NYCTHEMERAL AND MONTHLY OCCUPATION OF THE FISH ASSEMBLAGE ON A SHELTERED BEACH OF BAÍA NORTE, FLORIANÓPOLIS, SANTA CATARINA STATE, BRAZIL

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ABSTRACT

Interpreting fish community records is challenging for several reasons, including the lack of past ichthyofauna data, the cyclical temporal variations in the community, and the methodology employed, which usually underestimates fish assemblages. The objective of this study was to describe short-scale and meso-scale (nycthemeral period and months, respectively) temporal variations in the ichthyofauna composition and structure of a sheltered beach of Baía Norte (Florianópolis, Santa Catarina state, Brazil), using a capéchade net. Samples were collected monthly for a period of 48 hours. During the period from December 2010 to November 2011, a total of 19,302 individuals belonging to 89 species and 39 families were captured. The number of individuals that were sampled during the day and/or night was dependent on the sampling month. On average, the daytime assemblage was more abundant and different in structure and composition than the nighttime assemblage. Of the eight species that had the highest Index of Relative Importance (%IRI), five had higher variations (ANOVA F) between the day and night than between the months. This finding reinforced the need for sampling during both the day and night. The capéchade net effectively captured demersal and pelagic individuals in a broad range of sizes.

RESUMO

A interpretação dos registros da comunidade ictíca têm se mostrado um desafio por diversos motivos, entre eles a falta de dados pretéritos, existência de variações temporais cíclicas na comunidade e pelos métodos utilizados que geralmente subamostram a assembleia. Neste sentido, o objetivo do presente trabalho foi descrever o padrão de variação temporal (nictemeral e mensal) na composição e na estrutura da ictiofauna de uma praia abrigada da Baía Norte de Florianópolis, usando uma rede capéchade. Coletas foram realizadas mensalmente, integrando um período de 48 horas/mês. Durante os meses de dezembro de 2010 a novembro de 2011, 19302 indivíduos distribuídos em 89 espécies e 39 famílias foram capturados. O número de indivíduos capturados durante o dia e/ou noite foi dependente do mês de coleta. Em média, a assembleia foi mais abundante durante o dia, diferindo em estrutura e composição do período da noite. Das oito espécies com maior Índice de Importância Relativa (IRI%), cinco apresentaram maior variação (F ANOVA) entre o dia e a noite do que a verificada entre os meses, o que reforça a necessidade de amostragens durante o dia e a noite. A rede capéchade foi eficiente na captura de indivíduos demersais e pelágicos com ampla faixa de tamanho.

Descriptors: Coastal zone, Ichthyofauna; Temporal cycles.
Descritores: Zona costeira, Ictiofauna, Ciclos temporais.

INTRODUCTION

Rapid population growth threatens the ecological integrity of coastal environments due to the intense occupation of this narrow region and the overexploitation of nearby fishery resources (HOEFEL, 1998; KENNISH, 2002; FAO, 2010).

Sandy beaches make up a large part of the Brazilian coastal environments (HOEFEL, 1998; BORZONE et al., 2003), and many fish species of ecological and economic interest use these regions to feed, reproduce and develop (RUPLE, 1984; ARAUJO et al., 2008).

In beach environments, the seasonal movements of the ichthyofauna seem to be related to

the ontogenetic changes within each species (PESSANHA et al., 2003). Species typically stay for short periods of time because this accords with their patterns of recruitment and reproduction, which are synchronized to seasonal abiotic fluctuations (GIBSON et al., 1993; PESSANHA et al., 2003; FÉLIX et al., 2007). In addition, daily fish movement is likely dependent on individual physiological and ecological needs, such as feeding and protection against predators (SUDA et al., 2002; PESSANHA et al., 2003; GAELZER; ZALMON, 2008), which are often affected by physicochemical conditioners, such as turbidity, turbulence, salinity and depth, in the environment (LIN; SHAO, 1999; FÉLIX et al., 2007).

When compared to other environments, beaches provide less shelter for fishes (NAGELKERKEN et al., 2000). However, beach environments usually have high food availability (MCLACHLAN; DORVLO, 2005). Moreover, these areas may have high turbidity and turbulence, which could potentially decrease predation risk for small fishes (ROSS et al., 1987; FÉLIX-HACKRADT, 2010). Fish move into the intertidal zone at night to avoid piscivorous fishes, whereas during the day, they avoid the intertidal zone due to the presence of piscivorous birds (WRIGHT, 1989). The movement of fish species in and out of the beach environment can lead to short-term fluctuations in various community parameters that often exceed the long-term variability (LASIAK, 1984a). Thus, the diel and seasonal compartmentalization of the fish assemblage may be a key factor in understanding how so many species can be supported in a physically simple habitat (VASCONCELLOS et al., 2011).

Several studies in Brazil have looked at the fish communities in beach zones. Most of these studies have dealt with seasonal variations (GIANNINI; PAIVA-FILHO, 1995; GODEFROID et al., 1997; ROSENTAL ZALMON; GAELZER, 2003; ARAUJO et al., 2008; OLIVEIRA-SILVA et al., 2008). However, a few have also dealt with the variations between day and night in the ichthyofauna assemblage (PESSANHA et al., 2003; BARREIROS et al., 2004; GAELZER; ZALMON, 2008; FÉLIX-HACKDART et al., 2010; VASCONCELLOS et al., 2011) and have used small-sized nets for sampling, mainly beach seines.

On the coast of the state of Santa Catarina, the beach ichthyofauna are still largely unknown, with studies being primarily conducted in the Baía da Babitonga (northern Santa Catarina state) (COSTA; SOUZA-CONCEIÇÃO, 2009; VILAR et al., 2011a, 2011b). Despite the importance of the artisanal fishery in the Florianópolis region (MARTINS; PEREZ, 2008; BASTOS; PETRERE Jr., 2010), we found few studies on the ichthyofauna in this area (RIBEIRO et al., 1997, 1999; SOUZA-CONCEIÇÃO et al., 2005;

CARTAGENA et al., 2011). Therefore, the objective of this project was to describe the temporal variation in the composition and structure of the ichthyofauna community at a sheltered beach in Baía Norte (Florianopolis) using a more robust sampling plan than has usually been used in studies of the ichthyofauna at low-energy beaches in the region.

MATERIAL AND METHODS

Study Area

Baía Norte is shaped like a long channel, with a 4 km opening to the Atlantic Ocean to the North and a narrow channel (370 m wide) that is connected to the Baía Sul (Fig. 1). On both the island and the continent, the rivers flow along (across) a short plain of fluviomarine sediments and discharge into small estuaries along an extensive zone of mangrove forests and salt marshes (PAGLIOSA; BARBOSA, 2006). The system is dominated by wind waves and has a low capacity to rework coarse sediment, except in high-energy events, which can give rise to reflective beaches that are associated with muddy floodplains (SILVEIRA et al., 2011). Four high-density municipalities, which comprise a total population of 702,249 (IBGE, 2010), surround Baía Norte.

Índio beach (27º28'33.90"S and 48º32'0.75"W) is a wave-sheltered beach (JACKSON et al., 2002) that faces Northwest (Fig. 1). Nearby, there are large fluvial inputs from the Ratones and Veríssimo Rivers, which are approximately 1.7 km from the sampling site. The tidal regime is semidiurnal, with an average amplitude of 0.52 m (SORIANO-SIERRA; SIERRA DE LEDO, 1998). The physicochemical variations respond mainly to continental input, and the environment is usually mesotrophic (SIMONASSI et al., 2010). The salinity at this beach is generally high (above thirty), and the temperature fluctuates from 16 to 28ºC (MACIEL et al., 2010; SIMONASSI et al., 2010).

