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A N I N T E R N A T I O N A L J O U R N A L

Structure and Dynamics of Fish Assemblages in a Tidal Creek Environment

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ABSTRACT

Studies were carried out on structure and dynamics of fish assemblages in the Baguaçu tidal creek, Paranaguá Bay, Brazil. A total of 30,104 fish were captured, comprising 21 families and 47 species. Both in weight and in number, the species Anchoa parva prevailed. Monthly captures in number and weight were largest in the autumn and part of the winter. No seasonal tendency was observed in the indexes of community structure. The dendrogram produced by the classification of the samples separated the 12 months of collection into three groups, reflecting differences in the qualitative and quantitative occurrences of the most important taxa. Some ecological likeness, not only seasonal patterns of abundance, seemed evident in the seasonality of the groupings of species revealed through the cluster analysis. The principal component analysis reflected mainly the periods of rain and drought

Key words: Tidal creek, fish assemblages, seasonal variation, Brazil

INTRODUCTION

Mangrove channels, called tidal creeks, are features that have a meandering design and are dependent on the tide regime. They are characteristic of littoral plains in estuarine complexes of the southeastern-southern region of Brazil. Tidal creeks are important routes for the flow of organic matter between the continent and the estuary, and are also important for the development of juvenile individuals of fish and crustaceans, since these areas are used for feeding and refuge (Lana et al., 1989).

An evaluation of the functional value of the estuarine habitats as fish nurseries, mainly by identifying the structure of the assemblages and their interactions with the physical, chemical and biological characteristics that define the habitat, is necessary for the understanding of how natural disturbances or those induced by man that cause the degradation of these areas, can compromise the recruitment process. In this sense, this study tried to characterize the hydro-graphic pattern and identify the structure of the fish assemblages in the Baguaçu tidal creek, found in the euhaline section of Paranaguá Bay.

MATERIAL AND METHODS

The samples were obtained between April 1997 and March 1998 in the low quadrate tide. A seine net (30.0 x 3.0 m, threshes of 1 mm between adjacent knots) was used for four drags carried out

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in the area of the mouth of Baguaçu tidal creek. At each collection point, temperature data, salinity and pH of the surface water were collected. Air temperature data were obtained at the meteorological station of the Centro de Estudos do Mar in Pontal do Sul resort, and rainfall data from a meteorological station located in Guaraguaçu River, next to the studied area. With regard to the two meteorological variables, a four-day average was used, estimated by including the three days that preceded the collection plus the collection day.

To evaluate the monthly variation in size and weight structure, an analysis of variance with a posteriori test of Least Significant Difference was performed (Sokal and Rohlf, 1981). Temporary changes in composition and abundance were analyzed through captures in number and weight, number of species, richness index of Margalef, diversity index of Shanon-Wiener and evenness index of Pielou (Pielou, 1969).

Using the grouping method with the single average of the similarity values (UPGMA) and the coefficient of similarity of Bray-Curtis, a Cluster Analysis was applied to the log (x+1) transformed data of absolute frequency of the 19 most abundant species (Johnson and Wichern, 1992). To identify the environmental preferences, a Principal Component Analysis was used (Johnson and Wichern, 1992).

RESULTS

The water and air temperatures followed the seasonal pattern expected for the area, with the maximums between December and April, and minimum from June to October (Fig. 1a). The salinity ranged from 6.0 to 31.5‰, with the lowest salinities occurring from November to March, the period with most rainfall (Fig. 1b), and the lowest pH values (Fig. 1c).

We collected 30,104 fishes (72.39 Kg) from 47 species representing 21 families. Only six species presented a relative frequency greater than 1%, together accounting for 95.7% of the capture in number. About 93% of the capture in weight was constituted by eight species, the only ones with a relative weight larger than 1% (Table 1). Both in weight and in number, the species *A. parva* prevaled. The families Engraulidae, Gerreidae and Gobiidae were represented in the area by five species each, the families Carangidae and Tetraodontidae by four species and Clupeidae, Mugilidae and Sciaenidae by three species (Table 1).

