

Fishes from the Parque Nacional do Pantanal Matogrossense, upper Paraguai River basin, Brazil

Carla Natacha Marcolino Polaz^{1,2*}, Bruno F. Melo³, Ricardo Britzke³, Emiko Kawakami de Resende⁴, Francisco de Arruda Machado⁵, José Augusto Ferraz de Lima⁶ and Miguel Petrere Jr.⁷

1 Universidade de São Paulo, Escola de Engenharia de São Carlos, Centro de Recursos Hídricos e Ecologia Aplicada, Rod. Domingos Innocentini km13, 292. CEP 13566-590, São Carlos, SP, Brazil.

2 Centro Nacional de Pesquisa e Conservação de Peixes Continentais, Instituto Chico Mendes de Conservação da Biodiversidade, Rod. SP 201 km 6.5, 64. CEP 13630-000, Pirassununga, SP, Brazil.

3 Universidade Estadual Paulista, Instituto de Biociências, Departamento de Morfologia, Rubião Jr. s/n. CEP 18618-970, Botucatu, SP, Brazil.

4 Empresa Brasileira de Pesquisa Agropecuária, Embrapa Pantanal, Rua 21 de Setembro, 1880. 79320-900 Corumbá, MS, Brazil.

5 Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, nº 2367, Bairro Boa Esperança. CEP 78060-900, Cuiabá, MT, Brazil.

6 Parque Nacional do Pantanal Matogrossense, Instituto Chico Mendes de Conservação da Biodiversidade, Zona Rural de Poconé, MT. Caixa Postal 8005. CEP 78048-960, Cuiabá, MT, Brazil.

7 Universidade Federal de São Carlos, Rod. João Leme dos Santos, Km 110, SP-264, Itinga. CEP 18052-780, Sorocaba, SP, Brazil.

* Corresponding author. E-mail: carlapolaz@yahoo.com.br

ABSTRACT: The Pantanal Biosphere Reserve contains one of the highest concentration of animal species in the Neotropics, including about 300 fish species living in diverse environments associated with wetlands in the upper Paraguai River basin. This biome spans portions of Bolivia, Brazil and Paraguay and includes the Parque Nacional do Pantanal Matogrossense (PNPM), a region of the Pantanal which has been assigned as high conservation priority in Brazil. This study reports the results of an ichthyological survey within the PNPM, where samples were taken at 12 sites during the dry season in 2001, 2010 and 2011. We record 182 species representing three classes, 10 orders and 41 fish families. We report the first occurrence of the genus *Anchoiella* (order Clupeiformes), in the La Plata basin. This survey will provide information for future studies concerning conservation and management plans for the PNPM as well as for the Pantanal, which is one of the largest permanent wetland areas in the world and among the most unique and important South American biomes.

INTRODUCTION

Occupying the middle of the upper Paraguay River basin and draining portions of Bolivia, Brazil and Paraguay, the Pantanal biome is one of the largest continuous tropical wetlands on Earth, spanning approximately 150,000 km² (IBGE 2004). It has dry (March to September) and rainy (October to February) seasons, creating an annual rise and fall of water level that supports an abundant fish fauna (Catella and Petrere Jr. 1996; Corrêa *et al.* 2009). Because the Pantanal Biosphere Reserve contains one of the highest animal species richness of the Neotropical region, it is considered along with the Amazon an UNESCO World Natural Heritage Site and part of the RAMSAR convention (IBAMA 2004). This international zone includes the Parque Nacional do Pantanal Matogrossense (PNPM), which was created in 1981 and is considered to be a high priority area for the conservation of the Pantanal under Brazilian law (SNUC 2000).

The South American fish fauna is estimated to contain more than 7,000 species representing a great fraction of the world's freshwater fishes (Carvalho and Albert 2011). Beginning in the 19th Century, many publications concerning the fishes from the upper Paraguai River basin have been produced (Perugia 1891; Boulenger 1895; 1897; 1900; Eigenmann and Kennedy 1903; Eigenmann *et al.* 1907; Britski *et al.* 1999; 2007). The number of estimated species from the upper Paraguai River basin is about 330 species (Reis *et al.* 2003) and the last faunistic compilation (Britski *et al.* 2007) assigned 269 species to the Pantanal's core. However, formal and well-documented fish surveys

from Brazilian protected areas like the PNPM are scarce (*e.g.* Aquino *et al.* 2009; Ferreira *et al.* 2011; Pedroza *et al.* 2012), and lists of species from management plans are not usually published.

This study presents a survey of the ichthyofauna of the PNPM in the upper Paraguai River basin. Because its habitats remain virtually unchanged relative to their original condition, we aim to contribute to fish conservation in the Brazilian system of protected areas.

MATERIALS AND METHODS

The PNPM covers 1,350 km² at the border of Brazil (Poconé county, Mato Grosso State) and Bolivia (Figure 1). Within the PNPM, fishes were sampled at 12 sites in three different aquatic environments: river channels (*rios*, two sites), lakes (*baías*, six sites) and small streams (*corixos*, four sites) (Table 1, Figure 2). Rivers represent major waterways (*e.g.* Rio Cuiabá and Rio Paraguai), while lakes are large, lentic lagoons that are connected to river channels during the rainy season and isolated during the dry season. Streams (or *corixos*) are channels that connect the main rivers to lakes.