Data Sampling

Monthly sampling was conducted from December 2010 to November 2011 during the first neap tide of each month. Samples were collected using a fixed net (*capéchade*) (for an illustration of the fishing net, refer to Valest et al. (2010)), which was designed to operate at depths of 0.5 to 2.0 m and is composed of a barrier (20 m long; 2.0 m high; mesh: 13.0 mm) and three concave nets (mesh: 13.0 mm to 6.0 mm). The *capéchade* or Fyke, is a passive sampler commonly used in shallow estuarine areas and is well adapted to low energy environments and to intertidal habitats (LOUIS et al., 1995; IGNÁCIO; SPACH,

2009). One major advantage of this sampling gear is that the sample unit area can be large. However, the sample area cannot be defined, and effective sampling depends on tidal flow and fish movement (ROZAS; MINEILO, 1997). The net was set up at the same site at each sampling time, at a depth of 0.5 to 2 m, and it remained there for 48 hours. Fish were harvested in the morning and at night to give a total of two daytime and two nighttime samples, i.e. four monthly samples.

The specimens were weighed (g), measured [total length (TL) and standard length (SL)] and identified following Figueiredo and Menezes (1978, 1980, 2000), Menezes and Figueiredo (1980, 1985), Barletta and Corrêa (1992) and Marceniuk (2005).

In situ" recordings of surface water temperature and salinity were performed every 12 hours (4 recordings/month) using an *Incotherm* mercury thermometer (precise to 0.1ºC) and an RTS/101 ATC portable refractometer, respectively. Water transparency was measured every 24 hours (2 recordings/month) using a Secchi (cm) disk. Six sediment samples were collected at the site (three in the swash zone and three parallel to the first two meters of depth) and analyzed using the methods outlined in Suguio (1973). Rainfall and wind data were provided by the EPAGRI/CIRAM meteorological station (Florianopolis) (27º34'41.89"S and 48º30'32.79"W), which was 12 km from the study area.
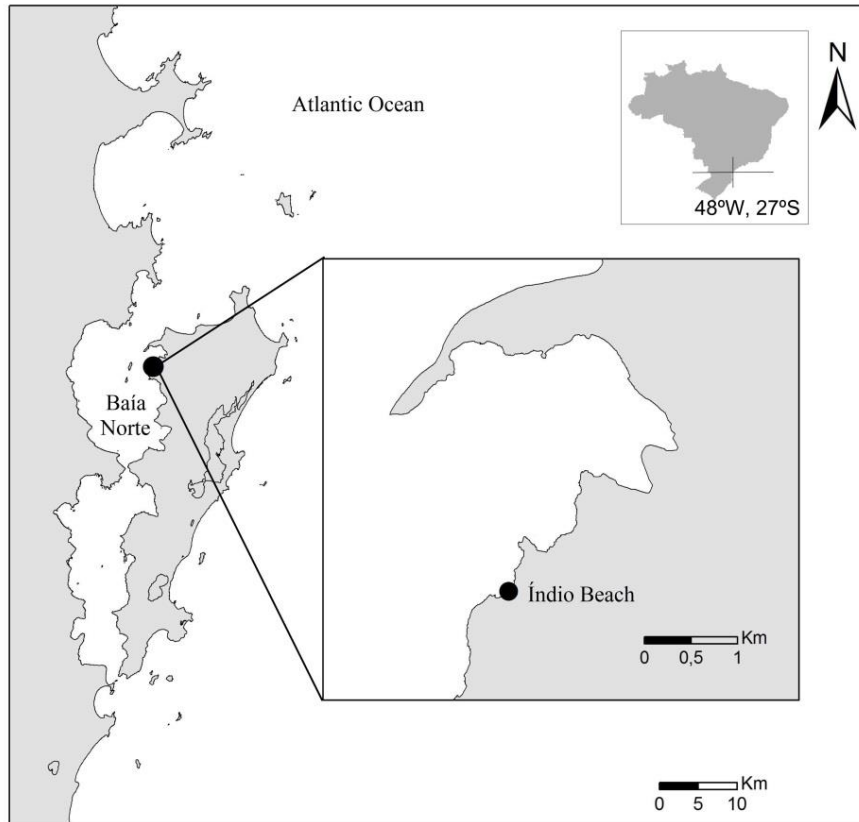

Fig. 1. Map of Brazil showing the location of the North Bay of Florianópolis and Índio Beach (27º28'33.90"S and 48º32'0.75"W).

Data Analysis

Species richness was calculated using PRIMER 6.0 (Plymouth Marine Laboratory, England). In addition, the nonmetric multidimensional scaling technique (MDS) from this statistical package was used to study the temporal (month and time of day) variations in the composition and abundance of the species caught over the twelve sampling months. To calculate the MDS, a Bray-Curtis similarity matrix was produced using transformed data (Log(x+1)) (CLARKE, 1993). The statistical significance between the groups formed using the MDS were evaluated using an analysis of similarity (ANOSIM) (CLARKE; GORLEY, 2006). Analysis of similarity percentages (SIMPER) were used to identify which species were mainly responsible for the similarities in each group defined by the MDS and for the dissimilarities between the groups (more discriminant species) (CLARKE; WARWICK, 1994).

The most important fish species from the assemblage in each period were obtained using an Index of Relative Importance (%IRI), which was a modified version of that of Pinkas et al. (1971), and calculated as [(%N + %W)*%FO]*100, where %N = percentage of the number of individuals of each species over the total number of individuals; %W = percentage by weight for each species over the total weight; %FO = n/N*100, where n = number of samples where the species was present; and N = total number of samples.

A one-way ANOVA (month as fixed factor) was used to examine the differences between the monthly transparency averages. A two-way ANOVA (month and time of day: day and night as fixed factors) was used to examine the differences between the averages from the day, the night, and the month, as well as differences in the environmental parameters (salinity and temperature), abundance, biomass, and fish species richness. In addition, this model was used to examine the differences between the averages of the abundance and total length of the eight main species (according to %IRI) from the day, the night, and the months. Before each ANOVA was calculated, the data were tested for homogeneity of variance (Bartlett's test) and normality of the distributions (Kolmogorov-Smirnov test). To satisfy these ANOVA assumptions, the abundance and biomass data were transformed [Log(x+1)]. When significant differences (p<0.05) were found, a Tukey HSD (Honestly Significant Difference) test was used to determine which averages were significantly different. With respect to the total length, only the months in which the species occurred both during the day and at night were included in the analysis. When it was impossible to satisfy ANOVA assumptions, differences were considered significant when p<0.01 (UNDERWOOD, 1997). The

relationships among the physicochemical parameters (salinity, transparency, temperature and rainfall), biological parameters, and abundance of the eight main species were verified using a Spearman correlation (p<0.05).