More than half of the captured individuals were immature (51.58%), 28.71% were females and 19.71% were males. The captured ichthyofauna was formed mainly by small-sized specimens, with a medium standard length of 7.27 (S=± 23.63) mm and a mean weight of 7.27 (S=± 12.09) g. There were significant differences between the monthly averages of the standard length ($F=15.50$ $p<0.01$), with the smaller averages occurring between February and March (Fig. 2a). The differences between the monthly averages of weight were also significant ($F = 3.95$ $p<0.01$), the smallest averages occurring in February and March (Fig. 2b).

The differences between the monthly captures in number and weight were great, with the largest captures occurring mainly in the autumn and part of the winter and in September (Fig. 3a). A larger number of species was present in the March, April and May samples, being smaller in August and October (Fig. 3b).

No seasonal tendency was observed in the indexes of community structure. The values of the richness index of Margalef (D) (Fig.4c), indicated larger richness in November (D = 3.75) and March (D = 3.11) and smaller richness in September (D = 1.69) and October (D = 1.87). The diversity of the ichthyofauna expressed by the index of Shanon-Wiener (H') (Fig. 3c), presented the largest values in November (H' = 1.45), January (H' = 1.76) and March (H' = 1.49), and the smallest ones in September (H' = 0.10), October (H' = 0.29) and December (H' = 0.006). The evenness varied from 0.02 in December to 0.64 in January (Fig. 3c).

