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Ichthyofauna of headwaters from Sepotuba River Basin, Upper Paraguay River Basin, Tangará da Serra, Mato Grosso State, Brazil

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Abstract: Studies of fishes from the Paraguay River basin usually concentrate on the main rivers of the Pantanal region (wetlands), due mainly to the easy access into these areas, when compared to the headwaters. This makes the knowledge of the fauna of streams almost non-existent. Thus, the aim of this study was to conduct an ichthyological inventory in 10 headwaters of the Sepotuba River basin (Upper Paraguay River Basin) region of Tangará da Serra, state of Mato Grosso, Brazil. A total of 711 specimens, belonging to 31 species, 22 genera, 11 families and four orders were collected. The most significant orders were Characiformes, Siluriformes, Gymnotiformes and Perciformes, corroborating with the pattern reported by Lowe-McConnell (1999) for South American Rivers.

Keywords: Characiformes, Siluriformes, Gymnotiformes, Perciformes, South American Rivers.

Resumo: Ictiofauna de riachos de cabeceiras da Bacia do Rio Sepotuba, Bacia do Alto Paraguai, Tangará da Serra, Mato Grosso, Brasil. Os estudos com peixes da Bacia do Rio Paraguai são geralmente concentrados nos principais rios da região do Pantanal (áreas alagadas), devido principalmente à facilidade de acesso nestas áreas em comparação com riachos de cabeceira. Isso faz com que o conhecimento da ictiofauna dos riachos de cabeceira seja praticamente inexistente. Desta forma, o objetivo deste estudo foi realizar um levantamento ictiológico em 10 riachos de cabeceira da bacia do rio Sepotuba (Bacia do Alto Paraguai), região de Tangará da Serra, Mato Grosso, Brasil. Foram coletados 711 espécimes distribuídos em 31 espécies, 22 gêneros, 11 famílias, e quatro ordens. As ordens mais representativas foram respectivamente Characiformes, Siluriformes, Perciformes e Gymnotiformes, corroborando com padrão relatado por Lowe-McConnell (1987) para os rios sul americanos.

Palavras-chave: Characiformes, Siluriformes, Gymnotiformes, Perciformes, rios sulamericanos.

Introduction

The ichthyofauna of the Neotropics is the most diverse in the world, with approximately 5,000 described species, distributed in 71 families (Reis *et al*. 2003, Buckup *et al*. 2007, Silva *et al.* 2015). However, current estimates seem to indicate a much larger number of species (Lévêque *et al.* 2008, Pazian *et al.* 2011) due to the diversity of environments in this region and also for reasons that involve historical and ecological factors in South America, previously described by Schaefer (1998) and Vari & Malabarba (1998) and recently studied by several authors (Bertaco 2009, Castro & Vizotto 2013, Ramos *et al.* 2014, Vidotto-Magnoni *et al*. 2015). In an evaluation of historical trends referring to the species descriptions in the families Characidae and Loricariidae, Schaefer (1998) estimated that there could be approximately 8.000 species of freshwater fish in the Neotropical region, corresponding to 25% of all fish species in the

world.

The Midwest region of Brazil is considered "the largest disperser of water in Brazil". From this region, the rivers run to almost all the main Brazilian basins, both in the north and south of the country (Souza 1984, Langeani *et al.* 2007). In a privileged manner, the Mato Grosso state has three distinct basins that can be highlighted due to the number of rivers and streams. This abundance of aquatic habitats has led to the occurrence of fish species from practically all the groups described for the Neotropical region (Britski *et al.* 2007), however numerous shortcomings still exist in several areas of ichthyology for these basins.

According to Oyakawa and Menezes (2011) , the fishes from headwater streams are little known, highly threatened by human activities and, as pointed out by Ribeiro *et al.* (2009) and Castro *et al.* (2003), there are still many species to be discovered, especially when we consider the headwaters, where many locations have been little explored or not explored at all. Studies applied to these types of streams have focused primarily on the effects of environmental disturbances and their relationship with the dynamics of fish populations (Schlosser 1995, Menezes *et al.* 2007). In this context, inventories of Neotropical fishes should be conducted to verify the actual status of biodiversity in this region.