RESULTS

Environmental variables

In shallow beach areas, sediment analysis showed high proportions of sand (91.55%), gravel (8.44) and organic matter (1.04) (silt and clay absent). In areas that were 2 m deep, there was an increase in the concentrations of silt (33.71%), clay (7.11) and organic matter (5.18), and a decrease in the concentrations of sand (53.66) and gravel (5.17) at about 2 m deep. From December 2010 to November 2011 the water temperature varied from 16 to 27.5ºC. Variations between the months were significant, with a distinctive seasonal pattern within the region. On average, the highest temperatures occurred during the day with no significant interactions recorded for month or time of day (Fig. 2a; Table 1). Salinity varied from 28 to 36 during the study period, with significant differences between the months, but no significant difference were observed between day and night. No tendency was observed in the salinity values during the sampling months, and the interaction between the month and the time of day was not significant (Fig. 2b; Table 1). Water transparency varied from 0.3 to 1.3 m during the sampling months. Significant differences between the months were found, with the highest values recorded in December, April, May and June, and the lowest in November, January, February and March (Fig. 2c; Table 1). High rainfall was recorded in August, September, October, January, and February, and low rainfall was recorded in March, April, May, June and July (Fig. 2d).

Ichthyofauna

During the study period, a total of 19,302 individuals (89 species and 39 families) were caught, which accounted for a biomass of 229,066 kg. The average number of individuals caught varied significantly between the months sampled and between day and night (Fig. 3a). In general, there was no consistent number of individuals seen over the course of the month. On average, the number of specimens was greater during the day, with a significant interaction recorded between the time of day and the sampling month (Fig. 3; Table 1). The average biomass caught varied significantly between the months, but there was no significant difference between the day and night samplings (Fig. 3b), and the

interaction between month and time of day was not significant (Fig. 3b; Table 1). Of the 39 families recorded in this study, the highest species richness were found in Sciaenidae (13 species), Engraulidae (9), Carangidae (8), Gerreidae and Tetraodontidae (5 each), and Ariidae and Paralichthyidae (4 each) (Table 2). Species richness varied significantly between the months; however, the *a posteriori* Tukey HDS test did not indicate any significant differences between the monthly averages (Fig. 3c; Table 1).
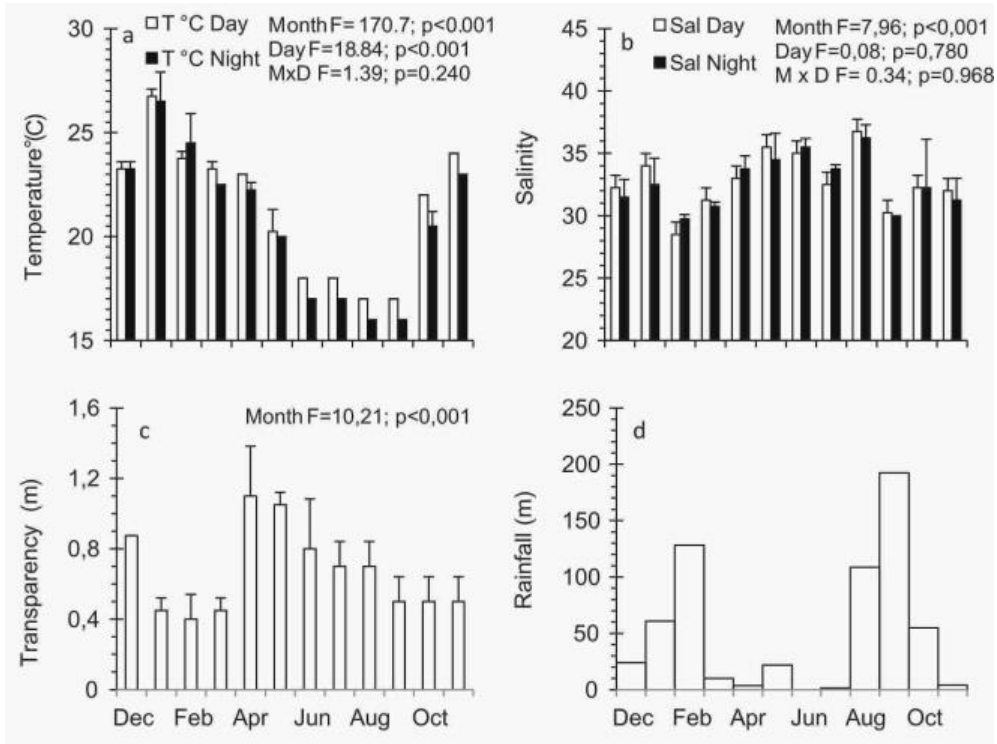
Fig. 2. Monthly average (± standard deviation) of the temperature (a), salinity (b) and transparency (c) for the entire sampling period (day and night) on Índio beach, as well as the rainfall accumulated during the seven days before monthly sampling began (d). Axis x: Month (Dec/2010 to Nov/2011).

Table 1. The results from the Tukey HSD post-hoc test that was used to identify group differences at Índio beach (Florianópolis, months range from December 2010 to November 2011) for: environmental parameters (temperature, salinity and transparency), the number of individuals (N(Log (x+1))), biomass (Log (x+1)), and richness (S). D = day; N = night; NS = not significant. Averages increase from left to right. ____ = homogeneous groups (Tukey). **p<0.01; *p<0.05.

Data set	Month												Period D > N	Interaction
Temperature	Se	Au	Jl	Jn	Ma	Oc	Ap	Mar	De	No	Fe	Ja	**	**	NS
Salinity	Fe	Se	Mar	No	De	Oc	Jl	Ja	Ap	Ma	Jn	Au	**	NS	NS
Transparency	Fe	Mar	Ja	No	Oc	Se	Jl	Au	Jn	De	Ma	Ap	**		
N ((Log(x+1))	Jl	Jn	Au	Se	Oc	Fe	Ap	No	Ma	De	Mar	Ja	**	D > N *	*
Biomass ((Log(x+1))	Jn	Jl	Ap	Se	Mar	Au	Ma	Oc	Fe	Ja	No	De	**	NS	NS
S	Mar	No	Fe	Oc	Se	Au	Ja	Jn	Ma	Jl	De	Ap	*	NS	NS
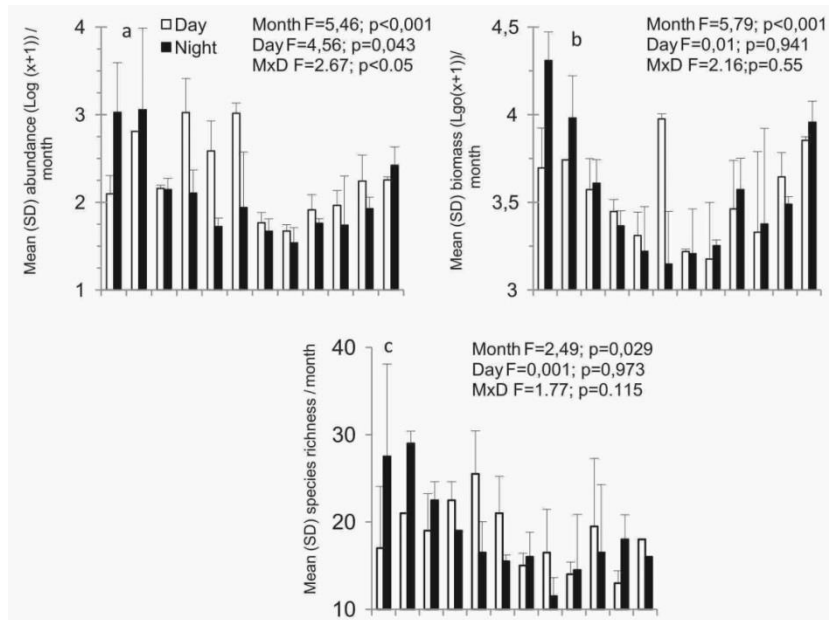
Fig. 3. Monthly average (+ standard deviation) of the (a) number of individuals (Log (x+1)), (b) biomass (grams) (Log (x+1)) and (c) species richness for day and night samplings at Índio beach between Dec 2010 and Nov 2011.