Data were collected in April, June and September 2001 (as part of the fish inventory management plan of the PNPM), in October and November 2010, and in October and November 2011 (in an attempt to capture and account for species not sampled in 2001) during daylight. Sampling efforts in 2010 and 2011 were standardized at all sites. Each site was sampled with seven gillnets blocking fish passage for two hours, two castnets (15 casts each) and

30 tows of dipnets along the vegetated margins by three collectors. A 20-meter bottom trawl was used at two lakes to complete the sampling of associated fish fauna. In 2001,

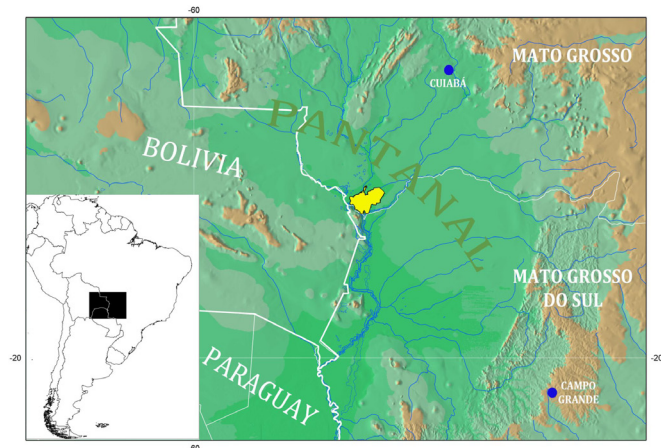


FIGURE 1. Map of the Pantanal biome showing the Parque Nacional do Pantanal Matogrossense in the yellow area, at the border of Bolivia and Brazil, upper Paraguai River basin.

the 12 sites were inventoried without standardization of gear. The Pantanal expeditions were entirely coordinated by the ICMBio/MMA team who has permission to collect wild species in protected areas in Brazil (SISBIO 15261-1 and 22855-1).

The specimens were counted and sacrificed in a solution of clove oil (Eugenol, 2 drops per liter; *cf.* American Veterinary Medical Association 2001). After that, the fish were fixed in 96% ethanol (for molecular studies) or 10% formalin solution (for morphological studies) and then preserved in 70% ethanol. Large specimens or those in poor conditions were not deposited in museums. Muscle tissues were collected and preserved in 96% ethanol to support later genetic analyses (voucher specimens were also preserved). Species identifications were performed consulting the taxonomic literature and identification keys (Britski *et al.* 1999; 2007; Costa 2011; Ferraris 2007; Géry 1977; Lucena 2003; 2007; Malabarba 2004; Souza-Filho and Shibatta 2007; Vari 1991; 1992a, b). Specimens that were not identified to species level were not inventoried to avoid accidentally listing a species twice. We used

