Spatial and temporal variations of the benthic macrofauna in different habitats of a lagoon of the northern coastal system of Rio Grande do Sul State, Brazil.

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ABSTRACT: Spatial and temporal variations of the benthic macrofauna in different habitats of a lagoon of the northern coastal system of Rio Grande do Sul State, Brazil. The present work analyses the structure of macrobenthic community in three areas of Itapeva Lagoon, northern coast of Rio Grande do Sul. In each study area, deltaic margin of Três Forquilhas River, central area and east margin, three sample units have been established, 500 meter equidistant, towards NE-SW fetch. Collects have been done during Summer and Winter of 2000 and Summer of 2001, with an Ekman-Birge type sampler, having an area of 225 cm². More abundant taxons at deltaic margin were Naidinae and Chironomidae (Polypedilum sp. and Cryptochironomus sp.); Tubificinae at the central area, Veneroida, Chaoboridae (Chaobors (Chaoborus) sp.) and Chironomidae (Coelotanypus sp. and Cladotanytarsus sp.) as well as Hidrobiidae at east margin (Heleo charruana and P. ribeirenses). The richness of families varied between 9 and 15, diversity varied between 1.22 and 2.05 and the equitability between 0.48 and 0.8. Variance analysis indicated that for values of families richness, total number of individuals and equitability, habitat has been a major factor in the community. Diversity values, however, varied in function of time. Highest values of correlation (Spearman) were found between macroinvertebrates densities and fine sand, sediments deposition form (Passega's classification) and hydrodynamics (sand/silt+clay relation); between equitability and organic matter, selection and silt percentage and diversity and asymmetry. Spatial variation of macrobenthos suffered the influence of textural variables of sediment and aquatic vegetation, which have build different substrates, thus supplying shelter and food resource. On the other hand, temporal variation is likely to have been favored by water lamina depth and hydrodynamics.
Key-words: Macroinvertebrates, habitats, spatial and temporal variations, coastal lagoon, Rio Grande do Sul.

RESUMO: Variação espaço-temporal da macrofauna bentônica em diferentes hábitats de uma lagoa do sistema costeiro norte do Rio Grande do Sul, Brasil. O presente trabalho analisa a estrutura da comunidade de macrobentos em três áreas da Lagoa Itapeva, Litoral Norte do Rio Grande do Sul. Em cada uma das áreas de estudo, margem deltaica do Rio Três Forquilhas, área central e margem leste, foram estabelecidas três unidades amostrais, eqüidistantes 500 m, na direção do fetch NE-SW. As coletas foram realizadas nos períodos de verão e inverno de 2000 e verão de 2001, com um amostrador do tipo Ekman-Birge, com área de 225 cm². Os táxons mais abundantes na margem deltaica foram os Naidinae e os Chironomidae (Polypedilum sp. e Cryptochironomus sp.); na área central, os Tubificinae, Veneroida, Chaoboridae (Chaobors (Chaoborus) sp.) e Chironomidae (Coelotanypus sp. e Cladotanytarsus sp.) e na margem leste os Hidrobiidae (Heleo charruana e P. ribeirenses). A riqueza de famílias variou entre 9 e 15, a diversidade entre 1,22 e 2,05 e a equitabilidade entre 0,48 e 0,8. A análise de variância indicou que para os valores de riqueza de famílias, número total de indivíduos e equitabilidade, o hábitat foi um fator de maior importância na comunidade, porém os valores de diversidade variaram em função do tempo. Os maiores valores de correlação (Spearman) foram encontrados entre o número total de indivíduos e as variáveis areia fina, forma de deposição dos sedimentos (classificação de Passega) e hidrodinâmica (relação areia/silte+argila); entre equitabilidade e matéria orgânica, percentual de silte e seleção do sedimento e entre diversidade e a assimetria. A variação espacial do macrobentos teve a influência das variáveis texturais do sedimento e da vegetação aquática, que construíram diferentes substratos, propiciando refúgio e recurso alimentar. Enquanto a variação temporal parece ter sido favorecida pela profundidade da lâmina d'água e hidrodinâmica.
Palavras-chaves: Macroinvertebrados, hábitats, variação espacial e temporal, lagoa costeira, Rio Grande do Sul.

Introduction

Coastal Plain of Rio Grande do Sul, in its northern area, is composed of a group of lagoons, most of them connected by channels, a water mirrors rosary, which opens between the sea and Serra Geral Formation mountains (Machado, 2000). Lagoons rosary is characterized by low depths that favor aeolian action. This aeolian action is the main function of ecologic force in the region, producing waves that influence development of margins through resuspension of bottom sediments. (Schwarbold & Schafer, 1984; Tomazelli, 1990; Machado, 2000).