The region of Tangará da Serra occupies two of these basins, the Upper Paraguay River Basin and the Amazon Basin, thus becoming a site of interest for studies of fish, especially because of the number of headwaters existing in this region, and also because no study has yet been conducted on the local ichthyofauna. Thus, an inventory of fish species in the region of Tangará da Serra was held to get more information about the ichthyofauna of headwater streams that occur in the Upper Paraguay River Basin.

Materials and Methods

Study Site: The collections were carried out at the Upper Paraguay River Basin, in ten headwater streams (tributaries of the Sepotuba River) (Figure 1), municipality of Tangará da Serra, south-west Mato Grosso State, Brazil. The streams where fish were collected are: Dimba's Stream (14°39'46,86"S - 57°44' 35,82"W), Formiga Stream (14°30'58,05"S - 57°35'23,80"W), Buriti Stream (14°37' 23,01"S - 57°28'46,80"W), Ermindo Stream (14°36'34,12 "S - 57°27'19,28"W), São José Stream (14°33'48,89"S - 57°24'32,51" W), Araputanga Stream (14°36'14,64"S - 57°30'02,34" W), Santa Fé Stream (14°33'59,01"S - 57°34'43,82"W), Seco Stream (14°37'42,76"S - 57°33'52,19"W), Cristalino Stream (14°39'35,46"S - 57°30'37,14" W) and Estaca Stream (14°39'17,86"S - 52°27'19,89"S). The collections were authorized by IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) with the permit number: IBAMA 01/1994.

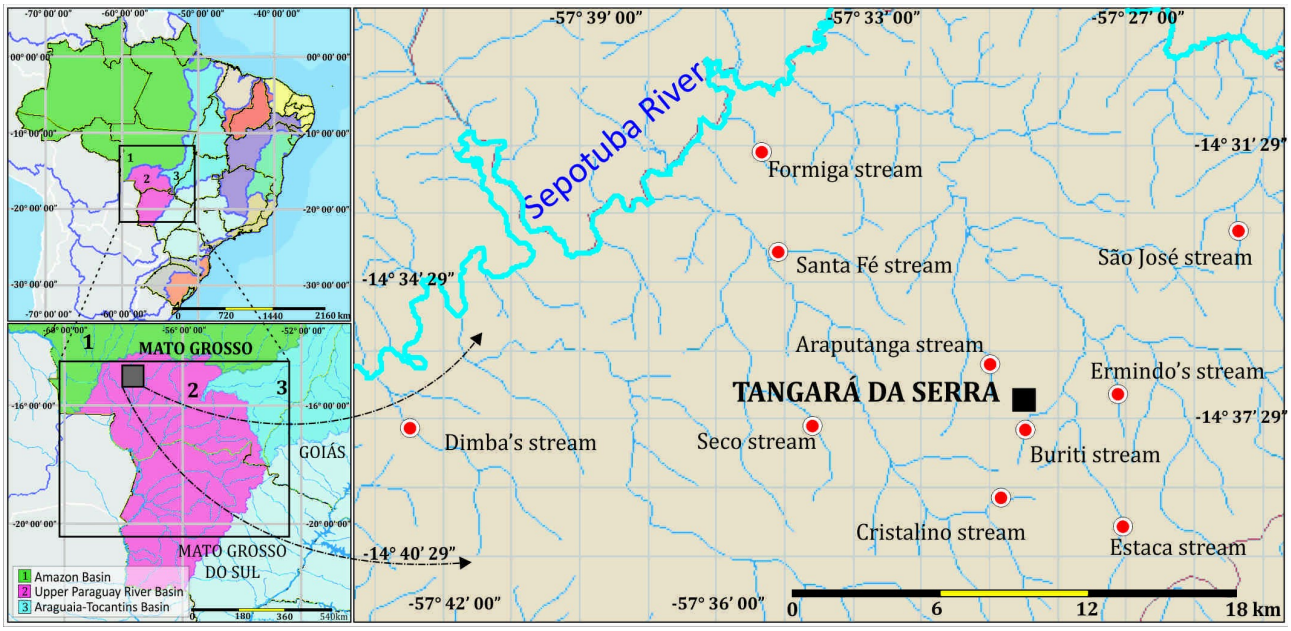

Figure 1. Map of Brazilian basins. Upper Paraguay River Basin. Headwater stream from Sepotuba River, state of Mato Grosso, with sampling sites.

