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Abundance of planktonic and non-planktonic rotifers in lagoons of the Upper Paraná River floodplain

by

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Abstract

The aim of this study was to analyse the planktonic and non-planktonic rotifers density in the pelagic region of several lagoons on the floodplain of the Upper Paraná River, during two distinct hydrological periods. In the dry period the total density of planktonic species was greater than the density of the non-planktonic species. The difference was significant. On the other hand, in the flood period the non planktonic species were more abundant, but the difference was not significant. Planktonic species contributed with 87.46 % in the abundance in the lagoons associated to Ivinheima river and 90.65 % in the Baía river lagoons. During the flood period non-planktonic species contributed with 61.68 % of the total density in the Ivinheima River lagoons and 66.39 % in the Baía river lagoons. ANOVA shows a significant relationship between the type of river (with more sediments suspended or not), the hydrological period and the variation of total density of planktonic and non-planktonic species. Based on these result was possible to verify the effect of changes in water level and the peculiar characteristics of the lagoons on the structure and dynamics of the planktonic and non-planktonic rotifers.
Keywords: **Rotifera, density fluctuation, lagoons, Brazil.**

Resumo

O objetivo deste trabalho foi analisar a contribuição de rotíferos planctônicos e não planctônicos em termos de densidade, na região pelágica de várias lagoas da planície de inundação do alto rio Paraná, durante dois períodos hidrológicos distintos. No período de seca a densidade total das espécies planctônicas foi maior em relação à das não planctônicas, sendo a diferença significativa. Entretanto na fase de cheia, as espécies não planctônicas foram mais abundantes; nessa fase não foi observada diferença significativa. Na seca, as espécies planctônicas contribuíram com 87.46 % da abundância total nas lagoas do rio Ivinheima e 90.65 % no rio Baía. Já na cheia, as espécies não planctônicas contribuíram com 61.68 % da abundância total no rio Ivinheima e 66.39 % no rio Baía. Os resultados da ANOVA mostraram a relação significativa entre o tipo de rio (com maior ou menor carga de sedimento em suspensão), o período hidrológico e a variação da densidade total das espécies planctônicas e não planctônicas. A partir desses resultados foi possível verificar a influência da elevação do nível da água, e das características particulares de cada lagoa sobre a estrutura e dinâmica dos rotíferos planctônicos e não planctônicos.

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Introduction

The flooding of floodplains causes alterations in the dynamics of the biota which responds developing numerous adaptations as for example the increase in growth rate and the capacity to colonise new habitats producing a dynamic and structure of the community characteristic of these environments (JUNK et al. 1989; NEIFF 1990). These changes were observed by ROBERTSON & HARDY (1984), BOZELLI (1992), PAGGI & JOSÉ DE PAGGI (1990), LANSAC-TÔHA et al. (1997) for rotifer assemblages, lending evidence to the increase in populations size of these organisms in situations of high water levels, due the contribution of planktonic and non planktonic species. The occurrence of these species in the plankton is related to the movement of masses of water in the environment particularly during the flood period on account of the greater current and the exchange of organisms coming from environments that were isolated during the dry period (BONECKER et al. 1998).

In this sense the aim of this study was to evaluate the contribution of planktonic and non-planktonic species in the rotifer assemblage of the pelagic zone of lagoons in the upper Paraná river floodplain during two distinct hydrological periods analysing the hypothesis that the greater contribution of the non-planktonic species occurs during the flood period due to the flooding which promotes the homogenization of the littoral and pelagic compartments.

Study area

The Ivinheima river differs from the Baía river in several ways but particularly with respect to a greater current velocity. In the Ivinheima basin eight lagoons were studied. Seven have a permanent connection with the river via a channel: Pintado, Peroba, Joaninho, Boca do Ipoitã, Patos, Finado Raimundo and Escondida lagoons. The last, Sumida lagoon, is connected to Escondida lagoon (Fig. 1).

The Baía river has a slow current characteristic of floodplain rivers and its waters are rich in humic compounds (THOMAZ et al. 1997). All the lagoons studied in this river basin (Guaraná, Carão, Boca Aberta, Pousada das Garças, Maria Luíza, Esperança, Gavião and Onça lagoons) have a permanent connection with the river via a channel. Both the Baía and the Ivinheima rivers are subjected to the flood regime of the Paraná basin which, in turn, is influenced by the numerous dams further upriver.