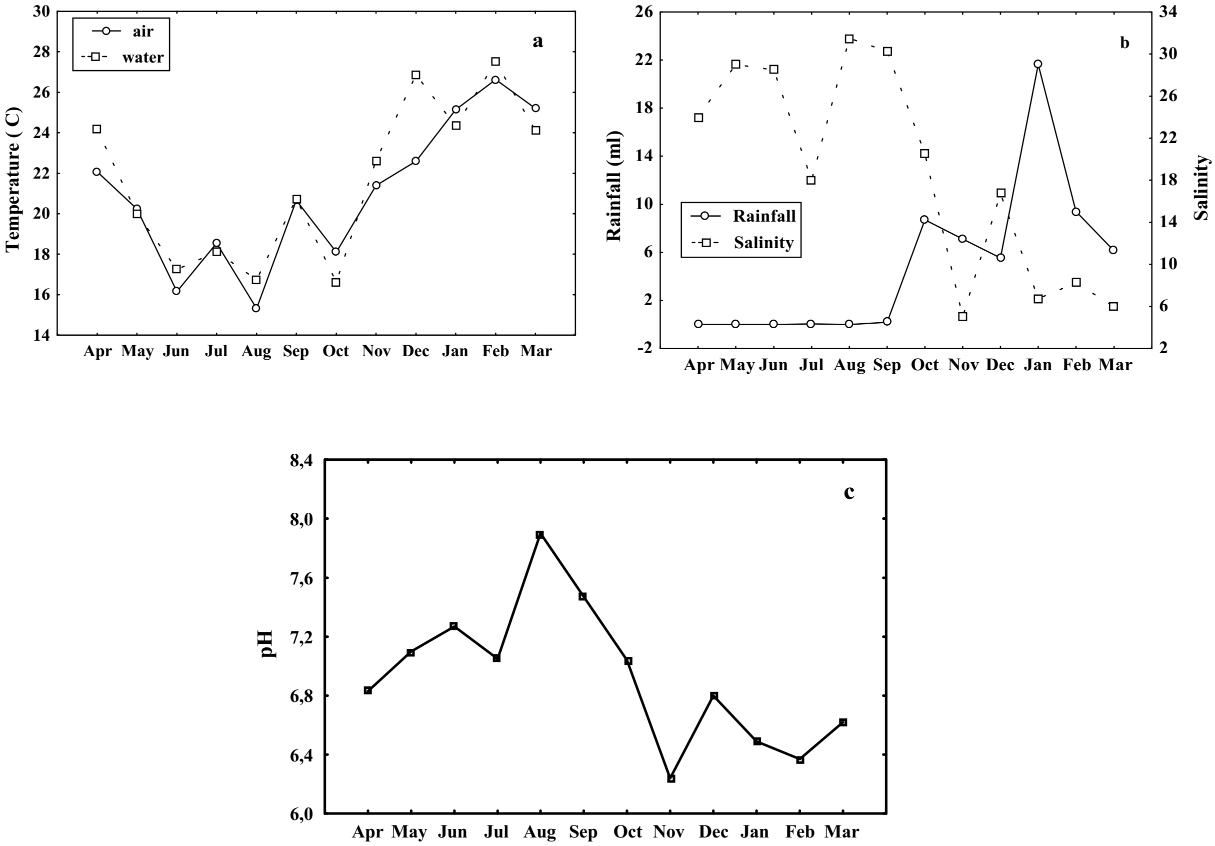

Figure 1 - Monthly variation of the water and air temperatures (a), rainfall and salinity (b) and pH (c).

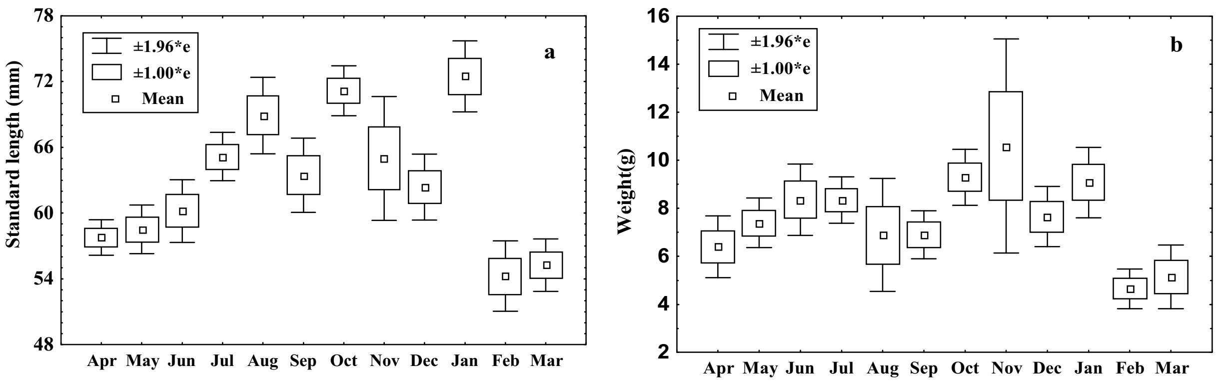

Figure 2 - Descriptive graphs of the analysis of variance used to evaluate the effect of the collection month on the standard length (a) and the mean weight (b) of the fish (e = standard error).

Table 1 - List of families and species of fish and the values of absolute frequency (n) and relative frequency (%) of total and relative weight (%). Families ordination according to Nelson (1994).

