

Fishes from the middle Cubatão River drainage São Paulo State, Brazil

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ABSTRACT: This study aimed to survey the fish fauna of Cubatão River and its tributaries on the Atlantic Coast of São Paulo State, Brazil. For this study we captured the fishes in eight sampled sites: three in the Cubatão River itself (points 5, 6 and 7) and five in its tributaries, three on the left bank (1, 2 and 3) and two on the right bank (4 and 8) using an SAMUS 725M electric shock device, in a 50 meters area. Two samplings were done in rainy and dry season (2011). A total of six orders, nine families and 15 species, of which 53% were Siluriformes and 20% were Characiformes. The number of species collected in the middle Cubatão River basin represents 26.3% of the total richness recorded for coastal basins in the State of São Paulo (about 600 km of coastline).

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INTRODUCTION

The Atlantic Forest, known in Brazil as “Mata Atlântica”, originally covered 12% of Brazil, occurring along the eastern coast. Because of its location, it has been extensively exploited and displaced by growing urban centers or agricultural land use. Currently this biome is a cluster of forest patches in different successional stages, occupying a total area of less than 8% of the national territory and still subject to varying levels of disturbance (INPE 2014). According to Menezes *et al.* (2007) there are about 300 species of fishes found in the rivers and streams of the Atlantic Forest, with about 80% of them being endemic and 15% endangered, while the ecology and conservation status of many species are still unknown.

The Cubatão River is located along the “Serra do Mar”, a mountain range that occurs along the Brazilian southern and southeastern coastline in the Atlantic Forest area, with its spring in the municipality of São Bernardo do Campo and its mouth feeding into the ocean near the municipality of Cubatão, both in São Paulo State. This river is of great socioeconomic importance to the city of Cubatão. It is an important source of water supply, receiving effluents from nearly all industries of Cubatão (Luiz-Silva *et al.* 2002), mainly of the chemical, petrochemical and fertilizer industries (CETESB 2001). The aim of this study was to inventory the species of fish in the middle section of the Cubatão River (area which is not affected by industry).

MATERIALS AND METHODS

Study site

The inland waters of the State of São Paulo are concentrated in four watersheds: Alto Paraná, Paraíba do Sul, Ribeira de Iguape and a set of small drainages located in a narrow coastal belt that flows directly to the Atlantic Ocean and form a region denominated Coastal Drainages or Coastal Basins (Oyakawa and Menezes 2011). The climate

is tropical rainy with an annual mean precipitation of 3.207 mm (EMBRAPA 2012). January to March (austral summer) is the highest rainfall period and July to August (winter) the least, not experiencing a real dry season. The average temperature is 24.8°C, the warmest month (February) 28.3°C and coldest month (July) 20.7°C (EMBRAPA, 2012).

The Cubatão River is located in the “Baixada Santista” region, being approximately 35 km long. It occupies an area of 175.55 km² and has a stream flow long-term average of 8.09 m³/s (CETEC 2000); it is inserted in the Serra do Mar State Park (Parque Estadual da Serra do Mar—PESM), Itutinga-Pilões center.

For this study we selected eight sampling sites, five in tributaries, three from the left bank (1, 2 and 3), two from the right bank (4 and 8) and three in the Cubatão River main stem (5, 6 and 7) (Figure 1). The geographical coordinates are shown in Table 1.

The sites 1, 2 and 3 have waterfalls and present rocky bottom, with dense vegetation cover. The site 4 has sandy bottom, with a predominance of low vegetation on the shore and lentic waters. The site 5 and 6 had substrate composed primarily of gravel and boulders, moderately fast water and riparian low vegetation. Site 7, is formed by a rapid, with rocky bottom and dense vegetation around preserved. Finally, section 8 is located inside a pineapple plantation, with few marginal vegetation, moderately fast water and bottom composed of sand and gravel.

Data collection

Two samplings were done, one in the rainy season (January 2011) and another in the dry season (July 2011). Authorization for the collections were issued by the Instituto Florestal—Secretaria do Meio Ambiente do Estado de São Paulo (license #260108-010.534/260108-010.525/260108-010.517). Fishes were captured by electrofishing using a SAMUS 725M electric shock device