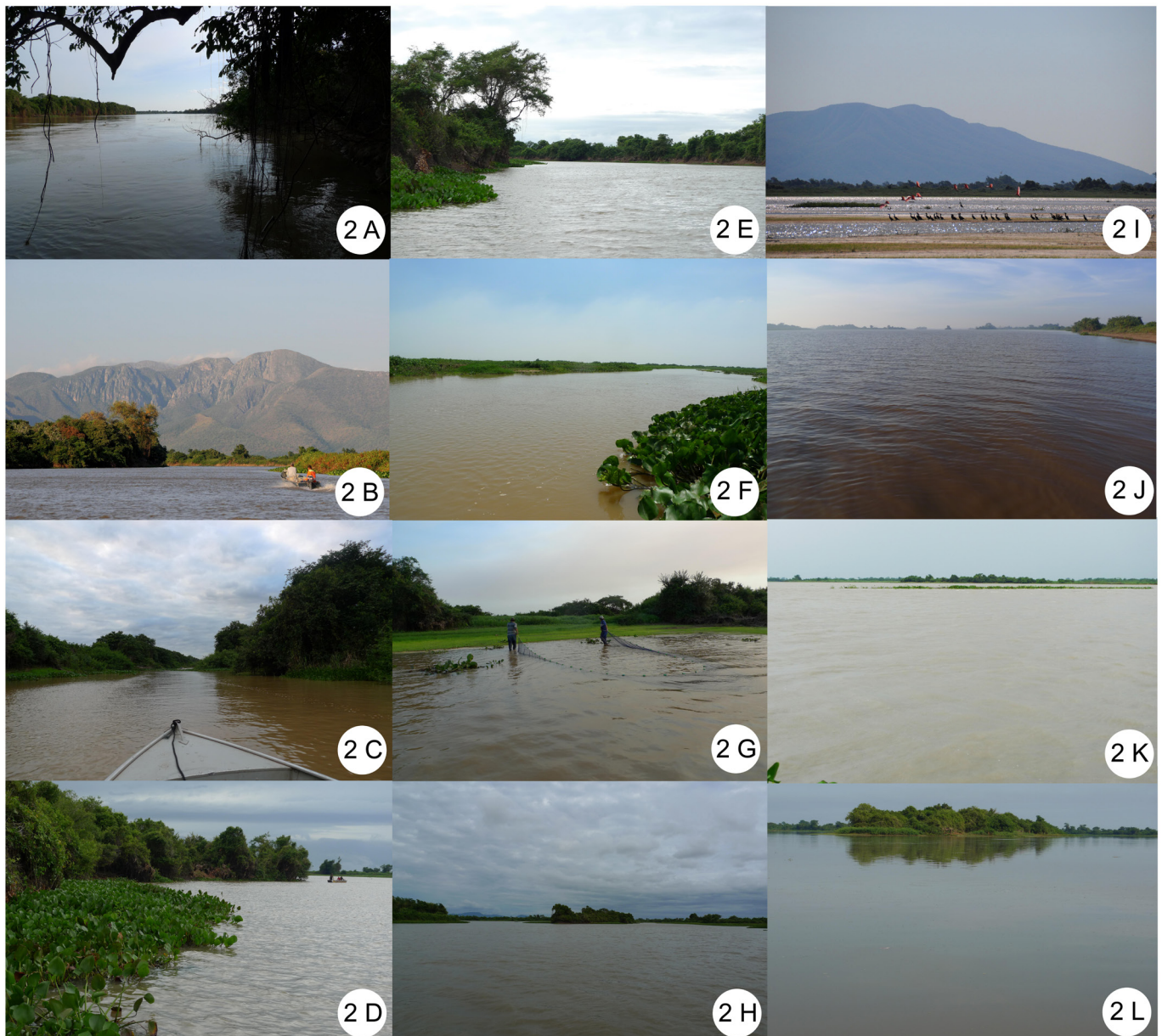


FIGURE 2. Sampled localities in the Parque Nacional do Pantanal Matogrossense, upper Paraguai River basin, Brazil. See Table 1 for detailed locality information. Photos by Carla N.M. Polaz (2A, 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K and 2L) and Leonardo Milano (2B and 2I).

CLOFFSCA (Reis *et al.* 2003) for classification of classes, orders and families, except in Characiformes in which we used the classification of Oliveira *et al.* (2011), and an alphabetical order for genera and species. The specimens and tissues were deposited at the Laboratório de Biologia e Genética de Peixes, Universidade Estadual Paulista, Botucatu, SP, Brazil (LBP) and Laboratório de Ictiologia de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, SP, Brazil (LIRP). Additional uncatalogued material is housed at Embrapa Pantanal, Campo Grande, MS, Brazil (collection of Pantanal fishes under construction).

RESULTS

A total of 182 fish species were collected during this survey, representing three classes, 10 orders and 41 families (Table 2). The orders comprising the highest percentage of species richness were Characiformes (45%) and Siluriformes (34.8%), followed by Perciformes (8.7%) and Gymnotiformes (5.4%). These four orders represented 93.9% of the total richness. The most highly represented family was Characidae (20.8% of the species), followed by Loricariidae (9.3%) and Cichlidae (8.2%). These values are consistent with other ichthyofaunal compilations in South American freshwaters (*e.g.* Langeani *et al.* 2007; Ortega and Hidalgo 2008; Vari *et al.* 2009; Le Bail *et al.* 2012). In collecting expeditions from 2010 and 2011, we sampled specimens of the genus *Anchoviella*, representing the first record of the genus in the upper Paraguai River basin (Figure 3).

DISCUSSION

Each habitat requires distinct and suitable methods for collecting fishes most effectively (Uieda and Castro

1999). Such methods can be ordinarily divided into active and passive approaches (Oyakawa and Esteves 2004). In 2010 and 2011, when methods were standardized, active methods were more efficient than passive ones. Nearly 75% of fish richness was collected with seines while gillnets were responsible for less than 20%. Although the bottom trawl was applied only in two localities (*baías*), it was the second most effective equipment for fish sampling. We strongly recommend the use of bottom trawls in surveys of the Pantanal whenever possible.

Some juveniles could not be identified to species-level (*Astyanax* sp., *Bryconamericus* sp., *Characidium* sp., *Hemigrammus* sp., *Hyphessobrycon* sp., *Odontostilbe* sp., *Pimelodella* sp., *Pimelodus* sp., and *Serrapinnus* sp.). Additionally, three species could only be identified to species complexes (*Ancistrus* sp., *Hypostomus* sp. and *Imparfinis* sp.). Such difficulties in identification are common among freshwater fishes, and many recent studies of systematics and taxonomy in the Paraguai basin have attempted to resolve such problems in many taxonomic groups, including characiforms (Malabarba 2004; Benine *et al.* 2009), gymnotiforms (Albert and Crampton 2003; Carvalho *et al.* 2011), and siluriforms (Zawadzki *et al.* 2010; Vera-Alcaraz *et al.* 2012).

The Pantanal expeditions made an interesting discovery in 2010 and 2011. We collected 24 specimens of *Anchoviella*, which represent the first report of the genus in the upper Paraguai River basin. Previously, the only member of Engraulidae known to occur in the freshwaters of the La Plata basin was the silver sardine *Lycengraulis grossidens* (Kullander and Ferraris 2003). The family Engraulidae comprises about 140 species

TABLE 1. Sampled localities in the Parque Nacional do Pantanal Matogrossense: environments, localities, geographic coordinates and their respective figures.

ENVIRONMENTS	LOCALITY	COORDINATES	FIGURES
Rivers	Rio Cuiabá	17°49'37.77" S, 57°22'53.38" W	Fig. 2A
	Rio Paraguai	17°52'41.80" S, 57°28'42.90" W	Fig. 2B
Small streams	Corixo Boca do Ricardo	17°51'36.14" S, 57°24'06.49" W	Fig. 2C
	Corixo Bigueirinho	17°47'33.70" S, 57°33'26.70" W	Fig. 2D
	Corixo Caracarazinho do Morro	17°49'28.09" S, 57°30'43.68" W	Fig. 2E
	Corixo Morro do Caracará	17°50'52.45" S, 57°26'23.63" W	Fig. 2F
	Baía do Burro	17°49'51.69" S, 57°23'42.82" W	Fig. 2G
Lakes	Baía Caracarazinho do Morro	17°49'26.40" S, 57°31'06.32" W	Fig. 2H
	Baía do Morro	17°50'49.50" S, 57°27'10.70" W	Fig. 2I
	Baía do Nove	17°47'59.00" S, 57°23'41.60" W	Fig. 2J
	Baía do Rio Bigueirinho	17°48'04.60" S, 57°33'58.10" W	Fig. 2K
	Baía das Três Bocas	17°51'29.60" S, 57°28'34.10" W	Fig. 2L



FIGURE 3. Specimen of *Anchoviella* sp., LBP 13692, 38.9 mm in total length, collected at corixo Bigueirinho in the PNPM, upper Paraguai River basin, Brazil.

worldwide, with some marine species entering brackish or freshwater environments (Whitehead *et al.* 1988; Kullander and Ferraris 2003). The genus *Anchoviella* lives in marine, estuarine, or freshwater habitats in South, Central, and North America (Loeb 2012). These specimens from Pantanal are currently being studied as part of a taxonomic review of *Anchoviella* (M. Loeb, personal communication).

