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Research Article

Spatial and temporal differences in the fish assemblage structure in a subtropical estuary

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ABSTRACT. A large number of fish species use the mangrove mainly due to food availability and protection against predators. The knowledge of temporal and spatial dynamics of ichthyofauna allows us to identify patterns of occupation of this ecosystem and to support the assessment and preservation of local biodiversity. In this sense, samplings were conducted in 1988 at five areas of the Itacorubi River estuary, Santa Catarina Island. A total of 3,883 specimens were collected, distributed in 21 families and 41 species with the predominance of *Cetengraulis edentulus*, *Mugil liza*, *Mugil curema*, *Genidens genidens*, *Mugil gaimardianus*, *Eucinostomus gula*, *Micropogonias furnieri*, *Pomatomus saltatrix* and *Sphoeroides testudineus*. On average, abundances differed between seasons and sampled areas. Differences were detected between the fish faunas of fall and winter compared to summer and spring and between sampling sites. This study identified a fish assemblage in the mangrove of the Itacorubi River with a similar structure to other estuaries of southern Brazil.

Keywords: fish; biodiversity; mangrove; Santa Catarina Island; southern Brazil

INTRODUCTION

In tropical and subtropical coastal areas, mangroves are one of the most endangered and important biological ecosystems, offering various environmental and economic services, such as coast protection, sediment retention, carbon sequestration, assimilation and transformation of nutrients, recreation and products of plant and animal origin (Rönnbäck *et al.*, 1999; Dahdouh-Guebas *et al.*, 2005; Blaber, 2007; Hussan & Bardolla, 2008). In mangroves, we can find a high diversity of marine and terrestrial species of fish, crustaceans, birds, reptiles and mammals (Alongi, 2002).

Compared to the nearby sandy and muddy plains, mangroves contain a large number of fish and species, especially at the juvenile stage (Kathiresan & Bringhan, 2001; Laegdsgaard & Johnson, 2001; Faunce & Serafy, 2006). The most intense use of this ecosystem by fish would be related to the abundance of food due to high productivity and associated benthic fauna (Kathiresan & Bringhan, 2001; Laedsgaard & Johnson, 2001) and the availability of protection against predators, mainly due to the structural complexity, shade, turbidity and shallow local depth (Cyrus & Blaber, 1987; Rönnbäck *et al.*, 1999; Ellis & Bell, 2004; Verweij *et al.*, 2006).

In addition to the influence of environmental factors on the spatial and temporal variations of the fish fauna in mangroves (Huxham *et al.*, 2004; Pittman *et al.*, 2004; Lugendo *et al.*, 2007; Nagelkerken & Faunce, 2007), latitude, coastal configuration and the ecological processes can also contribute to these variations (Verweij *et al.*, 2006; Rypel *et al.*, 2007; Guilstrom *et al.*, 2008). Furthermore, more than 50 percent of the world's population lives within the 50 km coastline, with the coastal community, especially in underdeveloped countries, using mangroves for livelihood, causing, among other things, disappearance at alarming rates of mangrove areas because of activities such as aquaculture, timber production, urbanization, tourism

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and pollution (Valiela *et al.*, 2001; Alongi, 2002; Duke *et al.*, 2007). Changes in mangroves may affect the structure of fish assemblages by interfering with species that use the area during their life cycle (Williamson *et al.*, 1994; Huxham *et al.*, 2004).

This study surveyed and evaluated seasonal and spatial changes of the fish community in a subtropical southern mangrove in the South American continent, specifically in Itacorubi River estuary, Santa Catarina Island, Brazil. This information is needed to understand how fish use this ecosystem and the strategies that can be used to maintain local biodiversity.

MATERIALS AND METHODS

Study area

In the western margin of Santa Catarina Island and to the south of the northern bay, there is the Itacorubi mangrove (27º34'14"-27º35'31"S, 48°30'07"-48°31'33"W) (Fig. 1), with an area of 1.42 km^2 (Soriano-Sierra, 1993), perimeter of 5.8 km, corresponding to 0.32% of the municipality of Florianópolis (Panitz, 1986). In this estuary, predominates fine sediments, mainly silt and vegetation composed of *Avicennia schaueriana*, and to a lesser extent *Laguncularia racemosa*, *Rhizophora mangle* and *Spartina alterniflora* (Soariano-Sierra, 1997). A remarkable feature of this mangrove is the high degree of anthropization through organic and chemical pollution due to its location close to the urban network and the past use of this site to deposit municipal waste, including domestic and hospital waste (Soriano-Sierra *et al.*, 1998).

