Seasonal effects on zooplanktonic community in a temporary lagoon of northeast Brazil.

CRISPIM[1], M.C. & FREITAS[1], G. T. DE P.

[1] Universidade Federal da Paraíba, Centro de Ciências Exatas e da Natureza, Departamento de Sistemática e Ecologia. Cidade Universitária 58039-970. João Pessoa-PB, Brazil.

e-mails: ccrispim@dse.ufpb.br; gleciatrinta@ig.com.br

ABSTRACT: Seasonal effects on zooplanktonic community in a temporary lagoon of northeast Brazil. We describe the influence of the seasonal effects on the zooplankton community in a temporary lagoon (Panati lagoon) of Northeast Brazil. Samples of zooplankton were collected monthly for two years in the littoral zone, by filtering 40 liters of water through a plankton net with 45 ㎜ mesh size. During this study, we characterized rainy and dry seasons in the region. The non-parametric Sperman test was used to determine any correlations between rainfall rate and densities of the most frequent zooplankton species. Rotifers were the dominant members of the zooplankton. The rotifer and cladoceran communities basically did not change qualitatively from one year to the next. Among the constant rotifer species the majority was composed by those common of aquatic vegetation (Lecane, Colurella and Lepadella genera), probably due the large quantity of macrophytes in Panati lagoon. Some zooplankton organisms showed quantitative changes related to dry and rainy seasons. Zooplankton species such as the rotifers Polyarthra dolichoptera, Brachionus patulus, Hexarthra mira, the cladoceran Diaphanosoma spinulosum, and cyclopoid copepods demonstrated a significant negative correlation with rainfall rate. Calanoid copepodites showed a significant positive correlation to rainfall rate in Panati lagoon. The rotifer Conochilus natans and calanoid copepods were also favoured in the rainy season.

Key words: zooplankton, semi-arid, temporary lagoons.

RESUMO: Efeitos da sazonalidade sobre a comunidade zooplanctônica de uma lagoa temporária do Nordeste do Brasil. Com o objetivo de descrever a influência da sazonalidade sobre a comunidade zooplanctônica de uma lagoa temporária localizada na região semi-árida do nordeste do Brasil (lagoa Panati), amostras zooplanctônicas foram coletadas por um período de dois anos através da filtragem de 40 litros de água da zona litoral da lagoa, usando uma rede de plâncton com 45 ㎜ de poro. Durante este estudo, as estações chuvosa e seca da região foram caracterizadas. O teste não paramétrico de Sperman foi usado para determinar correlações entre a taxa de precipitação mensal e as densidades das espécies zooplanctônicas mais freqüentes. Os rotíferos foram os membros dominantes da comunidade zooplanctônica. As comunidades de rotíferos e cladóceros basicamente não sofreram variação qualitativa de um ano para o outro. Dentre as espécies de rotíferos constantes ao longo das coletas realizadas no presente trabalho, à maioria foi composta por aquelas que vivem comumente associadas à vegetação aquática (gêneros Lecane, Colurella, Lepadella), provavelmente devido a grande quantidade de macrófitas presentes na lagoa Panati. Alguns organismos zooplanctônicos apresentaram mudanças quantitativas relacionadas às estações seca e chuvosa. Espécies zooplanctônicas tais como os rotíferos Polyarthra dolichoptera, Brachionus patulus, Hexarthra mira, o cladócero Diaphanosoma spinulosum, e os copépodos ciclopóides apresentaram uma significativa correlação negativa com a taxa de precipitação. Já os copepoditos calanóides mostraram uma significativa correlação positiva com a chuva. Os rotíferos Conochilus natans e os copépodos calanóides também foram favorecidos durante a estação chuvosa.

Palavras chave: zooplâncton, semi-árido, lagoas temporárias.

Introduction

Temporary lagoons are common in many regions, but they are ecologically more important in arid and semi arid areas, where the permanent water resources can be scarce or absent (Williams, 1987).

In Northeast Brazil, the lagoons show flutuation on water levels, caused mainly by high evaporation rate, high temperature and irregular rainfall. When the water level of these environments decline, they tend to eutrophization (Crispim et al., 2000). Thus, these ecossystems change, becoming favourable to some zooplanktonic species and adverse to others, producing a strong seasonal sucession.

