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UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
INSTITUTO DE BIOCIÊNCIAS
DEPARTAMENTO DE ECOLOGIA

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Variações da Riqueza, Diversidade e Abundância do Zooplâncton (Cladocera, Copepoda e Rotifera) do Delta do Jacuí, RS, Brasil, em resposta ao nível fluviométrico

Marcelo Gules Borges

Trabalho de conclusão apresentado ao Instituto de Biociências da Universidade Federal do Rio Grande do Sul como parte dos requisitos necessários para conclusão de curso de Bacharel em Ciências Biológicas – ênfase Ambiental.

Orientador: Dra. Catarina da Silva Pedrozo

Porto Alegre, Dezembro de 2006

Ao amor de minha Mãe e meu Pai...

A Daisy por colorir minha vida...

APRESENTAÇÃO

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Zooplankton (Cladocera, Copepoda and Rotifera) Richness, Diversity and Abundance variation in the Jacuí Delta, RS, Brazil, in response to the Fluviometric Level

Marcelo Gules Borges[1] & Catarina da Silva Pedrozo[2]

[1,2] Departamento de Ecologia, Instituto de Biociências, Universidade Federal do Rio Grande do Sul - Av. Bento Gonçalves, 9500. Prédio 43422, CEP 91540-000, Porto Alegre, RS, Brasil.

[1]marcelogulesborges@gmail.com

[2]catarina@ufrgs.br

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ABSTRACT

Surface zooplankton samples were taken at 14 sampling stations (4 stations at the mouth of the river, six stations in the river channels, and four stations in the deltaic lakes) in the Jacuí River Delta, during the winter/2005 (maximum fluviometric level) and summer/2006 (minimum fluviometric level) aiming to investigate richness, diversity and abundance variation. The abiotic variables analyzed were: fluviometric level, water temperature, Secchi transparence and chlorophyll a. The ANOVA results showed that richness and Shannon diversity index were higher at the maximum fluviometric level influenced by the species associated to the environment, species loading, and by probable competition reduction. Highest densities were observed in both periods at different places. Both highest reproduction rates and highest faunal input from delta tributaries occurred during the minimum fluviometric level at the mouths and in the channels of the rivers, related to the abiotic variables, and at the maximum fluviometric level in the deltaic lakes, associated to the fluviometrical level effect, lentic characteristics and high density of the macrophytes' bed.

Key-words: Zooplankton, Jacuí Delta, fluviometric level, richness, diversity

Variações da Riqueza, Diversidade e Abundância do Zooplâncton (Cladocer, Copepoda e Rotifera) do Delta do Jacuí, RS, Brasil, em resposta ao nível fluviométrico

Amostras superficiais de zooplâncton foram coletadas em 14 unidades amostrais (4 Foz, 6 Canais e 4 Sacos) no Delta do Jacuí, nos períodos de inverno/2005 (máximo fluviométrico) e verão/2006 (mínimo fluviométrico) com o objetivo de investigar a variação da riqueza, diversidade e abundância. As variáveis abióticas analisadas foram: nível fluviométrico, temperatura da água, transparência Secchi e clorofila a. O resultado da ANOVA mostrou que os valores de riqueza e diversidade de Shannon foram maiores no máximo fluviométrico influenciadas pelo carreamento de espécies de ambientes associados e pela provável diminuição da competição. Foram observadas maiores densidades nos dois períodos distintos e em ambientes diferentes. Ocorreu maior taxa de reprodução e aporte da fauna dos rios formadores do delta no mínimo fluviométrico na foz e no canal, relacionadas às variáveis abióticas e no máximo fluviométrico no saco, associadas ao efeito do nível fluviométrico, características lênticas e maior densidade do banco de macrófitas.

Palavras-chave: Zooplâncton, delta do Jacuí, nível fluviométrico, riqueza, diversidade

INTRODUCTION

Deltas are formed in lacustrine and marine marginal environments, both acting as level of base for deposition of sediments. They specifically occur in areas associated to the estuary and are called deltaic facies. The main factor for delta construction is the great amount of sedimentary supply brought by water channels and from river banks (Medeiros et al., 1971). These areas are characterized by presenting extensive floodplain areas.

Floodplains are humid areas characterized by the fluctuation of the water level and the oscillation between the terrestrial and aquatic phases (Junk et al., 1989; Junk & Silva, 1995). The majority of the rivers of great or average transport presents overflowing adjacent areas that, in set with the main channel, constitute the so-called floodplain rivers (Junk et al., 1989). These systems constitute a complex hydro system with the formation of islands, secondary channels and lagoons, in permanent change due the continuous processes of erosion and sedimentation. Transversal interactions and lateral gradients between main channel and adjacent floodplain are predominant in the system being more important that longitudinal variations. Another characteristic of these rivers is their dependence in relation to the floodplain, the maximum ecological diversity and the productivity that are associated to the maximum aquatic limit, that is, the ecotone (Sendacz & Junior, 2003).