The region has a humid subtropical climate, and rainfall is distributed throughout the year, with winds predominating from the north/northeast quadrant and maximum average temperatures in February and minimum in June (Dutra, 1998; MMA, 2004a). In the region, the tidal regime is semi-diurnal, with a maximum amplitude of 0.63 m inside the Itacorubi Estuary (Soriano-Sierra, 1997).

Sampling

In 1988, monthly samplings were carried out at five distinct areas: 1-mouth near the northern bay, 2-confluence of the rivers, 3 and 4-Itacorubi River, 5-Sertão River (Fig 1). In each area and each month, 30 throws were performed with the aid of cast nets with 10 and 20 mm mesh between opposing knots, with 15 throws for each net.

In the field, collected fish were packed in Styrofoam box with ice and transported to the laboratory. Fish were identified, measured (TL mm) and weighed (g) and classified according to the trophic guilds, using the estuary and depth preference based on regional literature (Passos *et al.*, 2013; Pichler *et al.*, 2015).

Statistical analysis

The following simple linear model was used to test the spatial and temporal fish assemblage variation in Itacorubi mangrove: $Y = \mu + Es + Ar + Es \times Ar + e$, where Y: dependent variable; μ: mean; Es: season of the year, Ar: area; e: error. The factors seasons of the year (summer: December, January, February; fall: March, April, May; winter: June, July, August; spring: September, October, November) and areas (1, 2, 3, 4 and 5) were considered fixed and orthogonal.

In general, to test the hypothesis of spatial and temporal differences in fish abundance, a permutational multivariate analysis of variance (Permanova) was applied (Anderson *et al.*, 2008). Permanova is a univariate or multivariate analysis of variance, which uses permutation procedures based on any measure of similarity. The advantage of this type of analysis is the absence of assumptions, as is the case of normality. Thus, it is a non-parametric analysis that allows the use of fixed or random factors related to orthogonally (crossed) or nested in hypothetical descriptive or experimental models (Anderson *et al.*, 2008).

When the null hypothesis was rejected by Permanova, a pairwise Permanova was applied for *a posteriori* comparisons between factors that had significant differences ($P < 0.05$), which is a similar test to a *post-hoc* analysis. In order to visualize the differences found in Permanova, we performed the canonical analysis of principal coordinates (CAP), which generates the graphical clusters through permutation (Anderson *et al.*, 2008). Within the CAP analysis, the Spearman correlation at the 0.5 level was used to determine which species (vectors) were responsible for the clusters.

RESULTS

Fish assemblage

A total of 3,883 individuals was collected, belonging to 21 families and 41 species (Table 1). The families that presented the highest species richness were Gerreidae (5 species), Mugilidae and Sciaenidae (4 each), Ariidae and Engraulidae (3 each), and Clupeidae, Gobiidae and Paralichthyidae (2 each) (Table 1). The other families had the occurrence of only one species.

In descending order, *Cetengraulis edentulus*, *Mugil liza*, *Mugil curema*, *Genidens genidens*, *Mugil gaimardianus*, *Eucinostomus gula*, *Micropogonias furnieri*, *Pomatomus saltatrix*, and *Sphoeroides testudineus* represented 90% of the catch in number; the