Data collection: The methodology used was a fast inventory with three types of data collection: (1) gill nets with 15mm mesh between adjacent knots, (2) casting net with 10mm mesh between adjacent knots and (3) sieve with 5mm mesh between adjacent knots.

The gill nets were used according to Mazzoni *et al*. (2000) with the adaptations described below: the first gill net was placed in such a way as to close the stream from one side to the other in the region downstream from the collection site (toward the estuary of the stream). The second gill net was assembled in the same way, 30 meters upstream from the first gill net (toward the stream headwaters).

After installing the first two gill nets, the three other gill nets were used for the collection itself. These gill nets were used in the opposite direction to the water stream (downstream to upstream), with the assistance of three people, one at each extremity of the gill net and another in the middle of the trawl. The sieves were dragged twice along both banks of the streams in the same direction as the trawl. The cast nets were launched 20 times randomly in each stream.

The collected fish were fixed (formalin 10% for 24 hours and preserved in 70% alcohol) and taken to the Laboratório de Citogenética Animal, at the Universidade Federal de Mato Grosso (UFMT) to be identified according to Eigenmann (1921, 1927), Garutti (1995) and Britski *et al*. (2007) using the nomenclature in Reis *et al.* (2003) reviewed by Buckup *et al*. (2007). The captured fish were identified and deposited at the Laboratório de Ictiologia de Ribeirão Preto (LIRP), at the Universidade de São Paulo (vouchers: LIRP 8839 to LIRP 8919).

Results

In this inventory 711 specimens were collected, belonging to 31 species, 22 genera, 11 families and four orders: Characiformes (Parodontidae, Curimatidae, Anostomidae, Crenuchidae, Characidae and Erythrinidae,), Siluriformes (Callichthyidae and Loricariidae), Perciformes (Cichlidae) and Gymnotiformes (Gymnotidae) (Table I and Figures 2-5). Among these families, Characidae (Characiformes) and Loricariidae (Siluriformes) presented the greater species richness, with 13 and four species, respectively. Perciformes were only represented by two species belonging to one Family (Cichlidae), while the Gymnotiformes were represented by a single species.

Discussion

The most significant orders recorded were Characiformes, Siluriformes, Gymnotiformes, and Perciformes, corroborating the pattern reported by Teresa *et al.* (2010) for rivers and streams of the Paraguay basin, who relate a variety number of species recorded with the diversity of mesohabitats, and the pattern observed by Castro & Vizzotto (2013) to nearby locations, as weel as the structure reported by Lowe-McConnell (1999) for South American rivers.

In general, the pattern of species found in the present study is typical of streams, including several species of 'lambaris' (*Astyanax*), as well as 'loricariids' (*Hypostomus*), which are widely distributed in basins such as the Upper Paraná River (Castro *et al.* 2003, Casatti 2005, Ferreira and Casatti 2006, Súarez and Lima-Junior 2009) and Upper Paraguay River Basin (Britski *et al.* 2007, Mehanna and Penha 2011). Coupled with this, according to Araujo *et al.* (2011), the hydrological and geomorphological features of headwaters, particularly the presence of rocky rapids, waterfalls, and pools, provide microhabitats that favor this species.

The structure of community observed in the present work agrees with comments by Castro and Menezes (1998) who, when referring to the fish fauna that live in the headwater streams of the hydrographic basins of São Paulo state, highlighted that the species are small-sized, limitedly distributed, have little or no commercial value and show a strong dependence on the riparian vegetation as a food source of non-native (alloctone) origin, for reproduction and protection, those characteristics also were discussed by Cetra *et al.* (2012) and Garavello & Oliveira (2014).

The importance of studying the environments of river headwaters is enhanced by Lowe-McConnell (1969) when he affirms that systems of large tropical rivers allow some fish species to become geographically isolated in the headwaters of its tributaries, through physical, chemical or biotic barriers. Therefore, ecological studies and faunistic inventories in streams are increasing significantly due to the great importance of these ecosystems in the maintenance of biodiversity (Ramos *et al.* 2014, Pinto *et al.* 2015), because there are several species that are restricted to these environments and not found in large rivers (Pedroza *et al.* 2012, Volcan *et al.* 2012). Moreover, as the headwater streams have peculiar conditions, as well as their fish fauna, the climate conditions interfere much more quickly in these environments, when compared with the great rivers.