All the lagoons are shallow and have mutispecific macrophyte stands the majority dominated by *Eichhornia azurea*, *Salvinia* spp., *Polygonum* spp. and Cyperaceae. The Ivinheima lagoons are protected by riparian vegetation and have an area that varied between 2.3 ha (Boca do Ipoitã lagoon) and 113.8 ha (Patos lagoon). The Baía river lagoons are inserted in a floodplain field and the areas vary between 3.8 ha (Pousada das Garças lagoon) and 27.2 ha (Onça lagoon).

Material and methods

Rotifers samples were collected at the surface of the pelagic region in 16 lagoons in two periods of the hydrological cycle; flood period (February, 1999) and the dry period (October, 1999) using an electric pump and a 70 µm plankton net. 600 liters of water were filtered per sample. The samples were fixed with buffered 4 % formalin

These hydrological periods were characterised by the differences in the mean depth in each lagoon (Fig. 2).

The abundance was determined using a SEDGEWICK-RAFTER counting cell and an optical stereoscope. A minimum of 80 individuals were counted in subsamples taken with a HENSEN-STEMPEL

(BOTTRELL et al. 1976). Three subsamples were counted and the results were expressed by ind/m^3.

The identification of the taxons was based on KOSTE (1978), KOSTE & ROBERTSON (1983), JOSÉ DE PAGGI (1989), SEGERS (1995) and SMET (1996, 1997). The classification of the taxons into planktonic and non-planktonic was according BONECKER et al. (1998).

The differences in the contributions of planktonic and non-planktonic species in the total of density in each hydrological period were analysed using the t-test for dependent samples (SOKAL & ROHLF 1991) which were considered significant when $p < 0,05$. The Analyse of Variance was used to verify the influence of independent factors (hydrological period and type of river) in the density of the planktonic and non planktonic species. The densities values were previously log (x) transformed. These analysis were performed using Statistica™ software (STATSOFT 1996).

Results

During the dry period the total abundance of the planktonic species was greater in relation to the density of non-planktonic species. The difference was significant (gl=17; T=1.104 and p=0.331). On the other hand, in the flood period the non planktonic species were more abundant and this difference was not significant (gl=17; T=-6.304 and p=0.001) (Fig. 3).

Analysing the participation of the planktonic species and the non-planktonic species separately in the lagoons associated with each river it was observed that the pattern described for total abundance was similar in both rivers. During the dry period the greater densities of planktonic species occurred in almost all lagoons with the exception of Finado Raimundo lagoon (6) connected to the Ivinheima river (Fig. 3). In these environments there was an elevated contribution of planktonic species in the Ivinheima river, 87.46 % in abundance, and the Baía river 90.65 %, particularly *Lecane proiecta*, *Euchlanis incisa* e *Ascomorpha ecaudis* (Table 2). The greater density of planktonic species during this phase was significant according to a t-test (Table 1).

On the other hand, during the flood period the majority of the lagoons had a greater contribution of non-planktonic species except for Peroba (2), Finado Raimundo (6) and Sumida lagoons (7) in the Ivinheima river and Carão (10), Boca Aberta (11) and Pousada das Garças (12) lagoons associated with Baía river (Table 1; Figs. 4, 5).

In this phase the non-planktonic species contributed with 61.68 % in the abundance in the Ivinheima river and 66.39 % in the Baía river. The most abundant species were *Lecane curvicornis*, *L. bulla*, *L. proiecta* and *Epiphanes clavulata*. The planktonic species participated with 38.32 % in the Ivinheima river and 33.61 % in the Baía river particularly *Polyarthra vulgaris*, *Filinia pejleri* e *F. longiseta*. The t-test did not show a significant difference in the relative contributions of the species in the different rivers (Table 1).

The ANOVA results show a significant relationship between the type of river and the hydrological period on the variation in the total density of these species. However the interaction of these two factors was not significant. (Table 3; Fig. 6).

Discussion

The spatial and temporal variations in the planktonic and non-planktonic populations of rotifers in the pelagic region of the lagoons were structured based on the influence of the factors characteristic of the floodplain. These factors are related to the spatial heterogeneity by the differences in the limnological variables observed in each river (THOMAZ et al. 1997) and the wash out effect due to the movement of the water masses brought on the flood pulse.

The wash out of zooplankton due to the movement of water masses is promoted by the increase in current velocity which washes out the non-planktonic taxons from the littoral zones to the pelagic zones, and an exchange of species, particularly of those present in the environments which are isolated during the dry season. ESTEVES (2000) pointed out that in the majority of the floodplain lagoons there is a strong oscillation in water level which allows for a lentic character in the dry season and a lotic character is the flood period.

PANOSSO & KUBRUSLY (2000) verified that in Batata lake, on the Amazon floodplain, the spatial heterogeneity of some limnological parameters was suppressed by the homogenising effect of the flood pulse. In contrast during the dry season, when the exchanges between the environments is reduced the differences in these variables are more distinct.