In these systems, the alterations of the flooding pulses determine variations of the physical, chemical and biological characteristics that in turn influence the structure and dynamics of the aquatic communities. The horizontal movement of the water and "transversal line" to the course of the river has greater importance because hydrometric differences of few centimeters determine that surfaces of hundreds of kilometers are flooded or droughts. These horizontal flows between the mentioned sub-systems (channel – islands – lateral plain), condition the productivity of the vegetal assemblies and associated processes (Neiff, 1990; 2003).

Thomaz et al. (1997) suggested that the distint occurrence of aquatic and transactional habitats of these systems propitiates the maintenance of a considerable biodiversity. This fact associated with the fragility of the river-floodplain systems, highlights the importance of research and preservation of these systems.

In these ecosystems, the zooplankton community plays an important role in the organization of the communities, since it represents the link of material and energy transfer in the food web. Thus, alterations on its structure and dynamics are phenomena of great relevance not only for the proper community as well as for the metabolism of the entire ecosystem (Thomaz et al., 1997).

The Tropical and sub-tropical part of South America is dominated by large river systems, which are followed by extensive floodplains (Junk & Silva, 1995). In the southern region of Brazil, floodplains are important ecosystems; however, studies on the behavior of the aquatic communities in these environments have been carried out mainly in the Paraná state. Few studies have been conducted in Rio Grande do Sul state, from which it is worth mentioning studies on the phytoplankton community, by Torgan et al. (1979; 2001), Rosa et al. (1988), Carvalho (1999), and Fortes et al. (2003); golden mussel (*Limnoperna fortunei*) by Mansur et al. (2003); porifera by Tavares et al. (2003); macroinvertebrates by Sternet et al. (2003); macrophytes by Maltichik et al. (2004); euglenophyta by Alvez-da-Silva & Bridi (2004); and, zooplankton by Silveira & Azevedo (2001), and Pedrozo & Borges (2004; 2005).

The present study investigated the richness, diversity and abundance variation of the zooplankton community in three different environments (river mouths, river channels and deltaic lakes) in the Jacuí Delta floodplain in response to the fluviometric level.

MATERIAL AND METHODS

STUDY AREA

This study was conducted in different environments (river mouths, river channels and deltaic lakes) in the Jacuí Delta floodplain, Jacuí Delta State Park (29°53'/30°03' latitude and 51°28'/51°13' longitude), which is located in the eastern-center part of Rio Grande do Sul state, Brazil (Figure 1). The Jacuí Delta is formed by the confluence of Jacuí, Caí, Sinos and Gravataí river mouths, originating a 30-island archipelago which is constituted by channels and deltaic lakes areas.

The considered ecosystem is of interior delta, in as much as the formation of sedimentary islands did not occur directly in the limit with the ocean, but in the headboard of Lago Guaíba (Tavares et al. , 2003). Alternating periods of drought and flooding and the waters drained for its forming rivers are derived from basins with raised urbanization and industrialization. The set of lands, direct or indirectly drained for these rivers, represent 44% of the surface of the State of Rio Grande Do Sul (Faria & Lersch, 2001).

