

Ichthyofauna of the rio Araguaia basin, states of Mato Grosso and Goiás, Brazil

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ABSTRACT: This study provides a list of fish species from tributaries of the rio Araguaia basin, in its upper-middle portions in the states of Mato Grosso and Goiás, Brazil. Fish assemblages were sampled in August 2008 using standard ichthyological gear along ten sampling sites. A total of 2246 individuals of 89 species, 21 families and five orders were collected. Most species collected were Characidae, Loricariidae and Cichlidae. The genera *Serrapinnus*, *Hyphessobrycon* and *Hemigrammus* were the most abundant and widely distributed in the total sampled area. The presence of endemic species, undescribed or with undefined taxonomic status requires attention to the knowledge and conservation of the Araguaia river basin ichthyofauna.

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INTRODUCTION

The Araguaia river system is a complex mosaic of lentic and lotic environments with high diversity of fish species (Merona 1987; Lowe-McConnell 1999). The fish fauna present in the Araguaia-Tocantins basin is similar to that of the Amazon basin, though with greater number of endemic species (Tejerina-Garro *et al.* 2002; Melo *et al.* 2005). Among recent publications, Melo *et al.* (2004) studied diet of 71 species of fish from a small stream of upper rio Araguaia; Benedito-Cecilio *et al.* (2004) studied a dividing water area of the Parque Nacional das Emas, in the headwaters of the rivers Araguaia (Araguaia basin) and Anaconda (upper Paraná basin), resulting in an account of 18 species; Melo *et al.* (2005) published a catalog comprising 51 medium to large sized fish species from rio das Mortes; Silva *et al.* (2007) investigated the factors that influenced the fish community in the Bananal plain, and found 80 species; Melo *et al.* (2007) found 72 species in the lower rio das Mortes. In the most recent study, Venere and Garutti (2011) listed 162 species in the Parque Estadual da Serra Azul, Araguaia basin.

Considering its importance for the Neotropical biodiversity, the Araguaia is seriously threatened because most of the basin, about 78%, is inserted in the biome Cerrado. This biome is one of the 25 most threatened biomes on the planet, being classified as “hotspot” of biodiversity (Mittermeier *et al.* 1999). The main causes for this alert on its conservation are human settlement, deforestation, degradation of riparian vegetation by agro-pastoral activities on a large scale, and the constant installation of mines and hydroelectric dams (Agostinho *et al.* 2009). The Cerrado has a rich and unique ichthyofauna, however, there are few studies and lists of fish species from the upper-middle rio Araguaia basin (Venere and Garutti 2011). Therefore this study aims to present the composition and distribution of fish fauna in this region.

MATERIALS AND METHODS

Study site

Fish samples were collected in the region of Serra Azul and Serra do Roncador in the upper-middle Araguaia basin, in the municípios Barra do Garças and Aragarças (Figure 1), in the states of Mato Grosso and Goiás respectively. The climate is tropical wet and characterized by two well defined seasons, rainy season (October to April) and dry season (May to September), with an average temperature of 25.5°C (Pirani *et al.* 2009).

Data collection

Ten sites were sampled in the tributaries of the Araguaia basin during the dry season, from July 29 to August 2, 2008 (Table 1). Fish collections were performed using standard ichthyological gear comprising sieves, seine nets and cast nets (IBAMA permit number 12120-1). The sampling effort included 60 minutes of sampling by three people at each site. Fish were fixed in 10% formalin solution and subsequently transferred to 70% ethanol. Species were identified up to the lowest possible taxonomic level, using available literature and further confirmation by experts when possible. The taxonomic classification follows Eschmeyer (2013). Voucher specimens were deposited in the fish collection of the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL), Londrina, Paraná State, Brazil. The voucher specimens and respective pictures are shown in Appendices 1 and 2.

Data analysis

Efficiency of sampling was assessed using species accumulation curves. Non-parametric estimators Chao 1 (Incidence-based Coverage Estimator, Chao 1987) and ACE (Abundance-based Coverage Estimator, Lee and Chao 1994) were used for compare the estimates of richness among data sets of this inventory, considering

the species-abundance distribution of the samples. For these analyzes we used EstimateS 8.2 software (Colwell 2009). Quantum GIS 2.0.1 software was used to perform a map of geographical distribution of collection sites (QGIS Development Team 2014).

RESULTS

A total of 2246 individuals were collected, belonging to five orders, 21 families, and 89 species (Table 2). Characiformes (45 spp.), Siluriformes (32 spp.) and Perciformes (7 spp.) were the orders that reached highest species richness, respectively representing 50%, 36.4% and 8.0% of the total fish species collected. Families with highest species richness were Characidae (31.8%), followed by Loricariidae (14.8%), Cichlidae (8%), Heptapteridae

(6.8%), Crenuchidae and Pseudopimelodidae (4.5%). The most abundant species were *Serrapinnus* sp. (34.2%), *Hyphessobrycon* sp. (6.5%), *Hemigrammus* aff. *geisleri* (5.9%), *Imparfinis mirini* and *Aspidoras poecilus* (3.6%); totaling 53.8% of the individuals captured.

