Zooplankton (Cladocera, Copepoda and Rotifera) richness, diversity and abundance variations in the Jacuí Delta, RS, Brazil, in response to the fluviometric level

Variações da riqueza, diversidade e abundância do zooplâncton (Cladocera, Copepoda e Rotifera) do Delta do Jacuí, RS, Brasil, em resposta ao nível fluviométrico

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Abstract: Aim: The richness, diversity and abundance variation of the zooplankton community of Jacuí River Delta was investigated. **Methods:** During the winter/2005 (maximum fluviometric level) and summer/2006 (minimum fluviometric level) surface zooplankton samples were taken at 14 sampling stations (4 stations at the mouth of the river, 6 stations in the river channels, and 4 stations in the deltaic lakes). The abiotic variables analyzed were: fluviometric level, water temperature, Secchi transparency and chlorophyll-*a*. **Results:** ANOVA results showed that richness and Shannon diversity index were higher at the maximum fluviometric level influenced by washout of species associated to the environment and by probable competition reduction. Highest densities were observed in both periods at different environments. **Conclusions:** 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 and were related to the abiotic variables. At the maximum fluviometric level, the values were higher in the deltaic lakes, due to the fluviometrical level effect, lentic characteristics and high density of macrophytes.

Keywords: zooplankton, Jacuí Delta, fluviometric level, richness, diversity.

Resumo: Objetivo: A variação da riqueza, diversidade e abundância da comunidade zooplanctônica do delta do rio Jacuí foi investigada. **Métodos:** Nos períodos de inverno/2005 (máximo fluviométrico) e verão/2006 (mínimo fluviométrico), amostras superficiais de zooplâncton foram coletadas em 14 unidades amostrais (4 Foz, 6 Canais e 4 Sacos). As variáveis abióticas analisadas foram: nível fluviométrico, temperatura da água, transparência Secchi e clorofila-*a*. **Resultados:** O resultado da ANOVA mostrou que os valores de riqueza e diversidade de Shannon foram maiores no período de maior nível fluviométrico, influenciados pelo carreamento de espécies de ambientes associados e pela provável diminuição da competição. Foram observadas maiores densidades nos dois períodos e em ambientes diferentes. **Conclusões:** Ocorreu maior taxa de reprodução e aporte da fauna dos rios formadores do delta no período de menor nível fluviométrico na foz e no canal, relacionados às variáveis abióticas. No período de maior nível fluviométrico os valores foram mais altos no saco, devido ao efeito do nível fluviométrico, características lênticas e maior densidade de macrófitas.

Palavras-chave: zooplâncton, Delta do Jacuí, nível fluviométrico, riqueza, diversidade.

1. 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 extensive floodplain areas.

Floodplains are humid areas subjected to water level fluctuations and to an oscillation between terrestrial and aquatic phases (Junk et al., 1989; Junk and Silva, 1995). The majority of the rivers of great or average transport present overflowing adjacent areas laterally to the main channel, and 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, showing a maximum ecological diversity and the productivity associated to the maximum aquatic limit, and this zone constitutes an ecotone (Sendacz and 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 and 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 Maltchik et al. (2004); euglenophyta by Alvez-da-Silva and Bridi (2004); and, zooplankton by Silveira and Azevedo (2001), and Pedrozo and 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.

2. Material and Methods

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' LS and 51° 28'-51° 13' LW), 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.