Of the species that were caught, 27 were only found at one time of day (day or night). Eleven of them (%IRI <0.09 and >0.0003) occurred exclusively at night (*Ophichthus gomesii*, *Diplodus argenteus*, *Centropomus parallelus*, *Odontesthes argentinensis*, *Bairdiella ronchus*, *Anisotremus surinamensis*, *Pogonias cromis*, *Porichthys porosissimus*, *Prionotu snudigula*, *Macrodon ancylodon* and *Hemicaran amblyrhynchus*). Sixteen (%IRI<0.285 and >0.001) of the species occurred exclusively during the day (*Lycengraulis grossidens*, *Mugil* sp., *Oligoplites saliens*, *Trachinotus falcatus*, *Sphyraena guachancho*, *Strongylura marina*, *Peprilus paru*, *Oligoplites palometa*, *Scomberomorus brasiliensis*, *Anchoa marinii*, *Paralichthys patagonicus*, *Pomatomus saltatrix*, *Elops saurus*, *Synodus foetens*, *Gobionellus oceanicus* and *Astroscopus ygraecum* (Table 2).

Eight species comprised 85% of the Index of Relative Importance (%IRI) (averages for day and night). In order of descending importance (%IRI for day and night, respectively), they were: *Sphoerides testudineus* (29.82 and 6.55), *Genidens barbus* (7.27 and 26.07), *Harengula clupeola* (9.52 and 18.63), *Anchoviella lepidentostole* (18.40 and 5.98), *Genidens genidens* (3.09 and 13.53), *Stellifer rastrifer* (5.56 and 6.93), *Cetengraulis edentulus* (1.38 and 9.89), and *Sphoeroides greeleyi* (7.09 and 0.88) (Table 2). The analysis of variance showed that of the eight species with the highest %IRI, *S. testudineus*, *S. greeleyi*, *G. genidens*, *G. barbus* and *A. lepidentostole* presented higher variation in abundance (ANOVA F) between

day and night than that which was verified between the monthly samplings (Table 3). *Sphoeroides testudines*, *S. greeleyi* and *A. lepidentostole* were significantly more abundant during the day, and *G. barbus*, *G. genidens* and *S. rastrifer* were significantly more abundant at night (Table 3).

MDS, which was based on the abundance of each species, separated the day and night catches reasonably well (Fig. 4). The differences between the day and the night ichthyofauna assemblages were verified using an ANOSIM (Global R = 0.311; p<0.01), which indicated that the means of separation for the groups were weak. SIMPER analysis recorded a dissimilarity of 67.42% between the day and the night (Table 4), with the highest contribution from *A. lepidentostole* and *S. testudineus* during the day, and *G. genidens* and *G. barbus* at night (Table 4). MDS showed a clearer separation of the months when compared to the time of day (Fig. 4) and formed 3 groups: G1 (November, December, January and February), G2 (March, April and May), and G3 (June, July, August, September and October). The groups were verified using an ANOSIM, and significant differences were found (Global R = 0.435; p<0.01). The groups overlapped but were reasonably different from each other. Pairwise comparisons showed that the difference between groups G1xG2 was greatest (Global R = 0.562; p<0.01), followed by G1xG3 (Global R = 0.426; p<0.01) and G2xG3 (Global R = 0.463; p<0.01).

Table 2. The abundance, total biomass, Index of Relative Importance (%IRI), average total length (TL) (± standard deviation) and range of TL for the species captured during the day and night from December 2010 to November 2011 at Índio beach.