The largest amount of collected species occurred in the rio Corrente (S5, 40 spp.), the lowest amount (6 spp.) were collected in the lagoon of the rio Corrente (S10), and the median was 19 species. The number of species expected for the study area according to the accumulation curve of species based on Chao 1 and ACE was 116 and 108, respectively. Species richness observed (89 species) represents 75.9% of the species estimated by Chao 1 and 81.5% by ACE, which demonstrates a good sampling efficiency (Figure 2).

TABLE 1. Geographical coordinates and altitude of sampling sites in the rio Araguaia basin, Mato Grosso and Goiás States, Brazil.

SITE	WATERCOURSES	LATITUDE (S)	LONGITUDE (W)	ALT (M)
S1	Córrego Fundo	15°51'32.2"	52°19'01.0"	378
S2	Rio Taquaralzinho	15°42'40.5"	52°35'28.6"	532
S3	Rio Taquaral	15°40'41.4"	52°17'52.3"	368
S4	Rio Ínsula	15°35'44.8"	52°22'35.8"	390
S5	Rio Corrente	15°29'56.9"	52°12'10.5"	324
S6	Afluente do rio Ínsula	15°34'19.7"	52°13'25.6"	321
S7	Córrego Jaraguá	15°56'26.9"	52°15'18.2"	350
S8	Rio das Mulas	15°54'34.7"	52°05'34.4"	321
S9	Rio Araguaia	15°53'28.1"	52°14'47.2"	351
S10	Lagoa do rio Corrente	15°29'56.9"	52°12'10.5"	317

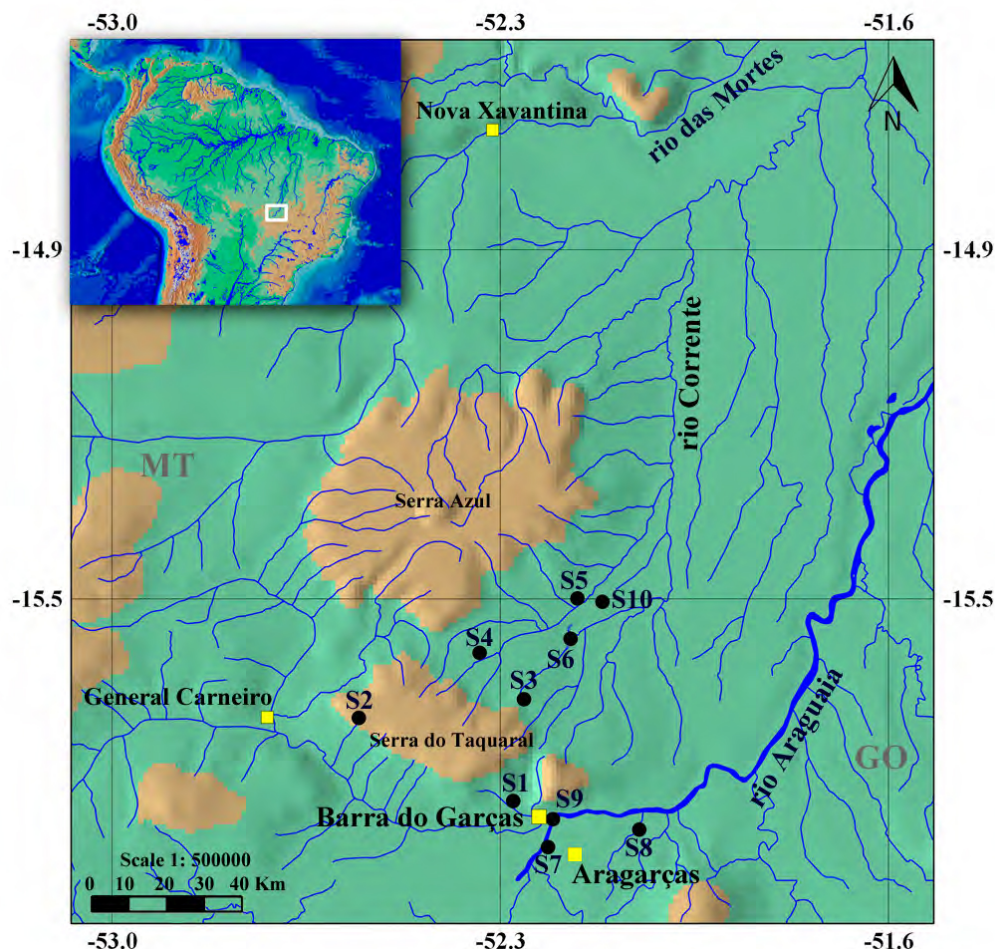


FIGURE 1. Map of the study area showing the collecting sites (black dots) in the rio Araguaia basin, Mato Grosso and Goiás State, Brazil. Corrêgo Fundo (S1), rio Taquaralzinho (S2), rio Taquaral (S3), rio Ínsula (S4), rio Corrente (S5), rio Ínsula tributary (S6), Córrego Jaraguá (S7), rio das Mulas (S8), rio Araguaia (S9), rio Corrente lagoon (S10). Cities are represented by yellow squares.