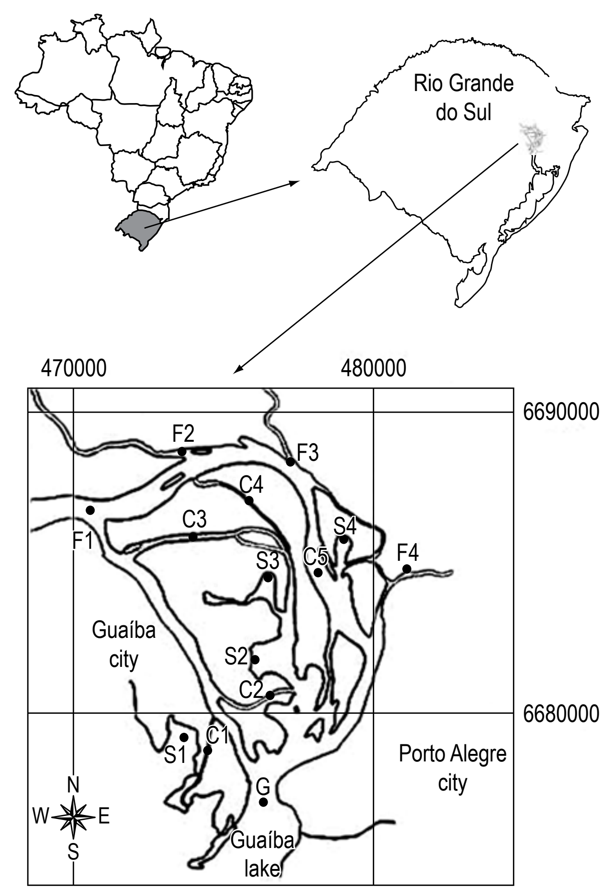

Figure 1. Map of the study area. F1 = Jacuí Mouth; F2 = Caí Mouth; F3 = Sinos Mouth; F4 = Gravataí Mouth; C1 = Pintada Channel; C2 = Maria Conga Channel; C3 = Formoso Channel; C4 = Lage Channel, C5 = Garças Channel; S1 = Santa Cruz Deltaic lake; S2 = Alemôa Deltaic lake; S3 = Quilombo Deltaic lake; S4 = Garças Deltaic lake; and G = Gasômetro. (Scale 1: 500.000).

The considered ecosystem is of interior delta shaped by the formation of sedimentary islands in the headboard of Guaíba Lake (Tavares et al., 2003). Alternating periods of drought and flooding, the waters are drained from areas with raised urbanization and industrialization and, the forming rivers are derived from basins, representing 44% of the surface of the Rio Grande do Sul State (Faria and Lersch, 2001).

Surface zooplankton samples were taken at 14 sampling stations (4 stations at the mouth of the river, 6 stations in the river channels, and 4 stations in the deltaic lakes) in the Jacuí River Delta, in the littoral zone of each environment, during the winter/2005 (a period of maximum fluviometric level) and summer/2006 (a period of minimum fluviometric level). Water samples (450 L volume) were collected with a pump at each station and were filtered in 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.m^{-3}) according to Rossa et al. (2001). Species were identified following Koste (1978), Reid (1985), Montú and Gloeden (1986), Segers (1995) and ElMoor-Loureiro (1997).

Water temperature (°C) was measured with a mercury thermometer and, transparency (m) with a Secchi disk. Chlorophyll-*a* analysis was performed following Jespersen and Christoffersen (1987) and Marker et al., (1980).

Data on fluviometrics levels (month averages from April/2005 to April/2006) of the Jacuí Delta were supplied by the Mineral Resource Research Company (CPRM - RS).

Shannon-Wiener (H') diversity index was calculated. Analysis of Variance (ANOVA and Factorial-ANOVA) was used to compare 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.

Principal Components Analysis (PCA) was made using abiotic variables (temperature, transparency and chlorophyll-*a*) to verify temporal and spatial variations among sample units. Statistical analyses were conducted using R Development Core Team (2005) pack.

3. Results

3.1. Fluviometric level

Monthly averages of the fluviometric levels are presented in Figure 2. In summer, the fluviometric level was the lowest, while winter, showed the highest.

3.2. Limnological variables

During summer (at minimum fluviometric level), both environments showed high temperature, transparence and chlorophyll-*a* values (Table 1). Higher transparency and chlorophyll-*a* values occurred in the mouths and channels during summer and winter (at minimum and maximum fluviometric levels, respectively).