Itapeva Lagoon is the last lagoon placed at the northern part of this rosary of lacustrine bodies of the coast of Rio Grande do Sul. This Lagoon receives waters from Três Forquilhas and Cardoso River's by its west margin. Among these rivers, Três Forquilhas plays an important role due to the formation of a fluvial-lacustrine delta (Tomazelli, 1990

A special focus is set in this work upon the study of the benthic macrofauna of three different habitats of Itapeva Lagoon: margins close to the deltaic formation of Três Forquilhas River, margin areas of the eastern part of the Lagoon and a central area of greater depth. This study aims at characterizing, in the space, the community frame of benthic macroinvertebrates in these three kinds of environment, taking into consideration peculiar environmental characteristics of each one as well as their changes in time.

Study Area

Itapeva Lagoon is located at the northern coast of Rio Grande do Sul and belong to the fluvial-lacustrine System of Tramandaí, which integrates the Hydrologic Basin of Tramandaí River (Fig. 1).

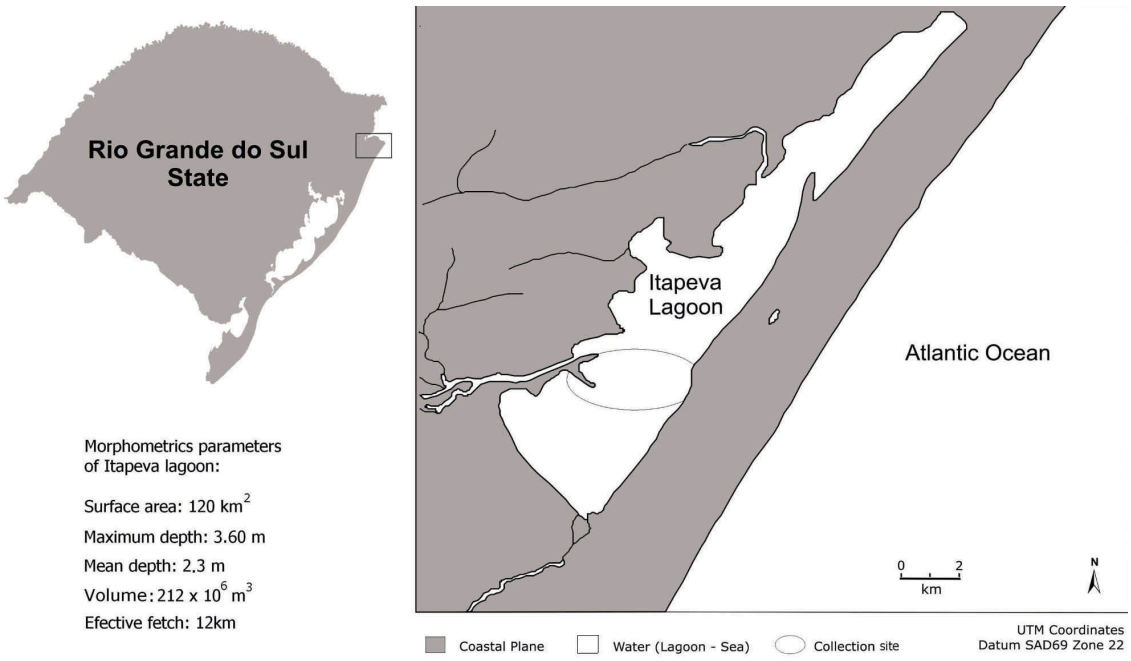

Figure 1: Location and study area in the Itapeva Lagoon, northern coastal of the Rio Grande do Sul, Brazil.

The Lagoon has an extended shape, 32 km in the SW-NE direction and an average width of approximately 2,5 km at the NE portion and 5,5 km at the SW part (Tomazelli, 1990; Cardoso, 2001). The effective "fetch" is over 12 km in the NE-SW direction. Lopardo (2002) points out differences in the circulation of water of the lacustrine body, dividing it into three regions: North, Center and South. According to variations in the direction of "fetch", the northern region becomes an independent compartment, from the course of the streams of central and south regions, allowing for specific studies in these regions of the Lagoon (Lopardo, 2002).

According to Tomazelli (1990), Três Forquilhas River forms a fluvial-lacustrine delta in a rectilineal way, thus forming small islands and channels, extending for 5 km inside the Lagoon. Average monthly outflows of the river vary between 3.9 and 6.3 m^3/s. However average discharges at the river estuary correspond to about 8.2 m^3/s (Machado, 2000).