In this manner the predominance of typically planktonic species in the pelagic regions of the lagoons during the dry season is related to the reduced movement of the water in these environments that do not transport the plankton from the marginal regions to the central regions giving evidence to a compartmentalisation of the planktonic invertebrates occurrence. This pattern of abundance was also observed by GARCIA et al. (1998) in one of the lagoons which were studied. BONECKER et al. (1998) verified also a greater planktonic species richness during this phase in the pelagic regions of the Baía river and the Guaraná lagoon.

On the other hand the greater contribution of non-planktonic species verified during the flood period was influenced by the homogenizing effect of the flood pulse. Although the t-test did not show significant differences between the contributions of the non-planktonic species and the planktonic species, this pattern was constant in the majority of the environments both in the Baía river and the Ivinheima river. BONECKER & LANSAC-TÔHA (1996) verified the co-occurrence of non-planktonic and planktonic rotifers during the flood period in the limnetic region of one of the lagoons studied in this study (Guaraná lagoon) and attributed this result to the flooding of the flood plain. SERAFIM (1997) observed in Patos lagoon that the non-planktonic species found their optimum development during the flood period. This fact suggests that the species are not only washed out into the central regions of the lagoons but also are able to develop large populations, principally the oportunistic species as discussed by FERNANDO (1980) who considers that this dominance can also last for some time.

The movement of the marginal vegetation to the central regions of the lagoons during the flood period can also be another factor that influences the contribution of the non-planktonic species to this compartment. During this phase a large banks of macrophytes move about the lagoons. The influence of this vegetation on the structure of the cladoceran assemblages in some lagoons was discussed by LIMA (2000) indicating the presence of planktonic and non-planktonic species in the roots of aquatic macrophytes.

Another factor that should be stressed is the loss of organisms in direction of the river mainly the planktonic species due to the greater velocity of current. JOSÉ DE PAGGI (1981) stressed this factor as responsible for the reduction of species particularly those less adapted to the brusque changes in the physical and chemical conditions of the floodplain of the Paraná river in Argentina. With regard to this adaptation HAMILTON et al. (1990) comment that if the residence time of the water is less than the generation time of the organisms there will not be time for the population to increase. LANSAC-TÔHA et al. (unpubl.) registered greater densities of zooplankton in lagoons without communication with the river, and these authors attribute this to the loss of organisms to other environments.

Among the most representative non-planktonic species *Lecane proiecta* dominated in the dry period and *L. curvicornis* and *L. bulla*, during the flood. The presence of *L. proiecta* in the limnetic region of the studied environments can be related to the round form of the body of this species indicating an adaptation to planktonic conditions (PAGGI & JOSÉ DE PAGGI 1990). SERAFIM (1997) registered a great abundance of this species and attributed this among other factors, to the presence of grasses in the sampling area. *Lecane curvicornis* and *L. bulla* have been registered as constant and abundant in many studies undertaken in floodplains (BOZELLI 1994; BONECKER et al. 1994; LANSAC-TÔHA et al. 1997; SERAFIM 1997). The first has been described as a "tropocopolita" species that occurs in the tropics and subtropics but that can occasionally be found in temperate zones. *L. bulla* has been described as cosmopolitan and a more eurytopic species (SEGERS 1995, 1996).

Keratella cochlearis and *K. tropica* were the planktonic species that presented greatest densities in the dry period. These species are considered to be amply distributed and develop large populations in tropical regions (FERNANDO 1980; DUMONT 1983).

The fact that in some lagoons planktonic and non-planktonic species contributed differently in terms of abundance is relation to several factors as, for example: 1) the dynamics of the environment in answer to the changes in water level along with the peculiar characteristics of the environment such as area morfometry extent of macrophyte stands connectivity and physical and chemical variables, 2) predation and competition and 3) available food resources.

Final considerations

The flood pulse (hydrometric level) as well as the spatial heterogeneity are important factors for the dynamics and structuring of rotifer populations. For the planktonic species the greater stability of the water during the dry period promotes the development of large populations. On the other hand the non-planktonic species attain their optimum during the floods when the currents are faster due to the rise in water level. This greater current promotes the exchange of organisms that find appropriate conditions for growth and reproduction as well as occurring the loss of planktonic species which diminishes competition and predation.

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References

BONECKER, C.C. & F.A. LANSAC-TÔHA (1996): Community structure of rotifers in two environments of the high River Paraná floodplain (MS), Brazil. - Hydrobiologia **325**: 137-150.