DISCUSSION

The Characiformes and Siluriformes were the most common, totaling 86% of the species caught. The dominance of these orders in this study is usually observed for most of the rivers of the Neotropical region, as pointed out by Lowe-McConnell (1987, 1999) Casatti *et al.* (2001) and corroborated by several authors (Castro and Casatti 1997; Böjsen and Barriga 2002; Cetra and Petrere 2006). Nevertheless, according to the number of species estimated by Chao 1 and ACE, additional samplings are required to get a more accurate prediction of the number of species in the rio Araguaia basin.

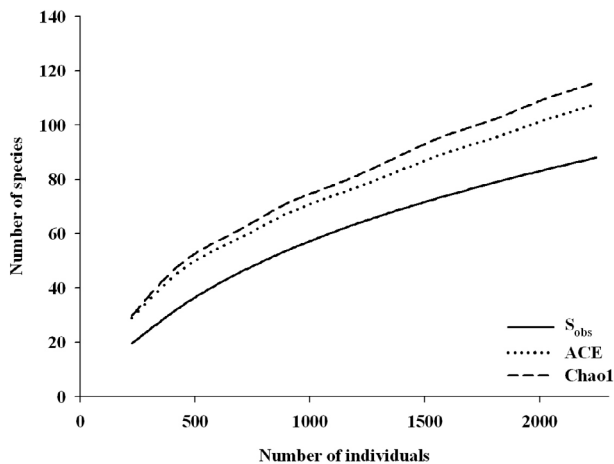


FIGURE 2. Comparison of species accumulation curves generated by species richness (Sobs) and the richness estimators (Chao 1 and ACE), for collections made in the tributaries of the rio Araguaia basin, Mato Grosso and Goiás State, Brazil.

Among the sampling sites formed by small streams, the most common families were Characidae and Loricariidae (46.6%), including mostly small species (Appendix 2, according to the size classification proposed by Vazzoler 1996). These species were characterized by differences in their spatial distribution (Table 2), which can be influenced by the variability of physical conditions, as well as the availability of habitats found in each of these environments (Vannote *et al.* 1980; Garutti 1988).

Were identified 23 species only to genus level and might be new records or new species, comprising Siluriformes (12 spp.) and Characiformes (11 spp.). It is noteworthy that the fauna surveyed by Claro-García and Shibatta (2013) from the upper rio Tocantins, had only 12 species shared with our inventory, indicating that these regions are distinct, despite belonging to the same ecoregion (Abell *et al.* 2008). Although most of these species occur throughout the Amazon basin, *Astyanax elachylepis* is exclusive to Araguaia-Tocantins basin. Of the 89 species presented in this study, 12.4% are possibly endemic species of the rio Araguaia basin. The high endemism of upper rio Araguaia basin had already been pointed out by Lima and Moreira (2003), when they described three species of *Hyphessobrycon* endemic to this region. This inventory also includes small-sized recently described species, as *Tetragonopterus denticulatus* (Silva *et al.* 2013), *Microglanis xylographicus* and *Microglanis oliveirai* (Ruiz and Shibatta 2011), possibly endemic to upper-middle rio Araguaia basin. The presence of a lot of unidentified small-sized species in tributaries of the rio Araguaia basin serves as evidence of the great importance of this kind of inventory, emphasizing its potential for discovery of new and endemic species.

TABLE 2. Fish species collected in the rio Araguaia basin, Mato Grosso and Goiás States, Brazil.

TAXA	SAMPLING SITES									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
CHARACIFORMES										
Hemiodontidae										
<i>Bivibranchia velox</i> (Eigenmann & Myers, 1927)									3	
<i>Hemiodus</i> sp.									1	
<i>Hemiodus unimaculatus</i> (Bloch, 1794)									1	
Parodontidae										
<i>Apareiodon argenteus</i> Pavanelli & Britski, 2003									15	
Curimatidae										
<i>Cyphocharax cf. spilurus</i> (Günther, 1864)	5							2		1
<i>Cyphocharax gouldingi</i> Vari, 1992				2	39					
<i>Steindachnerina amazonica</i> (Steindachner, 1911)			1				6			
Anostomidae										
<i>Anostomus ternetzi</i> Fernández-Yépez, 1949					3					
<i>Hypomasticus aff. megalepis</i> (Günther, 1863)	1		2	2		2				
Erythrinidae										
<i>Hoplias malabaricus</i> (Bloch, 1794)		1	1	1	7	1				
Lebiasinidae										
<i>Pyrrhulina australis</i> Eigenmann & Kennedy, 1903				1						
Ctenoluciidae										
<i>Boulengerella cuvieri</i> (Spix & Agassiz, 1829)				1						
Characidae										
<i>Aphyocharax</i> sp.							1		2	
<i>Astyanax argyrimarginatus</i> Garutti, 1999							17			
<i>Astyanax asuncionensis</i> Géry, 1972	6	1	2		1			2		1

TABLE 2. CONTINUED.