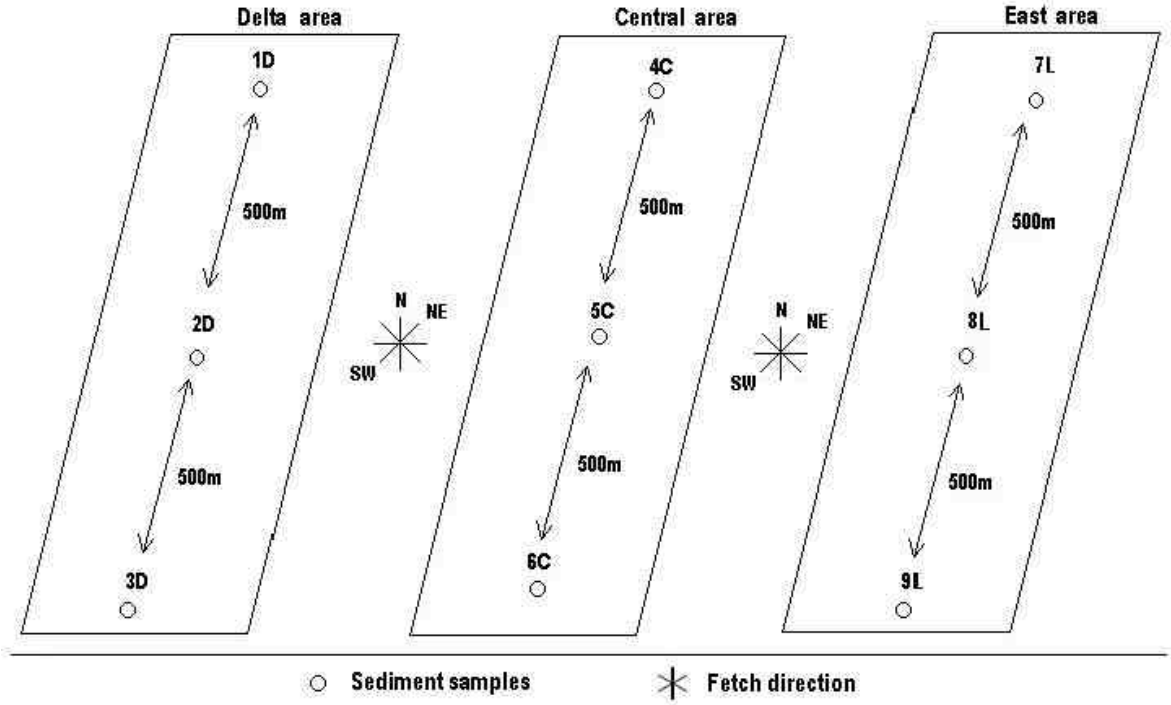

Figure 2: Samples strategy of the three areas in the Itapeva Lagoon, northern coastal of the Rio Grande do Sul, Brazil.

Material and methods

Samples strategy included the selection of three areas of Itapeva Lagoon, next to the delta region. The three areas were lined up in the W-E direction, approximately 2 Km under Três Forquilhas River. In each area three sample units have been spread covering an extension of 1Km, 500 m equidistant between themselves, in the direction of NE-SW fetch (Figs. 1 and 2). At the west margin three sites were sampled 1D, 2D and 3D (W 50°00 00 and S 29°33' 47"); in a central area, 4C, 5C and 6C (W 49°58' 32" and S 29°33' 47") and at the east margin, 7L, 8L and 9L (W 49°41' 31" and S 29°33' 47"). Field collects took place in summer and winter of 2000, and summer of 2001.

Sediment has been collected by a bottom sampler Ekman-Birge, with an area of 225 cm^2. Three replicates have been made in each sample units for the purpose of quantitative analysis of macroinvertebrate community. With "mud-snapper" have been collected samplers for granulometry and organic matter analysis. Water samples were collected at sampling units 2D, 5C and 8L, through a horizontal Van Dorn bottle. Depth (m), transparency (cm), temperature (°C), dissolved (mg/L) and saturated (%) oxygen, conductivity (mS/cm) and hydrogenionic potential (pH) have been measured.

