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Assemblage of fish species associated with aquatic macrophytes in Porto Murtinho Pantanal, Mato Grosso do Sul, Brazil

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Abstract: The Porto Murtinho Pantanal lies at the limit of the Upper Paraguay River basin, and despite its biogeographical importance, several aspects of the ecology of the fish assemblage are not known. Monthly samples of fish associated with aquatic macrophytes were taken from February 2009 through January 2011. A total of 46,327 individuals were collected, belonging to 144 species. Characiformes and Siluriformes were the predominant orders, and *Odontostilbe pequira*, *O. paraguayensis* and *Bryconamericus exodon* were the most abundant species. Two species, *Cynopotamus* sp. and *Pimelodus mysteriosus,* were recorded for the first time in the Pantanal, and a new occurrence record of *Cichla piquiti* was observed, representing an approximately 400 km range expansion in your distribution area in the Pantanal.
Keywords: *small fish, Paraguay river, fish inventories.*

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Resumo: O Pantanal de Porto Murtinho está no limite da Bacia do Alto Paraguai, e apesar de sua importância biogeográfica, alguns aspectos da ecologia das assembleias de peixes não são conhecidas. Amostras mensais de peixes associados a macrófitas aquáticas foram realizadas de Fevereiro de 2009 até Janeiro de 2011. Um total de 46.327 indivíduos foram coletados, pertencentes a 144 espécies. Characiformes e Siluriformes foram as ordens predominantes, e *Odontostilbe pequira*, *O. paraguayensis* e *Bryconamericus exodon* foram as espécies mais abundantes. Duas espécies, *Cynopotamus* sp. e *Pimelodus mysteriosus*, foram registrados pela primeira vez no Pantanal, e uma nova ocorrência de *Cichla piquiti* foi observada, o que representa uma expansão de cerca de 400 km de alcance em sua area de distribuição no Pantanal.
Palavras-chave: *peixes de pequeno porte, rio Paraguai, inventário de peixes.*

Introduction

Floodplain environments support higher taxonomic and functional diversity (Welcomme 1985, Lowe-McConnell 1999), in response to the widely varying spatial and temporal dynamics of aquatic, terrestrial and ecotone habitats (Ward et al. 1999, Robinson et al. 2002). Macrophyte beds are fundamentally important for the initial development of many fish species (Delariva et al. 1994, Sánchez-Botero & Araújo-Lima 2001), in addition to acting as feeding sites (Casatti et al. 2003) and a dispersal mechanism for small-sized species (Oliver & McKaye 1982, Machado-Allison 1990, Bulla et al. 2011). The abundance and complexity of macrophyte beds are among the main determinants of fish communities in both lentic (Súarez et al. 2001, 2004, Petry et al. 2003, Pelicice et al. 2005, Gomes et al. 2012) and lotic habitats (Bulla et al. 2011).

In the Pantanal, few and spatially poorly distributed analyses of fish communities have been published. Some studies have been carried out in the northern Pantanal (Baginski et al. 2007, Pacheco & Silva 2009, Fernandes et al. 2010, Milani et al. 2010, Silva et al. 2010, Lourenço et al. 2012) and the central region (Súarez et al. 2001, 2004); however few data are available from the southern Pantanal. This study aimed to characterize the composition of fish species associated with aquatic macrophytes in Porto Murtinho Pantanal, near the limit of the Upper Paraguay River.

Material and Methods

1. *Study area*

Porto Murtinho is an extreme southern portion of the Pantanal, defining the southern limit of the Upper Paraguay River Basin and comprising approximately 2.8% of the total Pantanal area (Silva & Abdon 1998). The predominant vegetation is savanna steppe (Chaco). The river reaches its highest level in June and July, and its lowest level from November through January.

2. *Sampling*

Samples were collected monthly from February 2009 through January 2011, in beds of aquatic macrophytes along the banks of the Paraguay and Amonguijá rivers and in the floodplain lakes Criminosa and Flores (Figure 1). Fish were sampled using a sieve (0.8 × 1.2 m), drag nets (1.5 × 5.0 m) with 2 mm mesh, and seines (1.5 × 10 m) with 15, 20 and 30 mm between adjacent knots. A total of 109 sample units were obtained, with non-standardized sampling effort. The scientific samples were authorized by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA/SISBIO # 13458-1).