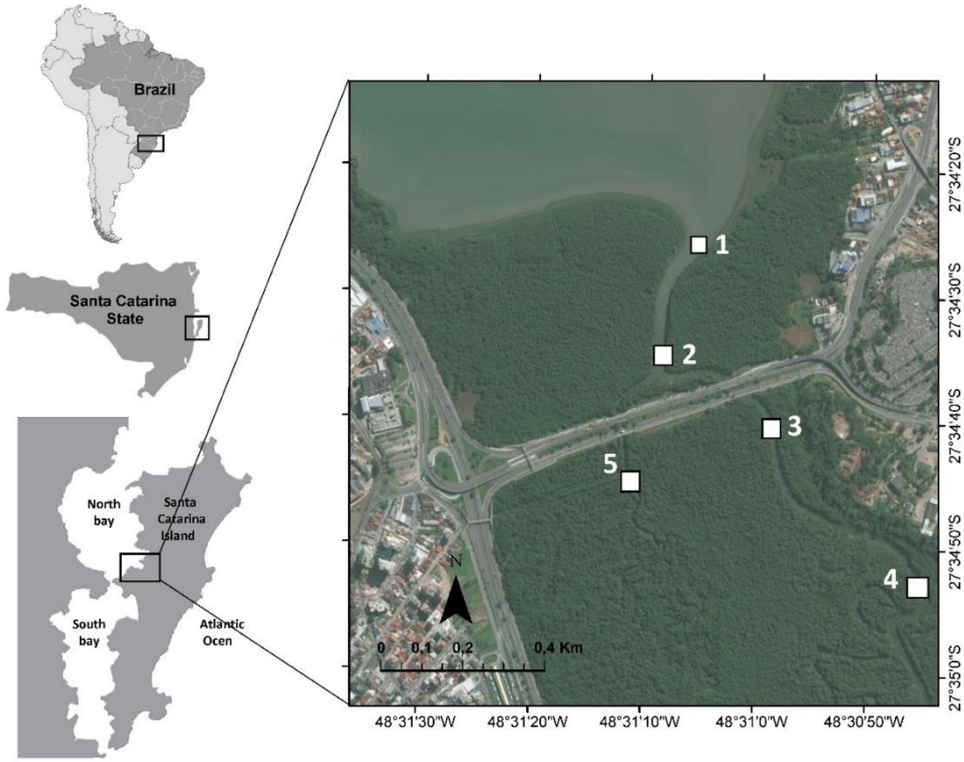

Figure 1. Map of the study area, detailing the five areas sampled in the Itacorubi mangrove, Santa Catarina Island, State of Santa Catarina, Brazil.

catch of *C. edentulus* accounted for approximately 65% of the total. Each of the other species contributed less than 1% of the total catch (Table 1). The total catch weight corresponded to 44,903.05 g (Table 1), with *M. liza*, *C. edentulus*, *M. curema*, *M. furnieri*, *G. genidens*, *Cynoscion leiarchus*, *S. testudineus*, *P. saltatrix*, *M. gaimardianus* and *E. gula* corresponding, in descending order, to approximately 91% of this total (Table 1). The catch of *M. liza* and *C. edentulus* accounted for approximately 70% of the total catch weight.

The broader total length range occurred for *M. liza* (316 mm), *G. genidens* (224 mm), *Cathorops spixii* (200 mm), *S. testudineus* (191 mm), *Strongylura marina* (155 mm), *C. edentulus* (148 mm), *M. furnieri* (144 mm) and *C. leiarchus* (139 mm), with predominance in the area of transient and demersal species, with residents and transients mostly demersal. Most species, considering their feeding habit, are zoobenthivorous, with a numerical predominance of zooplanktivorous species followed by detritivorous species (Table 1).

Comparing the values of abundance between seasons and areas, Permanova detected significant differences ($P < 0.05$) between the seasons and areas, and there were no significant differences in the interaction between the factors (Table 2). In the paired comparisons (Permanova pairwise test) between seasons, only between summer and fall and between summer and spring, differences between means were not significant (Table 3). In the paired comparisons between areas, only the differences between areas 1 and 2, 1 and 3 and between 2 and 3 were not statistically significant (Table 4).

The highest mean abundance occurred in the fall in areas 2 (mean ± standard deviation, 221.82 ± 210.54) and 4 (92.79 ± 68.7), followed by winter in area 4 (81.49 ± 65.67), summer in areas 4 (27.21 ± 27.74) and 3 (16.62 ± 18.85) and winter in area 2 (16.23 ± 14.68) (Fig. 2). The lowest values occurred in the spring in area 1 (3.18 ± 2.2), in the summer in areas 5 (3.07 ± 2.5) and 1 (2.64 ± 1.89), in winter in area 5 (2.15 ± 1.28), spring in area 5 (1.67 ± 0.98) and fall in area 5 (1.42 ± 0.67) (Fig. 2).