Zooplanktonic organisms play an important role in nutrients cycle and energy transfer as links between photosynthetic organisms (phytoplankton) and consumers along food chain (Nordi & Watanabe, 1978). Because of their short life cycles, when environmental conditions are suitable, it is possible to notice peaks in densities of some species. However, under adverse conditions, zooplanktonic species such as crustaceans (Fryer, 1996; Crispim et al., 2003) and rotifers (King & Snell, 1980; Gilbert, 1995) exhibit life strategies that permit them to stay in diapause stages to survive in temporarily adverse envionments (Crispim & Watanabe, 2001).

Many zooplanktonic species often have been related to different trophic degrees of environments (Pejler, 1983, Monteiro, 1988, Crispim et al., 2000) and can be used as bioindicators. Therefore, the characterization of zooplanktonic community and the analyse of more abundant and frequent groups is a very important tool for the verification of environmental conditions and water quality of an aquatic ecosystem (Margalef, 1983; Esteves & Sendacz, 1988), as well as providing data to studies about biological diversity.

The aim of this study is to describe the influence of the seasonal effects on zooplanktonic community in a temporary lagoon of Northeast Brazil.

Material and methods

Panati is a shallow temporary lagoon located in Taperoá borough (7°11'14"S and 36°49'52"W), in a semi arid region of Paraíba State (Northeast Brazil). Panati lagoon has a maximum depth of about 1.5 m (in the rainy season) and abundant aquatic macrophytes in its littoral zone. Nymphaea sp. and Nitela sp. are the most abundant in this environment, mainly during the dry season when nutrient enrichment occurs during the drastic reduction in water level due to evaporation and low rainfall.

Samples were collected monthly for two years (2002/2003). During this study, we characterized rainy and dry seasons in the region. For this, we considered each year the month which showed an abrupt transition in rainfall. The transition month was whichever that showed a rainfall change of about 50% of previous or following months (Ceballos, 1995). February-2002 was considered within the rainy season, despite having been a dry month, because it was between the two most rainy months in 2002. The rainfall rate used in this work was verified monthly and obtained by Meteorological Post of State Government in Taperoá borough (SEMARH/LMRS-PB, 2004). Rainy season of 2002 was from January to March and rainy season of 2003 was from January to June. January of 2002 was the most rainy month (232,8 mm) during the two years of study (Fig. 1).

Zooplanktonic samples were taken by filtering 40 liters of water (using a 4 liters bucket) in the littoral zone through a plankton net with 45 mm mesh size and the material was preserved with a 4% formalin solution, saturated with sugar. Three replicated samples were collected and the densities (ind.l^{-1}) represent the mean of the three replicate.

Identification and enumeration of material were realized using a Sedgwick-Rafter cell under microscope. At least 100 zooplanktonic individuals of the main groups

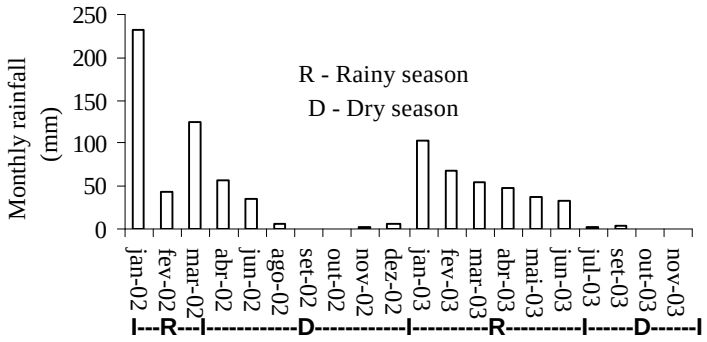

Figure 1: Monthly rainfall verified in Taperoá borough – semi arid region in Northeast Brazil, from Jan-2002 to Nov-2003.

(rotifer, cladoceran, copepod) were counted from subsamples of 1 ml. Only rotifers and cladocerans were identified, using the appropriate references Ruttner-Kolisko (1974) and Koste (1978) for rotifers; and Elmoor-Loureiro (1997) for cladocerans.