Comparing across the two different sampling periods,

105 species (57.2% of the total) were collected in both 2001 and 2010-2011, while 26 species were found only in the first period and 61 were collected only in the most recent expeditions (2010-2011). Our survey obtained approximately 70% of the total species known to inhabit the Pantanal (Britski *et al.* 2007). As the PNPM area is still incompletely explored and studied, it is likely that more new records of fish species will be discovered within its borders in the near future.

TABLE 2. List of fish species collected in the Parque Nacional do Pantanal Matogrossense, upper Paraguai River basin. Samples were made in 2001¹ and 2010-2011². () Total of species - *Genus* sp. represents cases that were not included in species counts, to avoid the possibility of counting a species twice.

CLASS/ORDER/FAMILY/SPECIES	
CLASS CHONDRICHTHYES (1)	
MYLIOBATIFORMES (1)	
Potamotrygonidae (1)	
^{1,2} <i>Potamotrygon motoro</i> (Müller & Henle, 1841)	LBP 12619
CLASS ACTINOPTERYGII (191 species)	
CLUPEIFORMES (2)	
Engraulidae (1)	
² <i>Anchoviella</i> sp.	LBP 13692, LBP 14024
Pristigasteridae (1)	
¹ <i>Pellona flavipinnis</i> (Valenciennes, 1837)	Embrapa uncatalogued
CHARACIFORMES (82)	
Parodontidae (1)	
^{1,2} <i>Apareiodon affinis</i> (Steindachner, 1879)	LBP 12934, LBP 12989
Curimatidae (8)	
^{1,2} <i>Curimatella dorsalis</i> (Eigenmann & Eigenmann, 1889)	LBP 13459
^{1,2} <i>Curimatopsis myersi</i> Vari, 1982	LBP 13434, LBP 13540, LBP 13641, LBP 14006
^{1,2} <i>Cyphocharax gillii</i> (Eigenmann & Kennedy, 1903)	LBP 13623, LBP 14014, LBP 14021, LBP 14064
^{1,2} <i>Potamorhina squamoraletis</i> (Braga & Azpelicueta, 1983)	LBP 12629
^{1,2} <i>Psectrogaster curviventris</i> Eigenmann & Kennedy, 1889	LBP 13338, LIRP 9538
² <i>Steindachnerina brevipinna</i> (Eigenmann & Eigenmann, 1889)	LBP 14057
² <i>Steindachnerina conspersa</i> (Holmberg, 1891)	LBP 12987, LBP 13461, LBP 14055
² <i>Steindachnerina "nigrotaenia"</i> Boulenger, 1902	LBP 13338
Prochilodontidae (1)	
^{1,2} <i>Prochilodus lineatus</i> (Valenciennes, 1837)	Embrapa uncatalogued
Anostomidae (8)	
^{1,2} <i>Abramites hypselonotus</i> (Günther, 1868)	LBP 12884, LBP 12918, LBP 13442, LBP 13522, LBP 13597, LBP 13718, LBP 14010, LBP 14049
^{1,2} <i>Leporinus cf. frederici</i> Bloch, 1794	LBP13443, LIRP 9450
^{1,2} <i>Leporinus lacustris</i> Amaral Campos, 1945	LBP 12906, LBP 12978, LBP 13339, LBP 13411, LBP 13517, LBP 13580, LBP 13629, LBP 13659, LBP 13696, LBP 16953
^{1,2} <i>Leporinus macrocephalus</i> Garavello & Britski, 1988	Embrapa uncatalogued
^{1,2} <i>Leporinus obtusidens</i> (Valenciennes, 1836)	LIRP 9448, LIRP 9449, LIRP 9657
^{1,2} <i>Leporinus striatus</i> Kner, 1858	LBP 12899, LBP 12938, LBP 12976, LBP 13481, LBP 13524, LBP 13568, LBP 13582, LBP 13619, LBP 13707, LBP 14028, LBP 14052
^{1,2} <i>Schizodon borellii</i> (Boulenger, 1900)	LBP 12626, LBP 13404, LBP 13625, LBP 13640
² <i>Schizodon isognathus</i> Kner, 1858	LBP 14027
Crenuchidae (2)	
^{1,2} <i>Characidium laterale</i> (Boulenger, 1895)	LBP 12894, LBP 12931, LBP 13414, LBP 13551
^{1,2} <i>Characidium</i> aff. <i>zebra</i> Eigenmann, 1909	LBP 12932, LBP 13421, LBP 13464, LBP 13512
² <i>Characidium</i> sp.	LBP 13675
Hemiodontidae (1)	
^{1,2} <i>Hemiodus orthonops</i> Eigenmann & Kennedy, 1903	Embrapa uncatalogued
Bryconidae (2)	
^{1,2} <i>Brycon hilarii</i> (Valenciennes, 1850)	LBP 12624
¹ <i>Salminus brasiliensis</i> (Cuvier, 1816)	Embrapa uncatalogued
Triportheidae (3)	
¹ <i>Clupeacharax anchoveoides</i> Pearson, 1924	Embrapa uncatalogued
^{1,2} <i>Triportheus nematurus</i> (Kner, 1858)	LBP 12640, LBP 12971, LIRP 9426
^{1,2} <i>Triportheus pantanensis</i> Malabarba, 2004	LBP 13457, LIRP 9427

TABLE 2. CONTINUED.