In the canonical analysis of principal coordinates (CAP), with the season of the year as factor, we verified a separation of the samples of the fall and winter more to the right and bottom of the graph and the summer and spring samples to the left and top of the graph (Fig. 3). High abundances of *C. leiarchus*, *M. furnieri* and *C. edentulus* in the summer and spring, as well as the predo-

Table 1. List of species, number of individuals (n), weight (W), mean, minimum and maximum total length (TL), trophic guild (TG) (ZP: zooplanktivorous, DV: detritivorous, PV: piscivorous, ZB: zoobenthivorous, OP: opportunistic), guild of use of the estuary (GU) (R : resident, T: transient) and depth preference (DP) (P: pelagic, D: demersal, BP: benthopelagic) of fish caught in 1988 in the Itacorubi mangrove, Santa Catarina Island. Global conservation status, according to IUCN (2019): data deficient[1], least concern[2], vulnerable[3], endangered[4]. National conservation status according to Ministry of the Environment (MMA) (2004b): †: endangered, ††: overexploited.

Families/Species	n	W (g)	Mean TL (mm)	Min-Max TL (mm)	TG	GU	DP	Economic importance
Achiridae								
Achirus lineatus[2]	3	13.17	58	46-69	ZB	R	D	Yes
Ariidae								
Cathorops spixii	7	373.47	161.57	81-281	ZB	R	D	Yes
Genidens barbus[4]	38	579.7	114.42	77-172	ZB	T	D	Yes
Genidens genidens[2]†	108	1504	101.22	61-285	ZB	T	D	Yes
Atherinopsidae								
Atherinella brasiliensis[2]	15	70.92	82.13	44-105	OP	R	P	Yes
Belonidae								
Strongylura marina[2]	7	91.62	215.29	153-308	PV	T	P	Yes
Carangidae								
Oligoplites palometa[2]	33	191.21	80.70	33-130	PV	T	P	Yes
Oligoplites saliens[2]	3	3.73	55	54-56	ZP	T	P	Yes
Oligoplites saurus[2]	3	11.06	79.33	74-86	PV	T	P	Yes
Selene vomer[2]	1	6.26	80	80	ZB	T	D	Yes
Centropomidae								
Centropomus parallelus[2]	4	49.63	106.5	86-139	ZB	R	D	Yes
Cichlidae								
Geophagus brasiliensis	9	385.9	124.89	103-166	ZB	T	P	Yes
Clupeidae								
Harengula clupeola[2]	38	167.4	75.21	64-99	ZP	T	P	Yes
Sardinella brasiliensis ††	1	3.33	69	69-69	ZP	T	P	Yes
Cynoglossidae								
Symphurus tessellatus[2]	18	95.18	90	73-126	ZB	T	D	Yes
Elopidae								
Elops saurus[2]	5	198.15	192	173-208	PV	T	P	Yes
Engraulidae								
Anchoa januaria	24	30.08	56.42	43-70	ZP	R	P	Not
Cetengraulis edentulus[2]	2579	12192	81.28	16-164	ZP	T	P	Yes
Lycengraulis grossidens[2]	26	457.25	132.15	102-169	ZP	T	P	Yes
Gerreidae								
Diapterus rhombeus[2]	4	12.48	62.5	52-77	ZB	T	D	Yes
Eucinostomus argenteus[2]	38	263.91	79.97	62-111	ZB	T	D	Yes
Eucinostomus gula[2]	84	581.64	79.5	48-115	ZB	T	D	Yes
Eucinostomus melanopterus[2]	7	97.01	100.43	57-153	ZB	T	D	Yes
Eucinostomus spp.	9	53.87	75.67	61-82	ZB	T	D	
Gobiidae								
Bathygobius soporator[2]	6	147.96	115.5	101-143	ZB	R	D	Yes
Gobionellus oceanicus[2]	2	36.48	158	158-158	ZB	R	D	Yes
Haemulidae								
Orthopristis ruber[2]	1	19.77	105	105	ZB	T	D	Yes
Mugilidae								
Mugil curema[2]	156	2065.3	103.68	73-143	DV	T	D	Yes
Mugil gaimardianus	97	754.21	93.35	61-116	DV	T	D	Yes
Mugil liza[1]††	293	19539	171.69	37-353	DV	T	D	Yes
Mugil spp.	5	1.52	30	27-33	DV	T	D	
Ophichthidae								
Ophichthus gomesii[2]	1	92.25	455	455		T	D	Yes
Paralichthyidae								
Citharichthys arenaceus[2]	2	13.97	94.5	93-96	ZB	R	D	Yes
Citharichthys spilopterus[2]	8	80.86	90.13	49-143	ZB	R	D	Yes