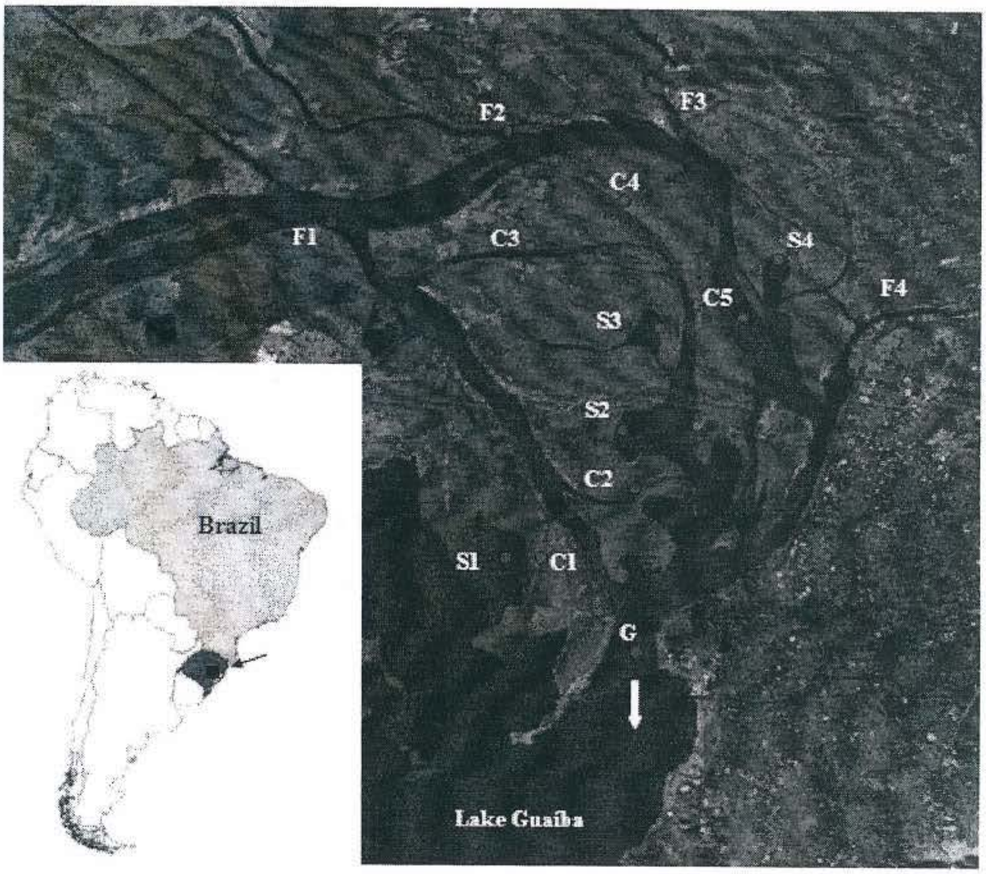

Figure 1. Map of the study area. F1 = Jacuí Mouth; F2 = Caí Mouth; F3 = Sinos Mouth; F4 = Gravataí Mouth; C1 = Pintada Channel; C2 = Maria Conga Channel; C3 = Formoso Channel; C4 = Lage Channel, C5 = Garças Channel; S1 = Santa Cruz Deltaic lake; S2 = Alemôa Deltaic lake; S3 = Quilombo Deltaic lake; S4 = Garças Deltaic lake; and G = Gasômetro. (Scale 1:25.000), (Miranda & Coutinho, 2006).

METHOD

Surface zooplankton samples were collected in the littoral zone of each environment during the winter 2005 and summer 2006. Samples were collected with a pump, and for each station 450 L of water was collected and passed through a plankton net with 68 μm of aperture. Samples were fixed with formalin 4% and buffered with borax 1%.

Qualitative and quantitative analyses of the organisms were performed using a Sedgewick-Rafter counting chamber and a dissecting microscope. Abundance was estimated by counting at least 200 individuals per sample (ind/m3) according to Rossa, et al, 2001. Species were identified following Koste (1978), Reid (1985), Montú (1986), Segers (1995) and ElMoor-Loureiro (1997).

Water temperature (°C) was measured with a mercury thermometer and Secchi transparence (m) with a Secchi disk. Chlorophyll *a* analysis was performed following Jespersen & Christoffersen (1987) and Marker *et. al.*, (1980) at the Limnology Laboratory, Ecology Department of the Rio Grande do Sul State Federal University.

Fluviometrics levels of the Jacuí Delta forming rivers used on this work correspond to the month averages from April, 2005 to April, 2006. Data were obtained at the Mineral Resource Research Company (CPRM/RS).

Shannon-Wiener (H') diversity index was calculated. Analysis of Variance (ANOVA 2-way) was used to analyze richness, diversity, and abundance of organisms in the different environments and time periods. Differences were considered significant when $\alpha < 0.05$. Density data was log (x+1) transformed before statistical analyses were performed. .

Principal Components Analysis (PCA) was executed with the abiotic variables to verify the existence of time and space variation among sample units. Statistical analyses were conducted using *R Development Core Team* (2005) pack.

RESULTS

Fluviometrics level

Monthly averages of the fluviometric level of the rivers that form the Delta of the Jacuí are presented in Figure 2. The arrows indicate the dates of collection and the respective maximum and minimum levels. Summer presented the lowest fluviometric level, while winter, had the highest.