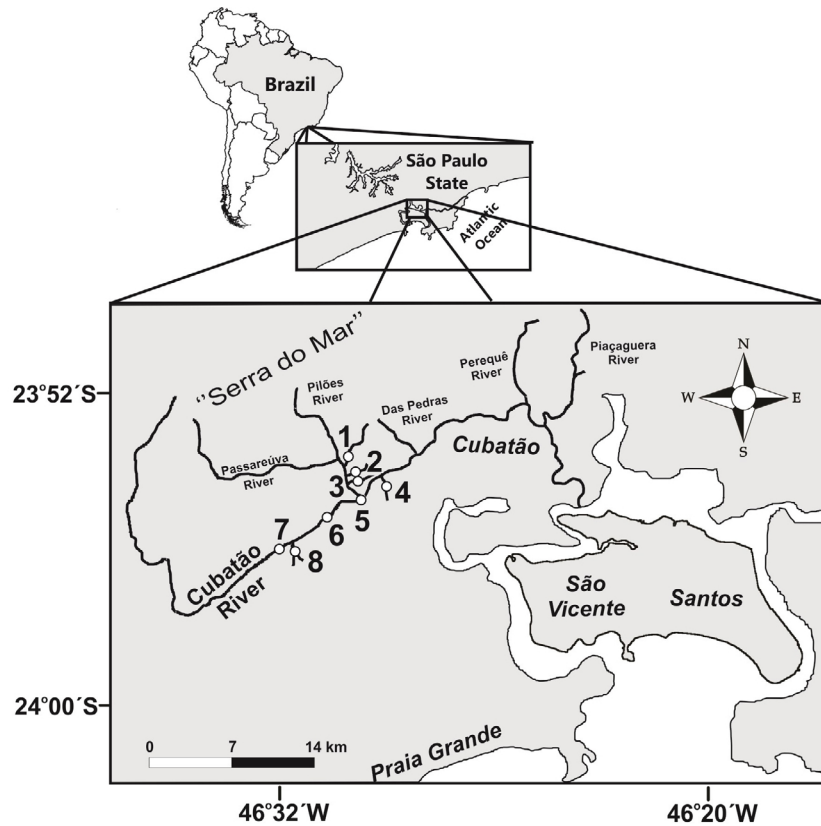


FIGURE 1. Map showing the sampling sites in the middle Cubatão River drainage.

TABLE 1. Geographical coordinates of the sampled sites. Datum: WGS 84.

SITE	NAME	GEOGRAPHICAL COORDINATES	STREAM ORDER	ELEVATION (m)
1	Rio sem nome	23°55'52" S, 46°31'05" W	2	90
2	Rio sem nome	23°54'36" S, 46°28'53" W	2	63
3	Rio sem nome	23°53'57" S, 46°29'35" W	2	65
4	Rio sem nome	23°54'03" S, 46°29'30" W	2	45
5	Rio Cubatão	23°55'16" S, 46°30'01" W	4	39
6	Rio Cubatão	23°55'49" S, 46°31'10" W	3	46
7	Rio Cubatão	23°54'40" S, 46°29'19" W	3	88
8	Rio sem nome	23°54'09" S, 46°29'26" W	2	79

(direct current, 650W, 12V, 99Hz, 8.0 λ, 12s), recording outputs for two dip nets with three passages in an area of 50 meters.

The specimens captured were anesthetized in a solution of benzocaine, fixed in 10% formalin and later transferred to 70% alcohol. The voucher specimens were deposited in Museu de Zoologia da Universidade de São Paulo. The species were identified according to Géry (1977) and Oyakawa et al. (2006) when necessary, compared with samples deposited in MZUSP. The species' nomenclature followed Reis et al. (2003) and Eschmeyer (2013).

RESULTS

We collected a total 1,598 specimens belonging to six orders, nine families and 15 species, of which 53% were Siluriformes and 20% were Characiformes (Table

2). The most representative families were Loricariidae, Characidae and Heptapteridae, both with three species each (20%). The other orders were represented by one family each (Figure 2).

Phalloceros reisi was the most frequent species among the streams studied, occurring in all locations. *Rhamdioglanis frenatus* and *Hollandichthys multifasciatus* occurred in four sites and *Acentronichthys leptos* in three sites (Figure 2). *Geophagus brasiliensis* and *Rineloricaria* sp. were the only species that occurred in only one site (Cubatão River) (Table 2).

The Cubatão River had the highest species richness (15 spp.) followed by T1 (10 spp.) and T3 (5 spp.) (Table 2).

DISCUSSION

The Siluriformes and Characiformes predominance, typical of Neotropical streams (Castro 1999), it's recorded in many places of the Atlantic Forest waterbodies (Sabino and Castro 1990; Aranha et al. 1998; Uieda and Uieda 2001; Esteves and Lobón-Cervia 2001; Oyakawa et al. 2006; Ribeiro et al. 2006; Sarmiento-Soares et al. 2007; Serra et al. 2007; Ferreira and Petrere Jr., 2009). Surveys in the Atlantic Forest streams found 15-26 fish species distributed in 11 families (Costa 1987; Aranha et al. 1998; Mazzoni and Lobón-Cervia 2000; Esteves and Lobón-Cervia 2001; Vilella et al. 2004; Sarmiento-Soares et al. 2007), a result that was observed in this study.