Continuation

Families/Species	n	W (g)	Mean TL (mm)	Min-Max TL (mm)	TG	GU	DP	Economic importance
Poeciliidae								
Poecilia sp.	2	2.59	44	37-51		T	BP	
Pomatomidae								
Pomatomus saltatrix [3]††	84	831.99	99.08	78-158	PV	T	P	Yes
Sciaenidae								
Bairdiella rhonchus[2]	2	32.01	107	104-110	ZB	R	D	Yes
Cynoscion jamaicensis[2]	3	28.81	88.67	69-126	ZB	T	D	Yes
Cynoscion leiarchus[2]	28	1085.8	141.11	67-206	PV	T	D	Yes
Micropogonias furnieri[2]††	84	1881.9	123.68	49-193	ZB	T	D	Yes
Tetraodontidae								
Sphoeroides testudineus[2]	45	855.74	80.18	40-231	ZB	R	D	Not
Total	3883	44903						

Table 2. Results of Permanova based on the Bray-Curtis similarity of abundance (square-root transformed). Factors, Es: season, A: area, Res: residual, df: degrees of freedom, MS: mean square sum.

Source of variation	df	MS	Pseudo-*F*	*P*(perm)
Es	3	5825.5	2.5567	0.0003
A	4	9152.8	4.017	0.0001
Es x A	12	2612.7	1.147	0.183
Res	39	2278.5		

Table 3. Results of pairwise Permanova based on the Bray-Curtis similarity of abundance (square-root transformed) between seasons, with values of the Student's *t*-test and permutation *P*-value (*P*(perm)).

Groups	*t*	*P*(perm)
Summer, Fall	1.331	0.0862
Summer, Winter	1.7503	0.0029**
Summer, Spring	1.188	0.2005
Fall, Winter	1.9676	0.0007***
Fall, Spring	1.7595	0.0059**
Winter, Spring	1.4703	0.0331*

$P < 0.05$*; $P < 0.01$**; $P < 0.001$***

minance of *M. curema*, *Harengula clupeola*, and *E. gula* in the fall and winter were responsible for the observed separation of the groups (Fig. 3).

In relation to the areas, three clusters were observed in CAP: a group of the samples taken in areas 1, 2 and 3 at the top of the graph; a cluster with samples from area 4 at the bottom and leftmost of the graph and a cluster to the right of the samples collected in area 5 (Fig. 4). High abundances of *G. genidens* and *M. curema* in areas 1, 2 and 3, of *C. edentulus* in area 4 and *Geophagus brasiliensis* in area 5 were responsible for the clusters observed (Fig. 4).

Table 4. Results of pairwise Permanova based on the Bray-Curtis similarity of abundance (square-root transformed) between sampling areas, with values of the Student's *t*-test and permutation *P*-value (*P*(perm)).

Groups	*t*	*P*(perm)
1, 2	1.0479	0.3545
1, 3	1.3609	0.0797
1, 4	2.2927	0.0002***
1, 5	2.0918	0.0022
2, 3	1.1945	0.1656
2, 4	1.971	0.0007***
2, 5	2.0733	0.0011**
3, 4	1.9928	0.0042**
3, 5	2.4039	0.0002***
4, 5	3.0215	0.0001***

$P < 0.05$*; $P < 0.01$**; $P < 0.001$***

DISCUSSION

The analytical approach used in the present study is unprecedented for the Itacorubi mangrove. A previous survey was done with similar results (Soriano-Sierra *et al.*, 1998). However, spatial and temporal assemblage patterns were not evaluated. Despite the dominance of a few species, which is a remarkable feature in lagoon and estuarine environments due to significant changes in physical and chemical variables (Day *et al.*, 1989), there are differences in abundance between seasons and areas, commonly present in other surveys conducted in shallow areas (Spach *et al.*, 2010; Contente *et al.*, 2011; Vilar *et al.*, 2011; Souza-Conceição *et al.*, 2013; Cartagena *et al.*, 2014; Ribeiro *et al.*, 2014; Soeth *et al.*, 2015; Cattani *et al.*, 2016a). The use of such environments by juveniles, generally zoobenthivorous, is characterized by the availability of food associated with the substrate. According to Whitfield & Elliott (2002), shallow areas, beaches and mangroves are of