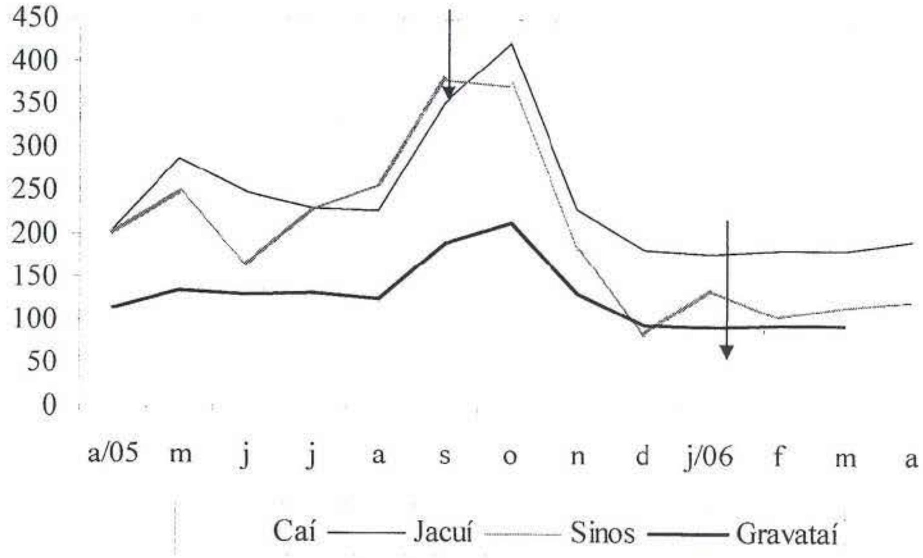

Figure 2. Monthly averages of the fluviometric level (cm) (from April, 2005 to April, 2006) of the Jacuí Delta forming rivers. Arrows indicate sampling dates and respective maximum and minimum fluviometric level.

Limnological variables

Table I shows results of limnological variables in the different environments. During summer (minimum fluviometric level) both environments showed high temperature, transparence and chlorophyll *a* values. Spatially higher transparency and chlorophyll *a* values occurred in the mouths and channels during summer and winter (minimum and maximum fluviometric levels, respectively).

PCA results (Figure 3) showed that the first two axes explained 72.83% of data variability. The first axis explains 47.56% and was positively affected by temperature (r = 0.77), transparency (r = 0.77) and chlorophyll *a* (r = 0.26). These results indicate that the first axis reflected data variation in response to the fluviometric level.

Table I. Environmental variables during winter (maximun fluviometric level) and summer (minimum fluviometric level) in the Jacuí Delta environments: temperature (°C), Secchi transparency (cm) and chlorophyll *a* (μg/L). *Non-collected data.

	Winter			Summer		
	Temp.	**Secchi**	**Chlor. *a***	**Temp.**	**Secchi**	**Chlor. *a***
Mouth						
M1	15.0	10	3,6	28,7	100	3,6
M2	13,5	35	34,5	29,3	80	6.6
M3	14,4	30	40.3	28,3	60	20,5
M4	14.0	20	5,8	27,7	45	12.0
Channel						
C1	14.9	10	14,4	28,3	20	22.0
C2	14.9	10	24,5	30,1	55	4.4
C3	14.9	10	1,4	29,2	120	2.1
C4	14,9	15	5.8	29,0	90	0.9
C5	14,5	20	7,2	27.9	90	0.9
Deltaic Lake						
DL1	15.9	10	10.0	27,5	30	10.9
DL2	15,2	10	16,7	29,6	55	21.9
DL3	15,4	15	15,0	29,6	40	5.0
DL4	14.5	55	5.8	27.6	35	*

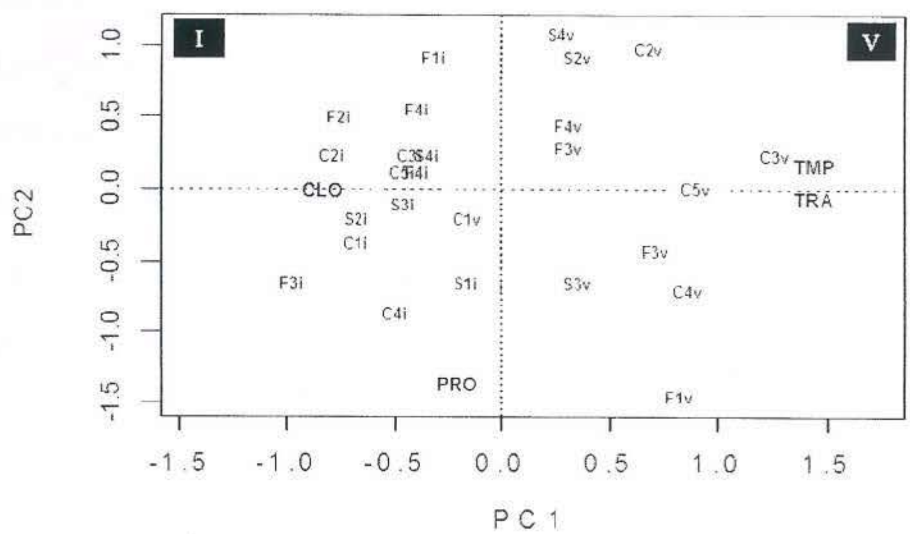

Figure 3. Principal components analysis for the environmental variables measured at the different sample units. **CLO** = chlorophyll, **TRA** = Transparency, **TMP** = Temperature, **PROF** = Depth, **i** = Max. fluviometric level, and **v** = Min. fluviometric level.

