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The fish fauna of the Corrientes stream basin, Patos lagoon system, state of Rio Grande do Sul, southern Brazil

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Abstract: The fish sampled in this study were captured in seasonal collections samplings, conducted between May 2006 and February 2007 in 15 stretches of the Corrientes stream basin, Patos lagoon system, Rio Grande do Sul state, Brazil. A total of 8088 specimens were collected, belonging to nine orders, 24 families and 68 species. In general, the ichthyofauna in this basin has the same pattern recognized for Neotropical rivers with predominance of Characiformes and Siluriformes orders and a high representative of the Characidae and Loricariidae families.

Introduction

The Neotropical region presents a high diversity of freshwater fish species (Lowe-McConnell 1999) and estimates indicates 3000-5000 species in Brazil (Menezes 1996; Reis *et al.* 2003; Buckup *et al.* 2007). Although there is a wide variation in estimates, Brazil has the highest richness of freshwater species of fish in the world.

In a review, Malabarba (1989) found 106 freshwater fish species described or related to Patos-Mirim lagoon basin and Jacuí River, in Rio Grande do Sul State. In a recent study, Malabarba *et al*. (2009) mentioned 125 described species to this system, and the necessity of describe another 35 species. Subsequent studies included species which occurrence was known in other hydrographic systems, as *Acestrorhynchus pantaneiro* (Saccol-Pereira *et al.* 2006), *Pachyurus bonariensis* (Dufech and Fialho 2007) and *Jenynsia onca* (Lanés *et al.* 2008). Besides these species, several other fish species of commercial interest have been introduced into natural environments due to pisciculture activity, as occurred in the estuary of Patos lagoon (Garcia *et al.* 2004), Caí River (Dala-Corte *et al.* 2009) and in the Sinos River (Leal *et al.* 2009).

Despite the high species richness of the Patos lagoon system, there are few studies of fish assemblages in coastal water bodies, mainly in the southern of Rio Grande do Sul state (Garcia *et al.* 2006). Most of the studies in this area were developed in independent drainages that flow directly into the sea (Tagliani 1994; Loebmann and Vieira 2005). Although being located in the same ecoregion (Abell *et al*. 2008), these drainages do not belong to Patos lagoon system. Knowledge of fish fauna composition of an environment is fundamental to future studies involving management and conservation. Thus, this work is aimed to provide the list of fish species of Corrientes stream, southern Rio Grande do Sul state, Brazil.

Material and Methods

Study site

The Corrientes stream basin have an area of about 300 km^2, and is inserted in two different geomorphologic situations: Crystalline Shield, characterized by high (up to 350 m) and undulating hills with many rock outcrops, and the Coastal Plain, flat and low, with meadows, wetlands and sandy areas.

The Corrientes stream is located north of the municipality of Pelotas, bordering the municipality of Turuçu in Rio Grande do Sul state, southern Brazil (Figure 1). It has about 30 km long; its water flow goes from west to east. In this stream, the density distribution of its sources increases dramatically in the portion corresponding to the slope of the Cristalline Shield, reaching altitudes of 230 m. Its drainage network reaches the 4th order in the transition to the plain, forming the lower course of the stream flowing to the Pequena lagoon, draining into the Patos lagoon.

Data collection

Samples were taken on 15 stretches in the Corrientes stream (Figure 1), with approximately 100 m each, covering sectors of the source to mouth (Table 1; Figure 2). Active collection was realized in the sampling points P1 to P15. Only P13, in the lower course was sampled by passive collecting. Four sampling collections were quarterly carried out, thereby fulfilling a chronogram of seasonal collection, which covered the four seasons (May 2007 to February 2008).

The midpoint of each sample site was georeferenced with GPS. To catch fishes, a standardized methodology was based on active collection with hand nets (60 x 40 cm) and a small trawl net (200 x 100 cm), both of 2 mm mesh, with sampling effort of 30 minutes per technique at each point.

On site P13, a battery of gillnets (meshes 18, 30 and 40 mm) was used during 24 h and examined every 12 h.