BONECKER, C.C., LANSAC-TÔHA, F.A. & D.C. ROSSA (1998): Planktonic and non planktonic rotifers in two environments of the upper Paraná river floodplain-MS, Brazil. - Brazilian Archives of Biology and Technology **41**(4): 447-456.

BONECKER, C.C., LANSAC-TÔHA, F.A. & A. STAUB (1994): Qualitative study of rotifers in different environments of the high Parná river floodplain (MS), Brazil. - Revista UNIMAR, Maringá **16**(3): 1-16.

BOTTREL, H.H., DUNCAN, A., GLIWICZ, Z., GRYGIEREK, E., HERZIG, A., HILLBRICHT-ILLKOWSKA, A., KURASAWA, H., LARSSON, P. & T. WEGLENSKA (1976): A review of some problems in zooplankton production studies. - Norw. J. Zool. **24**: 419-456.

BOZELLI, R.L (1992): Composition of zooplankton comunity of Batata and Mussurá lakes and of the Trombetas River, State of Pará, Brazil. - Amazoniana **12**(2): 239-261.

BOZELLI, R.L. (1994): Zooplankton comunity density in relation to water level fluctuation and inorganic turbity in an Amazonian lake, "Lago Batata", State of Pará, Brazil. - Amazoniana **13**(1/2): 17-32.

DUMONT, H.J. (1983): Biogeography of rotifers. - Hydrobiologia **104**: 19-30.

ESTEVES, F.A. (2000): Princípios ecológicos para mitigação do impacto antrópico. - In: BOZELLI, R.F., ESTEVES, F.A. & F. ROLAND (eds.): Lago Batata: Impacto e recuperação de um ecossistema amazônico: 1-16. IB-UFRJ/SBL, Rio de Janeiro.

FERNANDO, C.H. (1980): The freshwater zooplankton of Sri Lanka, with a discussion of tropical freswater zooplannkton composition. - Int. Ver. Ges. Hydrobiol. **65**(1): 85-125.

GARCIA, A.P.P., LANSAC-TÔHA, F.A. & C.C. BONECKER (1998): Species composition and abundance of rotifers in different environments of the floodplain of the upper Paraná river, Brazil. - Rev. Brasil. Zool. **15**(2): 327-343.

HAMILTON, S.K., SIPPEL, S.J., LEWIS, W.M. JR. & W.M. SAUNDERS III, F. (1990): Zooplankton abundance and evidence for its reduction by macrophyte mats in two Orinoco floodplain lakes. - J. Plankton Res. **12**(2): 345-363.

JOSÉ DE PAGGI, S. (1981): Variaciones temporales y distribuición horizontal del zooplâncton en algunos cauces secundários del rio Paraná Médio. - Stud. Neotrop. Fauna Environm. **16**: 185-199.

JOSÉ DE PAGGI, S. (1989): Rotíferos de algunas provincias del noroeste argentino. - Rev. Hydrobiol. Trop. **22**(3): 223-238.

JUNK, W.J., BAYLEY, P.B. & R.E. SPARKS (1989): The flood pulse concept in river-floodplain systems. - Can. Spec. Publ. Fish. Aquatic. Sci. **106**: 110-127.

KOSTE, W. (1978): Rotatoria die Rädertiere Mitteleuropas begründet von Max Voight. - Monogononta Vols. **1** & **2**. Berlin, Gebr. Borntraeger.

KOSTE, W. & B. ROBERTSON (1983): Taxonomic studies of the Rotifera (*Phylum Aschelminthes*) from a Central Amazonian varzea lake, Lago Camaleão (Ilha de Marchantaria, Rio Solimões, Amazonas, Brazil). - Amazoniana **8**(2): 225-254.

LANSAC-TÔHA, F.A., BONECKER, C.C., VELHO, L.F.M. & A.F. LIMA (1997): Composição, distribuição e abundância da comunidade zooplanctônica. - In: VAZZOLER, A.E.A.M., AGOSTINHO, A.A. & N.S. HAHN (eds.): A Planície de Inundação do Alto Rio Paraná: Aspectos físicos, biológicos e socioeconômicos: 117-155. Editora da Universidade Estadual de Maringá, Maringá-PR.

LIMA, A.F. (2000): Estrutura das assembléias de Cladocera (Crustacea) associadas à macrófitas aquáticas (*Eichhornia azurea*) em distintos ambientes da planície de inundação do alto rio Paraná. - Ph.D.-thesis, Univ. Estadual de Maringá, Brazil.

NEIFF, J.J. (1990): Ideas para la interpretación ecológica del Paraná. - Interciencia **15**(6): 424-441.