A constancy index was applied to each taxa recorded in Panati lagoon through the expression: C=n.100/N, n= number of samples holding the taxon / N= total number of samples collected (Dajoz, 1973). Taxa were termed constant when they appeared in more than 50% of samples; occasional, when found between 25% and 50% of samples; and accidental when the taxon was present in less than 25% of the analysed samples.

The non-parametric Spearman test was used to determine any correlations between rainfall rate and densities of zooplanktonic species that were found in at least 25% (or more) of samples analysed. Statistical analysis was conducted using Statistica for Windows, Statsoft (1998).

Results

Panati lagoon was represented by 43 species and sub-species of Rotifera and 10 species of Cladocera. Species composition of the planktonic rotifers and cladocerans was basically the same in the two years analysed. However, in 2002, the rotifers Brachionus caudatus, Brachionus dolabratus, Brachionus quadridentatus, Colurella uncinata f. bicuspidata, Euchlanis dilatata, Filinia opoliensis, Heterolepadella sp., were not found in Panati lagoon but, in 2003, these species were collected in this environment. In addition, three Lecane species, Lepadella apsida, Platyas quadricornis, Trichocerca similis and the cladoceran Macrothrix spinosa were collected in 2002 and they were not found in 2003 (Tabs. I and II).

By application of the Constancy Index we observed that Brachionus patulus, Colurella uncinata, Lecane (M.) lunaris, Lecane stichaea, Lepadella patella, Polyarthra dolichoptera, Scaridium sp., were the most frequent rotifers sampled in Panati lagoon during the year of 2002. In 2003, only the rotifer Lecane luna was found in more than 50% of samples collected (Tab.I). Diaphanosoma spinulosum, Ephemeroporus hybridus and Macrothrix laticornis were the most frequent cladocerans in 2002. In 2003, cladocerans species were not found in more than 50% of samples collected in the environment studied (Tab.II).

During the dry period, the water level of Panati lagoon declined and the quantity of aquatic macrophytes increased greatly. In the rainy season, the water level of Panati lagoon increased again. In the present study, we can notice that these two seasons (dry and rainy), caused alterations in the zooplanktonic community structure of this environment. P. dolichoptera, B. patulus, D. spinulosum, Hexarthra mira and cyclopoid copepods demonstrated a significant negative correlation with rainfall rate along two years of study. Calanoid copepodites showed a significant positive

Table I: Constancy Index for rotifer species collected in Panati lagoon in 2002 and 2003.

Taxa	Panati		Taxa	Panati	
Rotifera	**2002**	**2003**	**Rotifera**	**2002**	**2003**
Brachionus caudatus		==	L. (M.) scutata	==	///
B. angulares (Gosse, 1851)	///	///	L. hastata (Murray, 1913)	==	==
B.calyciflorus (Pallas,1766)	==	==	L. luna (O.F.Muller, 1776)	///	++
B. dolabratus		==	L. luna var. presumpta	==	==
B. falcatus (Zacharias, 1898)	///	///	L. ohioensis	==	
B. havanaensis (Rousselet, 1911)	==	==	L. stichaea (Harring, 1913)	++	///
B. patulus (O.F.Muller, 1786)	++	==	L. subtilis	==	
B. quadridentatus (Hermann, 1783)		///	Lecane sp[1]	==	
B. urceolaris (O.F. Muller, 1773)	///	==	Lecane sp[2]	==	
Cephalodella gibba	==	==	Lepadella apsida	==	
Colurella uncinata	++	==	L. ovalis (O.F.Muller, 1786)	///	==
C. uncinata f. bicuspidata		==	L.patella f. oblonga	++	///
Conochilus natans (Seligo, 1900)	==	==	Mytilina ventralis (Ehrenberg,1832)	///	==
Euchlanis dilatata (Ehrenberg, 1832)		==	Platyias quadricornis (Ehrenberg, 1832)	==	
Filinia longiseta (Ehrenberg, 1834)	==	///	Polyarthra dolichoptera (Idelson, 1925)	++	==
F. opoliensis		==	Rot. não ident. sp[2]	==	==
Heterolepadella sp.		==	Scaridium sp.	++	==
Hexarthra mira (Hudson, 1871)	///	==	Testudinella patina (Herman,1783)	///	==
Keratella lenzi (Hauer, 1973)	==	==	Trichocerca sp.	///	==
K. valga (O.F.Muller, 1786)	///	///	T (D.) similis (Wierzejski, 1893)	///	
Lecane (M.) lunaris f. perplexa	==	==			
L (M.) lunaris (Ehrenberg, 1832)	++	///			
L. (M.) pyriformis	///	==			

== Accidental; /// Occasional; ++ Constant

blank cells – absent species

Table II: Constancy Index for cladoceran species collected in Panati lagoon in 2002 and 2003.