CLASS/ORDER/FAMILY/SPECIES	
Gasteropelecidae (2)	
² <i>Gasteropelecus sternicla</i> (Linnaeus, 1758)	LBP 12940, LBP 12955, LBP 13429, LBP 13445, LBP 13715
^{1,2} <i>Thoracocharax stellatus</i> (Kner, 1858)	LBP 14015
Characidae (38)	
^{1,2} <i>Aphyocharax anisitsi</i> Eigenmann & Kennedy, 1903	LIRP 9552, LIRP 9553
^{1,2} <i>Aphyocharax dentatus</i> Eigenmann & Kennedy, 1903	LBP 12941, LBP 13475, LBP 13514, LBP 13581
^{1,2} <i>Aphyocharax nattereri</i> Steindachner, 1882	LBP 12939, LBP 13536, LBP 13608
² <i>Aphyocharax rathbuni</i> Eigenmann, 1907	LBP 13415, LBP 13533
² <i>Astyanax abramis</i> (Jenyns, 1842)	LBP 13584, LBP 13713
^{1,2} <i>Astyanax asuncionensis</i> Géry, 1972	LBP 12997, LBP 14011, LBP 14018, LBP 14043
² <i>Astyanax</i> sp.	LBP 13530, LBP 13677
^{1,2} <i>Bryconamericus exodon</i> Eigenmann, 1907	LBP 12926, LBP 13408, LBP 13463, LBP 13500, LBP 13565, LBP 13598
² <i>Bryconamericus stramineus</i> Eigenmann, 1908	LBP 12911
² <i>Bryconamericus</i> sp.	LBP 13711
² <i>Charax leticiae</i> Lucena, 1987	LBP 12935, LBP 13542, LBP 13620, LBP 13706, LBP 14025
² <i>Ctenobrycon alleni</i> (Eigenmann & Kennedy, 1907)	LBP 13668, LBP 14009, LBP 14032
^{1,2} <i>Cynopotamus kincaidi</i> (Schultz, 1950)	LBP 12638, LBP 13658
² <i>Gymnocorymbus ternetzi</i> (Boulenger, 1895)	LBP 14005
^{1,2} <i>Galeocharax humeralis</i> (Valenciennes, 1834)	LBP 12959, LBP 13453, LBP 13483, LBP 13694
² <i>Hemigrammus lunatus</i> Durbin, 1918	LBP 12927, LBP 12972, LBP 13472, LBP 13605
² <i>Hemigrammus marginatus</i> Ellis, 1911	LIRP 9559, LIRP 9560
² <i>Hemigrammus</i> sp.	LBP 14012
¹ <i>Hemigrammus ulreyi</i> (Boulenger, 1895)	Embrapa uncatalogued
^{1,2} <i>Hyphessobrycon eques</i> (Steindachner, 1882)	LBP 12903, LBP 13419, LBP 13509, LBP 13534, LBP 13570, LBP 14007
² <i>Hyphessobrycon megalopterus</i> (Eigenmann, 1915)	LBP 13538
² <i>Hyphessobrycon</i> sp.	LBP 13498, LBP 14033
^{1,2} <i>Jupiaba acanthogaster</i> (Eigenmann, 1911)	LBP 13572, LBP 13584, LBP 13713
¹ <i>Knodus chapadae</i> (Fowler, 1906)	Embrapa uncatalogued
^{1,2} <i>Moenkhausia bonita</i> Benine, Castro & Sabino, 2004	LBP 17827
^{1,2} <i>Moenkhausia dichrourea</i> Kner, 1858	LBP 12948, LBP 12998, LBP 13422, LBP 13553, LBP 14040
^{1,2} <i>Moenkhausia forestii</i> Benine, Mariguela & Oliveira, 2009	LBP 12946, LBP 12966, LBP 13423, LBP 13513
^{1,2} <i>Moenkhausia</i> cf. <i>oligolepis</i> (Günther, 1864)	LIRP 9578, LIRP 9579, LIRP 9560
^{1,2} <i>Odontostilbe paraguayensis</i> Eigenmann & Kennedy, 1903	LBP 12893, LBP 12942, LBP 12954, LBP 13508
^{1,2} <i>Odontostilbe pequirá</i> (Steindachner, 1882)	LBP 12912, LBP 12945, LBP 12975, LBP 13496
² <i>Odontostilbe</i> sp.	LBP 13574
¹ <i>Phenacogaster tegatus</i> (Eigenmann, 1911)	Embrapa uncatalogued
² <i>Piabarchus analis</i> (Eigenmann, 1914)	LIRP 9587, LIRP 9588, LIRP 9589
^{1,2} <i>Poptella paraguayensis</i> (Eigenmann, 1907)	LBP 12969, LBP 13409, LBP 13447, LBP 13554, LBP 13680, LBP 13695, LBP 14044
^{1,2} <i>Prionobrama paraguayensis</i> (Eigenmann, 1914)	LBP 12902, LBP 12951, LBP 13407, LBP 13564, LBP 13586
^{1,2} <i>Psellogrammus kennedyi</i> (Eigenmann, 1903)	LBP 12933, LBP 12953, LBP 12988, LBP 13425, LBP 13433, LBP 13590, LBP 13617, LBP 14045, LBP 16951
^{1,2} <i>Roeboides affinis</i> (Günther, 1868)	LBP 14023, LBP 14050, LBP 14066
^{1,2} <i>Roeboides descavadensis</i> Fowler, 1932	LBP 13618
^{1,2} <i>Roeboides microlepis</i> (Reinhardt, 1851)	LBP 13456
^{1,2} <i>Serrapinnus calliurus</i> (Boulenger, 1900)	LBP 12890, LBP 12947, LBP 12974, LBP 13420, LBP 13467, LBP 13511
² <i>Serrapinnus kriegi</i> (Schindler, 1937)	LBP 12900, LBP 12928, LBP 13503
² <i>Serrapinnus microdon</i> (Eigenmann, 1915)	LBP 12943, LBP 13497, LBP 13577
² <i>Serrapinnus</i> sp.	LBP 13550
^{1,2} <i>Tetragonopterus argenteus</i> Cuvier, 1816	LBP 12990, 13558, 14036, 14046
Serrasalmidae (8)	
² <i>Metynnis maculatus</i> (Kner, 1858)	Uncatalogued
¹ <i>Metynnis mola</i> Eigenmann & Kennedy, 1903	Embrapa uncatalogued
^{1,2} <i>Myleus levis</i> Eigenmann & McAtee, 1907	LBP 12644, LBP 13406
^{1,2} <i>Mylossoma duriventre</i> (Cuvier, 1818)	LBP 12623, LIRP 9628, LIRP 9629
^{1,2} <i>Piaractus mesopotamicus</i> Holmberg, 1887	Embrapa uncatalogued
^{1,2} <i>Pygocentrus nattereri</i> Kner, 1858	LBP 12641
^{1,2} <i>Serrasalmus maculatus</i> Kner, 1858	Embrapa uncatalogued
^{1,2} <i>Serrasalmus marginatus</i> Valenciennes, 1837	LBP 12639