Composition, Richness and Diversity

Zooplankton community was represented by 92 species: 11 species of Cladocera, 2 species of Copepoda and 78 species of Rotifera. The most representative Cladocera families were Bosminidae (2), Chidoridae (3) and Daphinidae (3). Copepoda was represented by the families Cyclopidae (1) and Diaptomidae (1). Rotifera was represented mainly by the families Brachionidae (22), Trichocercidae (12) and Lecanidae (11) (Table II).

The most representative genera belonged to the Phylum Rotifera, which are *Trichocerca* (12 species), *Brachionus* (11 species), *Lecane* (11 species), and *Keratella* (8 species).

ANOVA results showed that species richness and diversity were significantly influenced by time, but were not influenced by the environment or by time vs. environment interaction (Figure 4, Table III). Highest richness and diversity values were observed at the maximum fluviometric levels, and species in the genera *Brachionus* and *Keratella* (in the river mouths and channels), and *Lecane* (on the deltaic lakes) were responsible for the observed high values.

Richness mean values were higher in the river mouth in both periods ($S_{winter} = 26.7$ / $S_{summer} = 19.5$), when compared to the deltaic lakes values ($S_{winter} = 24.2$ / $S_{summer} = 16.5$) and to the channels values ($S_{winter} = 23$ / $S_{summer} = 17.2$). Shannon diversity index was high in the mouth of the rivers ($H'_{winter} = 3.23$ / $H'_{summer} = 3.01$) during winter (maximun fluviometric level) and summer (minimum fluviometric level) followed by deltaic lakes ($H'_{winter} = 3.23$ / $H'_{summer} = 2.84$), and by channels ($H'_{winter} = 3.09$ / $H'_{summer} = 2.81$).

Table II. Zooplankton community composition (Cladocera, Copepoda and Rotifera) in the Jacuí Delta.

	Cladocera	
Bosminidade	**Chydoridae**	**Daphinidae**
Bosmina longirostris O.F. Müller, 1785	*Alona sp.*	*Daphnia gessneri* Herbst, 1967
Bosminopsis deitersi Richard, 1834	*Chydorus sp.*	*Daphnia sp.*
	Camptocercus australis Sars, 1896	*Ceriodaphinia silvestri* Daday, 1902
Moinidae	**Sididae**	**Ilyocryptidae**
Moina minuta Hansen, 1899	*Diaphanossoma birgei* Korineck, 1981	*Iliocroptus spinifer* Herrich, 1884
	Copepoda	
Diaptomidae	**Cyclopidae**	
Notodiaptomus incompositus Brian, 1925	*Thermocyclops sp.*	
	Rotifera	
Brachionidae	**Colurellidae**	**Asplanchnidae**
Brachionus angularis Gosse, 1851	*Lepadela sp.*	*Asplanchna sp.*
B. bidentata Anderson, 1889	*L. cf. oblonga* Ehrenberg, 1834	
B. calyciflorus Pallas, 1866	*L. patella patella* O. F. Muller, 1773	**Epiphanidae**
B. caudatus personatus Ahlstrom, 1940	*L. ovalis* O. F. Müller, 1786	*Epiphanes sp.*
B. dolabratus dolabratus Harring, 1915		
B. falcatus falcatus Zacharias, 1898	**Conochllidae**	**Euchlanidae**
B. leydigi Cohn, 1862	*Conochilus unicornis* Rousselet, 1892	*Euclanis sp.*
B. mirus Daday, 1905	*C. coenobasis* Skorokov, 1914	*E. dilatata* Ehrenberg, 1832
B. patulus patulus O. F. Muller, 1786		*E. cf. lyra lyra* Hudson, 1886
B. quadridentatus Hermann, 1783	**Gastropodiae**	*Beauchampilla eudactyla eudactyla* Gosse, 1886
Brachionus sp.	*Ascomorpha eucadis* Perty, 1850	
Kelicotia longispina Kellicott, 1879	*Gastropus sp.*	**Floscularidae**
Keratella americana Carlin, 1943	*G. minor* Rousselet, 1892	*Ptygura cf. peduncula* Edmondson, 1939
K. cochlearis Gosse, 1851		*Ptygura sp.*

Continuation Table II.

Brachionidade
K. cochleraris var. Tecta Lauterborn, 1900
K. lenzi Hauer, 1953
K. quadrata Ahlstrom, 1943
K. serrulata Ehrenberg, 1838
K. serrulata f. curvicornis Rylov, 1926
K. tropica Apstein, 1907
Platyas quadricornis Ehrb., 1832
Paracorulela cf. logina logina Myers, 1934

Lecanidae
Lecane (M) bulla Gosse, 1886
L. cornuta cornuta O. F. Muller, 1786
L. curvicornis Murray, 1913
L. elsa Hauer, 1931
L. luna O. F. Müller, 1776
L. lunaris var. constricta Ehrenberg, 1832
L. lunaris Ehrenberg, 1832
L. cf. umbricata Carlin, 1939
L. proyecta Hauer, 1956
L. quadridentata Ehrenberg, 1832
Lecane sp.