Taxa	Panati	
Cladocera	**2002**	**2003**
Alona cambouei (Guerne & Richard, 1893)	==	==
Ceriodaphnia cornuta (Sars,1886)	==	==
Diaphanosoma spinulosum (Herbst, 1967)	++	///
Dunhevedia odontoplax (Sars, 1901)	///	==
Ephemeroporus hybridus (Daday, 1905)	++	==
M. laticornis (Jurine, 1820)	++	///
M. spinosa (King, 1853)	==	
Macrothrix sp.	==	==
Moina minuta (Hansen, 1899)	==	==
Simocephalus acutirostris (King, 1853)	///	==

== Accidental; /// Occasional; ++ Constant

blank cells – absent species

correlation to rainfall rate in Panati lagoon (Tab. III) ($p<0.05$; $N=20$). Despite the fact that densities of L. patella, C. uncinata and Brachionus falcatus didn't show a significant correlation to rainfall rate (Tab. III), we can observe that these organisms increased their densities in months of lower rainfall (Fig. 2). On the other hand, the rotifer Conochilus natans was collected in Panati lagoon only at the end of the strong rainy season of 2002. Calanoid copepods were more abundant in 2003, showing a peak in density in the beginning of the rainy season (83.04 ind.l^{-1}), keeping in this environment along the year, but in smaller densities. Cyclopoid copepodites, that were more abundant during dry season (as well as adult cyclopoids) showed an inverse dynamic when compared with calanoid copepodites (Fig. 2).

Table III: Spearman Correlation (N=20) between rainfall rate and zooplanktonic species collected monthly in Panati lagoon, from Jan-2002 to Nov-2003.

Zooplanktonic species & rainfall	Spearman R	p-level
Brachionus angularis	-0.01	0.97
B. falcatus	-0.26	0.27
B. patulus	-0.50	0.03
B. quadridentatus	0.22	0.34
B.urceolaris	0.19	0.44
Conochilus natans	0.13	0.60
Colurella uncinata	-0.33	0.16
Calanoid copepod	0.11	0.64
Calanoid copepodite	0.45	0.05
Cyclopoid	-0.46	0.04
Cyclopoid copepodite	-0.10	0.68
Dunhevedia odontoplax	0.10	0.70
Diaphanosoma spinulosum	-0.59	0.01
Ephemeroporus hybridus	-0.05	0.84
Filinia longiseta	0.14	0.57
Hexarthra mira	-0.45	0.05
Keratella valga	-0.35	0.13
Lecane (M.) lunaris	-0.29	0.22
L. (M.) pyriformis	-0.29	0.22
L. (M.) scutata	-0.21	0.37
L. luna	0.37	0.11
L. stichaea	-0.10	0.68
Lepadella patella	-0.09	0.71
Lovalis	-0.04	0.87
Macrothrix laticornis	0.003	0.99
Mytilina ventralis	-0.09	0.72
Polyarthra dolichoptera	-0.46	0.04
Simocephalus acutirostris	0.15	0.52
Testudinella patina	0.27	0.25
Trichocerca similis	0.24	0.30

Bold values are significant (p<0,05)