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

3.3. Composition, richness and diversity

Zooplankton community (with a total of 92 species) was represented by Cladocera (11 species), Copepoda (2 species) and Rotifera (78 species). The most representative Cladocera families were Bosminidae (2 species), Chydoridae (3 species) and Daphiinidae (3 species). Copepoda was represented by the families Cyclopidae and Diaptomidae, each one with 1 species. Rotifera was represented mainly by the families Brachionidae (22 species), Trichocercidae (12 species) and Lecanidae (11species) (Table 2).

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

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 ($S_{winter} = 24.2$; $S_{summer} = 16.5$) 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 (at maximum fluviometric level) and summer (at minimum fluviometric level) followed by deltaic lakes ($H'_{winter} = 3.23$; $H'_{summer} = 2.84$), and by channels ($H'_{winter} = 3.09$; $H'_{summer} = 2.81$).

ANOVA showed that species richness and diversity were significantly influenced by time, but no by the environment (Figure 4; Table 3).

Highest richness and diversity values were observed at the maximum fluviometric levels, and *Brachionus* and *Keratella* (in the river mouths and channels), and *Lecane* species (on the deltaic lakes) predominated.

3.4. Density

The highest zooplankton densities were observed in the river mouths (Mean density = 20495.4 ± 6065.86 SD ind.m^{-3}) and in the channels (Mean density = 16175.92 ind.m^{-3} ± 12272.08 SD ind.m^{-3}) during summer (minimum fluviometric level), and in deltaic lakes (Mean density = 7086.09 ind.m^{-3} ± 3883.71 SD ind.m^{-3})

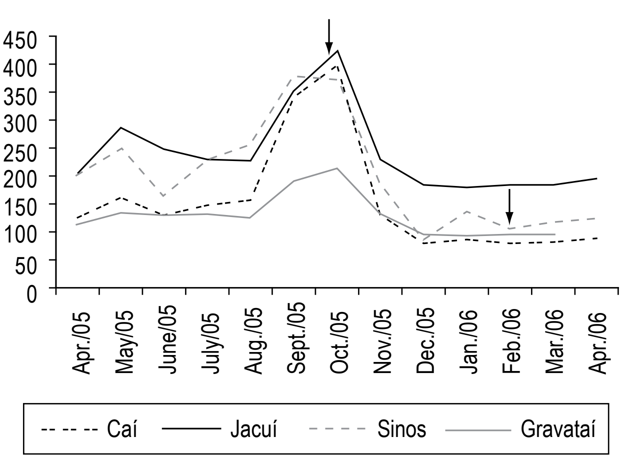

Figure 2. Monthly averages of the fluviometric level (cm) (from April/2005 to April/2006) of the Jacuí Delta forming rivers. Arrows indicate sampling dates and respective maximum and minimum fluviometric level.

Table 1. Limnological variables during winter (maximum fluviometric level) and summer (minimum fluviometric level) in the Jacuí Delta environments: Temp = temperature (°C), Secchi = Secchi transparency (cm) and Chlor.-*a* = chlorophyll-*a* (µg.L^{-1}). *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	*

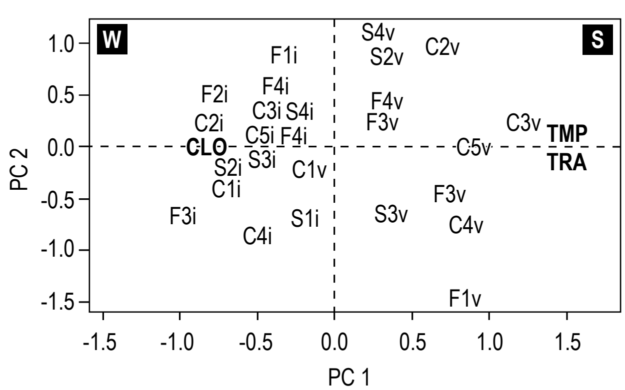

Figure 3. Principal components analysis for the limnological variables measured at the different sample units. **CLO** = chlorophyll, **TRA** = Transparency, **TMP** = Temperature, **W** = Maximum fluviometric level and **S** = Minimum fluviometric level.

during the winter (at maximum fluviometric level) (Figure 4; Table 3).