Family	Species	Day n	IRI (%)	TL (mean) (mm)	Range TL (mm)	Biomass (g)	Night n	IRI (%)	TL (mean) (mm)	Range TL (mm)	Biomass (g)
Achiridae	Achirus lineatus	2	0,006	103,5±44,5	72-135	57,3	2	0,003	86,0±12,7	77-95	24,1
Ariidae	Cathorops spixii	58	0,409	123,5±17,8	89-217	969	222	1,865	124,2±17,1	100 - 200	3603,4
	Genidens barbus	252	7,273	145,0±31,8	90-271	7272,5	849	26,076	151,7±43,9	81 - 575	31822,3
	Genidens genidens	92	3,098	158,5±45,7	78-325	3756,1	461	13,531	147,9±38,9	11 - 312	15351,9
	Genidens machadoi	2	0,006	204,5±16,2	193 - 216	155	10	0,034	178,4±37,5	135 - 238	511
Atherinopsidae	Atherinella brasiliensis	29	0,246	106,5±17,7	63 - 128	292	29	0,203	103,5	56 - 139	276,6
	Odontesthes argentinensis						2	0,023	313,5±19,0	300 - 327	407,8
Batrachoididae	Porichthys porosissimus						1	0,002	189	189	80,7
Belonidae	Strongylura marina	2	0,007	292,0±123,0	205 - 379	70,7					
Carangidae	Chloroscombrus chrysurus	42	0,496	96,3±57,5	21 - 254	778	31	0,12	71,9±35,6	21 - 165	180,3
	Hemicaranx amblyrhynchus						1	0	61	61	2,7
	Oligoplites palometa	4	0,005	140,2±23,9	126 - 176	82,4					
	Oligoplites saliens	11	0,034	132,1±24,6	108 - 192	186,9					
	Oligoplites saurus	31	0,342	125,3±37,6	23 - 180	512,4	5	0,012	111,6±37,3	71 - 147	50
	Selene vomer	64	1,044	94,83±27,2	28 - 146	886,4	17	0,106	92,5±43,5	38 - 180	285,2
	Trachinotus carolinus	14	0,065	81,7±29,1	42 - 124	140	3	0,005	79,0±24,3	63 - 107	22,4
	Trachinotus falcatus	3	0,023	114,6±104,3	50 - 235	181,4	0				
Centropomidae	Centropomus parallelus						5	0,028	159,2±52,3	98 - 212	203,5
Clupeidae	Harengula clupeola	1776	9,525	74,5±13,4	39 - 112	6211,9	5050	18,635	69,7±20,7	36 - 162	7839,6
	Opisthonema oglinum	40	0,079	61,4±13,4	43 - 90	92,7	34	0,056	70,9±8,8	50 - 88	107,7
	Sardinella brasiliensis	271	1,015	89,7±13,5	50 - 133	1612,4	27	0,081	101,2±26,7	83 - 200	270,8
Cynoglossidae	Symphurus tessellatus	2	0,002	119,5±36,0	94 - 145	25,8	3	0,007	126,6±27,1	98 - 152	45,4
Dactylopteridae	Dactylopterus volitans	9	0,038	93,8±24,0	79 - 155	111	1	0,001	120	120	19,2
Diodontidae	Chilomycterus spinosus	3	0,048	117,3±68,8	38 - 162	410,4	6	0,024	44,1±37,2	25 - 120	107,9
Elopidae	Elops saurus	1	0,001	191	191	28,7					
Engraulidae	Anchovia clupeoides	2	0,001	72,0±7,0	67 - 77	4,7	12	0,005	73,9±22,6	57 - 144	45,8
	Anchoa januaria	123	0,339	77,8±17,7	51 - 172	483,6	15	0,031	75,4±3,7	70 - 82	47,4
	Anchoviella lepidentostole	3380	18,403	61,7±15,0	27 - 121	4011,6	2146	5,982	64,1±13,1	35 - 82	5662,8
	Anchoa marinii	3	0,004	146,0±6,2	139 - 151	69					
	Anchoa spinifer	8	0,006	93,1±31,5	63 - 142	61,9	4	0,004	80,5±26,4	60 - 119	19,6
	Anchoa tricolor	35	0,031	47,2±5,2	39 - 63	24,8	4	0,001	53,0±6,6	47 - 62	4,3
	Cetengraulis edentulus	151	1,384	117,7±36,1	43 - 173	2563,5	641	9,893	137,8±25,5	50 - 183	16721,2
	Engraulis anchoita	31	0,027	55,3±5,2	45 - 66	26,4	5	0,003	52,8±5,4	47 - 61	3,5
	Lycengraulis grossidens	31	0,284	110,4±47,7	60 - 206	436,4					
Ephippidae	Chaetodipterus faber	7	0,045	74,4±19,6	46 - 93	127,1	13	0,09	75,3±24,1	38 - 117	260,1
Gerreidae	Diapterus auratus	3	0,017	143,3±19,2	128 - 165	121	3	0,013	144,6±19,4	128 - 166	129,8
	Diapterus rhombeus	16	0,346	156,9±20,1	125 - 185	1026,9	6	0,062	149,5±19,5	120 - 174	313
	Eucinostomus argenteus	9	0,058	114,1±21,1	77 - 140	167,6	6	0,011	124,0±8,0	113 - 138	131
	Eucinostomus gula	17	0,137	107,3±18,3	65 - 142	284,2	4	0,013	121,2±38,2	66 - 152	108,2
	Eucinostomus melanopterus	46	1,114	134,8±22,0	95 - 187	1304	21	0,291	137,0±37,2	43 - 186	728,2
Gobiidae	Gobionellus oceanicus	1	0,001	226	226	20,4					
Haemulidae	Anisotremus surinamensis						2	0,005	136,5 ±7,7	131 - 142	69,57
	Orthopristis ruber	10	0,225	153,6±66,3	60 - 255	670,3	28	0,71	161,2 ±59,7	60 - 267	2299,67
	Pomadasys corvinaeformis	6	0,015	91,4±10,4	77 - 102	71,4	8	0,036	102,3 ±45,5	24 - 158	169,9
Hemiramphidae	Hyporhamphus unifasciatus	3	0,014	209,6±35,9	181 - 250	97,4	6	0,033	221,3±35,9	199 - 292	234,11
Lutjanidae	Lutjanus analis	2	0,023	214,0±48,0	180 - 248	296,6	1	0,005	230	230	173,33
Monacanthidae	Stephanolepis hispidus	1	0,001	60	60	4,2	2	0,002	71,0±12,7	62 - 80	14,27
Mugilidae	Mugil curema	605	6,06	121,0±22,7	87 - 265	9989,7	53	1,585	159,3±75,9	28 - 335	3564,25
	Mugil liza	2	0,018	215,0±118,7	131 - 299	232,2	1	0,001	152	152	31,73
	Mugil sp	47	0,079	29,3±2,2	25 - 34	11,6					
Muraenidae	Gymnothorax ocellatus	1	0,005	438	438	122,3	1	0,004	463	463	141,46
Ophichthidae	Ophichthus gomesii						7	0,083	429,1±104,8	313 - 595	532,28
Paralichthyidae	Citharichthys macrops	40	0,358	115,0±14,5	64 - 147	542,3	11	0,05	121,7±9,5	111 - 146	176,9
	Citharichthys spilopterus	78	1,551	127,8±20,0	84 - 173	1654,4	26	0,293	135,1±16,1	92 - 163	592,86
	Etropus crossotus	7	0,022	94,0±24,2	48 - 121	72,9	6	0,018	102,3±5,2	96 - 110	63,18
	Paralichthys patagonicus	1	0,003	193	193	68,3					
Polynemidae	Polydactylus virginicus	7	0,129	187,4±40,5	140 - 252	518,8	23	0,927	199,2±42,9	110 - 297	2182,73
Pomatomidae	Pomatomus saltatrix	1	0,002	182	182	58,4					
Priacanthidae	Heteropriacanthus cruentatus						1	0	32	32	0,52
Pristigasteridae	Pellona harroweri	1	0,001	129	129	21,7	8	0,039	129,8±25,4	88 - 161	190,77
Sciaenidae	Bairdiella rhonchus						1	0,005	248	248	180,94
	Cynoscion jamaicensis	2	0,003	86,0±18,3	73 - 99	12,5	5	0,009	91,4±40,3	54 - 160	55,59
	Cynoscion microlepidotus	6	0,007	80,1±3,5	75 - 85	32,2	4	0,004	76,6±5,7	70 - 80	24,78
	Isopisthus parvipinnis	8	0,049	122,7±23,8	87 - 160	135,3	40	0,819	145,5±32,7	39 - 218	1416,56
	Larimus breviceps	7	0,023	122,2±46,0	73 - 193	237,2	7	0,067	130,5±68,1	41 - 226	332,96
	Menticirrhus americanus	1	0,002	163	163	38,1	13	0,213	161,2±55,0	58 - 250	722,23
	Macrodon ancylodon						1	0	75	75	4,07
	Micropogonias furnieri	32	0,769	143,7±48,0	65 - 237	1286,9	71	2,793	161,3±66,4	45 - 367	4601,4
	Menticirrhus littoralis	5	0,054	172,6±17,1	157 - 195	242,7	4	0,021	160,7±61,9	79 - 215	208,99
	Paralonchurus brasiliensis	1	0,004	229	229	108,2	5	0,085	229,4±42,5	187 - 279	731,37
	Pogonias cromis						1	0,003	420	420	101
	Stellifer rastrifer	176	5,561	151,4±19,1	58 - 193	9085,5	232	6,936	145,4±22,9	60 - 202	10748,68
	Stellifer stellifer	1	0,004	179	179	95,6	11	0,048	145,7±17,5	111 - 163	458,89
Scombridae	Scomberomorus brasiliensis	2	0,005	205,0±7,0	200 - 210	104					
Serranidae	Diplectrum radiale	8	0,05	99,7±36,7	52 - 146	140,3	1	0	64	64	3,28
Sparidae	Archosargus rhomboidalis	11	0,494	178,1±59,7	95 - 273	1408,7	7	0,084	157,6	107 - 236	536,08
	Diplodus argenteus						4	0,034	144,8	65 - 181	263,18
Sphyraenidae	Sphyraena guachancho	8	0,02	130,7±9,61	115 - 144	91,6					
Stromateidae	Peprilus paru	1	0,005	180	180	122,9					
Synodontidae	Synodus foetens	1	0,001	179	179	28,7					
Tetraodontidae	Lagocephalus laevigatus	1	0,002	145	145	55,6	1	0,002	136	136	44,25
	Sphoeroides greeleyi	379	7,099	82,5±16,0	32 - 124	5094,5	90	0,887	84,7	31 - 158	1104,49
	Sphoeroides spengleri	111	1,474	91,1±30,2	50 - 245	2470,2	22	0,083	79,4	57 - 98	246,11
	Sphoeroides testudineus	547	29,829	127,4±33,8	34 - 241	29981,1	193	6,556	128,3	33 - 231	9840,02
	Sphoeroides tyleri	9	0,019	92,6±15,5	79 - 119	155,7	18	0,022	74,6	48 - 110	194,5
Trichiuridae	Trichiurus lepturus	5	0,027	312,0±92,4	221 - 460	134,3	21	0,287	378,7	188 - 800	930
Triglidae	Prionotus nudigula						2	0,001	40,5	33 - 48	1,5
	Prionotus punctatus	5	0,036	121,4±38,6	89 - 178	142,1	10	0,034	72,4	33 - 168	89,42
Uranoscopidae	Astroscopus Ygraecum	1	0	28	28	0,5					