Fishes were fixed in 10% formalin and preserved in 70% ethanol for identification and counts. In the laboratory, identification was carried out with the help of the identification key to the Fishes of the Pantanal (Britski et al. 2007). Voucher specimens were catalogued in

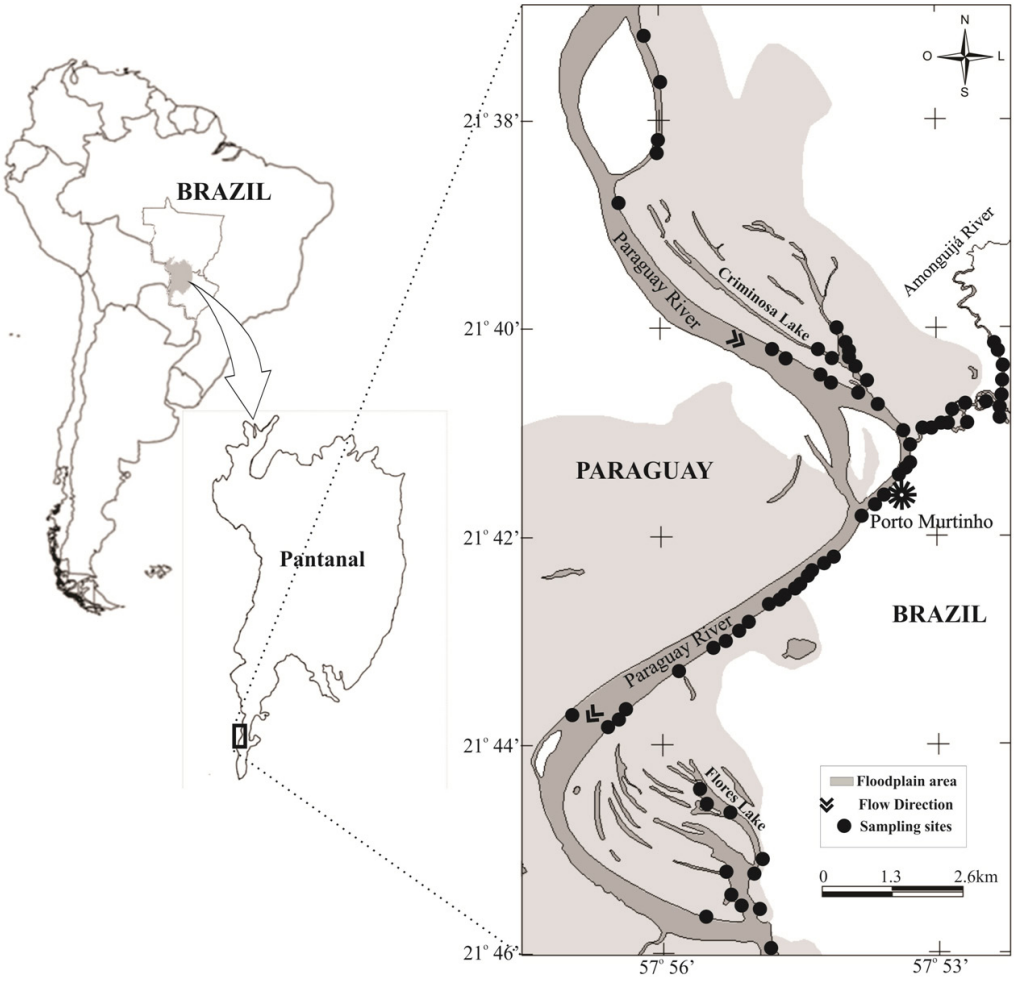

Figure 1. Study area with sampling localities at Porto Murtinho Pantanal, Mato Grosso do Sul, Brazil, from February 2009 through January 2011.

the collection of fishes of the Department of Zoology, Universidade Federal do Rio Grande do Sul, Porto Alegre, and in the Coleção de Peixes do Nupelia, Universidade Estadual de Maringá, Maringá, Brazil.

The richness per order in each locality was compared using a chi-square test to verify any differences in the general pattern of taxonomic composition among localities.

Results

A total of 46,327 specimens were collected, belonging to 144 species in nine orders. The Characiformes showed the highest richness, with 73 species (50.7%), followed by Siluriformes with 39 (27.1%), Perciformes with 16 (11.1%), Gymnotiformes with 10 (6.9%) and Cyprinodontiformes with 2 (1.4%). Other orders (Lepidosireniformes, Rajiformes, Synbranchiformes and Beloniformes) had one species each (Table 1). The chi-square test showed that no significant variation (chi-square=5.85; df=12; p=0.92) in richness per order existed among the localities (Figure 2).