Taxon		Frequency		Weight	
		n	%	Total	%
Engraulidae	*Anchoa lyolepis*	74	0.25	64.71	0.09
	A. parva	25980	86.30	42067.36	58.12
	Anchoviella lepidentostole	32	0.11	106.91	0.15
	Cetengraulis edentulus	4	0.01	40.41	0.06
	Lycengraulis grossidens	84	0.28	821.63	1.13
Clupeidae	*Harengula clupeola*	1331	4.42	6136.18	8.48
	Opisthonema oglinum	180	0.60	348.59	0.48
	Sardinella brasiliensis	40	0.13	157.02	0.22
Ariidae	*Genidens genidens*	425	1.41	3324.16	4.59
Mugilidae	*Mugil curema*	1	0.003	11.11	0.02
	M. gaimardianus	8	0.03	69.41	0.10
	M. platanus	2	0.006	276.83	0.38
	Mugil sp.	3	0.01	3.42	0.005
Atherinopsidae	*Atherinella brasiliensis*	366	1.22	2214.97	3.06
Belonidae	*Strongylura timucu*	1	0.003	2.23	0.003
	Strongylura sp.	2	0.006	3.12	0.004
Hemiramphidae	*Hyporhamphus unifasciatus*	8	0.03	53.30	0.07
Poecilidae	*Poecilia vivipara*	210	0.70	432.07	0.60
Triglidae	*Prionotus punctatus*	1	0.003	2.11	0.003
Centropomidae	*Centropomus parallelus*	41	0.14	302.56	0.42
	C. undecimalis	49	0.16	579.89	0.80
Pomatomidae	*Pomatomus saltatrix*	3	0.01	76.61	0.11
Carangidae	*Oligoplites saliens*	1	0.003	16.85	0.02
	O. saurus	4	0.01	65.61	0.09
	Selene vomer	1	0.003	30.38	0.04
	Trachinotus carolinus	1	0.003	4.21	0.006
Gerreidae	*Diapterus rhombeus*	23	0.08	133.08	0.18
	Gerres (Eucinostomus) argenteus	341	1.13	1862.27	2.57
	G. gula	37	0.12	302.93	0.42
	Ulaema lefroyi	4	0.01	1.80	0.002
Sciaenidae	*Bairdiella ronchus*	66	0.22	308.53	0.43
	Micropogonias furnieri	1	0.003	54.59	0.07
	Stellifer rastrifer	8	0.03	132.51	0.18
Gobiidae	*Bathygobius soporator*	26	0.09	179.53	0.25
	Gobionellus oceanicus	4	0.01	46.27	0.06
	G. smaragdus	63	0.21	129.77	0.18
	G. stigmaticus	1	0.003	0.56	0.0008
	Awaous tajasica	1	0.003	74.18	0.10
Ephippidae	*Chaetodipterus faber*	3	0.01	27.21	0.04
Paralichthyidae	*Citharichthys arenaceus*	7	0.02	56.28	0.08
	Etropus crossotus	1	0.003	10.68	0.01
Achiridae	*Achirus lineatus*	5	0.02	21.45	0.03
Cynoglossidae	*Symphurus tesselatus*	3	0.01	5.59	0.008
Tetraodontidae	*Lagocephalus laevigatus*	2	0.006	265.79	0.37
	Sphoeroides greeleyi	380	1.26	3772.19	5.21
	S. testudineus	295	0.98	7681.58	10.61
	S. tyleri	5	0.02	72.84	0.10
Diodontidae	*Cyclichthys spinosus*	1	0.003	13.46	0.02
Total		30,104		72,385.66	