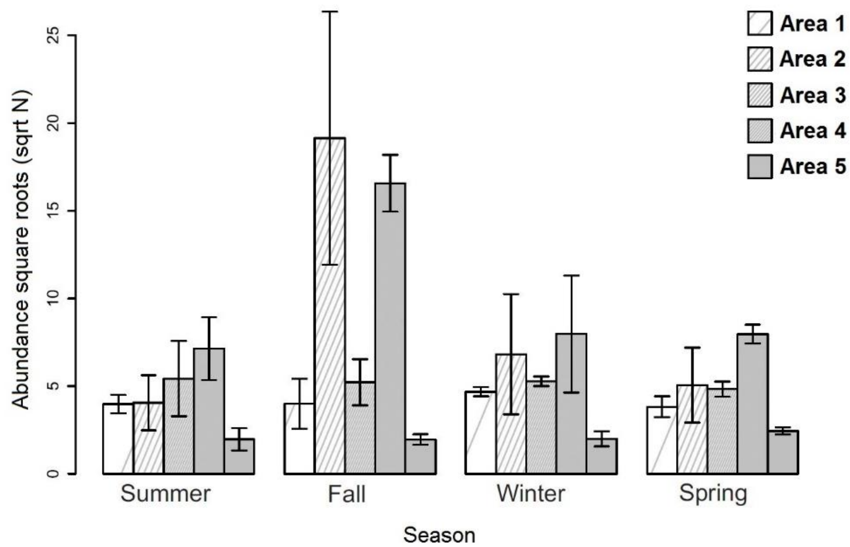

Figure 2. Mean values (standard error in the bars) of the abundance square root of fish caught in the four seasons of the year and areas 1, 2, 3, 4 and 5 in 1988 in the Itacorubi mangrove, Santa Catarina Island.

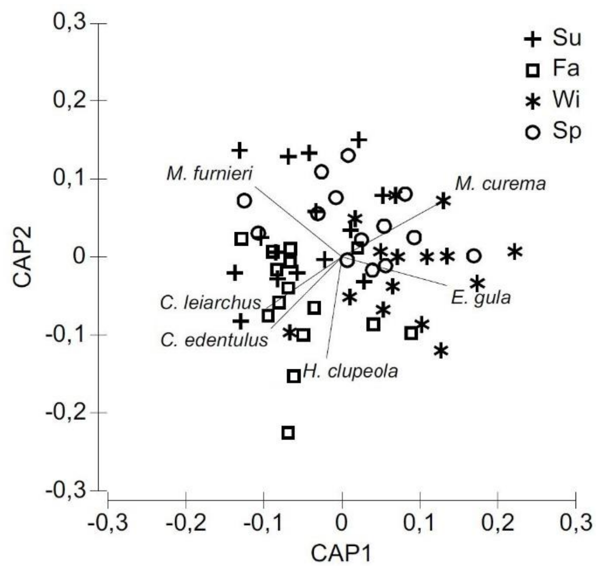

Figure 3. Result of the canonical analysis of principal coordinates (CAP), with the species that contributed to the differences between the seasons. Vectors of species elaborated based on the Spearman correlation with the index above 0.5 ($P > 0.5$). The canonical correlation of the axes obtained by the analysis was $\delta 1 = 0.6587$ and $\delta 2 = 0.5674$. Su: summer, Fa: fall, Wi: winter and Sp: spring.

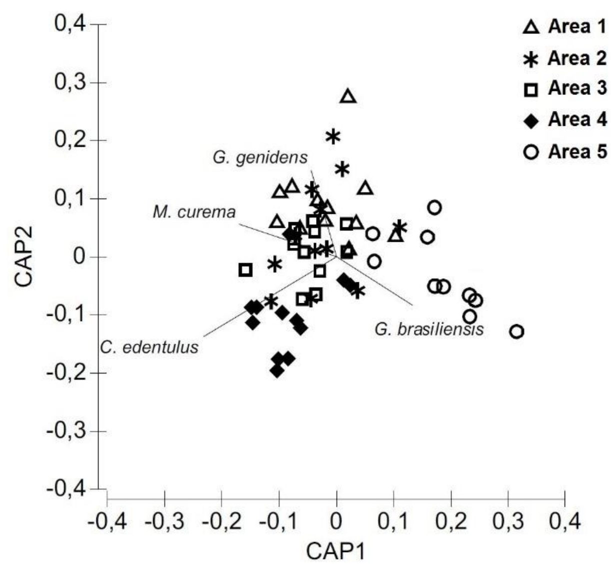

Figure 4. Result of the canonical analysis of principal coordinates (CAP), with the species that contributed to the differences between the areas. Vectors of species elaborated based on the Spearman correlation with the index above 0.5 ($P > 0.5$). The canonical correlation of the axes obtained by the analysis was $\delta 1 = 0.8487$ and $\delta 2 = 0.7044$.

extreme importance for juvenile fish and other aquatic organisms.