PAGGI, J.C. & S. JOSÉ DE PAGGI (1990): Zooplâncton de ambientes lóticos e lênticos do rio Paraná médio. - Acta. Limnol. Brasil. **3**: 685-719.

PANOSSO, R. & L. KUBRUSLY (2000): Avaliação espacial e temporal das variáveis limnológicas básicas e nutrientes. - In: BOZELLI, R.F., ESTEVES, F.A. & F. ROLAND (eds.): Lago Batata: Impacto e recuperação de um ecossistema amazônico: 55-71. IB-UFRJ/SBL, Rio de Janeiro.

ROBERTSON, B.A. & E.R. HARDY (1984): Zooplankton of Amazonian lakes and rivers. - In: SIOLI, H. (ed.): The Amazon: Limnology and landscape ecology of a mighty tropical river and its basin: 337-352. Monographie Biologicae. Junk, Dordrecht.

SEGERS, H. (1995): Rotifera. The Lecanidae (Monogonta): Vol. **2**. (Guides to the identification of the microinvertebrates of the continental waters of the world: Vol. **6**). - SPB Academic, The Hague.

SEGERS, H. (1996): The biogeography of littoral *Lecane* Rotifera. - Hydrobiologia **323**: 169-197.
SERAFIM, M., Jr. (1997): Heterogeneidade espacial e temporal da comunidade zooplanctônica do sistema rio Ivinhema-lagoa dos Patos, planície de inundação do alto rio Paraná (MS). - M.Sc.-thesis, Univ. Estadual de Maringá, Brazil.
SMET, DE W.H. (1996): Rotifera. The Proalidae (Monogononta): Vol. **1**. (Guides to the identification of the microinvertebrates of the continental waters of the world: Vol. **4**). - SPB Academic, The Hague.
SMET, DE W.H. (1997): Rotifera. The Dicranophoridae (Monogononta): Vol. **1**. (Guides to the identification of the microinvertebrates of the continental waters of the world: Vol. **5**). - SPB Academic, The Hague.
SOKAL, R.R. & F.J. ROHLF (1991): Biometry: the principles and pratice of statistics in biological research. - W.H. Freeman, New York.
STATSOFT (1996): Statistica Software, Statsoft Inc. Tulsa.
THOMAZ, S.M., ROBERTO, M.C. & L.M. BINI (1997): Fatores limnológicos abióticos e clorofila a: caracterização dos habitats e influências do pulso de inundação. - In: VAZZOLER, A.E.A.M., AGOSTINHO, A.A. & N.S. HAHN (eds.): A planície de inundação do Alto Rio Paraná: aspectos físicos, químicos, biológicos e sócio econômicos: 73-114. Editora Univ. Estadual de Maringá, Maringá-PR.

Table 1: t-test for dependent samples results between the planktonic and non planktonic contributions for total densities of rotifers in the lagoons associated with the Baía and Ivinheima Rivers during the dry and flood periods. Values marked were significant ($p < 0,05$).

Hydrological period	**river**	**gl**	**T**	**p**
dry	Ivinheima	7	**-3.068**	0.018
	Baía	7	**-4.777**	0.002
flood	Ivinheima	7	0.655	0.533
	Baía	7	1.142	0.290

Table 2: Contribution of planktonic and non planktonic densities (%) to the total density of rotifer in the lagoons associated with the Baía and Ivinheima Rivers during the dry and flood periods. H = habitat classification: planktonic (pk) and non planktonic (npk) species.

	Dry period H	Ivinheima	Baía
Lecane proiecta (HAUER, 1956)	npk	4.67	0.37
Euchlanis incisa CARLIN, 1939	npk	0.63	2.59
Ascomorpha ecaudis (PERTY, 1859)	npk	2.02	0.22
Total		**12.54**	**9.35**
Keratella cochlearis GOSSE, 1951	pk	35.46	6.24
K. tropica APSTEIN, 1907	pk	27.11	10.03
Brachionus mirus (KOSTE, 1972)	pk	0.04	30.06
B. calyciflorus PALLAS, 1766	pk	3.36	1.27
Filinia pejleri HUTCHINSON, 1964	pk	0.04	10.57
F. longiseta (EHRENBERG, 1834)	pk	2.36	14.67
Polyarthra vulgaris CARLIN, 1943	pk	3.78	4.98
Synchaeta pectinata EHRENBERG, 1832	pk	2.37	2.44
Conochilus unicornis (ROUSSELET, 1982)	pk	0.39	1.48
Total		**87.46**	**90.65**
	Flood period		
Lecane curvicornis (MURRAY, 1973)	npk	15.19	21.66
L. bulla (GOSSE, 1951)	npk	13.66	17.96
L .proiecta (HAUER, 1956)	npk	9.88	0.45
L. leontina (TURNER, 1892)	npk	1.74	5.98
Epiphanes clavulata (EHRENBERG, 1832)	npk	8.95	2.01
Dipleuchlanis p. propatula GOSSE, 1886	npk	2.30	2.14
Ascomorpha ecaudis (PERTY, 1859)	npk	1.08	1.44
Total		**61.68**	**66.39**
Polyarthra vulgaris CARLIN, 1943	pk	7.30	1.91
Filinia pejleri HUTCHINSON, 1964	pk	5.94	11.81
F. longiseta (EHRENBERG, 1834)	pk	2.41	0.36
Asplanchna sieboldi (LEYDIG, 1854)	pk	2.08	2.01
Conochilus natans (SELIGO, 1900)	pk	1.27	1.60
Total		**38.32**	**33.61**