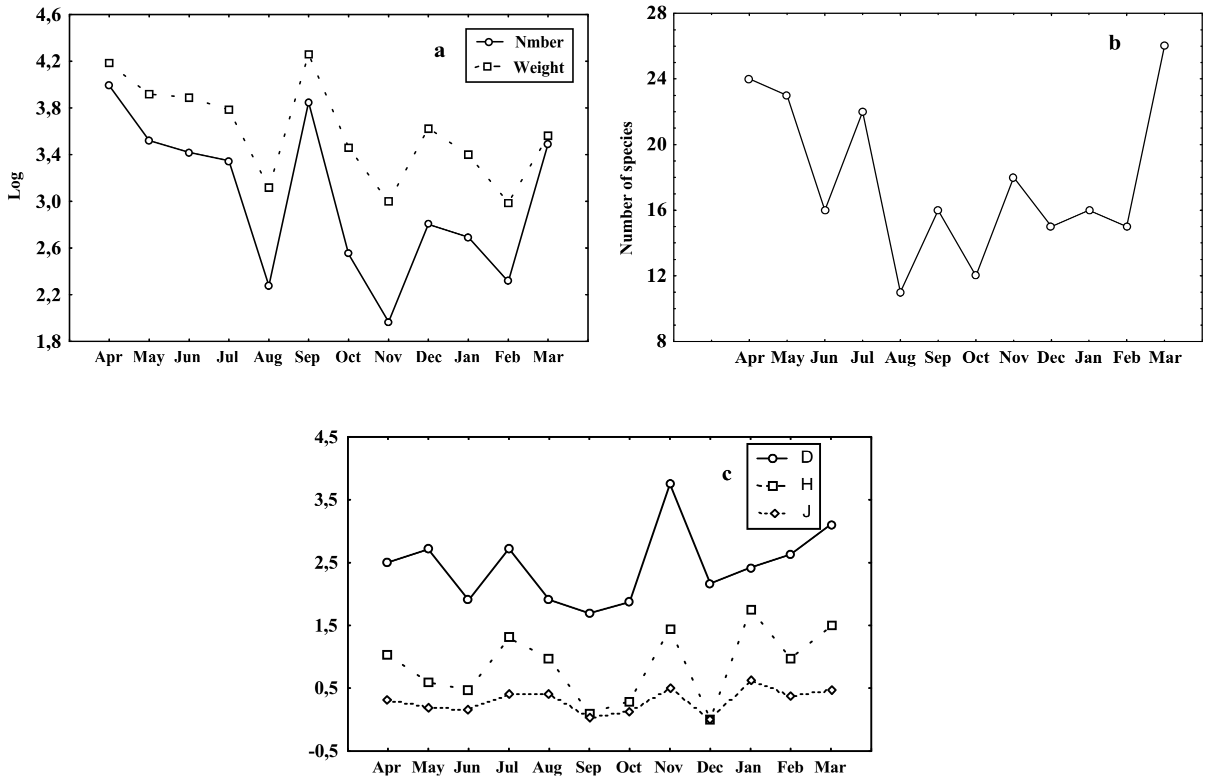

Figure 3 - Monthly variation in the number of fish and weight of the capture (a), number of species (b), and of the richness index of Margalef (D), diversity index of Shanon-Wiener (H ') and evenness index of Pielou (J) (c).

The dendrogram produced by the classification of the samples (Fig. 4), separated the 12 months of collection into three groups that join at a similarity level of 60%. Group I, constituted by the months of August, October and December, united at a similarity level of 62%, with small captures in weight and in number of individuals and species, and low richness, diversity and evenness values. The second group (II), formed by the samples of November and January, presented a similarity of 69%, with small captures in weight and in number of fish and species, but with larger richness, diversity and evenness values than in the previous group. Group III, composed by the months of March, April, May, June, July and September, presented a similarity of 66%, corresponding to the months with large captures in weight and in number of specimens and species.

The Cluster Analysis of the selected species, revealed three main groups, united at a similarity level of 59% (Fig. 5). Group I, contained at the similarity level of 61%, was constituted by the species *G. smaragdus, D. rhombeus, B. soporator, C. undecimalis* and *C. parallelus*, that occurred in small amounts throughout the year.

A second group (II), united at a similarity level of 60%, was formed by the species *P. vivipara, A. lyolepis, S. brasiliensis* and *O. oglinum*, also present during all seasons, but with larger abundance than the species of the In the Principal Components Analysis (PCA), components I and II, responsible for 22.94% and 18.0% of the variation of the data, respectively, are positively related to the rainfall and air and water temperatures, and negatively related to the salinity and pH. This opposes the conditions of part of the spring, summer and beginning of autumn, which have low salinities, acid pH, high air and water temperatures and high rainfall values, with those of part of the autumn, winter and beginning of the spring, which have medium to low salinities and temperatures, pH varying from basic to acid and an almost total absence of rain (Fig. 6).