Lowest density values were observed in deltaic lakes (Mean density = 14205.67 ± 9631.65 SD ind.m^{-3}) during summer (at minimum fluviometric level), and in the river mouths (Mean density = 3588.81 ± 1447.95 SD ind.m^{-3}) and channels (Mean density = 2483.30 ± 638.76 SD ind.m^{-3}) in the winter (at 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}), *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, high densities 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}).

Factorial-ANOVA showed the existence of interaction between environments vs. time (Table 3).

4. Discussion

Bosminidae, Daphinidae (Cladocera), Cyclopidae, Diaptomidae (Copepoda), Brachionidae, Trichocercidae, and Lecanidae (Rotifera) have been mentioned as common families in freshwater environments, especially in the South America´s floodplain rivers (Lansac-Toha, 1997; Aoyogui and 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). These genera are typically dominant in large floodplain rivers. Small organism's dominance as Rotifers in rivers' plankton is explained by fish predation on larger zooplankton organisms and by their high reproduction rate in relation to the short water residence time (Hynes, 1970; Espíndola et al., 1996; Lansac-Tôha et al., 1997; 2000; 2003).

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

Although PCA has demonstrated a temporal variation in the environmental variables, highest richness and diversity values observed in the winter (at maximum fluviometric

Table 2. 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	*Ilyocryptus spinifer* Herrich, 1884
	Copepoda	
Diaptomidae	**Cyclopidae**	
Notodiaptomus incompositus Brian, 1925	*Thermocyclops* sp.	
	Rotifera	
Brachionidae	**Lepadellidae**	**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	
Kellicottia 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.
Brachionidade	**Hexarthridae**	**Notommatidae**
K. cochleraris var *tecta* Lauterborn,1900	*Hexarthra intermedia braziliensis* Hauer, 1953	*Cephalodella gibba* Ehrenberg, 1832
K. lenzi Hauer, 1953		*Cephalodella* sp.
K. cf. *quadrata* Ahlstrom, 1943	**Synchaetidae**	*Monommata* sp.
K. cf. *serrulata* Ehrenberg, 1838	*Polyarthra vulgaris* Carlin, 1943	
K. serrulata f. curvicornis Rylov, 1926	*Synchaeta* sp.	**Testudinellidae**
K. tropica Apstein, 1907	*S.* cf. *oblonga* Ehrb., 1831	*Pompholyx* sp.
Platyas quadricornis Ehrb., 1832	*S. pectinata* Ehrenberg, 1832	*Pompholyx complanata* Gosse, 1851
Paracorulela cf. *logina logina* Myers, 1934	*Pleossoma truncatum* Levander, 1894	*Testudinela* cf. *truncata truncata* Harring, 1913
		T. parva Ternetz, 1892
Lecanidae	**Trichocercidae**	*Testudinella* sp.
Lecane bulla Gosse, 1886	*Trichocerca bidens* Lucks, 1912	
L. cornuta cornuta O. F. Muller, 1786	*T. capucina* Wierzejski and Zacharias, 1893	
L. curvicornis Murray, 1913	*T.* cf. *relicta* Donner, 1950	**Trichotriidae**
L. elsa Hauer, 1931	*T. elongata brasilienses* Murray, 1913	*Macrochetus subquadratus* Perty, 1850
L. luna O. F. Müller, 1776	*T.* cf. *truncata* Nakamura and Saigusa, 1997	
L. lunaris var. *constricta* Ehrenberg, 1832	*T. elongata* Gosse, 1886	**Filiniidae**
L. lunaris Ehrenberg, 1832	*T. tigris* O. F. Muller, 1786	*Filinia terminalis* Plate, 1886
L. cf. *umbricata* Carlin, 1939	*T. pusila* Lauterborn, 1898	
L. proiecta Hauer, 1956	*T. similis grandis* Hauer, 1965	**Trichotriidae**
L. quadridentata Ehrenberg, 1832	*T. similis* Wierzejski, 1893	*Trichotria tetractis* Ehrenberg, 1830
Lecane sp.	*Trichocerca* sp.	