TAXA	SAMPLING SITES									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
<i>Astyanax elachylepis</i> Bertaco & Lucinda, 2005	1									
<i>Bryconamericus</i> sp.						19				
<i>Bryconops alburnoides</i> Kner, 1858					7					
<i>Creagrutus seductus</i> Vari & Harold, 2001	2								61	
<i>Galeocharax gulo</i> (Cope, 1870)									1	
<i>Hemigrammus</i> aff. <i>geisleri</i> Zarske & Géry, 2007					132					
<i>Hemigrammus rodwayi</i> Durbin, 1909		1								
<i>Hemigrammus</i> sp.			1	4	1					
<i>Hyphessobrycon copelandi</i> (Steindachner, 1882)					1					
<i>Hyphessobrycon</i> sp.		3			81		7		56	
<i>Jupiaba polylepis</i> (Günther, 1864)					10					
<i>Jupiaba acanthogaster</i> (Eigenmann, 1911)	1									
<i>Knodus</i> sp.	17	19				1	1		38	
<i>Microschemobrycon elongatus</i> Géry, 1973				3		2				
<i>Moenkhausia</i> aff. <i>lepidura</i> (Kner, 1858)									2	
<i>Moenkhausia collettii</i> (Steindachner, 1882)					11					
<i>Moenkhausia dichroua</i> (Kner, 1858)										2
<i>Moenkhausia gracilima</i> Eigenmann, 1908									3	
<i>Moenkhausia oligolepis</i> (Günther, 1864)	2	2	1	7	13					
<i>Moenkhausia pankilopteryx</i> Bertaco & Lucinda, 2006		5								
<i>Moenkhausia</i> sp.	1			2	27				17	
<i>Phenacogaster</i> sp.	5			1	15		1			
<i>Roeboexodon guyanensis</i> (Puyo, 1948)					10					
<i>Serrapinnus</i> sp.	7	31		10	406		155		160	
<i>Tetragonopterus denticulatus</i> Silva, Melo, Oliveira & Benine, 2013									2	
<i>Xenrobrycon coracoralinae</i> Moreira, 2005	1									
Crenuchidae										
<i>Characidium</i> sp. 1				11	23	6				
<i>Characidium</i> sp. 2									1	
<i>Characidium zebra</i> Eigenmann, 1909		6	19				37			
<i>Melanocharacidium auroradatum</i> Costa & Vicente, 1994		4			3	1				
SILURIFORMES										
Doradidae										
<i>Nemadoras leporhinus</i> (Eigenmann, 1912)				2						
Pseudopimelodidae										
<i>Microglanis oliveirai</i> Ruiz & Shibatta, 2011					12		3			
<i>Microglanis xylographicus</i> Ruiz & Shibatta, 2011					4					
<i>Pseudopimelodus bufonius</i> (Valenciennes, 1840)									1	
<i>Pseudopimelodus</i> aff. <i>pulcher</i> (Boulenger, 1887)		6								
Heptapteridae										
<i>Imparfinis mirini</i> Haseman, 1911	5	33	15	3	10	4	1	10		
<i>Mastiglanis asopos</i> Bockmann, 1994				3	12					
<i>Phenacorhamdia somnians</i> (Mees, 1974)	6	22	6	2	17	3				
<i>Phenacorhamdia</i> sp.					1					
<i>Pimelodella</i> sp. 1		1	4					4		
<i>Pimelodella</i> sp. 2	4			4	40					
Aspredinidae										
<i>Bunocephalus</i> cf. <i>aleuopsis</i> Cope, 1870					5					
<i>Ernstichthys</i> sp.									1	
Trychomycteridae										
<i>Henonemus intermedius</i> (Eigenmann & Eigenmann, 1889)									9	
<i>Ituglanis macunaima</i> Datovo & Landim, 2005			1		9					
<i>Ochmacanthus</i> sp.					1					
Callichthyidae										
<i>Aspidoras poecilus</i> Nijssen & Isbrücker, 1976	3	73		1			3			
<i>Corydoras araguaiaensis</i> Sands, 1990				4						
<i>Corydoras</i> sp.		1								

TABLE 2. CONTINUED.