As a general framework, fish assemblage structure is influenced by a combined set of environmental variables, which provides a suitable habitat, and by other biological variables such as predator-prey interactions and inter- and intra-specific competition (Whitfield & Elliott, 2002). The higher abundances observed mainly in the fall could be explained by the nutrient input caused by highly rainfall, typical at this time of year. These patterns were also observed in nearby areas in the western margin of Santa Catarina Island (Cartagena *et al.*, 2014; Ribeiro *et al.*, 2014; Soeth *et al.*, 2015; Cattani *et al.*, 2016a,b).

Concerning the most abundant species, there was a high occurrence of *Cetengraulis edentulus* and *Mugil liza*, representing more than 70% of the individuals caught. This pattern, with emphasis on the occurrence of the genera *Mugil* and *Cetengraulis*, has also been observed in other studies in shallow areas (Souza-Conceição *et al.*, 2013; Cartagena *et al.*, 2014; Borgo *et al.*, 2015; Cattani *et al.*, 2016b).

Considering the high abundance of *C. edentulus* individuals caught in the summer and spring and at site 4, we can infer that these individuals may be hiding from predators and establishing their temporary niches for growth in these environments due to they are present in the Itacorubi River, an area with less influence of the tide, and because they are considered transient in the estuary. This assumption is in agreement with the breeding pattern of the species (Franco *et al.*, 2014), which presents an extended reproductive period between late winter and spring, with more intense reproductive activity in November, entering the estuaries in the following months. A similar pattern occurred in the shallow areas of the Sepetiba Bay (Pesanha & Araujo, 2003) and a tidal river in the Pinheiros Bay (Oliveira-Neto *et al.*, 2010). In the life cycle of most species of engraulids, there is a characteristic phase that occurs in more sheltered coastal areas, such as bays and lagoons (Blaxter & Hunter, 1982), where they seek protection against predators (Oliveira-Neto *et al.*, 2010), such as *Pomatomus saltatrix*, a top-chain predator fish species that use estuarine areas for feeding (Froese & Pauly, 2017), present in a significant number in Itacorubi.

The presence of *P. saltatrix*, classified as vulnerable by the red list of endangered species, was representative in Itacorubi and was also present in the works carried out in a mangrove with similar characteristics in the northern bay of Florianópolis (Cattani *et al.*, 2016b), in the Saco dos Limões region, in the southern bay of Florianópolis (Cartagena *et al.*, 2014) and in the Conceição Lagoon in Florianópolis (Borgo *et al.*, 2015). Besides that, the presence was also observed in the Paranaguá Estuary, State of Paraná, especially at beaches (Felix *et al.*, 2002), tidal rivers (Vendel *et al.*, 2002; Spach *et al.*, 2004b) and tidal plains (Santos *et al.*, 2002; Spach *et al.*, 2004a) near the entrances of the estuary, but was absent in most surveys performed in the more internal shallow areas of this estuary (Falcão *et al.*, 2006; Hackradt *et al.*, 2009; Pichler *et al.*, 2015). The absence of this species was also verified in shallow areas of the Babitonga Bay (Vilar *et al.*, 2011; Souza-Conceição *et al.*, 2013) and five estuaries of Rio Grande do Sul (Ramos & Vieira, 2001). Thus, the occurrence of this vulnerable species reinforces the importance of mangrove conservation.

The second most abundant species, *M. liza*, occurred predominantly in the winter, it is a species that performs reproductive migration from the coast of Argentina to the Brazilian southeast coast from April to June, with a spawning peak between the northern coast of Santa Catarina and Paraná (Lemos *et al.*, 2014). The highest abundances observed in the winter in the Itacorubi and other studies on the fish fauna (IBAMA, 1994; Spach *et al.*, 2000; Ramos & Vieira, 2001; Ignácio & Spach, 2009; Contente *et al.*, 2011) reflects the migratory and reproductive pattern described for this species.