Hexarthridae
Hexarthra intermedia braziliensis Hauer, 1953

Synchaetidae
Polyarthra vulgaris Carlin, 1943
Synchaeta sp.
S. cf. oblonga Ehrb., 1831
S. pectinata Ehrenberg, 1832
Pleossoma truncatum Levander, 1894

Trichocercidae
Trichocerca bidens Lucks, 1912
T. capucina Wierzejski and Zacharias, 1893
T. cf. relicta Donner, 1950
T. elongata brasilienses Murray, 1913
T. cf. truncata Nakamura & Saigusa, 1997
T. elongata Gosse, 1886
T. Tigris O. F. Muller, 1786
T. pusila Lauterborn, 1898
T. similis grandis Hauer, 1965
T. similis Wierzejski, 1893
Trichocerca sp.
Trichotria tetractis Ehrenberg, 1830

Notommatidae
Cephalodella gibba Ehrenberg, 1832
Cephalodella sp.
Monommata sp.

Testudinellidae
Pompholyx sp.
Pompholyx complanata Gosse, 1851
Testudinela cf. truncata truncata Harring, 1913
T. parva Ternetz, 1892
Testudinella sp.

Trichotriidae
Macrochetus subquadratus Perty, 1850

Trochosphaeridae
Filinia terminalis Plate, 1886

Density

ANOVA showed the existence of interaction between environments vs. time. The highest zooplankton densities were observed in the river mouths (Mean density = 20495.4 ind/m^3, standard deviation = 6065.86 ind/m^3) and in the channels (Mean density = 16175.92 ind/m^3, Standard deviation = 12272.08 ind/m^3) during summer (minimum fluviometric level), and in deltaic lakes (Mean density = 7086.09 ind/m^3, Standard deviation = 3883.71 ind/m^3) during the winter (maximum fluviometric level) (Figure 4, Table III).

Lowest density values were observed in deltaic lakes (Mean density = 14205.67 ind/m^3, Standard deviation = 9631.65 ind/m^3) during summer (minimum fluviometric level), and in the river mouths (Mean density = 3588.81 ind/m^3, Standard deviation = 1447.95 ind/m^3) and channels (Mean density = 2483.30 ind/m^3, Standard deviation = 638.76 ind/m^3) in the winter (maximum fluviometric level).

Species that presented highest density values in the river mouths and channels during summer were *Bosminopsis deitersi* (Mean density = 3239.75 ind/m^3), Copepoda nauplii (Mean density = 4397.73 ind/m^3), *Keratella cochlearis* (Mean density = 16684.15 ind/m^3) and *Polyarthra vulgaris* (Mean density = 6982.93 ind/m^3). In the deltaic lakes during the winter these high values were related to the presence of Copepoda nauplii (Mean density = 1716.66 ind/m^3), *Keratella cochlearis* (Mean density = 311.11 ind/m^3), *Polyarthra vulgaris* (Mean density = 2919.44 ind/m^3) and *Synchaeta pectinata* (Mean density = 738.88 ind/m^3).