Table I. List of fish collected in some headwaters from Upper Paraguay basin. Taxonomic classification, common name and sample stream: DI- Dimba' Stream; FO- Formiga Stream; BU- Buriti Stream; ER- Ermindo' Stream; SJ – São José Stream; AR- Araputanga Stream; SF- Santa Fé Stream; SE- Seco Stream; CR- Cristalino Stream, and ES- Estaca Stream. Asterisk indicates species not yet described in the literature.

TAXON	COMMON NAME	SAMPLE STREAM									
		DI	FO	BU	ER	SJ	AR	SF	SE	CR	ES
CHARACIFORMES											
Parodontidae											
Paradon nasus (Kner, 1859)	"canivete"	X									
Curimatidae											
Steindachnerina brevipinna (Eigenmann & Eigenmann , 1889)	"curimba"		X								
Anostomidae											
Leporellus vittatus (Valenciennes, 1850)	"piau"	X									
Leporinus striatus (Kner, 1858)	"piau"	X									
Crenuchidae											
Characidium sp.*	"canivete"										X
Characidium cf. *zebra* (Eignmann, 1909)	"canivete"		X								
Characidae											
Aphyocharax anisitsi (Eigenmann & Kennedy, 1903)	"lambari"	X	X								
Astyanax cf. *abramis* (Jenyns, 1842)	"lambari"							X	X		
Astyanax cf. *asuncionensis* (Géry, 1972)	"lambari"			X	X			X	X		X
Astyanax cf. *lineatus* (Cuvier, 1819)	"lambari"	X									
Astyanax marionae (Eigenmann, 1911)	"lambari"	X									
Astyanax cf. *scabripinnis* (*sensu* Eigenmann, 1927)	"lambari"					X					X
Bryconops melanurus (Bloch, 1795)	"lambari"			X				X			
Jupiaba acanthogaster (Eigenmann, 1911)	"lambari"	X	X								
Knodus chapadae (Fowler, 1906)	"lambari"	X	X	X	X	X	X		X	X	X
Moenkhausia cf. *dichoura* (Kner, 1858)	"lambari"		X	X	X	X		X	X		
Moenkhausia sanctaefilomenae (Steindachner, 1907)	"lambari"	X									
Moenkhausia sp.*	"lambari"	X	X	X		X		X	X		
Serrapinus microdon (Eigenmann, 1915)	"lambari"							X			
Erythrinidae											
Hoplias gr.malabaricus (Bloch, 1794)	"traíra"	X	X	X				X			
SILURIFORMES											
Callichthyidae											
Corydoras cf. *aeneus* (Gill, 1858)	"ronquinho"			X	X	X		X	X		
Ancistrus cuiabae (Knaak, 1999)	"cascudo"				X		X	X		X	X
Loricariidae											
Hypostomus gr. *cochliodon* (Kner, 1854)	"cascudo"	X		X	X			X	X		X
Hypostomus sp.1*	"cascudo"	X							X		
Hypostomus sp.2*	"cascudo"								X	X	
Rineloricaria sp.	"cascudo"							X			
Heptapteridae											
Rhamdia cf. *quelen* (Quoy & Gaimard,1824)	"bagre"			X	X	X				X	
Pimelodella sp.*	"chum-chum"							X			
PERCIFORMES											
Cichlidae											
Cichlasoma cf. *dimerus* (Kullander, 1983)	"cará:		X	X	X	X	X	X	X		X
Crenicichla cf. *lepidota* (Heckel, 1840)	"joaninha"		X	X				X			
GYMNOTIFORMES											
Gymnotidae											
Gymnotus carapo (Linnaeus, 1758)	"tuvira"		X								X

However, in order to be able to compare the species found in this study with those from headwater streams of the Upper Paraguay River Basin or others basins, further research should be conducted in these environments. This is especially true because many species collected in these small water bodies have not yet been described (Silva-Oliveira *et al.* 2015, Veríssimo *et al.* 2005, Maier *et al*. 2008). In this study three unidentified species (*Moenkhausia* sp., *Characidium* sp., *Hypostomus* sp.1 and *Hypostomus* sp.2) were collected and are being analyzed by experts.