Table 3: The ANOVA results between independent factors and planktonic (pk) and non planktonic (npk) species density. Values marked were significant (p <0,05).

Effect	Gl	F	p
River	2	**26.49**	0.001
Hydrological period	2	**9.22**	0.003
River and hydrological period	2	0.001	0.991

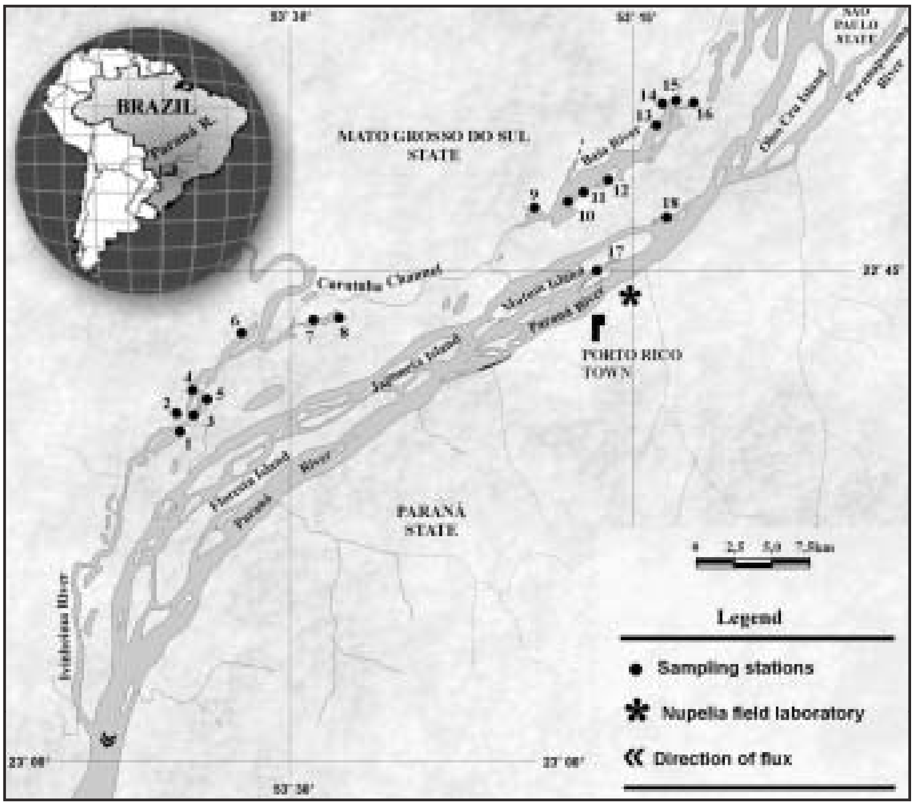

Fig. 1:
Map of the region studied indicating the sampling sites. Ivinheima River: Pintado (**1**), Peroba (**2**), Joaninho (**3**), Boca do Ipoitã (**4**), Patos (**5**), Finado Raimundo (**6**), Sumida (**7**) e Escondida (**8**) lagoons; Baía River: Guaraná (**9**), Carão (**10**), Boca Aberta (**11**), Pousada das Garças (**12**), Maria Luíza (**13**), Esperança (**14**), Gavião (**15**) e Onça (**16**) lagoons.