The most abundant species were *O. pequira* (10,259 individuals/22.14%), followed by *O. paraguayensis* (8,617 individuals/18.60%) and *B. exodon* (4,275 individuals/9.23%). In

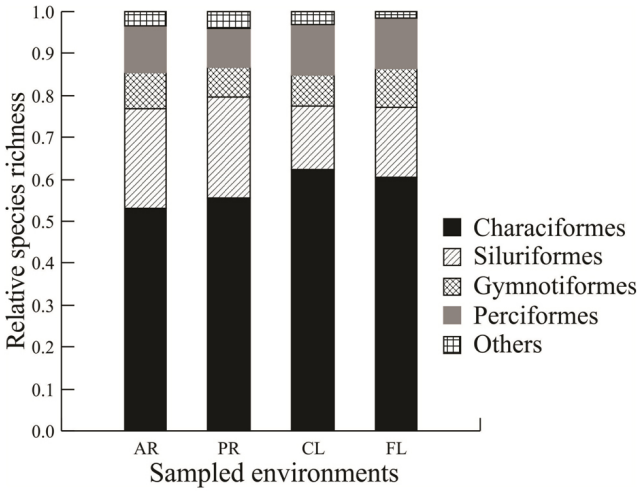

Figure 2. Relative richness per order in localities sampled at Porto Murtinho Pantanal, Mato Grosso do Sul, Brazil, from February 2009 through January 2011. AR= Amonguijá River; PR= Paraguay River; CL= Criminosa Lake; FL= Flores Lake.

Table 1. List of species and occurrences in localities sampled in Porto Murtinho Pantanal from February 2009 through January 2011. AR= Amonguijá River; PR= Paraguay River; CL= Criminosa Lake; FL= Flores Lake.

Species	AR	PR	CL	FL
Rajiformes				
Potamotrygonidae				
Potamotrygon brachyura (Günther, 1880)	-	X	-	-
Lepidosireniformes				
Lepidosirenidae				
Lepidosiren paradoxa Fitzinger, 1837	-	X	-	-
Characiformes				
Anastomidae				
Abramites hypselonotus (Günther, 1868)	X	X	X	X
Leporinus friderici (Bloch, 1794)	X	X	X	X
Leporinus lacustris Campos, 1945	X	X	X	X
Leporinus macrocephalus Garavello and Britski, 1988	X	X	X	X
Leporinus obtusidens (Valenciennes, 1836)	-	X	-	-
Leporinus striatus Kner, 1858	X	X	X	X
Leporinus sp.	X	X	X	X
Schizodon borellii (Boulenger, 1900)	X	X	X	X
Schizodon isognathus Kner, 1858	-	X	-	-
Characidae				
Acestrorhynchus pantaneiro Menezes, 1992	X	X	X	-
Aphyocharax dentatus Eigenmann and Kennedy, 1903	X	X	X	X
Aphyocharax rathbuni Eigenmann, 1907	X	X	X	-
Aphyocharax paraguayensis Eigenmann, 1915	X	X	X	X
Aphyocharax anisitsi Eigenmann and Kennedy, 1903	X	X	X	X
Astyanax asuncionensis Géry, 1972	X	X	X	X
Astyanax pellegrini Eigenmann, 1907	X	X	X	X
Astyanax marione Eigenmann, 1911	-	X	-	-
Bryconamericus exodon (Eigenmann, 1907)	X	X	X	X
Charax leticiae Lucena, 1987	X	X	-	-
Clupeacharax anchoveoides Pearson, 1924	X	X	X	-
Cynopotamus sp.	-	X	X	-
Engraulisoma taeniatum (Castro, 1981)	-	X	-	X
Galeocharax humeralis Valenciennes, 1834	X	X	X	X
Gymnocorymbus ternetzi (Boulenger, 1895)	X	-	-	X

Table 1. Continued...