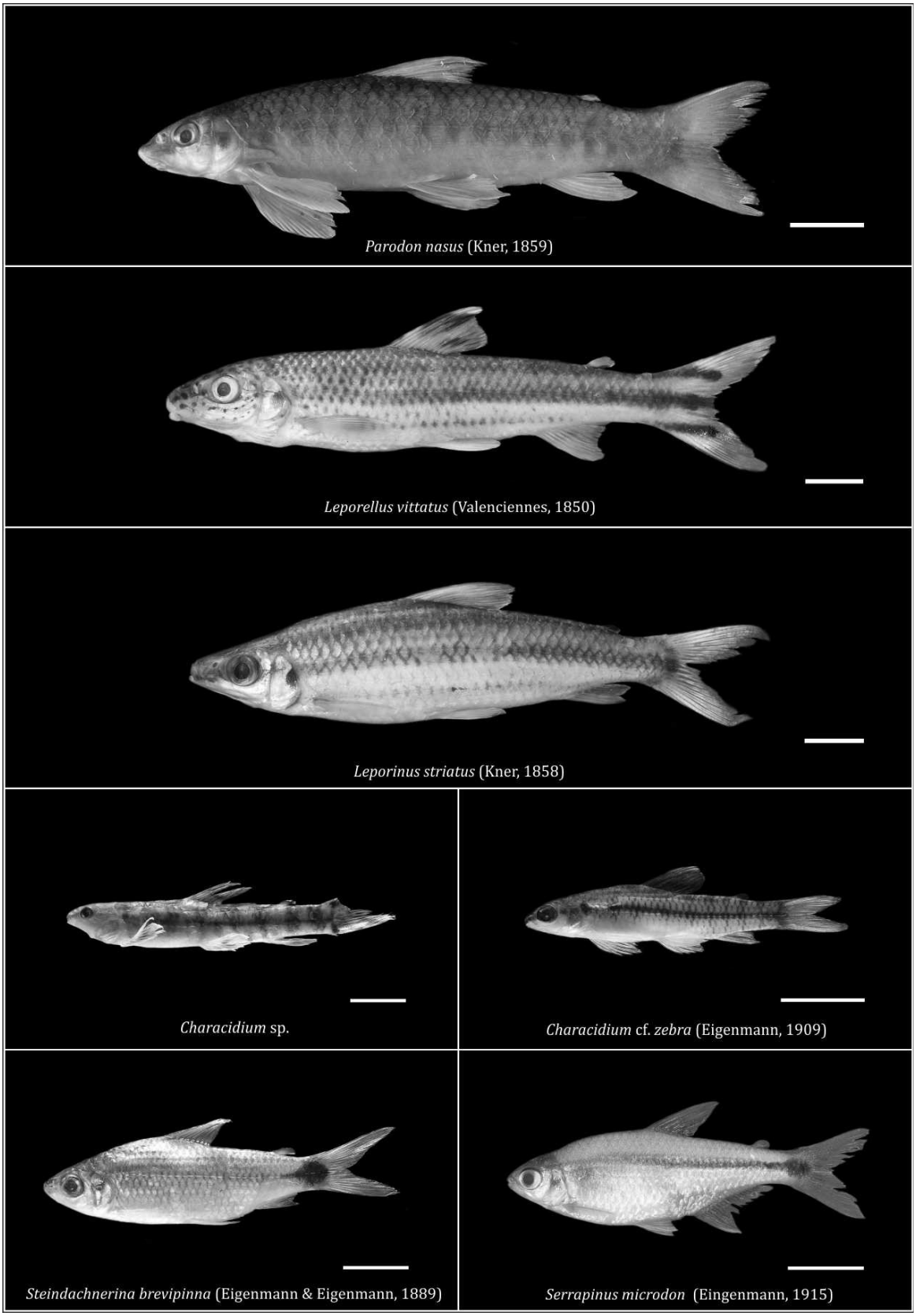

Figure 2. Some species photographed of Characiformes order: Paradontidae (*Paradon nasus*); Anastomidae (*Leporellus vittatus*, *Leporinus striatus*); Crenuchidae (*Characidium* sp., *Characidium* cf. *zebra*); Curimatidae (*Steindachnerina brevipinna*); Characidae (*Serrapinus microdon*). Bars: 1 cm.