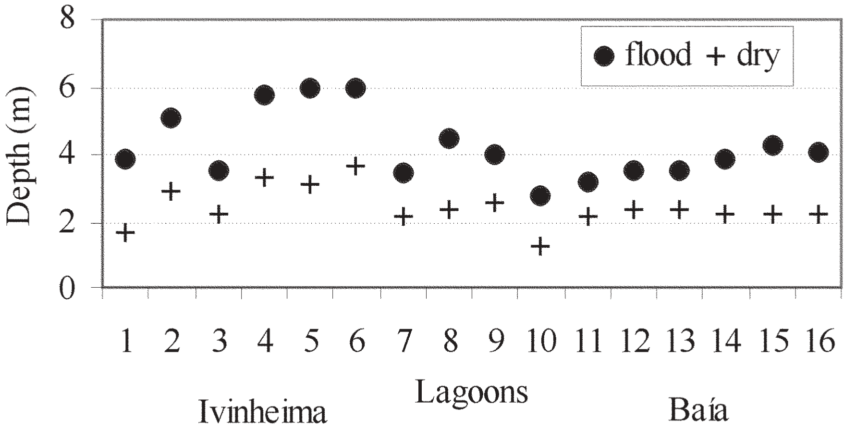

Fig. 2:
Depth of each lagoons in the flood (February, 1999) and dry (October, 1999) periods.

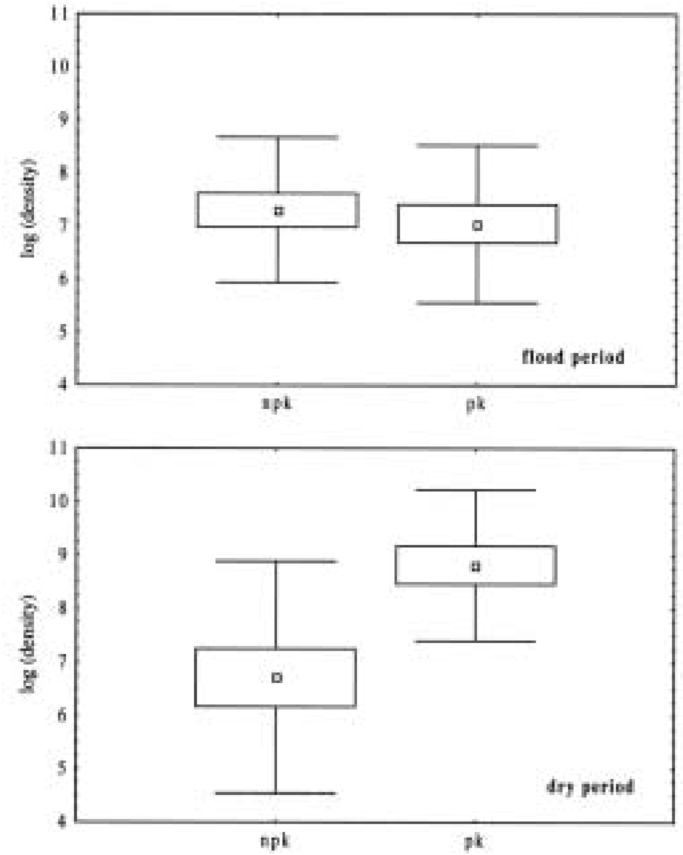

Fig. 3:
Mean densities of planktonic and non planktonic species in all lagoons in each hydrological periods (bars indicate the standard deviation and box the standard error).

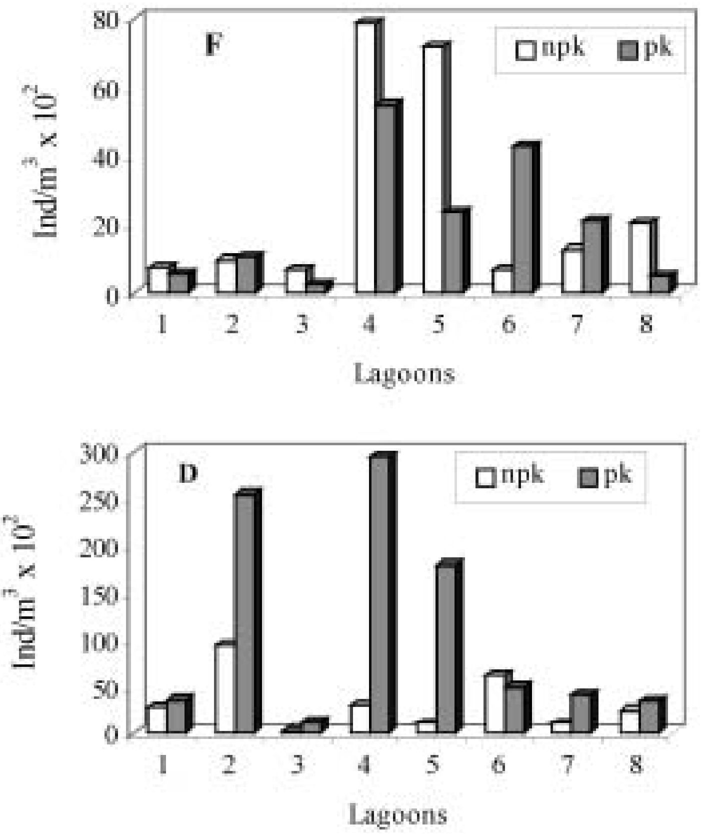

Fig. 4:
Densities of planktonic and non planktonic species in the flood (**F**) and dry (**D**) periods in the Ivinheima River lagoons.