TAXA	SAMPLING SITES										
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	
Loricariidae											
<i>Ancistrus</i> sp.	2	5		1							
<i>Farlowella</i> aff. <i>oxyrryncha</i> (Kner, 1853)					1		1	2			
<i>Farlowella henriquei</i> Miranda Ribeiro, 1918	5			13	1						
<i>Hypoptopoma muzuspi</i> Aquino & Schaefer, 2010					20	5					
<i>Hypostomus faveolus</i> Zawadzki, Birindelli & Lima, 2008						1					
<i>Hypostomus</i> sp. 1	6	14			2			2			
<i>Hypostomus</i> sp. 2			1			2					
<i>Hypostomus</i> sp. 3					9		4				
<i>Loricaria</i> sp.							3	1	20		
<i>Parotocinclus</i> cf. <i>britskii</i> Boeseman, 1974	5		2		38	5					
<i>Rineloricaria hasemani</i> Isbrücker & Nijssen, 1979		1	2	4	11	3		9			
<i>Spatuloricaria</i> sp.					1				1		
<i>Sturisoma</i> aff. <i>nigrirostrum</i> Fowler, 1940				1							
GYMNOTIFORMES											
Sternopygidae											
<i>Eigenmannia trilineata</i> López & Castello, 1966	1	8	9		7	1					
<i>Sternopygus macrurus</i> (Bloch & Schneider, 1801)					4						
Apteronotidae											
<i>Apteronotus albifrons</i> (Linnaeus, 1766)	1		1								
Hypopomidae											
<i>Microsternarchus bilineatus</i> Fernández-Yépez, 1968						2					
CYPRINODONTIFORMES											
Rivulidae											
<i>Rivulus zygonectes</i> (Myers, 1927)	1	16		1			3				
PERCIFORMES											
Cichlidae											
<i>Apistogramma eunotus</i> Kullander, 1981						1					
<i>Cichla kelberi</i> Kullander & Ferreira, 2006										1	
<i>Cichlasoma araguaense</i> Kullander, 1983				3						2	
<i>Crenicichla labrina</i> (Spix & Agassiz, 1831)		1	2	2	1			1			
<i>Geophagus proximus</i> (Castelnau, 1855)					2						
<i>Retroculus lapidifer</i> (Castelnau, 1855)									1		
<i>Satanoperca jurupari</i> (Heckel, 1840)										9	
Abundance	88	254	70	89	998	59	243	33	396	16	
Richness	23	22	17	26	40	17	15	9	21	6	

