aquaculture activities in general (e.g., *Oreochromis niloticus*, and *Coptodon rendalli*) (Ota et al., 2018; Reis et al., 2020a). Another remarkable example is *Iheringichthys labrosus*, which is considered a non-native species by Ota et al. (2018) but considered native by Reis et al. (2020a), indicating ongoing uncertainty regarding the origin of some putative non-native species.

Some species that occur in streams of adjacent regions were not recorded in our samples (e.g., *Ancistrus* sp., *Cambeva horacioi*, *Characidium* sp., *Hypostomus* sp. 1). Their absence is most likely related to the limited sampling effort within the Ivaí River basin in the municipality of Maringá (see Figure 1). These taxa are considered restricted to the Ivaí River basin, reinforcing the high degree of endemism already documented for this drainage (Frota et al., 2016; Reis et al., 2020a, 2020b). Consequently, expanding ichthyological surveys to additional Ivaí River tributaries is expected to substantially increase the number of species recorded in the municipality of Maringá.

5. Conclusion

Our findings highlight that the Maringá's streams ichthyofauna is both diverse and taxonomically

complex, with a richness comparable to that of larger river basins. The possibility of seven new species highlights the importance of ongoing taxonomic investigations, particularly within poorly resolved species complexes. Meanwhile, the presence of multiple non-native species (*e.g.,* introduced through aquarium releases, mosquito control, live bait, or aquaculture) illustrates how anthropogenic activities are reshaping local fish assemblages and increasing the ecological vulnerability of already impacted urban and rural streams. Furthermore, expanding ichthyological surveys, especially across additional tributaries of the Ivaí River basin, and in the Pirapó River basin in the municipality of Maringá, will not only refine the understanding of regional biodiversity and endemism but also provide critical information for the development of strategies to mitigate biological invasions and preserve native fish communities. With this updated checklist of freshwater fishes' species from Maringá, we hope it will be a source of data for decision-makers and to be used in management and conservation plans in the region.

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Data availability

All research data analyzed in the research (supplementary material file) is available in the SciELO Dataverse Repository. Access is available for download. It can be accessed at http://doi:10.48331/SCIELODATA.AP10VU.

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