Sediment samples were processed at the CECO – Centro de Geologia Costeira e Oceânica (Coastal and Oceanic Geology Center) of the Geosciences Institute of Universidade Federal do Rio Grande do Sul - UFRGS. Sediments have been classified according to the granulometric scale of Wentworth (1932), and the building of curves of accumulated frequency have been made with the aid of the PARCOM program of UFRGS/CECO. Data interpretation has been made applying Folk & Ward (1957) and Passega (1964) methods. Folk & Ward's methods (1957) include the calculation of selection degree (Ti), which indicate both the tendency of grain sizes to spread over the sedimentary bottom or to granulometric homogeneity. Asymmetry (Ski) and Kurtosis (KG) verify the amount of fines subject to selection by different types of bottom streams and waves (Machado, 2000). Passega's classification deals with the characteristics of depositional agent, which are reflected on the sediments (Passega, 1964).

Monthly data of wind direction were provided by DEPREC - Departamento Estadual de Portos Rios e Canais (State Department of Ports, Rivers and Channels), at Maquiné and Imbé stations.

Quantitative samples of macrobenthos have been washed in running water in a sieve with an opening of mesh of 250 mm and were preserved in tamponated

formaldehyde at 4% for later sorting under stereomicroscope. After sorting all organisms were identified at family level. When possible some groups have been identified in tribes, genus or species; or even morphotypes by means of taxonomic keys: Saether (1970, 1972), Brinkhurst & Cook (1974), McCafferty (1981), Olivier & Roussel (1983), Ponds da Silva & Davis (1983), Ponds da Silva & Thomé (1985), Brinkhurst & Marchese (1991), Angrisanto (1995), Angrisanto & Trémouilles (1995), Bachmann (1995), Bachmann & Mazzucconi (1995), Dominguez et al. (1995), Lopretto (1995), Strixino-Trivino (1995), Trémouilles et al. (1995) and Epler (2001).

Average medium density (ind/m²) and relative abundance (%) of organisms have been calculated at family level. Richness index (S), total number of individuals (IND), diversity of Shannon-Weaver (H') and equitability (J) of Pielou (1969) were reckoned through DIVERS': for species diversity analyses, complete version Smith (1993). Statistical analyses has taking into consideration the time-space variation of diversity indexes, aiming to find out which variation factor, time or habitat, influenced the community variation, by adopting the variance analysis (ANOVA), with a£0.05 probability. Through the correlation of Spearman, the group of variables that contributed for the variation of the community has been verified, assuming that r £ 0.5 and a £ 0.05, by the STATISTICâ program 5.0 version.

Results

At the Lagoon the wind direction was predominantly northeast (NE), winds being little pronounced from quadrants west (SW) and east (SE). At Table I it can be observed that depth values were higher during the summer in 2000.

Table I: Medium values of the physical ad chemical environmental variables in the sampling areas in the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

Environmental variables	Summer 2000			Winter 2000			Sumer 2001		
	Delta	**Central**	**East**	**Delta**	**Central**	**East**	**Delta**	**Central**	**East**
Depth (m)	**1.6**	**3.6**	**1.7**	0.7	2.6	0.8	0.9	2.5	0.8
Transparency (m)	0.7	0.5	0.4	0.2	0.35	0.35	0.4	0.4	0.4
Temperature (°C)	28	26.5	26	13	12	12	28.8	28.2	28.2
Conductivity (mS/cm)	51	45	38	45.8	46	56	57.5	59.6	58.9
Saturated Oxygen (%)	87	117	126	74.7	78.1	73.4	84.2	100.1	96
Dissolved oxygen (mg/L^{1})	7.5	9.3	9.2	7.9	8.55	7.83	6.72	8.2	7.26
PH	7.8	7.5	5.9	7.85	7.87	7.22	7.54	7.92	7.56

According to the granulometric analysis, delta area is a sedimentary transition environment showing fluvial and lacustrine influences. At the central area sediment pointed out a resultant of lacustrine circulation, which are controlled both by aeolian action and bathymetric quotas. East area presented, as a resultant, deposition from a uniform suspension. It may be observed, through fine sand percentages and by the sand/(silt+clay) relationship, that areas with high hydrodynamics are east and delta areas, while central area shows low hydrodynamics. Organic matter and degree of selection values support the dynamics characteristics founded (Tab. II).

An amount of 81 samples have been analyzed in order to establish the space frame of benthic macrofauna in the study areas, where a total of 2,671 specimens have been gathered, spread in 54 taxons. Table III presents the most representative groups of macrofauna found in the habitats of Itapeva Lagoon.

At the delta area the taxa with higher relative abundance were Hidrobiidae (Heleobia charruana) (26%), Chironomidae (Polypedilum sp., Cryptochironomus sp. and Cladotanytarsus sp) (21%), Naidinae (15%), Tubificinae (13%) and Veneroida (11%). In central area the most abundant were Chironomidae (Coelotanypus sp. and Cladotanytarsus sp.) and Hidrobiidae (Heleobia charruana) both with 20%, Veneroida (17%), Chaoboridae (Chaoborus sp.) (16%), and Tubificinae (15%). East area had 59% of its community represented by Hidrobiidae assembly (Heleobia charruanae and Potamulithus ribeirensis) (Tab. IV).