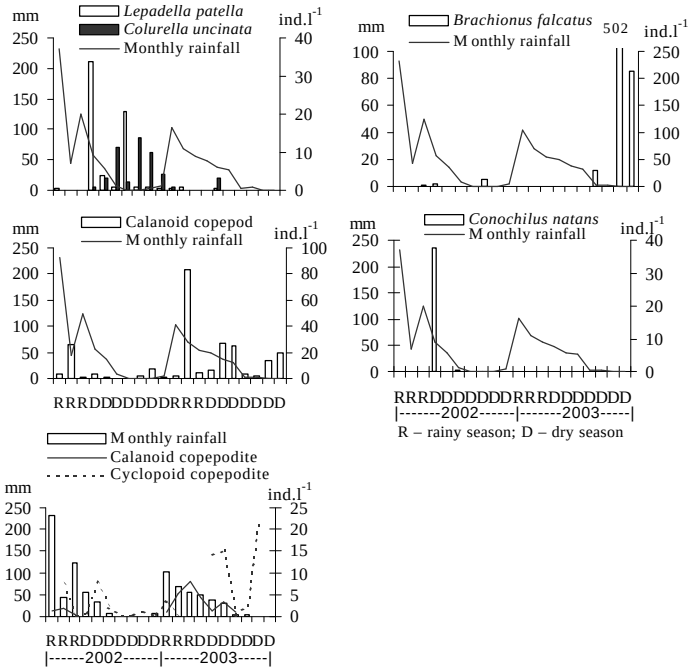

Figure 2: Density (ind.l^{-1}) of some zooplanktonic species collected in Panati lagoon, in the rainy and dry seasons of 2002 and 2003.

During this study, the most abundant zooplanktonic species were Brachionus falcatus (maximum density of 502 ind.l^{-1}), Keratella valga (maximum density of 458 ind.l^{-1}), Lecane luna var. presumpta (maximum density of 161.1 ind.l^{-1}), P. dolichoptera (maximum density of 106 ind.l^{-1}) and Brachionus angularis (maximum density of 104 ind.l^{-1}) (Fig. 3).

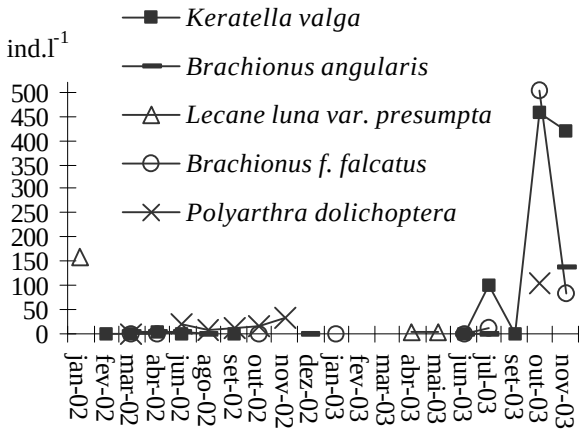

Figure 3: Density of more abundant zooplanktonic species recorded in Panati lagoon from Jan-2002 to Nov-2003.

The relationship between the total density of zooplanktonic species collected in Panati lagoon and monthly rainfall in this region is described in Fig. 4. During the two years of the study, we observed two peaks in abundance of zooplankton (rotifer + cladoceran + copepod); the first peak (242. 94 ind.l^{-1}) occurred during the latter part of the dry season of the 2002; and the second and greatest peak (1707 ind.l^{-1}) corresponded to the latter part of the dry season of the second year of this study (2003). The second peak was caused by an increase in the rotifers densities (B. angularis, B. falcatus, K. valga, P. dolichoptera) and nauplii (486 ind.l^{-1}).

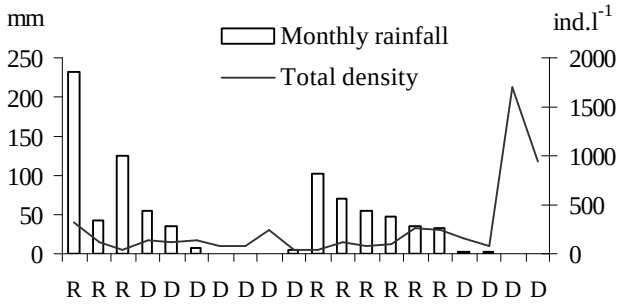

Figure 4: Total density (rotifer + cladoceran + copepod) of zooplankton colletected in Panati lagoon during the rainy and dry seasons from 2002 to 2003.

Discussion

Rotifers were the dominant members of the zooplankton in this environment. In most dams in Brazil the zooplankton is dominated by Rotifera (in densities and species richness) (Sampaio et al., 2002), mainly because they have less specialized feeding, high fecundity and frequent parthenogenetic reproduction (Allan, 1976; Matsumura-Tundisi et al., 1990).