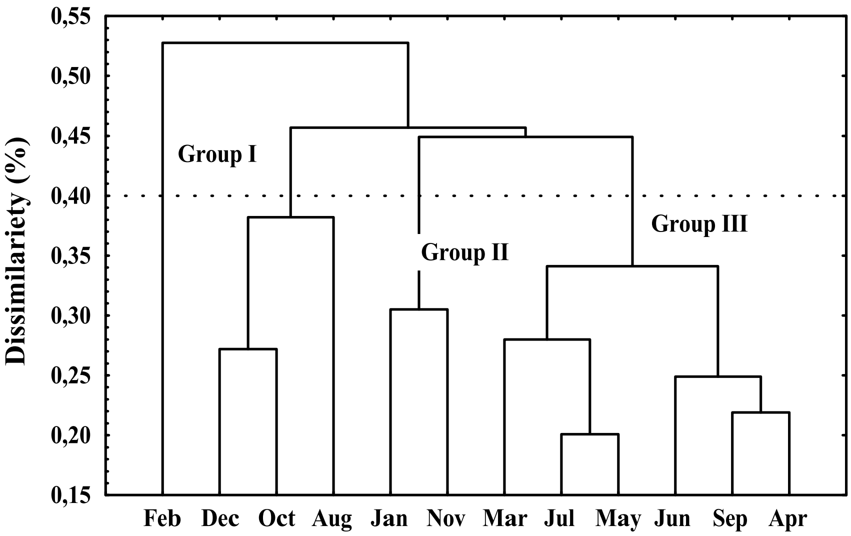

Figure 4 - Dendrogram based on the abundance data of the main 19 taxa, sampled every month.

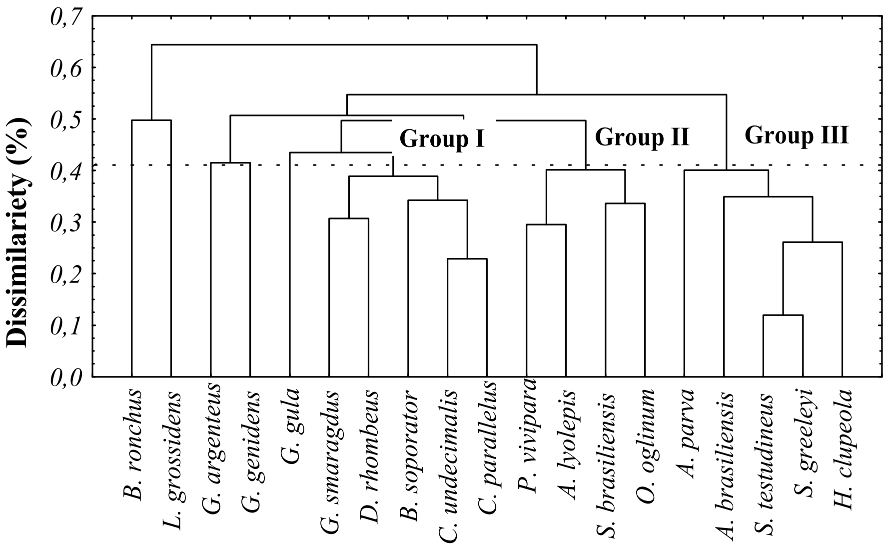

Figure 5 - Dendrogram showing the similarities among the most abundant taxa, based on their occurrence throughout twelve months of sampling.

The PCA reflected mainly the periods of rain and drought, with the species *B. ronchus, G. smaragdus* and *C. parallelus* more associated to the rainy periods, especially the first species. With similar occurrences in both periods, the following species were observed: *P. vivipara, B. soporator, C. undecimalis, G. genidens, L. grossidens, G. argenteus, G. gula, S. testudineus* and *D. rhombeus*. A larger abundance in the area during the drought period, occurred for *S. greeleyi, H. clupeola*, *A. parva, A. lyolepis, S. brasiliensis, A. brasiliensis* and *O. oglinum*. The species *S. greeleyi* showed the largest correlation with salinity and high pH, characteristics of the drought period (Fig. 6).