Taking into consideration all three periods of sampling at Itapeva Lagoon

Table II: Variables of the sediment in the sampling areas of the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

	Environmental variables	Characteristics of the sediments		
		Delta	Central	East
AG	Coarse sand (%)	0.08	0.03	0.2
AM	Medium sand (%)	6	0	1
AF	Fine sand (%)	71	1	87
AMF	Very fine sand (%)	24	5	13
SIL	Silt (%)	0	66	0
ARG	Clay (%)	0	27	0
MO	Organic Mater (%)	3.84	11.09	0.94
Ti	Selection degree *	Moderately selected	Very poor selected	Selected well
SKi	Asymmetry *	Asymmetry very positive will be positive	Asymmetry positive	Asymmetry positive
KG	Kurtosis*	Leptokurtic for very platykurtic	Mesokurtic for platykurtic	Mesokurtic
CM	Passega's classification*	Suspension and rolling, Suspension uniform	Suspension for calm waters	Suspension uniform
RAS	Sand/(silt+clay) relationship	High hidrodynamic	Low hidrodynamic	Higth hidrodynamic

* adapted from the sample units distributed in the areas of study in the direction N – S

Table III: Composition of the macrobenthic community in the sampling areas (delta, central and east) of the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

Class	Order	Family	Subfamily	Tribe	Specie ou Morfotype
Oligochaeta	Tubificida	Naididae	Naidinae		Genus not determined
		Enchytraeidae			Genus not determined
		Tubificidae	Tubificinae		Genus not determined
Bivalve	Veneroida				Genus not determined
		Corbiculidae			Corbicula fluminea Műller, 1774
Gastropoda	Mesogastropoda	Hydrobiidae			Heleobia charruana (d'Orbigny, 1840)
					Potamulithus ribeirensis Pilsbry, 1911
		Chilinidae			Chilina fluminea parva Martens, 1868
Crustacea	Tanaidacea	Tanaidae			Sinelobus stanfordi (Richardson, 1901)
Insecta	Coleoptera	Elmidae			Gener not determined
	Diptera	Chaoboridae			Chaoborus (Chaoborus) sp1. (morfotipo)
		Chironomidae		Coelotanypodini	Coelotanypus Kieffer, 1913 sp.
				Chironomini	Polypedilum sp. Kieffer, 1913
					Cryptochironomus sp Kieffer, 1918
				Tanytarsini	Cladotanytarsus sp. Kieffer, 1921
	Ephemeroptera	Polymitarcidae	Campsurinae		Genus not determined
	Lepidoptera	Pyralidae	Nymphulinae		Genus not determined
	Trichoptera	Brachycentridae			Genus not determined

Table IV: Medium density, maximum and minimum (ind/m²) and relative abundance (%) of the benthic macrofauna (³ 1%) in the sampling areas of the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

Taxons	Delta			Central			East		
	Min./ máx.	Ind/m²	%	Min./máx.	Ind/m²	%	Min./máx.	Ind/m²	%
Naidinae	89 - 543	211	**15**	0 - 5	28	4	35 – 444	160	6
Enchytraidae	0 – 5	2	0,1	-	-	-	10 – 306	112	4
Tubificinae	40 - 267	188	**13**	15 - 281	105	**15**	128 – 331	204	8
Corbiculidae	40 – 74	56	4	15 - 69	35	5	114 – 173	135	5
Veneroida*	153 - 168	160	**11**	5 - 356	120	**17**	44 – 178	123	5
Sphaeridae	0 – 5	2	0,1	-	-	-	40 – 119	71	3
Hidrobiidae	227 - 435	364	**26**	123 - 163	137	**20**	914 – 1852	1534	**59**
Tanaidae	10 - 232	84	6	-	-	-	5 – 281	95	4
Elmidae	-	-	-	-	-	-	0 – 119	40	2
Chaoboridae	10 – 54	21	2	5 - 207	110	**16**	-	-	-
Chironomidae	119 – 509	301	**21**	89 - 188	142	**20**	69 – 163	102	4
Pyralidae	-	-	-	0 - 20	7	1	0 – 15	5	0,2
Brachycentridae	0 – 35	12	1	-	-	-	-	-	-
Others**	2 - 3	13	1	2 - 3	10	1	2 - 8	15	1
Total	**1,269–1,595**	**1,412**	**100**	**514-963**	**693**	**100**	**1,452–3,517**	**2,596**	**100**