TABLE 2. CONTINUED.

CLASS/ORDER/FAMILY/SPECIES	
Acestorhynchidae (1)	
^{1,2} <i>Acestorhynchus pantaneiro</i> Menezes, 1992	LBP 12632, LBP 13451
Cynodontidae (1)	
^{1,2} <i>Rhaphiodon vulpinus</i> Spix & Agassiz, 1829	LBP 12615
Erythrinidae (3)	
² <i>Erythrinus erythrinus</i> (Bloch & Schneider, 1801)	LBP 16949
² <i>Hoplerythrinus unitaeniatus</i> (Spix & Agassiz, 1829)	LBP 12888
^{1,2} <i>Hoplias</i> aff. <i>malabaricus</i> (Bloch, 1794)	LBP 13444, LBP 13557, LBP 13061
Lebiasinidae (1)	
^{1,2} <i>Pyrrhulina australis</i> Eigenmann & Kennedy, 1903	LBP 12910, LBP 12937, LBP 13426, LBP 13614, LBP 13669, LBP 13704
Iguanodectidae (2)	
¹ <i>Bryconops melanurus</i> (Bloch 1794)	Embrapa uncatalogued
² <i>Piabucus melanostoma</i> Holmberg, 1891	LBP 12929, LBP 13410, LBP 13452, LBP 13462, LBP 17830, LIRP 9645
SILURIFORMES (63)	
Aspredinidae (3)	
² <i>Amaralia hypsiura</i> (Kner, 1855)	LBP 12968
¹ <i>Bunocephalus doriae</i> Boulenger, 1902	LBP 14063
² <i>Pseudobunocephalus rugosus</i> (Eigenmann & Kennedy, 1903)	LBP 13531, LBP 13594, LBP 13649, LBP 13689
Trichomycteridae (4)	
² <i>Ituglanis eichorniarum</i> (Miranda Ribeiro, 1912)	LBP 13585, LBP 14062
² <i>Ituglanis herberti</i> (Miranda Ribeiro, 1940)	LBP 13468
¹ <i>Ochmacanthus batrachostomus</i> (Miranda Ribeiro, 1912)	Embrapa uncatalogued
² <i>Trichomycterus johnsoni</i> (Fowler, 1932)	LBP 13468
Callichthyidae (4)	
¹ <i>Callichthys callichthys</i> (Linnaeus, 1758)	Embrapa uncatalogued
^{1,2} <i>Corydoras hastatus</i> Eigenmann & Eigenmann, 1888	LBP 12901, LBP 13418, LBP 13502, LBP 13552
^{1,2} <i>Hoplosternum littorale</i> (Hancock, 1828)	LBP 12885, LIRP 9433
^{1,2} <i>Lepthoplosternum pectorale</i> (Boulenger, 1895)	LBP 16957, LIRP 9432
Scoloplacidae (2)	
² <i>Scoloplax distolothrix</i> Schaefer, Weitzman & Britski, 1989	LBP 12952
² <i>Scoloplax empousa</i> Schaefer, Weitzman & Britski, 1989	LBP 17829
Loricariidae (17)	
² <i>Ancistrus</i> sp.	LBP 12970
² <i>Farlowella paraguayensis</i> Retzer & Page, 1997	LBP 12914, LBP 13665
^{1,2} <i>Hemiodontichthys acipenserinus</i> (Kner, 1853)	LBP 13593
^{1,2} <i>Hypoptopoma inexpectatum</i> (Holmberg, 1893)	LBP 13602, LBP 13636, LBP 13655, LBP 13727, LIRP 9387, LIRP 9388, LIRP 9389
² <i>Hypostomus</i> aff. <i>ancistroides</i> (Ihering, 1911)	LIRP 9461, LIRP 9463
² <i>Hypostomus boulengeri</i> (Eigenmann & Kennedy, 1903)	LBP 12625, LBP 12944
^{1,2} <i>Hypostomus cochliodon</i> Kner, 1854	LBP 12886, LBP 12963, LBP 13499, LBP 13555
² <i>Hypostomus latifrons</i> Weber, 1986	LBP 12887, LBP 12925, LBP 12965, LBP 13518
^{1,2} <i>Hypostomus</i> sp.	LBP 13435, LBP 13437, LBP 13460, LBP 13600
^{1,2} <i>Loricaria</i> sp.	LBP 13400
² <i>Loricariichthys labialis</i> (Boulenger, 1895)	LBP 17840
^{1,2} <i>Loricariichthys platymetopon</i> Isbrücker & Nijssen, 1979	LBP 12621
¹ <i>Megalancistrus parananus</i> (Peters, 1881)	Embrapa uncatalogued
^{1,2} <i>Otocinclus vittatus</i> Regan, 1904	LBP 13607, LBP 13729
² <i>Proloricaria prolixa</i> (Isbrücker & Nijssen 1978)	LBP 12620, LBP 17839
^{1,2} <i>Pterygoplichthys ambrosettii</i> (Holmberg, 1893)	LBP 12618, LBP 13545, LIRP 9429, LIRP 9430
^{1,2} <i>Rineloricaria parva</i> (Boulenger, 1895)	LBP 12922, LBP 12964, LBP 13439, LBP 13474, LIRP 9382, LIRP 9383, LIRP 9384
^{1,2} <i>Sturisoma barbatum</i> (Kner, 1853)	LBP 12622, LBP 12895, LBP 12996
Pseudopimelodidae (1)	
¹ <i>Microglanis cottoides</i> (Boulenger 1891)	Embrapa uncatalogued
Heptapteridae (6)	
² <i>Imparfinis</i> sp.	LBP 17828, LBP 12892, LBP 12930, LBP 12950, LBP 13413, LBP 13465
^{1,2} <i>Phenacorhamdia hoehnei</i> (Miranda Ribeiro, 1914)	LBP 13520
^{1,2} <i>Pimelodella</i> cf. <i>gracilis</i> (Valenciennes, 1835)	LBP 13401, LBP 13450, LBP 13588
² <i>Pimelodella mucosa</i> Eigenmann & Ward, 1907	LBP 12646
² <i>Pimelodella notomelas</i> Eigenmann, 1917	LBP 12995