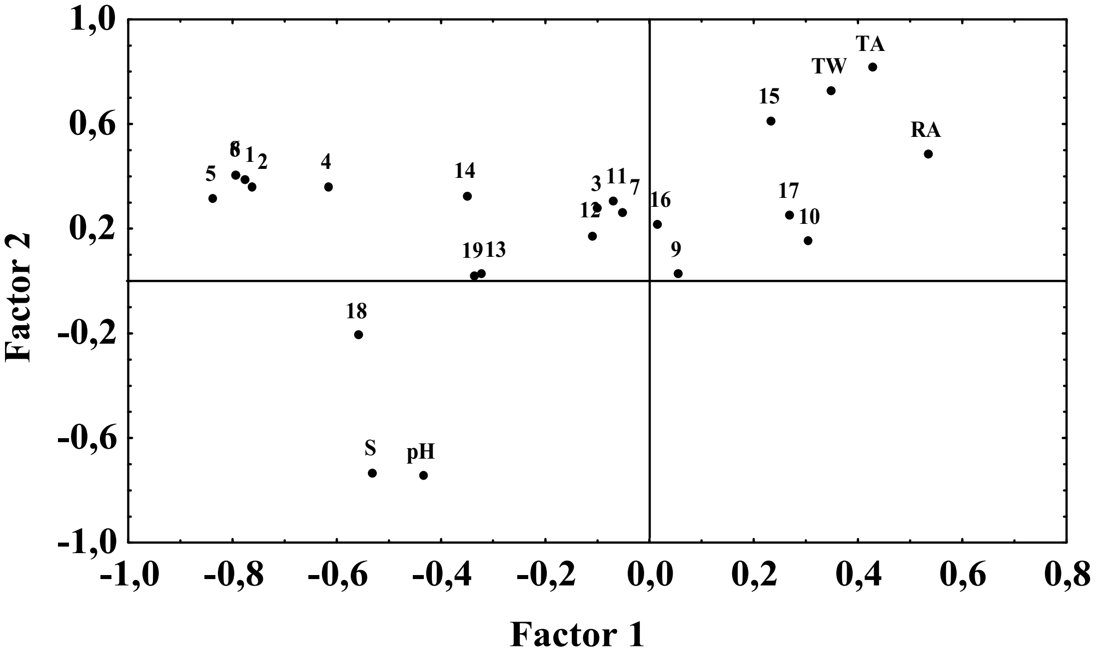

Figure 6 - Principal Components Analysis, with the simultaneous projection of the variables (species/physical-chemical), with the interpretation of components I and II. (S=salinity, TA= air temperature, TW= water temperature, RA= rainfall, 1= *A. lyopelis*, 2= *A. parva*, 3= *L. grossidens*, 4= *H. clupeola*, 5= *O. oglinum*, 6= *S. brasiliensis*, 7= *G. genidens*, 8= *A. brasiliensis*, 9= *P. vivipara*, 10= *C. parallelus*, 11= *C. undecimalis*, 12= *G. argenteus*, 13= *G. gula*, 14= *D. rhombeus*, 15= *B. ronchus*, 16= *B. soporator*, 17= *G. smaragdus*, 18= *S. greeleyi* and 19= *S. testudineus.*

DISCUSSION

In spite of the high specific diversity, few species dominated in the samples of Baguaçu tidal creek, with a great number of rare species, a characteristic of estuarine areas (Kennish, 1990; Chaves and Bouchereau, 1999). The numeric dominance of the species *A. parva, H. clupeola, G. genidens, S. testudineus* and *S. greeleyi* observed in this study was also reported by Nardi (1999). These two studies differed mainly with regard to the dominance of *A. brasiliensis, G. argenteus, B. ronchus* and *P. vivipara*. The first three species were more abundant in the study of Nardi (1999), because they prefer more saline waters, entering the tidal creek particularly during high tide (Bemvenuti, 1987; Barbieri, 1991), while *P. vivipara* was a small-sized fish that inhabited waters of low salinity, and was captured in larger amounts by the fine-meshed net used in this study.