Fish specimens were fixed in 10% formalin and preserved in 70% alcohol. The material was collected under IBAMA license number 56/2006RS. Voucher specimens are deposited in the fish collection at the Museu de Ciência e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre (MCP) and Museu da Universidade Federal do Rio Grande do Sul (URGS) (Table 2). Species were identified by experts and using pertinent literature and keys (Menezes (1987), Vari (1992), Buckup and Hahn (2000), Costa (2002), Lucinda (2008), Malabarba (2008), Rodriguez and Reis (2008), Bertaco and Lucena (2010), Carvalho and Reis (2011), Fisher *et al*. (2011)). The taxonomic classification follows Reis *et al.* (2003).

Figure 1. Image of sample sites in the Corrientes stream Basin, Patos lagoon system, Brazil.

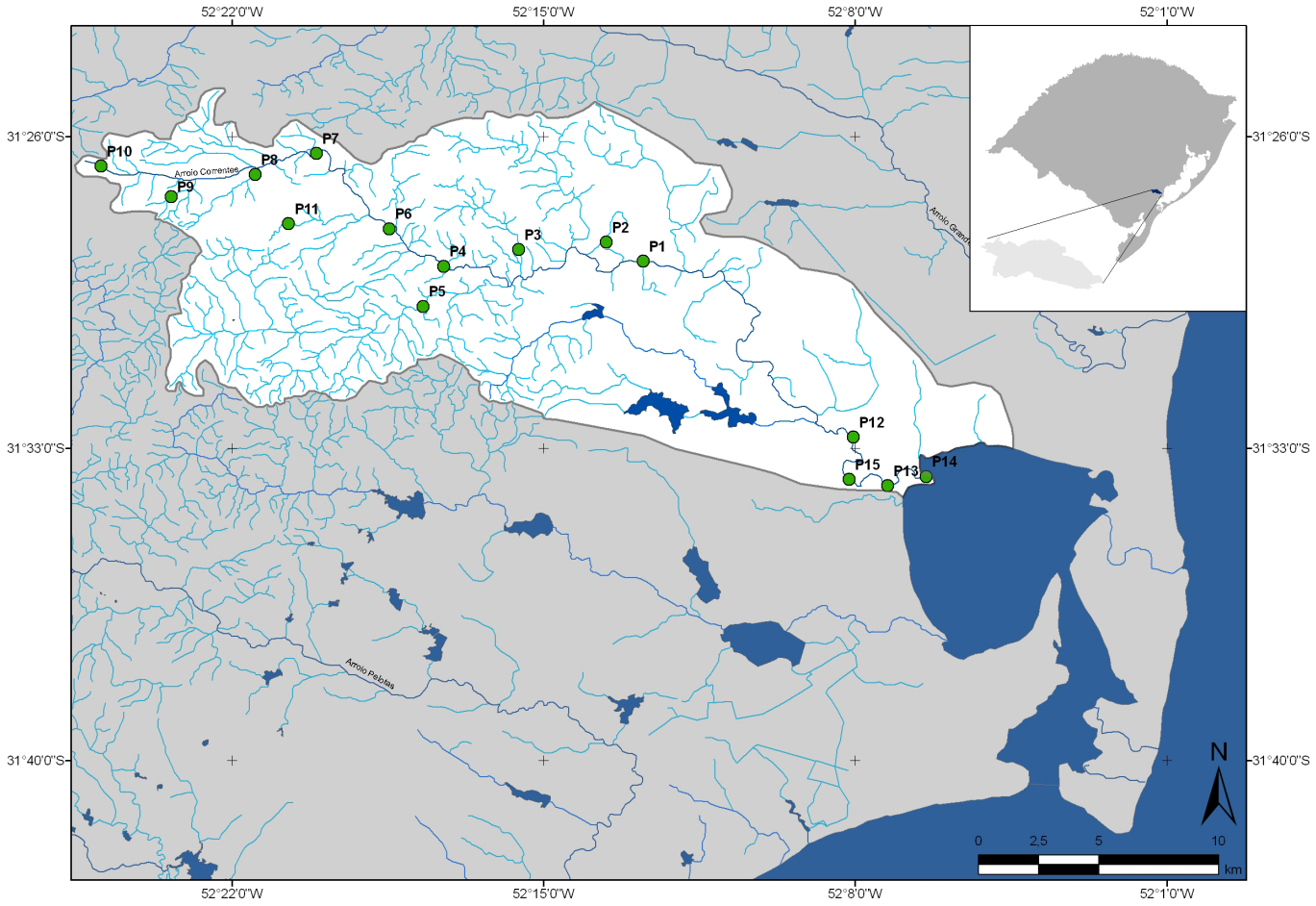

Figure 2. Map of Corrientes stream basin, Patos lagoon system, Rio Grande do Sul, indicating the 15 sampling sites. Author: Michel P. Corrêa.