Species	AR	PR	CL	FL
Hemigrammus marginatus Ellis, 1911	X	X	X	-
Hemigrammus lunatus Durbin, 1918	X	X	-	-
Hyphessobrycon eques (Steindachner, 1882)	X	X	X	X
Jupiaba acanthogaster (Eigenmann, 1911)	-	X	-	-
Markiana nigripinnis (Perugia, 1891)	X	X	X	-
Metynnis maculatus (kner, 1858)	-	X	-	-
Mylossoma paraguayensis Norman, 1928	X	X	X	-
Moenkhausia forestii Benine, Mariguela and Oliveira, 2009	X	X	X	X
Moenkhausia sanctafilomenae (Steindachner, 1907)	X	X	X	X
Moenkhausia dichroura (Kner, 1858)	X	X	X	X
Moenkhausia intermedia Eigenmann, 1908	X	X	-	-
Myloplus levis (Eigenmann and McAtee, 1907)	X	X	X	-
Odontostilbe pequira (Steindachner, 1882)	X	X	X	X
Odontostilbe paraguayensis Eigenmann and Kennedy, 1903	X	X	X	X
Piabucus melanostoma Holmberg, 1891	X	X	X	-
Poptella paraguayensis (Eigenmann, 1907)	X	X	X	-
Prinobrama paraguayensis (Eigenmann, 1914)	X	X	X	X
Psellogrammus kennedyi (Eigenmann, 1903)	X	X	X	X
Pygocentrus nattereri Kner, 1858	-	X	-	-
Roeboides microlepis Steindachner, 1879	X	X	-	X
Roeboides prognatus Boulenger, 1895	X	X	X	-
Roeboides descalvadensis Fowler, 1932	X	X	X	X
Salminus brasiliensis (Cuvier, 1816)	-	X	-	-
Serrapinus calliura (Boulenger, 1900)	X	X	X	X
Serrasalmus maculatus Kner, 1858	X	X	X	-
Serrasalmus marginatus Valenciennes, 1837	X	X	X	X
Tetragonopterus argenteus (Cuvier, 1816)	X	X	X	X
Triportheus pantanensis (Kner, 1858)	X	X	X	X
Triportheus nematurus (Günther, 1874)	X	X	X	X
Crenuchidae				
Characidium aff. *zebra* Eigenmann, 1909	X	X	X	X
Characidium laterale (Boulenger, 1895)	X	X	X	X
Curimatidae				
Curimatella dorsalis (Eigenmann and Eigenmann, 1889)	X	X	X	X
Cyphocharax gillii (Eigenmann and Kennedy, 1903)	X	X	X	X
Psectrogaster curviventris Eigenmann and Kennedy, 1903	X	X	X	-
Potamorhina squamoralevis (Braga and Azpelicueta, 1983)	X	X	X	-
Steindachnerina brevipinna (Eigenmann and Eigenmann, 1889)	X	X	X	-
Steindachnerina conspersa (Holmberg, 1891)	X	X	X	-
Steindachnerina nigrotaenia (Boulenger, 1902)	X	X	X	-
Cynodontidae				
Rhaphiodon vulpinus Spix and Agassiz, 1829	X	X	X	-
Engraulididae				
Lycengraulis sp.	X	X	X	X
Erythrinidae				
Hoplias sp.	-	X	-	-
Hoplias malabaricus (Bloch, 1794)	X	X	X	X
Hoplerythrinus unitaeniatus (Spix, 1829)	X	-	-	-
Gasteropelecidae				
Gasteropelecus sternicla (Linnaeus, 1758)	-	X	X	-
Thoracocharax stellatus (Kner, 1858)	X	X	X	-
Hemiodontidae				
Hemiodus orthonops (Eigenmann and Kennedy, 1903)	X	X	X	X
Lebiasinidae				

Table 1. Continued...