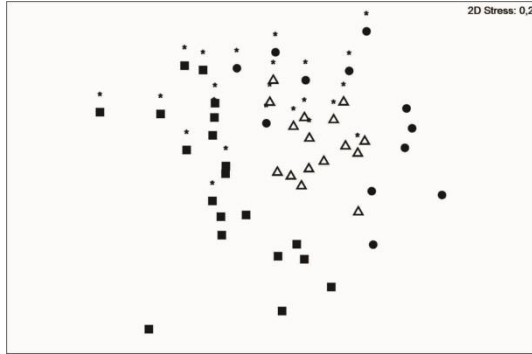|		Day	Night
	Number of individuals (n)	8711	10591
	Biomass (g)	100203	128863,3
	Number of species	77	74

Fig. 4. MDS based on the Bray-Curtis similarity matrix that considered groups G1 (November, December, January and February, triangles), G2 (March, April and May, circles), and G3 (June, July August, September and October, square) and time of day. Nighttime samples are marked with an *. Índio beach, December 2010 to November 2011.

The dissimilarity average from the SIMPER analysis for G1xG2 was 62.46%, with *G.barbus*, *S. testudineus* and *C. edentulus* in G1 and *A. lepidentostole*, *G. barbus* and *H. clupeola* in G2 contributing the most to the dissimilarity. In the G1xG3 comparison, the average dissimilarity was 66.70%, with *G. barbus*, *S. testudineus* and *C. edentulus* in G1 and *G. genidens*, *S. testudineus* and *S. rastrifer* in G3 having the greatest average abundances. The greatest dissimilarity was found between G2xG3 (average of 72.30%), with *A. lepidentostole*, *G. barbus* and *H. clupeola* in G2 and *G. genidens*, *S. testudineus* and *S. rastrifer* in G3 having the greatest average abundances (Table 4).

A significant positive correlation ($p < 0.05$) between salinity with transparency, and a significant negative correlation ($p < 0.05$) for salinity with temperature and rain, as well as between rain with transparency were found when environmental data were compared using a Spearman correlation (Table 5). When biotic and abiotic data were compared, a significant positive correlation ($p < 0.05$) was observed for temperature with total biomass, number of individuals, and with the abundance of *S. testudineus*, *G. barbus*, *H. clupeola*, *C.edentulus*, *S. greeleyi* and *A. lepidentostole*. Transparency had a significant negative correlation ($p < 0.05$) to *G. barbus* and *G. genidens*, and a significant negative correlation ($p < 0.05$) was also recorded between *G. barbus* and salinity. There was a positive ($p < 0.05$) and significant correlation for meteorological precipitation with total biomass and *G. genidens* abundance.

Table 3. The results of the Tukey HSD post-hoc test identifying differences at Índio beach (Florianópolis, months range from December 2010 to November 2011) for: abundance (N) and total length (TL) (fixed factors: month and time of day). D = day; N = night; NS = not significant. Average values increase from left to right. ____ = homogeneous groups (T= Tukey). F= F ANOVA. **$p < 0.01$; *$p < 0.05$. *Spte= S. testudineus; Geba= G. barbus; Hacl= H. clupeola; Anle= A. lepidentostole; Gege= G. genidens; Stra= S. rastrifer; Ceed= C. edentulus; Spgr= S. greeleyi.*

Sp	Data set		Month														Period	Interaction
Spte	N	F	8.39														45.29	1.61
		T	Jl	Se	Ma	Au	Ap	Mar	Jn	Fe	No	Oc	Ja	De	**	D>N **	NS
	TL	F	2.25														1.54	1.63
		T	Ja	Se	Ap	Mar	Fe	Oc	No	Jn	Au	De	Ma	Jl	**	NS	NS
Geba	N	F	10.32														24.42	0.96
		T	Au	Jn	Jl	Se	Oc	Ma	Ap	Fe	Mar	No	Ja	De	**	D<N **	NS
	TL	F	3.55														5.08	2.48
		T	Mar	Ma	Ap	Se	No	Jl	De	Ja	Fe	Jn	Oc	Au	**	NS	**
Hacl	N	F	11.92														2.12	1.49
		T	Ap	Au	Jl	No	Se	Jn	Fe	Ou	De	Mar	Ma	Ja	**	Ns	NS
	TL	F	90.03														24.21	24.33
		T	Ja	Mar	De	Ma	Ou									NS	**
Anle	N	F	4.35														9.43	2.33
		T	Se	No	Jl	Ja	Oc	Jn	Fe	De	Au	Ap	Ma	Mar	**	D>N*	NS
	TL	F	78.19														1.78	1.56
		T	Mar	Ap	Fe	Ma	De	**								NS	NS
Gege	N	F	1.3														33.6	NS 0.58
		T	NS														D>N **	NS
	TL	F	4.92														3.26	2.18
		T	Ja	Fe	Mar	No	De	Jn	Se	Oc	Ap	Au	Jl			NS	NS
Stra	N	F	12.07														5.63	0.83
		T	Mar	Ma	Ap	Au	Fe	Jn	Jl	Ja	Se	Oc	No	De	**	D<N *	NS
	TL	F	11.86														0.08	0.9
		T	Ja	De	No	Oc	Au	Ap	Jn	Jl	Se	**				NS	NS
Ceed	N	F	2.49														2.05	0.48
		T	Se	Jl	Au	Jn	Ap	Mar	Fe	De	Ma	No	Ja	**		NS	NS
	TL	F	108.49														32.48	7.31
		T	Ja	De	No	Oc	Au	Ap	Jl	Se	**					D<N *	**
Spgr	N	F	8.65														38.09	3.72
		T	Jl	Se	Jn	Ma	Au	Ap	Oc	Fe	No	Mar	De	Ja	**	D>N **	**
	TL	F	6.65														5.73	5.72
		T	Jl	Ma	Ap	Fe	Au	Mar	No	Ja	De	**				NS	**

Table 4. The analysis of similarity percentages (SIMPER) between the groups formed using MDS. The results show the dissimilarity (%) of the nine species that contributed the most to each analysis. D = day; N = night; G1 = November, December, January and February; G2 = March, April and May; G3 = June, July, August, September and October.

Species	NxD	G1xG3	G1xG3	G2xG3
A. lepidentostole	5,47	7,94		9,18
G. genidens	4,69			
S. testudineus	4,68	3,97	4,64	
H. clupeola	4,51	5,96		5,11
G. barbus	4,50		6,23	4,03
S. greeleyi			4,99	
C. edentulus		4,57	6,23	4,10
S. rastrifer		4,82	4,35	
M. curema				3,92

Table 5. Spearman correlation for the environmental parameters, total abundance, total biomass, and abundance of the eight main species caught according to the %IRI. Significant correlations (p<0.05) are in bold.