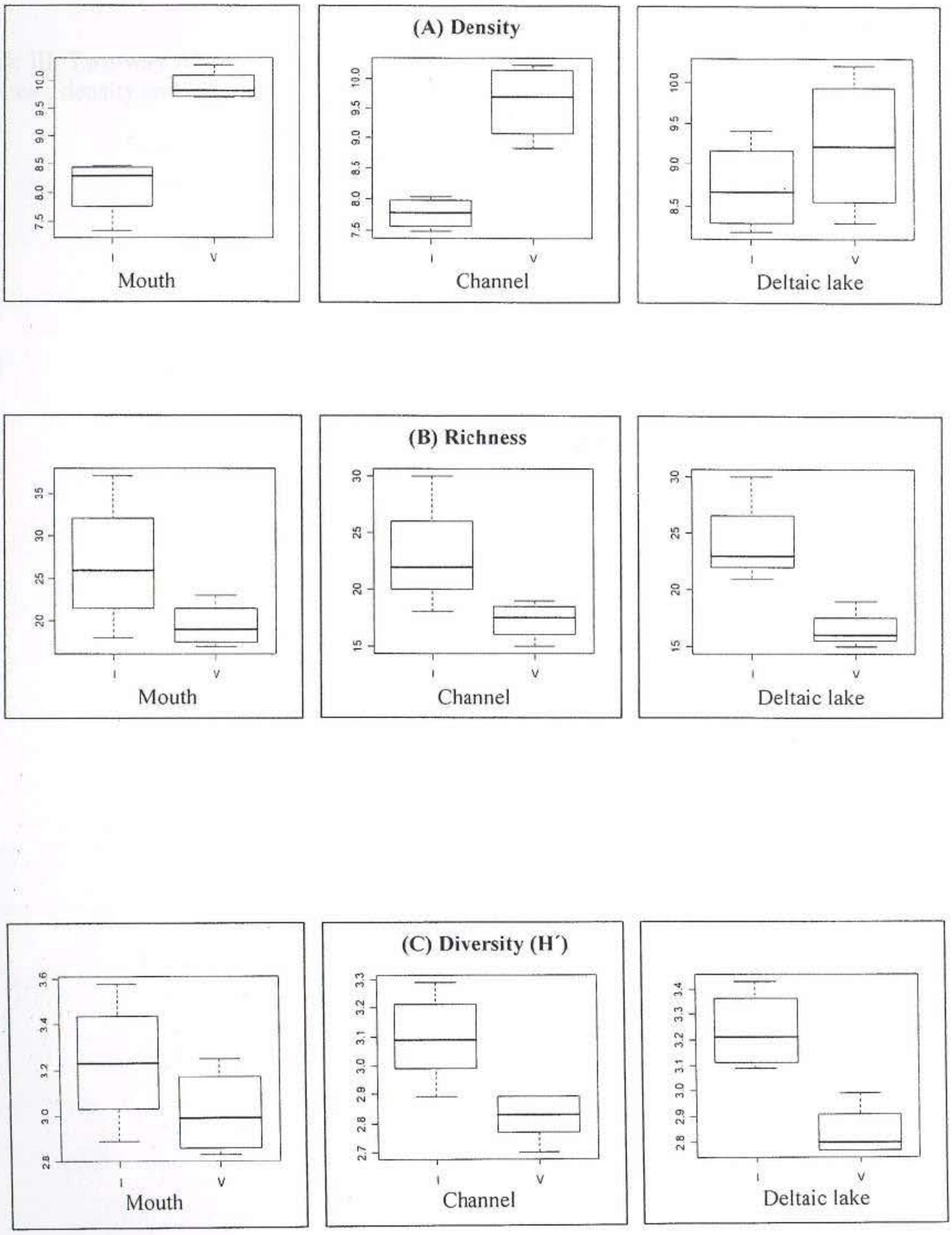

Figure 4. Zooplankton Log.Density (a), Richness (B) and Diversity (C) at the three different environments during maximum fluviometric level (I) and minimum fluviometric level (V).

Table III. Two-way ANOVA showing the results of the influence of enviromental effects on richness, density and diversity values.

Effects	df	*F*	*p*
Density			
Environment	2	0.813	0.458
Time	1	37.158	<0.01
Environment vs. Time	2	3.752	0.043
Richness			
Environment	2	1.152	0.338
Time	1	14.922	<0.01
Environment vs. Time	2	0.112	0.894
Shanon			
Environment	2	0.143	0.143
Time	1	19.143	<0.01
Environment vs. Time	2	0.552	0.584

DISCUSSION

Bosminidae, Daphinidae (Cladocera), Cyclopidae, Diaptomidae (Copepoda), Brachionidae, Trichocercidae, and Lecanidae (Rotifera) have been mentioned as common families in freshwater environments, specially in the South America´s floodplain rivers (Lansac-Toha, 1997; Aoyogui & Bonecker, 2004a). In this study, high richness values represented by the occurrence of these families were due to the presence of *Trichocerca, Brachionus* and *Keratella* (planktonic), and *Lecane* (non-planktonic). According to Hynes (1970), Espíndola *et al.* (1996) and Lansac-Toha *et al.* (1997; 2000; 2003) these genera are typically dominant in large floodplain rivers. Small organisms dominance like Rotifers in rivers' plankton are explained by fish predation on larger zooplankton organisms and by their high reproduction rate in relation to the short water residence interval.

High richness and diversity values observed in the winter (maximum fluviometric level) have also been reported in other studies (Lansac-Toha, 1997; 2000; 2003, Hoberg, 2002 and Aoyogui & Bonecker, 2004b).

Although PCA has demonstrated a temporal variation in the environmental variables, highest richness and diversity values observed in the winter (maximum fluviometric level) are probably directly associated to flood pulse effect and its consequent water and fauna homogenization among the different environments.

Flood-pulse allows species from other environments associated to the floodplain, both from the delta forming tributaries as from the Jacuí Delta itself, to reach the river bed. According to Junk et al. (1989), the occurrence of distinct aquatic and transitional habitats in these systems is what allows considerable biodiversity maintenance.Another .important factor is the dilution effect which decreases competition among species and contributes to an increase in equitability which, therefore, increases diversity.