level) are directly associated to flood pulse effect and consequent fauna homogenization among the different environments (Thomaz et al., 2007). 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. The occurrence of distinct aquatic and transitional habitats in these systems allows considerable biodiversity maintenance (Junk et al., 1989).

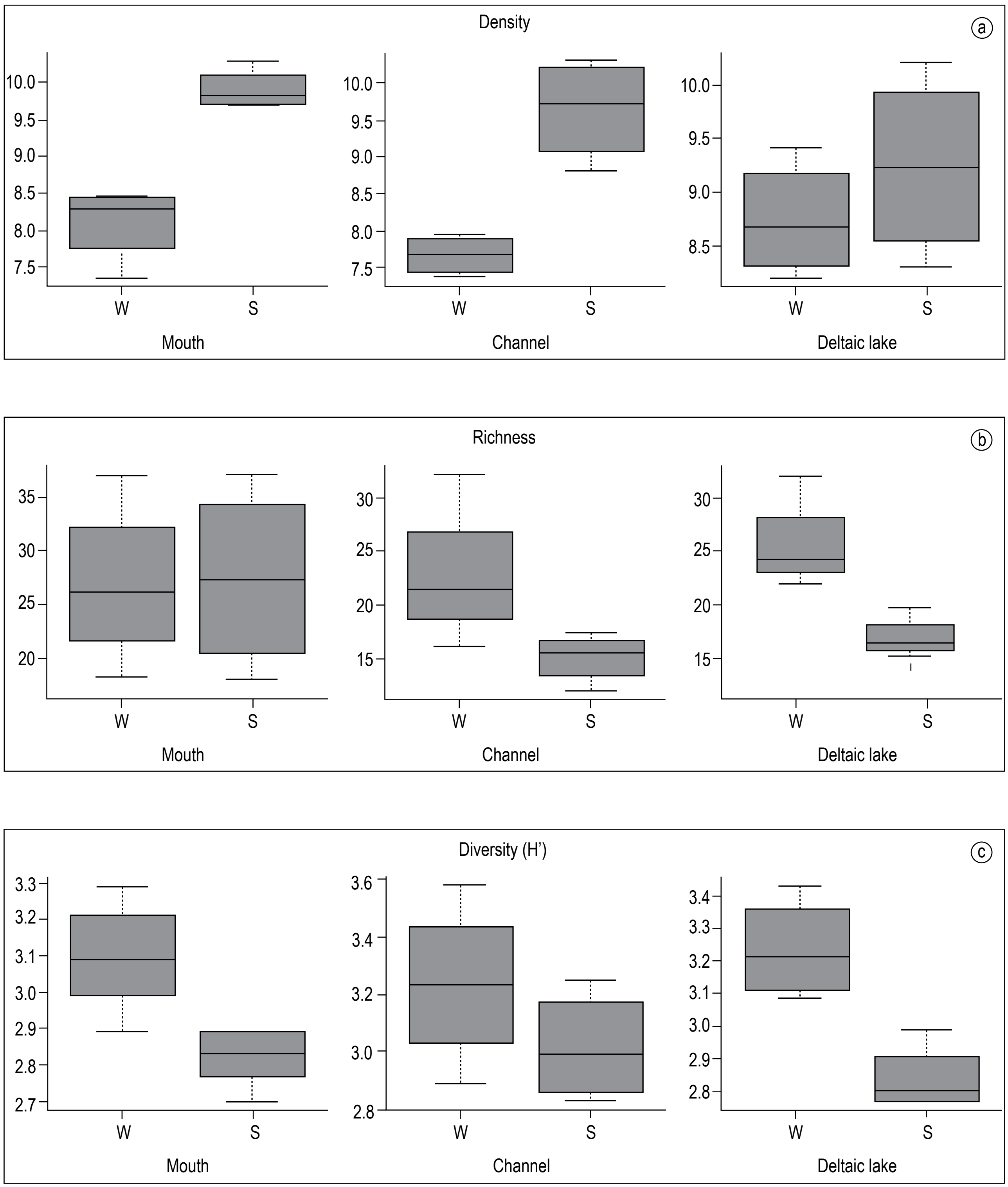

Figure 4. Zooplankton density (log) a) richness b) and diversity c) at the three different environments during maximum fluviometric level (W) and minimum fluviometric level (S).

Table 3. ANOVA and Factorial-ANOVA showing the results of the influence of the type of the environment and the time on richness, density and diversity values.

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

According to Thomaz, et al. (2007), increase in river water level enhances the connection between the river and the floodplain aquatic habitats as well as among floodplain habitats. Increase in the connectivity enhances the exchange of water, sediments, minerals and organisms among the different habitats in the floodplain. Another important factor is the dilution effect which decreases competition among species and contributes to an increase in equitability which, therefore, increases diversity (Lampert and Sommer, 1996).

There is a tendency of the river mouths to present high richness and diversity values both in the winter (at maximum fluviometric level) as during the summer (at minimum fluviometric level). According to Rodrigues (2004), high phytoplankton values in the mouths of the Jacuí Delta's forming rivers are related to the presence of lentic environments in some of these rivers, as dams and/or wetland areas where eggs of most planktonic organisms are originated. Despite these considerations, Thomaz et al. (2007) emphasize that even if the highest diversity is reached at intermediate levels of disturbance, intensive floods (which promotes high connectivity) are important for exchange of propagules, nutrients, and organisms among habitats.

In situ observations have shown that river mouth and channel areas present lower macrophytes densities in relation to the deltaic lakes. This may allow 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* presents its highest richness 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), high richness values in littoral zone environments occur due to the influence of river bank vegetation.