Table 1. Geographical coordinates and altitude of the 15 stretches sampled in the basin of the Corrientes stream, Patos lagoon system, Rio Grande do Sul state.

SITES	S	W	ALT. (M)
P1	31°28'48,2"	52°12'45,4"	13
P2	31°28'22,5"	52°13'35,8"	19
P3	31°28'32,4"	52°15'33,4"	22
P4	31°28'58,0"	52°16'12,0"	24
P5	31°29'48,9"	52°17'42,6"	31
P6	31°28'04,3"	52°18'27,7"	41
P7	31°26'23,2"	52°20'06,0"	78
P8	31°26'51,6"	52°21'28,7"	93
P9	31°27'10,2"	52°12'48,2"	110
P10	31°26'55,7"	52°24'51,6"	168
P11	31°27'57,8"	52°20'43,8"	112
P12	31°33'50,2"	52°07'55,1"	6
P13	31°33'54,4"	52°07'17,6"	7
P14	31°33'46,2"	52°06'21,1"	4
P15	31°33'47,0"	52°07'42,3"	7

Results and Discussion

In the Corrientes stream basin, 8088 specimens were collected, belonging to nine orders, 24 families and 68 species (Table 2). Among the collected species, 40% were Characiformes, 29% Siluriformes, 12% Perciformes, 7% Gymnotiformes, 6% Cyprinodontiformes, and other orders accounted for 1.5% each. Characiformes (53%) and Siluriformes (33%) were also the most abundant orders in terms of number of individuals caught, followed by Cyprinodontiformes (10 %). The predominance of species of these two orders is consistent with studies conducted on river systems in the Neotropical region (Mathews 1998; Lowe-McConnell 1999), and was also observed on Patos lagoon system (Malabarba 1989; Malabarba *et al.* 2009; Reis *et al.* 2003).

It was observed a larger representation of the family Characidae, with 20 species and 47 % of the individuals captured, followed by Loricariidae, with eight species and representing 22 % of fishes sampled. The highest richness for the family Characidae recorded in this study, was also observed in other basins of the Patos lagoon system (Garcia *et al.* 2006; Petry and Schulz 2006; Leal *et al.* 2009). According to Mathews (1998), the number of families represented is relatively large in places with high richness, and few families have most of the species.

The record of 68 species of fishes in the Corrientes stream basin is in accordance with other studies conducted in the state of Rio Grande do Sul: Tagliani (1994) reported the occurrence of 31 species in three streams of the coastal plain of Rio Grande do Sul; in the National Park of Lagoa do peixe, 73 species were recorded (Loebmann and Vieira 2005); in the Ecological Station of Taim, Garcia *et al.* (2006) identified 62 species of fishes, while in the Sinos River basin, Petry and Schulz (2006) captured 63 species. In a recent study, Leal *et al.* (2009) expanded the richness

of the Sinos River, totaling 102 species. In Caí River basin, Dala-Corte *et al.* (2009) reported the occurrence of 20 species. In the estuary of Patos Lagoon, which has a large volume of water and is connected with Camaquã, Jacuí, Caí, Sinos, Gravataí River basins and the Mirim lagoon complex, the richness is of 110 species (Garcia and Vieira, 2001). Moreover, in adjacent drainages of Uruguay River, Copatti *et al.* (2009) recorded 26 species on Jaguari River basin and Azevedo *et al.* (2003) sampled 27 species in the Felizardo stream.

The most abundant species were respectively *Hyphessobrycon luetkenii*, *Rineloricaria cadeae*, *Bryconamericus iheringii* and *Phalloceros caudimaculatus*, totaling about 55 % of the specimens captured. The high abundance of *H. luetkenii* was also observed by Tagliani (1994) and, according to the author, this characid was one of the most abundant species in the sampled streams, but has shown seasonal variation in abundance throughout the sampling period. Five species had only one specimen captured: *Atherinella brasiliensis*, *Brachyhypopomus bombilla, Oligosarcus* sp. and *Paralichthys orbignyanus*.