	Temperature	Salinity	Transparency	Rainfall	Abundance
Salinity	**-0,356**				
Transparency	-0,340	**0,556**			
Rainfall	0,061	**-0,340**	**-0,437**		
Abundance	**0,656**	-0,149	0,034	0,176	
Biomass	**0,515**	-0,168	-0,076	**0,315**	**0,723**
S. testudineus	**0,553**	-0,124	-0,324	0,192	**0,485**
G. barbus	**0,688**	**-0,402**	**-0,498**	0,065	**0,459**
H. clupeola	**0,369**	0,126	0,028	0,149	**0,549**
A. lepidentostole	0,271	-0,073	0,207	-0,135	**0,465**
G. genidens	-0,060	-0,278	**-0,635**	**0,304**	-0,028
S. rastrifer	0,141	-0,223	-0,159	0,022	0,040
C. edentulus	**0,616**	0,057	-0,007	-0,024	**0,447**
S. greelevi	**0,661**	-0,180	-0,347	0,152	**0,595**

DISCUSSION

Sediment analysis confirmed the environmental dynamics for a low-energy beach typically sheltered from waves. The deposition of silt, clay, and organic matter at shallow depths was recorded, as was their absence in a short swash zone that had high concentrations of sand due to the action of small waves and/or past high-energy events (JACKSON et al., 2002; SILVEIRA et al., 2011). The sedimentary characteristics found in this study are also commonly found on some estuarine beaches inside Baía de Paranaguá, with coarse sand on the beach face and an associated muddy plain (ROSA; BORZONE, 2008), which are characteristics that generally increase the richness and abundance of the macrofauna (MCLACHLAN; DORVLO, 2005). This type of environment could, theoretically, increase the availability of food at Índio beach.

Increased salinity and transparency occurred during periods of decreased rainfall. The opposite was recorded when rainfall increased, which indicated that the environment was capable of trapping water from continental drainage, even if it was a low quantity, due to the nearness to the channel that links Baía Norte to the Atlantic Ocean. The salinities recorded during the study period were mostly above 30, which was expected for the study area (MACIEL et al., 2010; SIMONASSI et al., 2010). Nevertheless, the small variation recorded for the salinity is hardly ever found on exposed beaches, where it is rarely a relevant factor for the structure of the ichthyofauna community (GIANNINI; PAIVA FILHO, 1995).

The physicochemical characteristics of Índio beach were significantly correlated to the structure of the fish assemblage. *G. barbus* and *G. genidens* had significant negative correlations to transparency, which has also been documented for Ariidae in Baía de Sepetiba (AZEVEDO et al., 1999). The captured biomass was positively correlated to temperature and rainfall, which were higher in spring and summer when they enhanced the productivity in Baía Norte (SIMONASSI et al., 2010) and likely sustained the higher biomasses observed. Higher biomass has also

been recorded during the hottest months of the year by Santos and Nash (1995) and Suda et al. (2002). On the tidal plains, periods of higher rainfall have been correlated with the increases in fish biomass and richness (SPACH et al., 2004). In addition, prior research has shown that the biomass of demersal fish increased in the middle sector of Baía de Paranaguá during periods of high rainfall (BARLETTA et al., 2008).

The number of individuals caught during the day and/or night was dependent on the sampling month. The meso-scale (months) variations to the assemblage presented an irregular pattern in the number of individuals caught over the course of the months, without a defined trend. However, for short-scale (daytime) variations, the results indicated that on average, the assemblage was more abundant during the day and differed in structure and composition at night. Regular patterns in both the short-scale and meso-scale variations were recorded for the families Ariidae and Tetradontidae, with both of the families having well-defined dynamics of occupation at the beach studied. This has also been ascertained by Ignácio and Spach (2009) for *S. testudineus*, *S. greeleyi*, and *G. genidens* on a tidal plain in Baía de Paranaguá.

The number of species found in this study was larger than that recorded on other Brazilian beaches in the states of Paraná, São Paulo, Rio de Janeiro, Espírito Santo, and Bahia (GODEFROID et al., 1997; PESSANHA et al., 2003; FÉLIX et al., 2007; GAELZER; ZALMON, 2008; OLIVEIRA-SILVA et al., 2008; FÉLIX-HACKDART et al., 2010; VASCONCELLOS et al., 2011). This is, in part, a result of the intermediate physicochemical characteristics found at the site, which ranged between a typical and an estuarine beach, and favored the occurrence of estuarine species at the site (e.g. *S. testudineus*, *S .greeleyi*, *Cathorops spixii*, *Atherinella brasiliensis*, *Achirus lineatus*, *Anchoa januaria*, *Anchoa tricolor*, *Diapterus rhombeus*, *Cynoscion microlepidotus*, *Stellifer stellifer*) (GARCIA; VIEIRA, 2001; BARLETTA et al., 2008; REIS-FILHO et al., 2010; VILAR et al., 2011a). However, the low energy of the study site allowed for the use of a *capéchade* net (visibly efficient in other low-energy environments) for the samplings (IGNÁCIO; SPACH, 2009; VASLET et al., 2010). Given that in most beach studies the sampling is performed using relatively small trawl nets (PESSANHA et al., 2003; GAELZER; ZALMON, 2008; FÉLIX-HACKDART et al., 2010; VASCONCELLOS et al., 2011), which are apparently ineffective at catching individuals that respond rapidly to the visual and mechanical stimulus of the net (GLASS; WARDLE, 1989; METHVEN et al., 2001), the richness of the local ichthyofauna may be underestimated. In addition, nocturnal samplings

are essential for evaluating fish diversity because they increase the chances of catching species rarely collected during the day. In the present study, eleven species were recorded exclusively at night (Table 2), which allowed for a better representation of the true community structure (MORRISON et al., 2002). Nevertheless, the number of species recorded was similar to that usually found in shallow environments in southeastern-southern Brazil, which may indicate a pattern of richness in this region.

The species richness caught during the day (77) and at night (74) at Índio beach were very close, with 61 species occurring both during the day and at night. As verified in other shallow areas, the species that were exclusive to a single time of day were not very abundant (GRIFFITHS, 2001; PESSANHA et al., 2003; IGNÁCIO; SPACH, 2009; FÉLIX-HACKRADT, 2010; VASCONCELLOS et al., 2011).

The dominance pattern recorded in the present study, in which eight species showed high abundance and relative importance (%IRI), was similar to various results obtained at other beaches and estuaries worldwide, where generally less than 10 species dominate the environment (SANTOS; NASH, 1995; GIBSON et al., 1993; GRIFFITHS, 2001; STRYDOM, 2003; GODEFROID et al., 1997; PESSANHA et al., 2003; FÉLIX et al., 2007). However, the species that showed high %IRI in the present study, with the exception of *H. clupeola*, were not classified as dominant species in most of the work carried out on sheltered and exposed beaches from the western portion of the South Atlantic (GODEFROID et al., 1997; PESSANHA et al., 2003; FÉLIX-HACKDART et al., 2010; VASCONCELLOS et al., 2011). *Sphoeroides testudineus* and *S. greeleyi* are widely distributed in estuarine regions (HACKRADT et al., 2011; VILAR et al., 2011b) and rarely abundant on oceanic beaches (GODEFROID et al., 2003; FÉLIX et al., 2007; GAELZER; ZALMON, 2008; FÉLIX-HACKRADT et al., 2010). A similar pattern has been documented for *Genidens genidens* and *G. barbus* (MISHIMA; TANJI, 1983; ARAÚJO, 1988; BARLETTA et al., 2008). On the other hand, *Harengula clupeola* was the most abundant species on sheltered beaches within the states of Paraná (FÉLIX-HACKRADT et al., 2010) and Rio de Janeiro (GAELZER; ZALMON, 2008; VASCONCELLOS et al., 2011), and *Cetengraulis edentulus* and *Anchoviella lepidentostole* were apparently abundant in the coastal regions of the state of Santa Catarina (BARREIROS et al., 2004; SOUZA-CONCEIÇÃO, 2005). The demersal species that composed a large portion of the %IRI in the present study were also abundant in demersal trawls in Baía Sul (Florianópolis) (CARTAGENA et al., 2011). Parameters such as spatial differences (as mentioned in the studies cited) and different selectivity among sampling gear can

affect abundance and/or dominance (ROZAS; MINEILO, 1997). The most important species in this study were selected based on the %IRI, which considered the proportional contribution of each variable (weight, FO% and abundance) in the index. Thus, a species with low weight (g) and low FO%, regardless of its abundance, may show smaller %IRI values than species with higher weight and FO%, as observed for *H. clupeola* and *S. testudineus* in this study.