* Juvenil Forms of the Corbiculidae and Sphaeridae; ** (£1%) Hirudínea, Hyriidae, Ancylidae, Chilinidae, Naucoridae, Ceratopogonidae, Polymitarcidae, Leptoceridae, Phryganeidae and Isotomidae

(Tab. V), more representative taxons in 2000 summer have been Hidrobiidae (H. charruana) (34%) and Polymitarcidae (18%), in 2000 winter Hidrobiidae (H. charruana) (52%) and in 2001 summer Hidrobiidae (H. charruana) (35%), Naidinae (17%) and Tubificinae (18%).

Higher values of equitability and diversity have been registered at the central area and in 2000 winter. The greatest number of individuals occurred at east area in 2000 summer and the greatest richness of families was located on east margins in 2000 summer and at delta area in 2000 winter and 2001 summer (Tab. VI).

ANOVA indicated that for values of S, IND and J' habitat has been a major factor in community. Nevertheless values of H' have varied in function of time, as shown in Table VII.

Table V: Medium density, maximum and minimum (ind/m²) and relative abundance (%) of the benthic macrofauna (³ 1%) in the sampling periods in the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

Taxons	Summer 2000			Winter 2000			Summer 2001		
	Min. – máx.	Ind/m²	%	Min. – máx.	Ind/m²	%	Min. – máx.	Ind/m²	%
Naididade	89 – 444	178	7	5 - 35	13	1	79 – 543	207	**17**
Enchytraidae	0 – 20	7	0.3	5 - 306	104	7	0 – 10	3	0.3
Tubificidae	20 – 267	147	6	15 - 331	128	8	128 – 281	222	**18**
Corbiculidae	54 – 173	99	4	15 - 119	69	5	20 – 114	58	5
Verenoida*	153 – 356	229	**10**	44 - 158	67	4	5 – 168	107	9
Sphaeridae	0 – 119	40	2	0 - 40	13	1	5 – 54	20	2
Hidrobiidae	163 – 1,852	816	**34**	123 – 1,837	797	**52**	123 - 914	421	**35**
Chilinidae	0 – 5	2	0.1	0 - 5	2	0.1	5 – 15	7	1
Tanaidae	232 – 281	171	7	5 - 10	5	0.3	0 – 10	3	0.3
Chaoboridae	10 – 207	72	3	0 - 119	40	3	5 – 54	20	2
Chironomidae	119 – 163	143	6	74 - 509	257	**17**	69 – 277	145	**12**
Polymitarcidae	5 – 1,309	438	**18**	5 - 10	5	0.3	-	0	0
Pyralidae	-	0	0	15 - 20	12	1	-	0	0
Brachycentridae	-	0	0	0 - 35	12	1	-	0	0
Others**	0 – 3	7	0.3	2 – 3	12	1	0 - 3	3	0.3
Total	**963 –4,825**	**2,392**	**100**	**514 –2,820**	**1,534**	**100**	**79–543**	**1,216**	**100**

*Juvenil forms of the Corbiculidae and Sphaeridae; ** (£1%) Hirudínea, Hyriidae, Ancylidae, Elmidae, Naucoridae, Ceratopogonidae, Leptoceridae, Phryganeidae and Isotomidae

Table VI: Values of richness indexes of family (S), total number of individuals (IND); Pielou's equitability and (J) and Shannon-Weaver diversity (H'), in each area and sampling period in the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

Area	Sumer 2000				Winter				Summer 2001				Total		
	Delta	Central	East	Total	Delta	Central	East	Total	Delta	Central	East	Total	Delta	Central	East
S	13	9	**15**	19	15	14	13	23	15	14	10	21	22	15	18
IND	293	151	681	**1,125**	232	112	578	922	344	139	297	780	869	402	1,556
J"	0.73	0.79	0.6	0.65	0.7	**0.8**	0.48	0.57	0.75	0.71	0.57	**0.68**	0.71	**0.83**	0.54
H'	1.86	1.72	1.62	1.92	1.86	**2.05**	1.22	1.8	**2.02**	1.85	1.31	**2.06**	2.19	**2.24**	1.56

Based upon the results of variance analysis it was found out that for S and IND a significant difference was pointed out between the central area (with low values for S and IND) and marginal areas. Equitability values presented a significant difference on the east area, with lower values compared to delta and central areas, as shown on Tables IV, VI and VII.