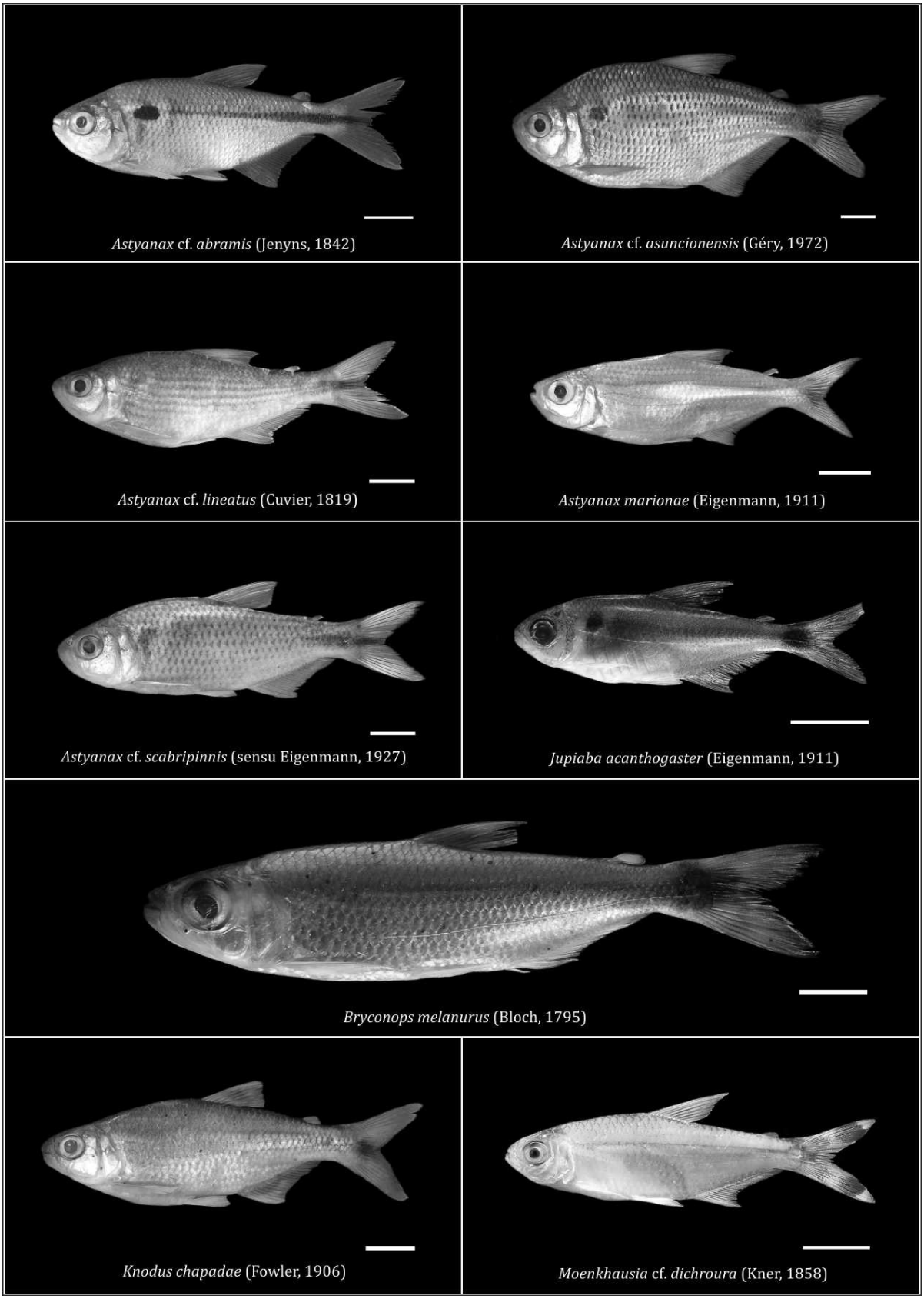

Figure 3. Species photographed of Characiformes order. Characidae family (*Astyanax* cf.. *abramis*, *Astyanax* cf.. *asuncionensis*, *Astyanax* cf.. *lineatus*, *Astyanax marionae*, *Astyanax* cf. *scabripinis*, *Astyanax acanthogaster*, *Bryconopus melanurus*, *Knodus chapadae* and *Moenkhausia* cf.. *dichroura*) Bars: 1 cm.