In the Coastal Basin region of São Paulo state, Oyakawa and Menezes (2010) reported 57 species, of which 15 were found in this study, being the equivalent of a 26.3% of the total of that basin.

In Jurubatuba River, the study by Mattox and Iglesias (2010), there were 19 freshwater species captured belonging to the same orders of middle Cubatão. Seven

TABLE 2. Order, family, species, voucher number and their respective occurrences at sampling sites.

ORDER/FAMILY	SPECIES	VOUCHER	1	2	3	4	5	6	7	8
Characiformes/ Characidae	<i>Deuterodon iguape</i> Eigenmann, 1907	MZUSP 113617 / 113630	-	-	-	X	-	-	X	-
	<i>Bryconamericus microcephalus</i> (Miranda Ribeiro, 1908)	MZUSP 113619 / 113637	-	-	-	-	X	X	-	X
	<i>Hollandichthys multifasciatus</i> (Eigenmann & Norris, 1900)	MZUSP 113633	-	X	X	X	-	-	-	X
Siluriformes/ Callichthyidae	<i>Scleromystax barbatus</i> (Quoy & Gaimard, 1824)	MZUSP 113615 / 113623	-	-	-	X	X	X	X	-
Siluriformes/ Heptapteridae	<i>Rhamdia quelen</i> (Quoy & Gaimard, 1824)	MZUSP 113634	-	-	X	-	-	X	X	-
	<i>Rhamdioglanis frenatus</i> Ihering, 1907	MZUSP 113627 / 113635	-	-	X	X	-	-	X	X
	<i>Acentronichthys leptos</i> Eigenmann & Eigenmann, 1889	MZUSP 113621 / 113628	-	-	X	X	-	-	X	-
Siluriformes/ Loricariidae	<i>Ancistrus multispinis</i> (Regan, 1912)	MZUSP 113636	-	-	-	X	-	-	-	-
	<i>Schizolecis guntheri</i> (Miranda Ribeiro, 1918)	MZUSP 113618 / 113620 / 113624	-	-	-	X	X	-	-	-
	<i>Rineloricaria</i> sp.	MZUSP 113622 / 113625	-	-	-	-	X	X	-	-
Siluriformes/ Trichomycteridae	<i>Trichomycterus alternatus</i> (Eigenmann, 1917)	MZUSP 113638	-	-	-	X	-	X	-	-
Gymnotiformes/ Gymnotidae	<i>Gymnotus pantherinus</i> (Steindachner, 1908)	MZUSP 113616 / 113632	-	-	-	X	X	-	X	-
Cyprinodontiformes/ Poeciliidae	<i>Phalloceros</i> cf. <i>reisi</i> Lucinda, 2008	MZUSP 113612 / 113626	X	X	X	X	X	X	X	X
Labriformes/ Cichlidae	<i>Geophagus brasiliensis</i> (Quoy & Gaimard, 1824)	MZUSP 113614 / 113631	-	-	-	-	X	X	-	-
Synbranchiformes/ Synbranchidae	<i>Synbranchus marmoratus</i> (Bloch, 1897)	MZUSP 113639 / 113613	-	X	-	-	X	X	-	-
TOTAL			1	2	5	10	8	7	7	4

of these were found in both surveys (*Hollandichthys multifasciatus*, *Schizolecis guntheri*, *Acentronichthys leptos*, *Rhamdia quelen*, *Gymnotus pantherinus*, *Synbranchus marmoratus* and *Geophagus brasiliensis*). The Cubatão River showed greater richness in the Family Loricariidae with three species. The Jurubatuba River had greater richness within the order Cyprinodontiformes, with six species. The genus *Phalloceros*, was the only one of this order to occur in both studies. These results perhaps demonstrate the high selectivity of environments by the species of the Atlantic Forest (Menezes et al. 2007).

The absence of *Hollandichthys multifasciatus* in the main river (Cubatão) may be associated with the species preference of vegetation cover (Bertaco and Malabarba, 2013), as it has insectivore eating habits and predominantly consumes allochthonous material (Sabino and Castro 1990). On the other hand, *Rineloricaria* sp. and *Geophagus brasiliensis* occurred only in sites located in the main river. *Rineloricaria* sp. is a species associated with sites with higher current (Reis and Cardoso 2001). However, according to Sarmento-Soares et al. (2007) *G. brasiliensis* is an opportunistic species adaptable to intense solar incidence. Opportunistic species tend to have higher trophic plasticity, suggesting that low-order rivers, exhibit low variability in food supply, thus resulting in the absence of *G. brasiliensis* in these environments (Knoppel 1970).

Additional samples, mainly in the headwaters of Cubatão river, a still unexplored region, are necessary to better represent the richness of the local fish fauna. Although this study contributes to knowledge of Cubatão River fish, new studies should be performed to diagnose anthropogenic changes, as accidents with chemical spills on roads that border the river and give access to the largest port in Latin America, in order to produce a more complete and consistent diagnosis because the species may be subject to temporal changes.