Greatest values of correlation for the total amount of individuals, refer to fine sand, deposition form (Passega's classification) and hydrodynamics degree, indicating marginal habitats. Equitability values were correlated to organic matter and to sediment selection, which indicate the central area of the Lagoon. Diversity variation was correlated to the asymmetry of granulometric category, denoting changes on the sedimentary substrate of sampling areas (Tab. VIII).

Table VII: Analysis of variance of the diversity indexes, where: QM, mean square; F, distribution of the variance and the degrees of freedom: 2 - Time (1), 2 - Hábitat (2) e 4 - Interaction (1x2) and Resídue, variance inside the groups in the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil.

Indices		Factor of variance			Residue
		Time (1)	Hábitat (2)	Interaction (1x2)	
S	QM	0.010	0.041	0.015	0.008
	F	1.153	4.866	1.782	
	p-level	0.338	**0.020**	0.177	
IND	QM	0.096	0.750	0.051	0.063
	F	1.526	11.917	0.804	
	p-level	0.244	**0.001**	0.538	
H'	QM	0.186	0.093	0.032	0.042
	F	4.455	2.222	0.759	
	p-level	**0.027**	0.137	0.566	
J'	QM	0.021	0.099	0.004	0.013
	F	1.635	7.554	0.267	
	p-level	0.223	**0.004**	0.895	

Table VIII: Spearman's Correlation (r£0.5 e p £0.05) between sediment variables (VT) and diversity indexes in the Itapeva Lagoon, northern coast of Rio Grande do Sul, Brazil (see Tab.I).

VT	S		IND		J'		H'	
	R	p-level	R	p-level	R	p-level	R	p-level
MO	-0.08	0.84	**-0.90**	**0.001**	**0.84**	**0.004**	0.63	0.066
AG	-0.08	0.84	**-0.90**	**0.001**	**-0.84**	**0.004**	0.64	0.066
AM	0.41	0.28	0.53	0.145	-0.26	0.493	0.16	0.683
AF	0.08	0.84	**0.90**	**0.001**	**-0.84**	**0.004**	-0.64	0.066
AMF	0.41	0.28	0.53	0.145	-0.26	0.493	0.16	0.683
SIL	-0.28	0.46	**-0.82**	**0.007**	0.64	0.064	0.28	0.474
ARG	-0.28	0.46	**-0.82**	**0.007**	0.64	0.064	0.28	0.474
Ti	-0.08	0.84	**-0.90**	**0.001**	**0.84**	**0.004**	0.64	0.066
Ski	0.32	0.39	-0.37	0.329	0.58	0.102	**0.79**	**0.011**
KG	0.41	0.28	0.53	0.145	-0.26	0.493	0.16	0.683
CM	0.081	0.84	**0.90**	**0.001**	**-0.84**	**0.004**	-0.64	0.066
RAS	0.281	0.464	**0.82**	**0.007**	**-0.64**	**0.064**	-0.28	0.474

Discussion

Macrobenthic community at the delta area was represented mainly by the families Hidrobiidae, Chironomidae (Polypedilum sp., Cryptochironomus sp. and Cladotanytarsus sp.), Naidinae and Tubificinae, which attained higher abundances. Naidinae in this area was more abundant than in other areas. On the central area almost the same families stood out, except for Naidinae and the presence of Chaoboridae. Chironomidae was represented by Coelotanypus and Cladotanytarsus. At the east area two species of Hidrobiidae were more abundant: Heleobia charruana and Pothamulitos ribeirensis.

Hidrobiidae occurs in the south of Brazil, Uruguay and Argentina, is widely spread in aquatic environments associated to silty substrates macrophytes, being fed with perifiton (Lanzer & Schafer, 1985; Ponds da Silva, 1983; Simões, 2002). In Itapeva Lagoon they stand for the most abundant taxon, being present on the three areas, in the three collecting periods.

Polypedilum is a cosmopolitan genus, which appears associated to silty sediments in areas that were settled by macrophytes (Oliver & Roussel, 1983; Epler, 2001). Wiedenbrug (1993) found the genus associated to macrophyte S. californicus. Rodrigues (1996) has mentioned predation of Polypedilum species by the genus Cryptochironomus sp.. This genus is known as a predator and preferring silty substrates in lotic and lentic systems (Oliver & Roussel, 1983; Epler, 2001; Santos & Henry, 2001).

Naidinae, according to Poi Neiff (1992) and Colado et al. (1999), can be found in coastal regions, and is likely to be associated to low oscillation of the water column or to vegetated substrates. Corbi & Trivinho-Strixino (2002) have confirmed the presence of Naidinae in low depths and silty substrates or associated to the presence of aquatic macrophytes.