The fish assemblages of intertidal areas are characterized by low richness and strong temporary fluctuations in the density of the species, being the diversity patterns strongly influenced by the dynamics of the local populations (Kennish, 1990). The species abundance varied frequently, suggesting successive entrances and exits throughout time. Such heterogeneous patterns of temporary variation were also influenced by the dynamic population of the dominant species *A. parva*. The temporary variation observed in Baguaçu tidal creek, in abundance, weight biomass, number of species and structural indexes, seemed to be associated with the reproduction and recruitment dynamics. As most of the species in the area spawn in the spring and summer, with the recruitment being prolonged throughout the autumn (Godefroid, 1997; Abilhôa, 1998, Pinheiro, 1999), the largest values observed in the summer and autumn would be a result of the entrance of recruits into the area.

The assemblages of fish in infra-littoral habitats of areas connected with the main body of the estuary are generally a sub-group of the assemblages in the adjacent estuary (Cattrjsse et al., 1994). The assemblages observed in this study, both in composition and in structure, were quite similar to those observed previously in the adjacent areas, in spite of the great differences in the sampling strategy used (periodicity and nets) (Godefroid, 1997; Abilhôa, 1998; Pinheiro, 1999).

The grouping of the months defined by the normal Cluster Analysis reflected differences in the qualitative and quantitative occurrences of the most important taxa. The seasonal character observed in Baguaçu, with a larger number of individuals and species in the autumn and winter, repeat itself in the tidal creek in the survey with fyke nets (Nardi, 1999). Although some likeness existed, in a general way, this pattern present in Baguaçu was different from the one observed in shallow areas of the margin of the euhaline section of Paranaguá Bay, where the largest occurrences were in the warmest periods. (Godefroid, 1997; Lopes, 2000).

Some ecological likeness, not only the seasonal patterns of distribution and abundance, were evident in the seasonality of the groupings of species revealed through the Cluster Analysis. Except for *G. smaragdus, B. soporator* and *P. vivipara*, all the other species of groups I and II were estuarine-dependent, present in the area during part of their life cycle, and therefore less abundant (Figueiredo and Menezes, 1978; Figueiredo and Menezes, 1980; Menezes and Figueiredo, 1980). The low abundance of the species *G. smaragdus, B. soporator* and *P. vivipara*, seemed to be related in the first two species to their non-aggregated distribution and to the permanence in lairs (Menezes and Figueiredo, 1985) and, in the latter species, to the distribution limited to the zone where percolated fresh water mixed with the marginal water of the tidal creek (Kneib, 1997). On the other hand, the species of group III, more abundant in the tidal creek, were resident in the estuary, and therefore used the area in a more intense way (Figueiredo and Menezes, 1978; Figueiredo and Menezes, 2000).

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RESUMO

As amostras foram obtidas mensalmente na baixa-mar de quadratura na Gamboa do Baguaçu, Baía de Paranaguá, Brasil, com uma rede tipo picaré, com malha de 1mm, 30 m de comprimento e 3 m de altura. Foram capturados 30104 peixes pertencentes a 21 famílias e 47 espécies. A espécie *Anchoa parva* foi a mais abundante, tanto em número como em peso. As capturas em número e peso foram maiores no outono e parte do inverno. Nenhuma tendência sazonal foi observada nos índices da estrutura da comunidade. O agrupamento dos meses definidos pela análise de cluster normal refletiram diferenças na ocorrência qualitativa e quantitativa dos taxa mais importantes. Algumas afinidades ecológicas, e não somente os padrões sazonais de abundância, parecem evidentes na sazonalidade dos agrupamentos de espécies revelados através da análise de cluster. A análise de componentes principais reflete principalmente os períodos de chuva e seca.

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