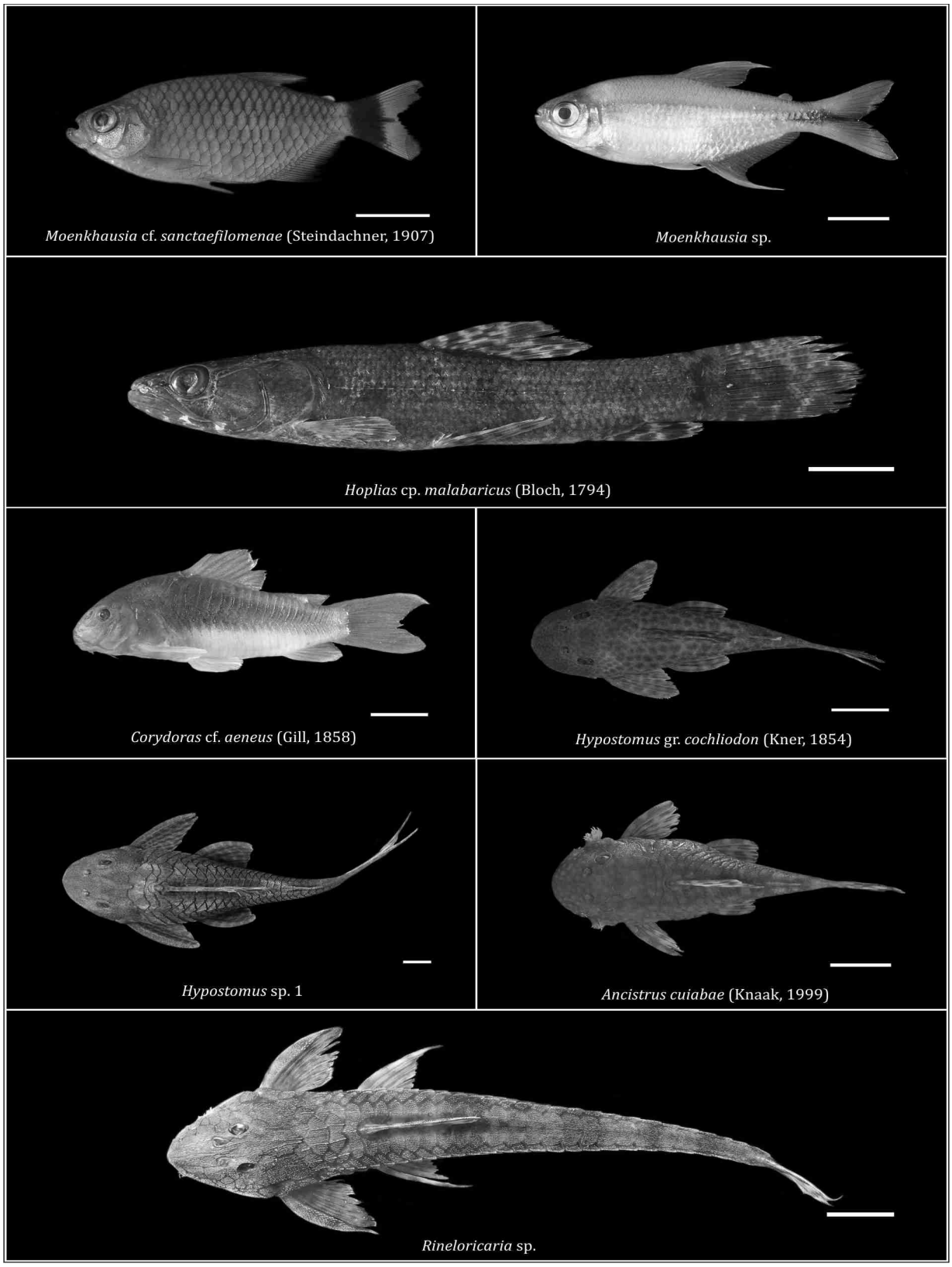

Figure 4. Fish species from tributaries of the Sepotuba River. Characiformes order: Characidae (*Moenkhausia* cf. *sanctaefilomenae*, *Moenkhausia* sp.); Erythrnidae (*Hoplias* cf. *malabaricus*) and Siluriformes order: Callichthydae (*Corydoras* cf. *aeneus*, *Ancistrus cuiabae*); Loricariidae (*Hypostomus* gr. *cochliodon*, *Hypostomus* sp1.., *Rineloricaria* sp.). Bars: 1 cm.