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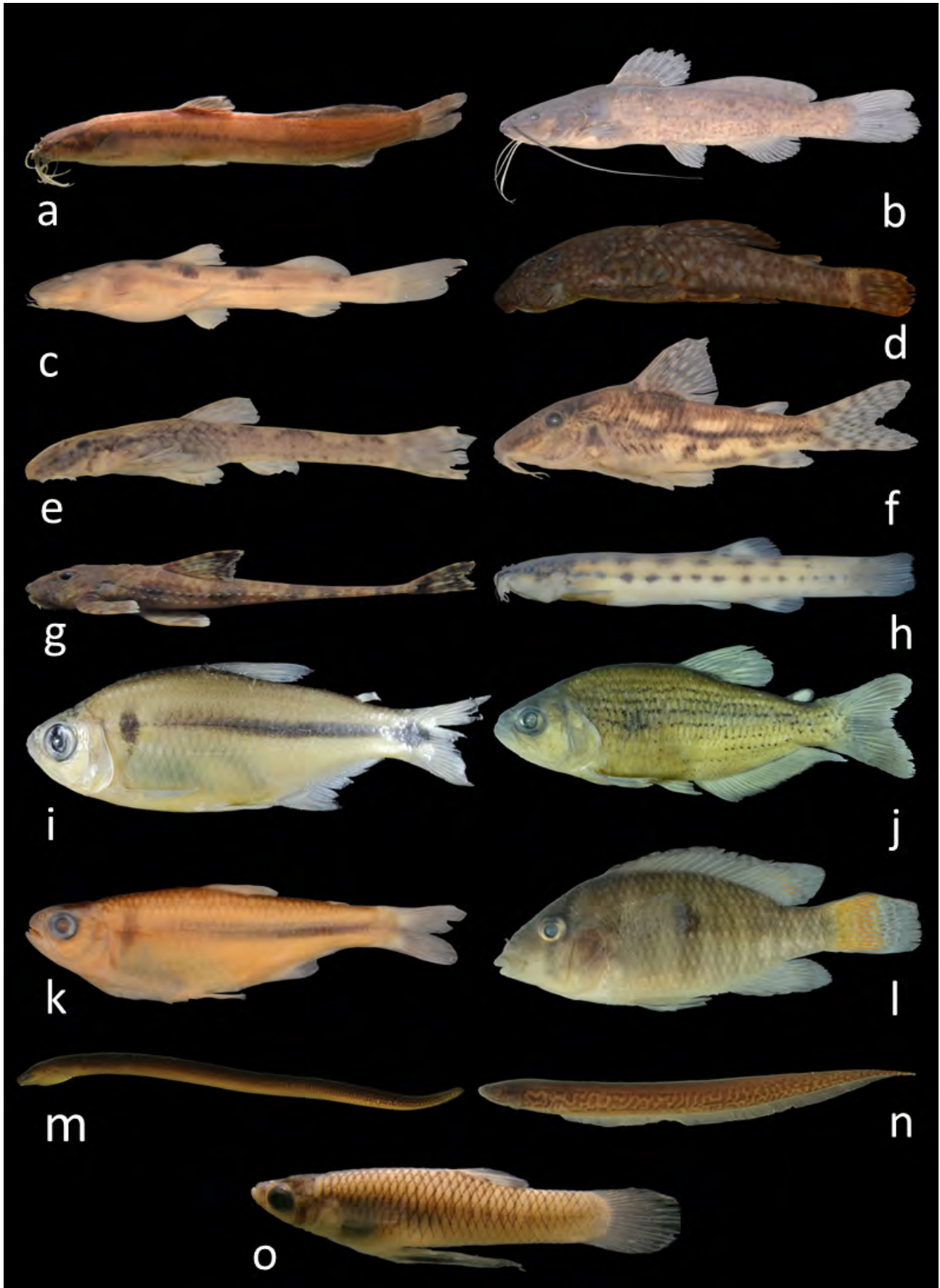


FIGURE 2. Species collected: [a] *Acentronichthys leptos*, [b] *Rhamdia quelen*, [c] *Rhamdioglanis frenatus*, [d] *Ancistrus multispinis*, [e] *Schizolecis guntheri*, [f] *Scleromystax barbatus*, [g] *Scleromystax barbatus*, [h] *Trichomycterus* sp., [i] *Deuterodon iguape*, [j] *Hollandichthys multifasciatus*, [k] *Bryconamericus microcephalus*, [l] *Geophagus brasiliensis*, [m] *Synbranchus marmoratus*, [n] *Gymnotus pantherinus*, [o] *Phalloceros* cf. *reisi*.

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