TABLE 2. CONTINUED.

CLASS/ORDER/FAMILY/SPECIES	
² <i>Pimelodella</i> sp.	LBP 17832
^{1,2} <i>Rhamdia</i> aff. <i>quelen</i> (Quoy & Gaimard, 1824)	LBP 12628, LBP 12991, LBP 13454, LBP 13622
Pimelodidae (11)	
^{1,2} <i>Pseudoplatystoma corruscans</i> (Spix & Agassiz, 1829)	Embrapa uncatalogued
^{1,2} <i>Pseudoplatystoma reticulatum</i> Eigenmann & Eigenmann, 1889	Embrapa uncatalogued
^{1,2} <i>Hemisorubim platyrhynchos</i> (Valenciennes, 1840)	LBP 12631
² <i>Hypophthalmus edentatus</i> Spix & Agassiz, 1829	Embrapa uncatalogued
¹ <i>Megalonema platanum</i> (Günther, 1880)	Embrapa uncatalogued
^{1,2} <i>Pimelodus argenteus</i> Perugia, 1891	LBP 12634
^{1,2} <i>Pimelodus ornatus</i> Kner, 1858	LIRP 9527
^{1,2} <i>Pimelodus pantaneiro</i> Souza-Filho & Shibatta, 2007	LBP 12633
² <i>Pimelodus</i> sp.	LBP 17831
¹ <i>Pinirampus pirinampu</i> (Spix & Agassiz, 1829)	LBP 12611
^{1,2} <i>Sorubim lima</i> (Bloch & Schneider, 1801)	LBP 12610
¹ <i>Zungaro jahu</i> (Ihering, 1898)	LBP 12612
Doradidae (6)	
^{1,2} <i>Anadoras weddellii</i> (Castelnaud, 1855)	LBP 13416, LBP 13523
² <i>Ossancora eigenmanni</i> (Boulenger, 1895)	LBP 13583, LBP 13637, LBP 16954
^{1,2} <i>Oxydoras kneri</i> Bleeker, 1862	LBP 14650
² <i>Platydoras armatulus</i> (Valenciennes, 1840)	LBP 12973, LBP 13595, LBP 14001, LBP 14058
^{1,2} <i>Pterodoras granulosus</i> (Valenciennes, 1821)	LBP 12613
^{1,2} <i>Rhinodoras dorbignyi</i> (Kner, 1855)	Embrapa uncatalogued
Auchenipteridae (9)	
¹ <i>Ageneiosus inermis</i> (Linnaeus, 1766)	Embrapa uncatalogued
¹ <i>Ageneiosus ucayalensis</i> Castelnaud, 1855	Embrapa uncatalogued
^{1,2} <i>Auchenipterus nigripinnis</i> (Boulenger, 1895)	LIRP 9439
^{1,2} <i>Auchenipterus osteomystax</i> (Miranda Ribeiro, 1918)	LBP 12637
² <i>Entomocorus radius</i> Reis & Borges, 2006	LBP 14003
¹ <i>Tatia neivai</i> (Ihering, 1930)	Embrapa uncatalogued
² <i>Trachelyopterus coriaceus</i> Valenciennes, 1840	LBP 12984
^{1,2} <i>Trachelyopterus galeatus</i> (Linnaeus, 1766)	LBP 13426, LBP 13661, LBP 13699
^{1,2} <i>Trachelyopterus striatulus</i> (Steindachner, 1877)	LBP 12635, LBP 12889, LBP 13603, LIRP 9454, LIRP 9455
GYMNOTIFORMES (10)	
Gymnotidae (3)	
¹ <i>Gymnotus</i> cf. <i>carapo</i> Linnaeus 1758	Embrapa uncatalogued
² <i>Gymnotus inaequilabiatus</i> (Valenciennes, 1839)	LBP 12616, LBP 12996
² <i>Gymnotus paraguayensis</i> Albert & Crampton, 2003	LBP 12979, LBP 13477
Sternopygidae (3)	
^{1,2} <i>Eigenmannia trilineata</i> López & Castello, 1966	LBP 12909, LBP 12961, LBP 13404, LBP 13458, LIRP 9378, LIRP 9379
^{1,2} <i>Eigenmannia virescens</i> (Valenciennes, 1842)	LBP 13431, LBP 13685
¹ <i>Eigenmannia</i> sp.	Embrapa uncatalogued
^{1,2} <i>Sternopygus macrurus</i> (Bloch & Schneider, 1801)	LBP 12916, LBP 12923, LBP 12962, LBP 13404, LBP 13412, LIRP: 9393, LIRP 9394, LIRP 9395
Rhamphichthyidae (2)	
² <i>Gymnorhamphichthys britskii</i> Carvalho, Ramos & Albert, 2011	LBP 13624
^{1,2} <i>Rhamphichthys hahni</i> (Meiken, 1937)	LBP 13486, LBP 14013, LIRP 9421, LIRP 9422, LIRP 9423
Hypopomidae (2)	
^{1,2} <i>Brachyhypopomus</i> sp.	LBP 12981, LBP 13516
^{1,2} <i>Brachyhypopomus</i> sp. B	LBP 12993
Aptereronotidae (2)	
^{1,2} <i>Aptereronotus albifrons</i> (Linnaeus, 1766)	LBP 12982, LBP 13720
² <i>Aptereronotus caudimaculosus</i> de Santana, 2003	LBP 12908, LBP 12919, LBP 13440, LIRP 9430
CYPRINODONTIFORMES (3)	
Rivulidae (2)	
² <i>Melanorivulus punctatus</i> (Boulenger, 1895)	LBP 12980, LBP 13493, LBP 13644
¹ <i>Neofundulus paraguayensis</i> (Eigenmann & Kennedy, 1903)	Embrapa uncatalogued
Poeciliidae (1)	
² <i>Pamphorichthys hasemani</i> (Henn, 1916)	Uncatalogued