Among the species caught, *Trachelyopterus lucenai* is considered invasive to the Patos lagoon system (Bertoletti *et al.* 1992; Buckup *et al.* 2007). This species is commonly recorded in the system, and their populations are already considered stabilized (Becker 2001). The composition of the ichthyofauna found in the Corrientes stream is typical of this type of aquatic environment and most of the species commonly occur in the Patos lagoon system (Malabarba 1989; 2008; Reis *et al.* 2003; Buckup *et al*. 2007).

Table 2. Fish fauna caught at each sample site in the Corrientes stream basin, Patos lagoon system, Rio Grande do Sul state, from May 2007 to February 2008.

TAXON	SAMPLING SITES																VOUCHER
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
ATHERINIFORMES																	
Atherinidae																	
Atherinella brasiliensis (Quoy and Gaimard, 1825)														X			MCP 46511
CLUPEIFORMES																	
Engraulidae																	
Lycengraulis grossidens (Agassiz, 1829)														X		X	MCP 46515
CHARACIFORMES																	
Curimatidae																	
Cyphocharax saladensis (Meinken, 1933)														X			MCP 45801
Cyphocharax voga (Hensel, 1870)				X								X	X	X	X	X	MCP 45800
Steindachnerina biornata (Braga and Azpelicueta, 1987)				X									X			X	MCP 46521
Crenuchidae																	
Characidium orientale Buckup and Reis, 1997	X	X	X	X	X	X						X	X				MCP 45821
Characidium pterostictum Gomes, 1947	X	X	X	X	X	X	X										MCP 45820
Characidium rachovii Regan, 1913	X		X	X								X	X	X	X		MCP 45822
Characidium tenue (Cope, 1894)	X		X	X													MCP 45818
Characidae																	
Astyanax laticeps (Cope, 1894)		X	X	X	X	X	X	X	X	X	X	X					MCP45782
Astyanax henseli de Melo and Buckup, 2006	X		X	X		X		X	X			X	X				MCP 45804
Astyanax jacuhiensis (Cope, 1894)	X	X	X	X	X							X	X	X	X		MCP 45787
Astyanax aff. *eigenmaniorum* (Cope, 1894)	X	X	X	X	X	X	X	X	X		X		X	X	X	X	MCP 45805
Astyanax sp.													X	X		X	MCP 45803
Bryconamericus iheringii (Boulenger, 1887)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			MCP 45814
Cheirodon interruptus (Jenyns, 1842)			X	X	X	X					X		X	X	X		MCP 45815
Cheirodon ibicuhiensis Eigenmann, 1915	X	X		X									X	X			MCP 45816, MCP 45817
Charax stenopterus (Cope, 1984)	X											X	X	X	X		MCP 45785
Cyanocharax alburnus (Hensel, 1870)	X	X	X	X									X	X			MCP 45826
Diapoma speculiferum Cope, 1894	X	X			X							X	X				MCP 45825
Mimagoniates inequalis (Eigenmann, 1911)	X	X	X	X	X												MCP 45824
Pseudocorynopoma doriae Perugia, 1891	X	X		X	X							X	X	X			MCP 45798
Oligosarcus jenynsii (Günther, 1864)		X		X				X	X		X		X				MCP 45780
Oligosarcus robustus Menezes, 1969													X			X	MCP 46519
Oligosarcus sp.																X	MCP46520
Hyphessobrycon boulengeri (Eigenmann, 1907)					X							X	X		X		MCP 45796
Hyphessobrycon bifasciatus Ellis, 1911				X								X	X	X	X		MCP 45802
Hyphessobrycon luetkenii (Boulenger, 1887)	X	X	X	X	X	X	X	X			X	X	X	X	X		MCP 45806
Hyphessobrycon meridionalis Ringuelet, Miquelarena and Menni, 1978				X													MCP 46513
Erythrinidae																	
Hoplias malabaricus (Bloch, 1794)	X		X	X					X		X	X	X	X	X	X	MCP 45790