Lampert & Sommer (1993) have pointed out space as a limiting factor, emphasizing that low densities of Cladocera in few liters of water could result in high predation rates on Rotifers.

There is a tendency of the river mouths to present high richness and diversity values both in the winter (maximum fluviometric level) as during summer (minimum fluviometric level). Higher values for chlorophyll *a* have also been observed in these environments in both periods. Rodrigues (2004) has mentioned that high phytoplankton values in the mouths of the Jacuí Delta's forming rivers are related to the fact that they present lentic environments in some areas of their basins, as dams and/or wet areas, from where eggs of most planktonic organisms are originated.

In situ observations have shown that river mouth and channel areas present lower macrophytes densities in relation to the deltaic lakes. This may non-planktonic species (e.g., *Lecane* spp.) to be carried out occurring in deltaic lakes during the winter (maximum fluviometric level), and contributing to an increase in richness and diversity values.

According to Segers (1995), the genus *Lecane* achieves its highest diversity in water bodies of littoral zones that present very low or absent water flux, such as in the tropics and subtropics, where this genus assembly may have up to 40 different species.

As stated by Green (1972), quoted by Serafim (2003) and Bonecker *et al.* (1998), high richness values in littoral zone environments occur due to the influence of river bank vegetation that supports habitats of high diversity.

High densities in river mouths and in the channels during summer (minimum fluviometric level) were especially due to contributions from *Bosminopsis deitersi*, Copepoda nauplii, *Keratella cochlearis* and *Polyarthra vulgaris*, typically planktonic species. High density values of these species have also been mentioned in other floodplain areas (Ulloa, 2004, Hynes, 1970, Lansac-Toha, 1997; 2000; 2003 and Azevedo & Bonecker, 2003).

Rossa (2001) observed that the family Bosminidae dominated the zooplanktonic community during rainy and dry seasons in river and lagoon environments in the Paraná River floodplain, Mato Grosso do Sul State. The round and small shape of the species in this family allow their survival when compared to other larger sized species. Their food preferences, combining passive filtration and active particles capture, allow them to choose the food item to be consumed (De Mott & Kerfoot, 1982).

However, *K. cochlearis* subspecies and many *Polyarthra* species are able to select food particles (Bogdan, 1980), giving them some advantage over other species. Pourriot (1997), observed in the Marne River that the growth and reproduction of *Keratella* and *Polyarthra* were not significantly different, since both species have a developmental time shorter than the water residence time. In addition, Gilbert & Bogdan (1984) characterized *Keratella* as generalists, being able to feed on a wide range of flagellate and non-flagellate cells and detritus.

These results – higher density values in river mouths and channels during summer – may be strongly associated both to higher temperature and transparency values and to higher chlorophyll *a* when compared to deltaic lakes. Chlorophyll *a* elevated values demonstrated more food availability. According to Ulloa (2004) and Frutos (1998), high densities and biomass of rotifers are directly correlated to chlorophyll *a* and temperature.

High density values have been observed at maximum fluviometric levels in other floodplain regions (Paggi, 1993; Rossa, 2001; Ulloa, 2004; Lansac-Toha, 1997;2000;2003 and Frutos, 1998). However, in those regions the maximum fluviometric level occurs during summer.

Thus, environmental variables, fluviometric level and specially temperature have important synergic effects in the increase of density values.

In this study, it could be observed that environmental variables – temperature, Secchi transparency and chlorophyll *a* – added to the characteristics of the forming river basins are more important to the increase in density in the river mouths during summer (minimum fluviometric) than the effect of fluviometric level.

High density values observed in deltaic lakes during the winter (maximum fluviometric level) suggested that both the fluviometric level effect and the hydrodynamic characteristics of the deltaic lakes are more important than the measured environmental variables for the increase in zooplankton densities. Not only deltaic lakes present more lentic characteristics (for example, low flux velocity allowing high reproduction capacity) when compared to river mouths and channels, but also present higher macrophyte densities. Affected by dilution effect, species associated to the vegetation are carried out into the deltaic lakes, contributing for numerical increase of species densities in those places.

CONCLUSION

Highest richness and diversity values in the winter (maximum fluviometric) are associated to dilution effects, to the input of species in the environment, and due to a possible decrease in competition.

High density values in the river mouths in the summer (minimum fluviometric level) are directly related to abiotic variables (temperature, transparency and chlorophyll *a*), possible high reproduction rates, and fauna input from the Jacuí Delta forming basins.

On the other hand, high densities in deltaic lakes during the winter (maximum fluviometric level) are directly associated to fluviometric effect, macrophytes bank and lentic characteristics, allowing more stability for the zooplankton community in the water column.

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