However, the alternating peaks of abundance between *M. liza* and *M. curema* are recurrent. While in the spring and summer, there is a peak of *M. curema* and a low occurrence of *M. liza*, in the fall and winter, the pattern reverses. As in the Itacorubi mangrove, this pattern of alternating occurrence of *M. liza* and *M. curema* was also registered in the Camboriú River (IBAMA, 1994), in the northern bay of Florianópolis (Cattani *et al.*, 2016a), in the mangrove of the Ratones River (Cattani *et al.*, 2016a) and in shallow areas of the State of Rio Grande do Sul: Arroio Chuí estuary, Patos Lagoon estuary, Peixe Lagoon estuary, Tramandaí-Armazém Lagoon Complex and Mampituba River estuary (Ramos & Vieira, 2001).

The catfish *Genidens genidens* was among the most abundant in the present study, as also reported for the Ratones River estuary (Cattani *et al.*, 2016a) and demersal areas of the northern bay (Cattani *et al.*, 2016a) and Saco dos Limões on the southern bay (Cartagena *et al.*, 2014), and to a lesser extent in relation to the total catch in the Conceição Lagoon (Borgo *et al.*, 2015) and Indio Beach (Ribeiro *et al.*, 2014; Soeth *et al.*, 2015).

The presence of *Genidens barbus* in the Itacorubi mangrove was also verified in the estuarine (Cattani *et al.*, 2016b), beach (Ribeiro *et al.*, 2014; Soeth *et al.*, 2015) and demersal environments of the northern (Cattani *et al.*, 2016a) and southern (Cartagena *et al.*, 2014) bays of Florianópolis, but not in samples from the Conceição Lagoon (Borgo *et al.*, 2015). This same pattern of occurrence in different environments near the estuary of the Itacorubi mangrove was also observed in *Micropogonias furnieri* (Cartagena *et al.*, 2014; Ribeiro *et al.*, 2014; Soeth *et al.*, 2015; Cattani *et al.*, 2016a,b) but in this case, the species was captured in the Conceição Lagoon (Borgo *et al.*, 2015).

In addition to the mentioned species, such as in the Itacorubi River estuary, occurred at the Índio Beach (Ribeiro *et al.*, 2014; Soeth *et al.*, 2015), Conceição Lagoon (Borgo *et al.*, 2015), Ratones River estuary (Cattani *et al.*, 2016b), and in the northern (Cattani *et al.*, 2016a) and southern (Cartagena *et al.*, 2014) bays, all located on the Santa Catarina Island, the species *Achirus lineatus*, *Centropomus parallelus*, *Citharichthys spilopterus*, *Cynoscion leiarchus*, *Diapterus rhombeus*, *Eucinostomus argenteus*, *E. gula*, *Gobionellus oceanicus*, *Harengula clupeola*, *Oligoplites saurus*, *Sphoeroides testudineus* and *Symphurus tessellatus*.

In study research, we caught nine individuals of *Geophagus brasiliensis*, a freshwater species, which is expected, as this species was caught in the Sertão River (site 5, Fig. 1) where the marine influence should be reduced due to the low tidal amplitude in the estuary (Soriano-Sierra, 1997). In the Ratones Estuary, also on the shore of northern bay of the Santa Catarina Island, the catch of this species was even larger (35 specimens) at a more internal sampling point located in an area where the physical and chemical variations mainly respond to the continental contribution (Simonassi *et al.*, 2010).

As far as the economic importance is concerned (Table 1), in the geographic distribution area of the species, 33 species are commercially used in fishing, aquaculture or aquaria, and for four, there is no economic interest (Froese & Pauly, 2017). Most of the fish fauna of the Itacorubi River estuary was evaluated according to conservation status (Table 1). Thirty-three are on the red list of the Union for Conservation of Nature and Natural Resources - IUCN (IUCN, 2019), where 30 are classified as least concern, *G. genidens* as endangered, *M. liza* as deficient data and *P. saltatrix*, as vulnerable. On the other hand, only four species of this estuary are evaluated according to the conservation status in the list of the Ministry of Environment - MMA (MMA, 2004b), with *Sardinella brasiliensis* exclusive of this list and classified as overexploited, *G. genidens*, least concern in the IUCN list and endangered in the MMA list, *M. liza* as deficient data in the IUCN list and overexploited in the MMA list and *P. saltatrix*, as vulnerable in IUCN and overexploited in MMA.

Finally, this study considered only the abundance of species at different sites of a micro estuary and showed the importance of seasonality in structuring fish assemblage, especially in the ecological niche structures. Thus, for a better understanding of these niches, we suggest studies with molecular tools focusing on key species to better interpret these patterns.

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