Among the constant rotifer species the majority was composed by Lecane,

Colurella and Lepadella genera. Moreover, among the 43 rotifers species recorded in Panati lagoon during this study, 12 species were Lecane genera. Lecane genera is characteristic of littoral zone, among aquatic vegetation (Sládecek, 1983; Koste & Shiel, 1987); C. uncinata and L. patella are also common in water bodies rich in aquatic vegetation (Sládecek, 1983). Thus, the large quantity of aquatic macrophytes in Panati lagoon would account for the frequent occurrence of these species in the samples studied. The cladoceran M. laticornis, which was also constant in 2002, show bentonic habits and would be influenced by aquatic vegetation present through out of littoral zone.

Dry and rainy seasons induce changes in the organization of temporary ecosystems (Maltchik, 1999) due to indirect consequences caused by fluctuation of water level.

The presence of a greater number of constant species in 2002 than in 2003, was probably due to the high rainfall verified in January (232.8 mm) and March (124.5 mm) of 2002. The increased precipitation permitted a greater maintenance of water level in Panati lagoon during the dry season of the respective year and, thus, this environment stayed more stable in the earlier year than in the latter.

During this study, dry and rainy seasons caused alterations on the zooplanktonic community structure. Some zooplanktonic species such as L. patella, C. uncinata, B. patulus, B. falcatus, P. dolichoptera, H. mira, D. spinulosum and cyclopoid copepods were more abundant in dry months. However, C. natans and calanoid copepods were favoured in the rainy season. The trophic level of water changes quickly in Paraiban dams of the semi arid region. The dry period cause an increase of trophic degree due mainly to the reduction of water level (this reduction ranges according to the degree of drough). Therefore, an increase occurred in the concentration of nutrients in the water and, consequentely, development of aquatic vegetation and dead of algal biomass. Thus, species that live among this kind of vegetation e.g. L. patella, C. uncinata are favoured. During the rainy season, the water level increase and the eutrophization process tends to decline (Crispim et al., 2000; Vieira et al., 2000).

Monteiro (1988), analysing zooplanktonic communities of dams in Portugal, observed that P. dolichoptera was well represented as an indicator of increase of trophic conditions of the environment, related to absence of calanoid copepods. Sendacz & Kubo (1982) in studies in São Paulo have not found calanoid copepods in dams strongly eutrophicated. Patalas (1972) noticed that in the lakes of EUA the cyclopoid copepods were more abundant in eutrophic waters than calanoid copepods.

Crispim et al. (2000), analysing Taperoá dam, located in semi arid Northeast Brazil, observed that the rotifer Brachionus urceolaris reached 2.180 ind.l^{-1} when this dam was more dry. Zooplankton of Panati lagoon, as opposed to the dam, didn't reach such high densities. This is probably because a larger quantity of nutrients were being incorporated into the macrophyte biomass and not directed toward the planktonic food web.

We observed two peaks in abundance of total zooplankton (rotifer + cladoceran + copepod) collected in Panati lagoon. Both occurred during the latter part of the dry season (the first peak occurred in 2002 and the second and greater peak was observed in 2003). The second peak was caused by an increase in the rotifers biomass and nauplii. Karabin (1985) noticed that eutrophication leads to a rise in the total density of planktonic rotifers. But, in general, the total density of zooplankton (rotifer + cladoceran + copepod) in Panati lagoon along this study was smaller than 300 ind.l^{-1} (Fig. 5). Compared to other kind of temporary environments located in Northeast Brazil, like dams, we can see that these densities are lower whereas the richness is higher (Crispim et al., 2000; Vieira et al., 2000).

In Panati lagoon the rotifer and cladoceran communities basically did not change qualitatively from one year to the next. However, some zooplanktonic organisms showed quantitative changes related to dry and rainy seasons. The second year of the study was more adverse to the zooplanktonic organisms than the first. This

evidence is based on the high densities observed in some rotifer species compared to other zooplanktonic species. According to Odum (1988), variable ecosystems show some few species more abundant that the others.

Although more papers on temporary environments are being published, we know more about zooplanktonic communities in permanent waters than in temporary ones. However, studies about these kind of ecosystems are fundamental to the understanding and protection of these unique and so variable habitats.

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