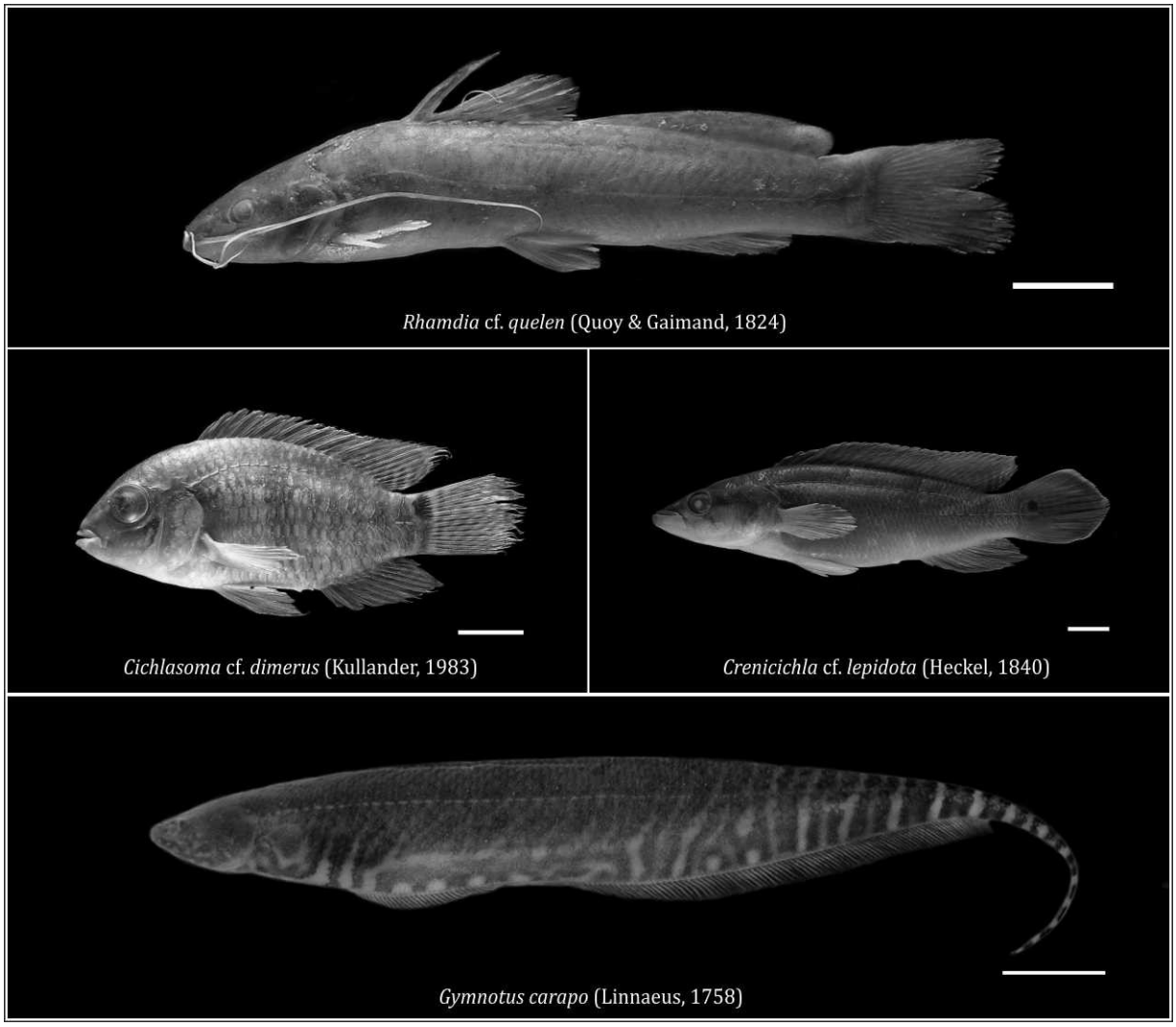

Figure 5. Species photographed from headwater streams. Siluriformes: Heptapteridae (*Rhandia* cf. *quelen*); Perciformis: Cichlidae (*Cichlosoma* cf. *dineus*, *Crenicla* cf. *lepidota*) and Gymnotiformes : Gymnotidae (*Gymnotus carapo*). Bars: 1 cm.

These results justify the need for further sampling effort in these headwater streams, mainly in non-urbanized environments, in order to find and record additional new species for the Upper Paraguay River Basin.

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