Species	AR	PR	CL	FL
Pyrrhulina australis Eigenmann and Kennedy, 1903	X	X	X	X
Paradontidae				
Apareiodon affinis (Steindachner, 1879)	X	X	X	-
Prochilodontidae				
Prochilodus lineatus (Valenciennes, 1836)	X	X	X	X
Siluriformes				
Auchenipteridae				
Auchenipterus nigripinnis (Boulenger, 1895)	X	X	-	-
Epapterus dispilurus Cope, 1878	-	X	-	-
Parauchenipterus striatulus (Steindachner, 1876)	X	-	-	X
Parauchenipterus galeatus (Linnaeus, 1766)	X	X	X	X
Aspredinidae				
Bunocephalus doriae Boulenger, 1902	X	X	X	X
Callichthyidae				
Callichthys callichthys (Linnaeus, 1758)	-	-	X	-
Corydoras hastatus Eigenmann and Eigenmann, 1888	X	X	X	X
Hoplosternum littorale (Hancock, 1828)	X	-	-	-
Leplosternum pectorale (Boulenger, 1895)	X	-	-	X
Doradidae				
Platydoras armatulus (Valenciennes, 1840)	X	-	-	-
Oxydoras kneri Bleeker, 1862	-	X	-	-
Heptapteridae				
Rhamdia sp. Bleeker, 1858	X	X	X	-
Loricariidae				
Farlowella paraguayensis Retzer and Page, 1997	X	X	-	-
Hemiodontichthys acipenserinus (Kner, 1853)	X	X	-	-
Hypoptopoma inexspectatum (Holmberg, 1893)	X	X	X	X
Hypostomus sp. Lacépède, 1803	X	X	X	X
Hypostomus boulengeri (Eigenmann and Kennedy, 1903)	X	X	-	-
Hypostomus latifrons Weber, 1986	X	X	-	-
Loricariichthys platymetopon Isbrücker and Nijssen, 1979	X	X	X	-
Loricariichthys labialis (Boulenger, 1895)	-	X	X	-
Loricaria sp. Linnaeus, 1758	X	X	-	-
Otocinclus vittatus Regan, 1904	X	X	X	X
Pterygoplichthys ambrosettii (Holmberg, 1893)	-	X	-	-
Pyxiloricaria menezesi Isbücker and Nijssen, 1984	X	X	-	X
Rineloricaria parva (Boulenger, 1895)	X	X	X	X
Sturisoma barbatum (Kner, 1853)	X	X	-	-
Pimelodidae				
Pimelodella taenioptera Ribeiro, 1914	X	X	X	-
Pimelodella gracilis (Valenciennes, 1840)	-	X	-	-
Pimelodella mucosa Eigenmann and Ward, 1907	-	X	-	-
Pimelodus maculatus Lacépède, 1803	X	X	X	X
Pimelodus mysteriosus Azpelicueta, 1998	X	-	-	-
Pimelodus argenteus Perugia, 1891	-	X	-	-
Iheringichthys labrosus (Lütken, 1874)	-	X	-	-
Pinirampu pirinampu (Spix and Agassiz, 1829)	-	X	-	-
Megalonema platanum (Günther, 1880)	X	X	-	-
Sorubim lima (Bloch and Schneider, 1801)	X	X	-	-
Pseudoplatystoma corruscans (Spix and Agassiz, 1829)	X	X	-	-
Zungaro zungaro (Humboldt and Valenciennes, 1821)	X	-	-	-
Trichomycteridae				
Ituglanis eichorniarium (Miranda Ribeiro, 1912)	-	-	X	-

Table 1. Continued...

Species	AR	PR	CL	FL
Gymnotiformes				
Apternotidae				
Apteronotus albifrons (Linnaeus, 1766)	X	X	-	X
Gymnotidae				
Gymnotus spp.	X	X	X	-
Gymnotus inaquilabiatus (Valenciennes, 1839)	X	X	X	-
Gymnotus paraguensis Albert and Crampton, 2003	X	X	-	-
Hypopomidae				
Brachyhypopomus sp. A Mago Leccia, 1994	X	-	X	-
Brachyhypopomus sp. B Mago Leccia, 1994	X	X	X	X
Brachyhypopomus sp. C Mago Leccia, 1994	X	X	X	X
Sternopygidae				
Sternopygus macrurus (Bloch and Schneider, 1801)	X	X	X	X
Eigenmannia trilineata López and Castelo, 1966	X	X	X	X
Eigenmannia virescens (Valenciennes, 1842)	X	X	-	X
Perciformes				
Cichlidae				
Aequidens plagiozonatus Kullander, 1984	X	X	X	X
Apistogramma trifasciata (Eigenmann and Kennedy, 1903)	X	X	X	X
Apistogramma commbrae (Regan, 1906)	X	X	X	X
Apistogramma borellii (Regan, 1906)	X	X	X	X
Astronotus crassipinnis Heckel, 1840	X	-	X	-
Bujurquina vittata (Heckel, 1840)	X	X	X	X
Chaetobranchopsis australis Eigenmann and Ward, 1907	X	X	X	-
Cichla piquiti Kullander and Ferreira, 2006	-	X	-	-
Cichlasoma dimerus (Heckel, 1840)	X	-	-	-
Crenicichla semifasciata (Heckel, 1840)	X	X	X	X
Crenicichla lepidota Heckel, 1840	X	X	X	X
Crenicichla vittata Heckel, 1840	X	X	X	-
Gymnogeophagus balzanii (Perugia, 1891)	X	X	X	-
Mesonauta festivus (Heckel, 1840)	-	-	-	X
Satanoperca pappaterra (Heckel, 1840)	X	-	-	-
Sciaenidae				
Pachyurus bonariensis Steindachner, 1879	-	X	-	-
Beloniformes				
Belonidae				
Potamorhaphis eigenmanni Ribeiro, 1915	X	X	X	-
Cyprinodontiformes				
Rivulidae				
Rivulus punctatus Boulenger, 1895	X	X	X	-
Trigonectes balzanii (Perugia, 1891)	X	-	-	-
Synbranchiformes				
Synbranchidae				
Synbranchus marmoratus Bloch, 1795	X	X	X	X