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- APPENDIX 1.** Voucher specimens of species from the rio Araguaia basin, examined in the present study.
- CHARACIFORMES: Hemiodontidae:** *Bivibranchia velox* (MZUEL 7646), *Hemiodus* sp. (MZUEL 7648), *Hemiodus unimaculatus* (MZUEL 7647). **Parodontidae:** *Apareiodon argenteus* (MZUEL 7609, 7621). **Curimatidae:** *Cyphocharax* cf. *spilurus* (MZUEL 7619, 7620, 7624, 7625), *Cyphocharax gouldingi* (MZUEL 7626, 7627), *Steindachnerina amazonica* (MZUEL 7622, 7623). **Anostomidae:** *Anostomus ternetzi* (MZUEL 7628, 7629), *Hypomasticus* aff. *megalepis* (MZUEL 7630, 7631, 7632, 7633). **Erythrinidae:** *Hoplias malabaricus* (MZUEL 7650, 7651, 7652, 7653, 7654, 7655, 7656, 7657, 7658). **Lebiasinidae:** *Pyrhulina australis* (MZUEL 7659). **Ctenoluciidae:** *Boulengerella cuvieri* (MZUEL 7660). **Characidae:** *Aphyocharax* sp. (MZUEL 7782, 7783), *Astyanax argyrimarginatus* (MZUEL 7790), *Astyanax asuncionensis* (MZUEL 7784, 7785, 7786, 7787, 7788, 7789), *Astyanax elachylepis* (MZUEL 7791), *Bryconamericus* sp. (MZUEL 7808), *Bryconops alburnoides* (MZUEL 7793, 7794), *Creagrutus seductus* (MZUEL 7795, 7796, 7797, 7798), *Galeocharax gulo* (MZUEL 7799), *Hemigrammus* aff. *geisleri* (MZUEL 7800, 7801, 7802), *Hemigrammus rodwayi* (MZUEL 7803), *Hemigrammus* sp. (MZUEL 7804, 7805, 7806, 7807), *Hyphessobrycon copelandi* (MZUEL 7814), *Hyphessobrycon* sp. (MZUEL 7792, 7809, 7810, 7811, 7812, 7813, 7815, 7816, 7817, 7818, 7819, 7820), *Jupiaba polylepis* (MZUEL 7821, 7822, 7823, 7824), *Jupiaba acanthogaster* (MZUEL 7649), *Knodus* sp. (MZUEL 7825, 7826, 7827, 7828, 7829, 7830, 7831, 7832), *Microschemobrycon elongatus* (MZUEL 7833, 7834), *Moenkhausia* aff. *lepidura* (MZUEL 7836), *Moenkhausia colletii* (MZUEL 7835), *Moenkhausia dichroua* (MZUEL 7837), *Moenkhausia gracilima* (MZUEL 7838), *Moenkhausia oligolepis* (MZUEL 7839, 7840, 7841, 7842, 7843, 7844), *Moenkhausia pankilopteryx* (MZUEL 7880), *Moenkhausia* sp. (MZUEL 7845, 7846, 7847, 7848, 7849, 7850, 7851, 7852, 7853), *Phenacogaster* sp. (MZUEL 7855, 7856, 7857, 7858, 7859, 7860), *Roebioxodon guyanensis* (MZUEL 7861, 7862), *Serrapinnus* sp. (MZUEL 7781, 7854, 7863, 7864, 7865, 7866, 7867, 7868, 7869, 7870, 7871, 7872, 7873, 7874, 7875), *Tetragonopterus denticulatus* (MZUEL 7876), *Xenobrycon coracoralinae* (MZUEL 7877). **Crenuchidae:** *Characidium* sp. 1 (MZUEL 7634, 7635, 7636, 7641, 7642), *Characidium* sp. 2 (MZUEL 7638), *Characidium zebra* (MZUEL 7637, 7639, 7640), *Melanocharacidium auroradiatum* (MZUEL 7643, 7644, 7645). **SILURIFORMES: Doradidae:** *Nemadoras leporhinus* (MZUEL 7664). **Pseudopimelodidae:** *Microglanis oliveirai* (INPA 35623, 35624, MZUEL 5174, 5175), *Microglanis xylographicus* (MZUEL 5173), *Pseudopimelodus bufonius* (MZUEL 7715), *Pseudopimelodus* aff. *pulcher* (MZUEL 7716). **Heptapteridae:** *Imparfinis mirini* (MZUEL 7731, 7732, 7733, 7734, 7735, 7736, 7737, 7738, 7739, 7740), *Mastiglanis asopos* (MZUEL 7726, 7727, 7728, 7729, 7730), *Phenacorhamdia somnians* (MZUEL 7611, 7717, 7718, 7719, 7720, 7721, 7722, 7723, 7724), *Phenacorhamdia* sp. (MZUEL 7725), *Pimelodella* sp. 1 (MZUEL 7748, 7749, 7750), *Pimelodella* sp. 2 (MZUEL 7741, 7742, 7743, 7744, 7745, 7746, 7747). **Aspredinidae:** *Bunocephalus* cf. *aleuropsis* (MZUEL 7751), *Ernstichthys* sp. (MZUEL 7752). **Trychomycteridae:** *Henonemus intermedius* (MZUEL 7670), *Ituglanis macunaima* (MZUEL 7665, 7666, 7667, 7668, 7669), *Ochmacanthus* sp. (MZUEL 7615). **Callichthyidae:** *Aspidoras poecilus* (MZUEL 7610, 7617, 7661, 7662), *Corydoras araguaiaensis* (MZUEL 7614), *Corydoras* sp. (MZUEL 7663). **Loricariidae:** *Ancistrus* sp. (MZUEL 7671, 7672, 7673), *Farlowella* aff. *oxyrryncha* (MZUEL 7618, 7674, 7675), *Farlowella henriquei* (MZUEL 7676, 7677, 7678, 7679), *Hypoptopoma muzuspi* (MZUEL 7616, 7680, 7681, 7682), *Hypostomus faveolus* (MZUEL 7683), *Hypostomus* sp. 1 (MZUEL 7684, 7685, 7686, 7687, 7688), *Hypostomus* sp. 2 (MZUEL 7689, 7690), *Hypostomus* sp. 3 (MZUEL 7691, 7692), *Loricaria* sp. (MZUEL 7693, 7694, 7695, 7696, 7697), *Parotocinclus* cf. *britskii* (MZUEL 7698, 7699, 7700, 7701, 7702, 7703, 7704), *Rineloricaria hasemani* (MZUEL 7612, 7613, 7705, 7706, 7707, 7708, 7709, 7710, 7711), *Spatuloricaria* sp. (MZUEL 7712, 7713), *Sturisoma* aff. *nigrirostrum* (MZUEL 7714). **GYMNODONTIFORMES: Sternopygidae:** *Eigenmannia trilineata* (MZUEL 7753, 7754, 7755, 7756, 7757, 7758, 7759), *Sternopygus macrurus* (MZUEL 7760, 7761). **Apterodontidae:** *Apterodontus albifrons* (MZUEL 7763, 7764). **Hypopomidae:** *Microsternarchus bilineatus* (MZUEL 7762). **CYPRINODONTIFORMES: Rivulidae:** *Rivulus zygonectes* (MZUEL 7765, 7766, 7767, 7768). **PERCIFORMES: Cichlidae:** *Apistogramma eunotus* (MZUEL 7777), *Cichla kelberi* (MZUEL 7779), *Cichlasoma araguaianse* (MZUEL 7774, 7775), *Crenicichla labrina* (MZUEL 7769, 7770, 7771, 7772, 7773), *Geophagus proximus* (MZUEL 7776), *Retroculus lapidifer* (MZUEL 7778), *Satanoperca jurupari* (MZUEL 7780).