Table 2. ***Continued.***

TAXON	SAMPLING SITES															VOUCHER
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
SILURIFORMES																	
Auchenipteridae																	
Trachelyopterus lucenai Bertoletti, Silva and Pereira, 1995	X											X				X	MCP 46514
Asprendinidae																	
Pseudobunocephalus iheringii (Boulenger, 1891)	X	X		X	X								X				MCP 45799
Trichomycteridae																	
Homodiaetus anisitsi Eigenmann and Ward, 1907	X	X			X						X		X				MCP 45781
Scleronema sp. aff. *operculatum* Eigenmann, 1917	X	X	X		X	X		X									MCP 45807
Scleronema sp. aff. *minutum* (Boulenger, 1891)	X	X	X	X	X	X	X	X									MCP 45808
Pseudopimelodidae																	
Microglanis cottoides (Boulenger, 1891)	X	X	X	X	X												MCP 45813
Heptapteridae																	
Rhamdia quelen (Quoy and Gaimard, 1824)	X	X	X			X									X		MCP 45783
Heptapterus mustelinus (Valenciennes, 1835)	X	X	X	X	X	X	X	X	X	X	X						MCP 45788
Heptapterus sympterygium Buckup, 1988													X		X		MCP 46518
Pimelodella australis Eigenmann, 1917	X	X		X	X									X			MCP 45793
Challichthyidae																	
Corydoras paleatus (Jenyns, 1842)	X	X		X													MCP 45784
Hoplosternum littorale (Hancock, 1828)													X		X		MCP 46523
Loricariidae																	
Ancistrus brevipinnis (Regan, 1904)		X	X		X	X		X			X						MCP 45794
Hisonotus nigricauda (Boulenger, 1891)	X	X	X	X	X								X		X		MCP 45827
Hisonotus taimensis (Buckup, 1981)		X	X		X							X		X			MCP 45828
Hypostomus commersoni Valenciennes, 1836	X		X	X	X							X	X	X	X	X	MCP 45789
Loricariichthys anus (Valenciennes, 1835)																X	MCP 46517
Rineloricaria cadeae (Hensel, 1868)	X	X	X	X	X	X	X	X	X		X		X				MCP 45829
Rineloricaria strigilata (Hensel, 1868)	X	X	X	X		X		X									MCP 45830, MCP 45831
GYMNOTIFORMES																	
Hypopomidae																	
Brachyhypopomus bombilla															X		UFRGS 13299
Brachyhypopomus gauderio Giora and Malabarba, 2009													X		X		UFRGS 13327,
Sternopygidae																	
Eigenmannia trilineata López and Castello, 1966	X	X		X								X	X		X		UFRGS 13329
Gymnotidae																	
Gymnotus sp. aff. *carapo* Linnaeus, 1758			X		X	X		X									MCP 45832, UFRGS 13331
Gymnotus sp. aff. *pantherinus* (Steindachner, 1908)					X												UFRGS 13296
CYPRINODONTIFORMES																	
Rivulidae																	
Cynopoecilus melanotaenia (Regan, 1912)													X		X		MCP 45791
Poeciliidae																	
Cnesterodon decemmaculatus (Jenyns, 1842)			X														MCP 46522
Phalloceros caudimaculatus (Hensel, 1868)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		MCP 4512
Anablepidae																	
Jenynsia multidentata (Jenyns, 1842)	X			X										X			MCP 45792
SYNBRANCHIFORMES																	
Synbranchidae																	
Synbranchus marmoratus Bloch, 1795	X		X	X	X	X		X					X				MCP 45786
PERCIFORMES																	
Cichlidae																	
Autraloheros acaroides (Hensel, 1870)		X												X			MCP 45823
Cichlasoma portalegrense (Hensel, 1870)	X	X	X		X							X	X		X		MCP 46516
Crenicichla lepidota Heckel, 1840	X		X	X	X	X					X	X	X	X	X	X	MCP 45795
Crenicichla punctata Hensel, 1870				X		X											MCP 45794
Geophagus brasiliensis (Quoy and Gaimard 1824)	X			X	X						X	X	X	X	X	X	MCP 45811
Gymnogeophagus gymnogenys (Hensel, 1870)	X	X	X	X	X	X							X			X	MCP 45809
Gymnogeophagus rhabdotus (Hensel, 1870)	X	X		X	X	X							X				MCP 45819

Table 2. ***Continued.***

TAXON	SAMPLING SITES																VOUCHER
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Gobiidae																	
Ctenogobius shufeldti (Jordan and Eigenmann, 1887)														X			MCP 46512
PLEURONECTIFORMES																	
Paralichthyidae																	
Paralichthys orbignyanus (Valenciennes, 1839)																X	MCP 46520

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