TABLE 2. CONTINUED.

CLASS/ORDER/FAMILY/SPECIES	
BELONIFORMES (1)	
Belonidae (1)	
^{1,2} <i>Potamorhaphis eigenmanni</i> Miranda Ribeiro, 1915	LBP 13721, LBP 14004
SYNBRANCHIFORMES (1)	
Synbranchidae (1)	
^{1,2} <i>Synbranchus marmoratus</i> Bloch, 1795	LBP 13417, LBP 13628, LBP 13647
PERCIFORMES (16)	
Sciaenidae (1)	
^{1,2} <i>Plagioscion ternetzi</i> Boulenger, 1895	LBP 12617
Cichlidae (15)	
^{1,2} <i>Aequidens plagiozonatus</i> Kullander, 1984	LBP 12983, LBP 13473, LBP 13480
^{1,2} <i>Apistogramma borellii</i> (Regan, 1906)	LBP 11492, LBP 11495, LBP 12999, LBP 13579
^{1,2} <i>Apistogramma commbrae</i> (Regan, 1906)	LBP 11493, LBP 11496, LBP 11498, LBP 13539
^{1,2} <i>Apistogramma trifasciata</i> (Eigenmann & Kennedy, 1903)	LBP 11490, LBP 11494, LBP 11497, LBP 13490, LBP 13587
² <i>Astronotus crassipinis</i> (Heckel, 1840)	Uncatalogued
¹ <i>Astronotus ocellatus</i> (Agassiz, 1831)	Embrapa uncatalogued
^{1,2} <i>Bujurquina vittata</i> (Heckel, 1840)	LBP 14035
^{1,2} <i>Cichlasoma dimerus</i> (Heckel, 1840)	LBP 12905, LBP 13430, LBP 13630
^{1,2} <i>Crenicichla lepidota</i> Heckel, 1840	LBP 12636, LBP 12897, LBP 12920, LBP 12972
^{1,2} <i>Crenicichla vittata</i> Heckel, 1840	LBP 12967, LBP 14031
¹ <i>Crenicichla semifasciata</i> (Heckel, 1840)	Embrapa uncatalogued
¹ <i>Gymnogeophagus balzanii</i> (Perugia, 1891)	Embrapa uncatalogued
^{1,2} <i>Laetacara dorsigera</i> (Heckel, 1840)	LBP 13562
² <i>Mesonauta festivus</i> (Heckel, 1840)	LBP 12645, LBP 13529, LBP 13638, LBP 14000
¹ <i>Satanoperca pappaterra</i> (Heckel, 1840)	Embrapa uncatalogued
CLASS SARCOPTERYGII (1)	
LEPIDOSIRENIFORMES (1)	
Lepidosirenidae (1)	
¹ <i>Lepidosiren paradoxa</i> Fitzinger, 1837	Embrapa uncatalogued

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