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APPENDIX 2. Photos of fishes from rio Araguaia basin, Mato Grosso and Goiás State, Brazil.

CHARACIFORMES

Hemiodontidae



Bivibranchia velox 27.1 mm MZUEL 7646



Hemiodus tocantinensis 29.7 mm MZUEL 7648



Hemiodus unimaculatus 185.7 mm MZUEL 7647

Parodontidae



Apareiodon argenteus 64.9 mm MZUEL 7621

APPENDIX 2. CONTINUED.

Curimatidae



Cyphocharax cf. spilurus 85.1 mm MZUEL 7624



Cyphocharax gouldingi 29.4 mm MZUEL 7627



Steindachnerina amazonica 35.1 mm MZUEL 7622

APPENDIX 2. CONTINUED.

Anostomidae



Anostomus ternetzi 67.4 mm MZUEL 7629



Hypomasticus aff. *megalepis* 93.1 mm MZUEL 7631

Erythrinidae



Hoplias malabaricus 56.3 mm MZUEL 7652

APPENDIX 2. CONTINUED.

Lebiasinidae



Pyrrhulina australis 22.9 mm MZUEL 7659

Ctenoluciidae



Boulengerella cuvieri 162.1 mm MZUEL 7660

Characidae



Aphyocharax sp. 28.1 mm MZUEL 7782

APPENDIX 2. CONTINUED.



Astyanax argyrimarginatus 50.6 mm MZUEL 7790



Astyanax asuncionensis 49.1 mm MZUEL 7787



Astyanax elachylepis 96.7 mm MZUEL 7791

APPENDIX 2. CONTINUED.



Bryconamericus sp. 22.7 mm MZUEL 7792



Bryconops alburnoides 39.2 mm MZUEL 7793



Creagrutus seductus 64.7 mm MZUEL 7796



Galeocharax gulo 129.2 mm MZUEL 7799

APPENDIX 2. CONTINUED.



Hemigrammus aff. *geisleri* 22.8 mm MZUEL7800



Hemigrammus rodwayi 20.9 mm MZUEL 7803



Hemigrammus sp. 27.8 mm MZUEL 7807

APPENDIX 2. CONTINUED.



Hyphessobrycon copelandi 17.8 mm MZUEL 7814



Hyphessobrycon sp. 28.3 mm MZUEL 7808



Jupiaha polylepis 34.3 mm MZUEL 7822

APPENDIX 2. CONTINUED.



Jupiaba acanthogaster 19.7 mm MZUEL 7649



Knodus sp. 30.8 mm MZUEL 7825



Microchemobrycon elongatus 24.2 mm MZUEL 7833

APPENDIX 2. CONTINUED.



Moenkhausia aff. *lepidura* 33.4 mm MZUEL 7836



Moenkhausia *collettii* 32.1 mm MZUEL 7835



Moenkhausia *dichrourea* 71.1 mm MZUEL 7837

APPENDIX 2. CONTINUED.



Moenkhausia gracilima 32.2 mm MZUEL 7838



Moenkhausia oligolepis 30.9 mm MZUEL 7839



Moenkhausia pankilopteryx 39.4 mm MZUEL 7880

APPENDIX 2. CONTINUED.



Moenkhausia sp. 29.9 mm MZUEL 7850



Phenacogaster sp. 30.6 mm MZUEL 7860



Roeboexodon guyanensis 35.6 mm MZUEL 7861

APPENDIX 2. CONTINUED.



Serrapinnus sp. 20.3 mm MZUEL 7863



Tetragonopterus denticulatus 46.2 mm MZUEL 7876



Xenurobrycon coracoralinae 10.3 mm MZUEL 7877

APPENDIX 2. CONTINUED.

Crenuchidae



Characidium sp. 1 30.2 mm MZUEL7634



Characidium sp. 2 30.4 mm MZUEL 7638



Characidium zebra 41.7 mm MZUEL 7639



Melanocharacidium auroradiatum 30.9 mm MZUEL 7644

APPENDIX 2. CONTINUED.

SILURIFORMES

Doradidae



Nemadoras leporhinus 107.2 mm MZUEL 7664

Pseudopimelodidae



Microglanis oliveirai 26.5 mm MZUEL 5175



Microglanis xylographicus 16.9 mm MZUEL 5173

APPENDIX 2. CONTINUED.