contrast, 22 species were each represented by only one individual. Thus, the three most abundant species comprised approximately 50% of the total sampled individuals, while 123 species represented individually less than 1%, and together comprised 14.14% of the total sample. Despite the predominance of small species, many of the fishes collected are important for fisheries, including *P. corruscans* (Pintado), *Z. zungaru* (Jaú), *S. brasiliensis* (Dourado), and *S. lima* (Jurupensen), among others.

Among the species collected, the tucunaré *Cichla piquiti*, an introduction from the Amazon basin, was found in the Paraguay River. Another, *Cynopotamus* sp., was recorded for the first time in the Upper Paraguay River, and its taxonomic status is unknown.

Pimelodus mysteriosus, a species of the Paraná basin, was recorded for the first time in the Upper Paraguay River.

Discussion

The fish species associated with aquatic macrophytes in Porto Murtinho Pantanal comprised 53.5% of the total species richness known for the Pantanal (Britski et al. 2007). This shows both the homogeneity in fish species distribution across the Pantanal floodplain, and the importance of aquatic macrophytes for maintenance of fish diversity. Moreover, the predominance of Characiformes and Siluriformes observed follows the Neotropical biogeographic pattern and other studies in the Pantanal (Willink et al. 2000, Súarez et al. 2001, Baginski et al. 2007, Pacheco & Silva 2009, Milani et al. 2010).

The dominance of two small species of Cheirodontinae (*O. pequira* e *O. paraguayensis*) follows a habitat pattern, since other studies on fishes associated with aquatic macrophytes have yield the same general results (Súarez et al. 2001, Baginski et al. 2007, Pacheco & Silva 2009, Silva et al. 2010). This suggests that the macrophyte habitat is favorable for these species, probably because of the good availability of food and protection from predators. Moreover, the greater dominance of a few species is common in tropical communities. Magurran & Henderson (2003) suggested that abundant/common species are those residing in this habitat, while other species are occasional visitors. This hypothesis can be used to explain our data, in response to the close association between the species found and macrophyte beds. The smaller fish species are possibly more abundant because they are resident in the macrophyte beds.

Also, the occurrence of some commercially important species occurred as juveniles, suggesting that macrophyte beds are also an important habitat for the initial development of larger species, as demonstrated by Delariva et al. (1994) for the Upper Paraná River.

In relation to introduced specie tucunaré *Cichla piquiti*, Resende et al. (2008) defines as a well-established species in the Pantanal, and reported its occurrence from the Piquiri River (northern Pantanal) to the region of Corumbá (central Pantanal). Our data revealed that it occurs approximately 400 km southward, at the limit of the Pantanal (Upper Paraguay River). Therefore, along the main river (the Paraguay), the tucunaré occupies approximately 70% of the north-south axis of the Pantanal, although its occurrence in tributaries of the Paraguay River has not been evaluated, nor has its influence on aquatic communities.

The specimens of *Cynopotamus* sp. collected are of unknown taxonomic status; they differ from others reported from the Pantanal, although they may have been recorded in the Middle Paraguay River. Only after careful analysis can we can determine if this record is a geographical expansion of distribution, or an undescribed species. Complementarily, *P. mysteriosus* is a species described from the Paraná basin, and is here first recorded in the Pantanal.

In conclusion, the fish diversity associated with aquatic macrophytes in Porto Murtinho Pantanal is composed by small-sized species, with some juveniles and adults of larger species occurring in different frequencies. Some species were recorded for the first time in the Pantanal (*Cynopotamus* sp. and *P. mysteriosus*), or the record represents an expansion of the known distribution (e.g., *C. piquiti*). Finally, the great fish diversity, typical of the Pantanal, suggests the fundamental importance of macrophyte beds for fish and fisheries ecology.

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