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

Rossa et al. (2001) observed that the 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 species in this family increases their survivorship when compared to other larger sized species. According to Zaret (1975), in tropical environments, the composition community zooplankton depends of predators. In general, the biggest individuals of zooplankton that have more pigments in the body and are more easily seen by predators.

However, *K. cochlearis* subspecies and many *Polyarthra* species are able to select food particles (Bogdan et al., 1980), being a competitive advantage over other species. In addition, Gilbert and 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. Elevated chlorophyll-*a* values are indexes of high food availability and according to Ulloa (2004) and Frutos (1998), high densities and biomass of rotifers are directly correlated to chlorophyll-*a* and temperature.

High density values of zooplankton have been observed at maximum fluviometric levels in other floodplain regions (Paggi, 1993; Rossa, 2001; Ulloa, 2004; Lansac-Toha, 1997; 2000; 2003; Frutos, 1998). However, in those regions the maximum fluviometric level occurs during summer. Thus, environmental variables, fluviometric level and especially temperature have important synergic effects in the increase of density values.

High density values observed in deltaic lakes during the winter (at maximum fluviometric level) suggested that both the dilution 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 sites.

5. Conclusion

Highest richness and diversity values in the winter (at maximum fluviometric level) 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*), 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.

Acknowledgements

We would like to thank Dr. Albano Schwarzbold, Dr. Maria Teresa Raya-Rodrigues, Dr. Laura Utz and MSc. Andre Frainer Barbosa for help in writing and translating this paper.

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Received: 02 October 2008
Accepted: 13 March 2009