At Índio beach, abundance had a tendency to increase in the hottest months, i.e. November to April, a finding which is congruent with those of other studies. In the Gulf of Mexico (ROSS et al., 1987) and Scotland (GIBSON, 1973) ichthyofauna abundance peaks were recorded at the end of spring and in summer. In addition, on beaches of the Azores archipelago (SANTOS; NASH, 1995) and in Japan (SUDA et al., 2002), higher abundance and biomass were recorded in the hottest months of the year. Higher abundance was also found during the summer by Bennett (1989) in South Africa, unlike that observed by Lasiak (1984b) and Clark et al. (1996) in the same region. The rise in the average abundance during the hottest periods of the year seems to result from, first, the spawning peaks of some species (e.g. *S. rastrifer* and *C. edentulus*) and, second, the recruitment peaks of other species (e.g. *G. barbus* and *S. testudineus*).

The short-scale biomass variations (day and night) were not significant at Índio Beach; however, the biomass was slightly higher in the nocturnal catches, which may indicate a possible entry process of larger individuals at night (NASH et al., 1994). Statistically, for the species with higher %IRI, only larger-sized individuals of *C. edentulus* were documented at night. On the other hand, the specific composition of the average biomass for each time of day varied widely and was molded by the composition of the ichthyofauna in each period, as observed by MORRISON et al. (2002).

Of the species with higher %IRI, only *S. greeleyi* and *A. lepidentostole* had an interaction (ANOVA) in the abundance between the time of day and the month of sampling. Vasconcellos et al. (2011) found an interaction between the season and the time of day for *Atherinella brasiliensis*, *Pomatomus saltatrix*, *Trachinotus carolinus*, *Umbrina coroides* and *Anchoa lyoleps*, which showed an inconsistent pattern of nycthemeral occupation within the beach environment. Higher nocturnal richness was also found by Methven et al. (2001) in a shallow area of the estuary in Newfoundland, with two groups of species – one showing predominance at night and another during the day. On tidal plains in a temperate estuary in New Zealand, the ichthyofauna presented higher richness and abundance at night, with

interaction (ANOVA) between the tide and the time of day for two of the eight most abundant species (MORRISON et al., 2002). The small tidal amplitude (~0.52 m) at Índio beach (SORIANO-SIERRA; SIERRA DE LEDO, 1998), and the standardization of the sampling at neap tide in the present study decreased the tidal effect on the catches. However, even though this effect was reduced, it may have influenced the catches, given that the dynamics of the ichthyofauna varied widely between the tidal regimes, with a possible concentration of fish in channels at low tide and an exploitation of the floodplains at high tide (GIBSON et al., 1996; MORRISON et al., 2002; OLIVEIRA-NETO et al., 2008).

To understand the aspects that govern the movement of specific groups to greater depths, trophic analyses between the sampled ichthyofauna and the beach fauna, could be promoted (NAGELKERKEN et al., 2000; SOARES; VAZZOLER, 2001). A greater number of ariids were collected at night at Índio beach and were also associated with lower depths at night in Baía Sul (Florianópolis) (CARTAGENA et al., 2011). These fish use barbells to help them recognize food items on the bottom (CHAVES; VENDEL, 1996), which is a morphological characteristic that may favor the nocturnal activity of the family (also recorded for *Polydactylus virginicus*). During the day, the ariids seem to be associated with deeper environments (>3m) (SCHWARZ Jr. et al., 2007; CARTAGENA et al., 2011), which is an adaptation that most likely decreases the interspecific competition and predation risk from birds in shallow areas (HYNDES et al., 1996; YOUNG et al., 1997; CLARK et al., 2003).

Another explanation for the nycthemeral variation in the abundance of the ariids could be physiological. Among the species with higher %IRI, only *G. barbus* and *G. genidens* presented negative correlations with transparency, in addition to being preferentially nocturnal. Some fish species are particularly deprived, or possess low quantities of skin compounds called photoprotectors (FABACHER; LITTLE, 1995). These compounds are mainly melanin pigments capable of absorbing UV radiation. Melanin may vary in quantity according to the species and the stage of life (FABACHER; LITTLE, 1995; HADER et al., 2007); however, its production can also be stimulated. Individuals exposed to high levels of radiation at the surface present high concentrations of melanin (ADACHI et al., 2005), which may lead to a consequent energy expenditure. In this context, the levels of solar radiation, which vary according to the depth, the water transparency and the time of day, could be influencing the displacement of the ariids.

The high number of individuals of *S. testudineus* and *S. greeleyi* recorded during daytime samplings coincided with their feeding activity on crustaceans (Brachyura and Penaeidae) and mollusks

(Gastropoda and Bivalvia) (SANTOS; RODRIGUEZ, 2011).

The results obtained at Índio beach for the other families and species also showed short-scale variations; however, in most cases, the small number of specimens collected or the occurrence of seasonal peaks, guided the formulations of hypotheses and cautious inferences. Gerreidae were more abundant during the day, while Haemulidae were more abundant at night. These findings were similar to those found in a Caribbean estuary where Gerreidae were more abundant during the day in mangrove environments, and Haemulidae were more abundant at night in algal banks (NAGELKERKEN et al., 2000). In this study, Sciaenidae presented high species abundance and richness, with a tendency for higher nocturnal occurrences, a finding that was also verified by Ignácio and Spach (2009) and Barreiros et al. (2005). On the South-southeastern continental shelf, members of Sciaenidae feed during the entire daytime period, with some species showing preference for nighttime or daytime food resources, indicating a possible resource partitioning strategy for coexistence (SOARES; VAZZOLER, 2001). *Anchoa januaria* was present in the winter and spring, with higher abundance during the day. *Anchoa januaria* feeds on zooplankton during the day and exploits different strata of the water column. In winter, when there is lower availability of planktonic food, this small pelagic species mainly eats Harpacticoida copepods from interstitial fauna (SERGIPENSE et al., 1999), which is probably associated with the catches of these species in a beach environment. The daytime predominance of *C. spilopteturs* was most likely a result of its consumption of mysids and polychaetes (TOEPFER; FLEEGER, 1995), which was facilitated during the day in shallow areas by the morphological characteristics of this visual predator (GUEDES, op. cit.).

Fish that are sensitive to changes in the sunlight during the crepuscular periods of dawn and dusk can respond physiologically (SPIELER; NOESKE, 1981) or ecologically (HYNDES et al., 1996; YOUNG et al., 1997; CLARK et al., 2003), or may gradually change their activity within beach environments. Thus the pattern of nycthemeral variation verified for several species could have been more prominent if a crepuscular interval (i.e. 2 hours) were added between the diurnal and nocturnal samplings. Moreover, measuring the level of nocturnal luminosity might be a way to determine if the monthly and day/night abundance interactions that were calculated using the ANOVAs as well as the elevation in the nocturnal averages for predominantly diurnal species could be verified.

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