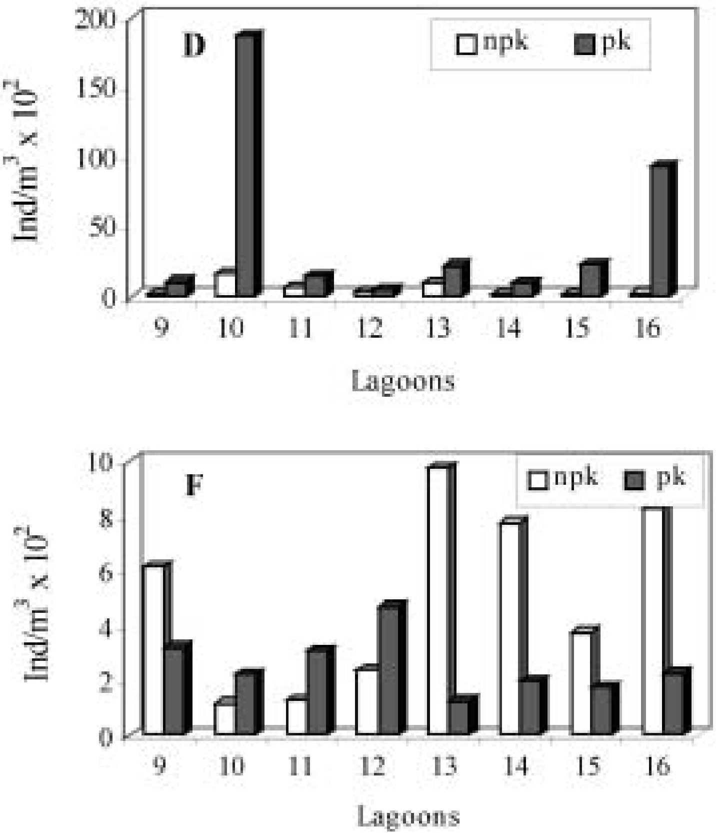

Fig. 5:
Density of planktonic and non planktonic species in the flood (**F**) and dry (**D**) periods in the Baía River lagoons.

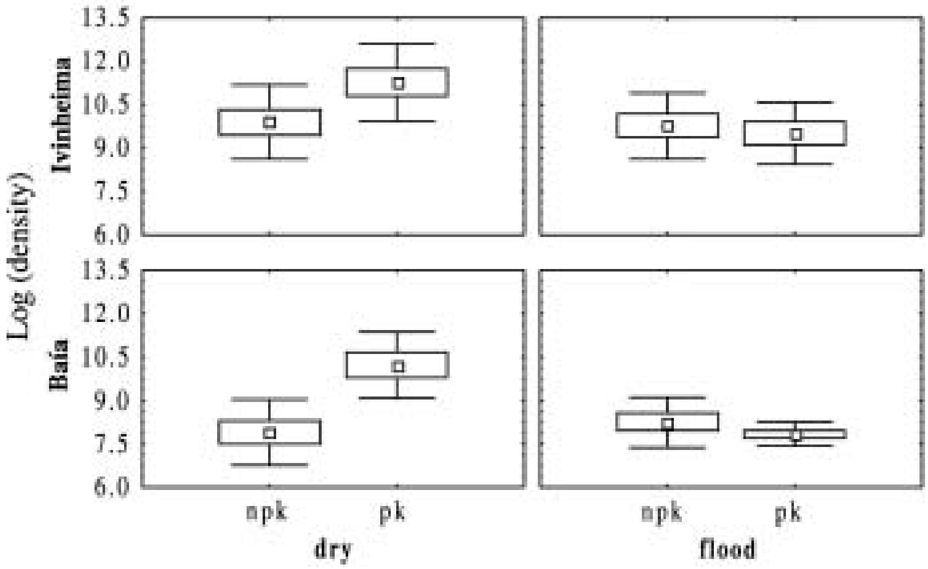

Fig. 6:
Mean density (ind/m^3) of planktonic and non planktonic species in the lagoons associated to each river (Baia e Ivinheima), during the flood and dry periods (bars indicate the standard deviation and box the standard error).