Tubificinae was abundant in the delta area, its greater abundance, however, occurred in the central area. Some species are associated to enriched areas of organic matter and vegetated substratum, thus changing even the specific dominance of other species in the habitat (Brinkhurst & Marchese, 1989; Johnson et al., 1987; Colado et al., 1999).

Chaoboridae can dwell in areas of greater depth (Saether, 1970). Corbi & Trivinho-Strixino (2002) have confirmed its presence in a tank, in São Paulo state, more than 5m deep, in muddy-silty sediments. It has also been commented that it is the main taxa to occupy areas with predominance of organic sediments (Corbi & Trivinho-Strixino, 2002).

Coelotanypus sp. is a predator associated to macrophytes, fine sediments and organic remains (Marchese & Drago, 1992; Wiendenbrug, 1993; Oliver & Roussel, 1983; Epler, 2001). Rodrigues (1996) has found the genus in substrates of a coastal lagoon of the northern coast of Rio Grande do Sul with high levels of organic matter. Corbi & Trivinho-Strixino (2002) have registered its presence in a tank in São Paulo state, in littoral areas with silty bottom.

At Itapeva Lagoon, it can be observed that the margin were constituted of silty substrate, but with different compositions. Delta area presents a hydrodynamics directly influenced by the fluvial flow and by the load transported by Três Forquilhas River, through the channels of delta formation and by the production of waves formed by winds predominant in the region. This area is both under fluvial and lacustrine influence, what may add a greater diversity of habitats. On the other hand, the east area presents a greater granulometric homogeneity than the delta margin and presents a high and bi-directional hydrodynamics due to waves. Probably, the dominance of Hidrobiidae on this margin reflects its better adaptation to this kind of environment, while Naidinae, Tubificinae and Chironomidae find better conditions on the delta area.

Another characteristic that influences the habitat frame on the two marginal zones, east and west areas, are the settlements of Scirpus californicus macrophyte. This macrophyte is used to form a rizomes net that help the stabilization of sediments (Schwarzbold, 1982; Würdig et al., 1998 and Freitas, 2002).

The central area is a zone with greater depth, free from aeolian action, with high levels of organic matter. This area, near the bottom, is of low hydrodynamics, where the selection and transportation of sediment grains are subject to the influence of bottom streams. Chaoboridae, Chironomidae, Tubificinae and Hidrobiidae species seem to be well associated to textural characteristics of sediments and to the height of the water column in this region.

Through the community analysis it was observed that the richness of families and the number of individuals were significant on the marginal areas, where percentages of fine sand are high, indicating a relatively high hydrodynamics. Benthic macrofauna of delta and east areas presented different compositions, associated, to the textural composition of sediment and to the presence of macrophytes. Equitability in Spearman's analysis was strongly correlated to the organic matter, selection degree of sediments and, in a smaller degree, with silt and clay. Higher values of equitability were registered on the central area, where organic matter percentages are higher in relation to the margins areas, sediments are poorly selected and silt and clay have high percentages. Macrobenthic community was represented by deposit collectors, Tubificinae; by predators, Chaoborus (Chaoborus) sp. and Coelotanypus sp. and filters Cladotanytarsus sp. and young forms of Veneroida, all of them belonging to trophic groups typical in this type of environment. Greater diversities were registered in central and delta areas, correlated to the asymmetry. Asymmetry, in the granulometric study, reflects the progressive action caused by the removal of fines by streams. Classifications of very positive and positive asymmetry, of the study areas, indicated that these areas present a greater amount of fines, subject to the progressive selection through streams and waves (Machado, 2000).

The temporal fluctuation of the macrobenthic community must be related to seasonal variables, as temperature and the fluctuation of the height of the water column. In 2000 summer, when the lagoon presented its greater water level, it was observed the high individuals density. Variance analysis indicated that community diversity varied as a function of time.

Space variation of the community was related to the habitat frame. Variance analysis indicated habitat as the factor of greater importance to the families' richness changes, number of individuals and equitability. Beisel et al., (2000) and Bis et al. (2000) mention that sedimentary facies contribute to density increase, species richness, diversity and resources exploitation by benthic community and hydrodynamic features help in benthic organisms dispersion. Habitats characterization of study areas of Itapeva Lagoon points out to aeolian action and fluvial discharge in the system as main hydrodynamic agents. Both force functions control textural features of bottom sediments, diversity and distribution of macrophytes banks, influencing in habitats complexity, which on their side may determine settling frame, distribution and strategies of macrobenthos community.

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