Pseudopimelodus bufonius 85.1 mm MZUEL 7715



Pseudopimelodus aff. *pulcher* 28.4 mm MZUEL 7716

Heptapteridae



Imparfinis mirini 44.9 mm MZUEL 7740

APPENDIX 2. CONTINUED.



Mastiglanis asopos 29.2 mm MZUEL 7728



Phenacorhamdia somnians 36.2 mm MZUEL 7721



Phenacorhamdia sp. 45.7 mm MZUEL 7725



Pimelodella sp. 1 61.2 mm MZUEL 7748

APPENDIX 2. CONTINUED.



Pimelodella sp. 2 45.2 mm MZUEL 7745

Aspredinidae



Bunocephalus cf. *aleuopsis* 62.4 mm MZUEL 7751

APPENDIX 2. CONTINUED.



Ernstichthys sp. 25.4 mm MZUEL 7752

Trychomycteridae



Henonemus intermedius 85.3 mm MZUEL 7670



Ituglanis macunaima 63.3 mm MZUEL 7668

APPENDIX 2. CONTINUED.



Ochmacanthus sp. 29.3 mm MZUEL 7615

Callichthyidae



Aspidoras poecilus 22.3 mm MZUEL 7661



Corydoras araguaiaensis 42.8 mm MZUEL 7614

APPENDIX 2. CONTINUED.



Corydoras sp. 28.1 mm MZUEL 7663

Loricariidae



Ancistrus sp. 30.9 mm MZUEL 7672



Farlowella aff. *oxyrryncha* 90.4 mm MZUEL 7675



Farlowella henriquei 117.8 mm MZUEL 7679

APPENDIX 2. CONTINUED.



Hypoptopoma muzuspi 26.9 mm MZUEL 7616



Hypostomus faveolus 42.1 mm MZUEL 7683



Hypostomus sp. 1 52.2 mm MZUEL 7685



Hypostomus sp. 2 32.8 mm MZUEL 7689

APPENDIX 2. CONTINUED.



Hypostomus sp. 3 39.5 mm MZUEL 7692



Loricaria sp. 37.2 mm MZUEL 7696



Parotocinclus cf. *britskii* 27.4 mm MZUEL 7699



Rineloricaria *hasemani* 47.8 mm MZUEL 7710



Spatuloricaria sp. 59.9 mm MZUEL 7712

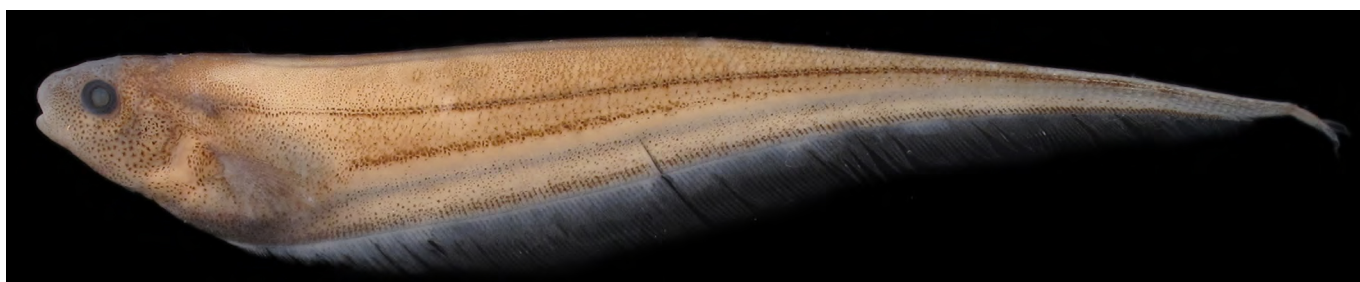
APPENDIX 2. CONTINUED.



Sturisoma aff. *nigrirostrum* 94.4 mm MZUEL 7714

GYMNOTIFORMES

Sternopygidae



Eigenmannia trilineata 80.3 mm MZUEL 7757



Sternopygus macrurus 109.7 mm MZUEL 7760

Apteronotidae



Apteronotus albifrons 121.6 mm MZUEL 7764

APPENDIX 2. CONTINUED.

Hypopomidae



Microsternarchus bilineatus 70.3 mm MZUEL 7762

CYPRINODONTIFORMES

Rivulidae



Rivulus zygonectes 29.9 mm MZUEL 7766

PERCIFORMES

Cichlidae



Apistogramma eunotus 17.7 mm MZUEL 7777

APPENDIX 2. CONTINUED.



Cichla kelberi 253.7 mm MZUEL 7779



Cichlasoma araguaense 58.9 mm MZUEL 7775



Crenicichla labrina 56.3 mm MZUEL 7769

APPENDIX 2. CONTINUED.



Geophagus proximus 43.1 mm MZUEL 7776



Retroculus lapidifer 88.4 mm MZUEL 7778



Satanoperca jurupari 155.3 mm MZUEL 7780