Testate amoebae abundance in plankton samples from Paraná State reservoirs

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ABSTRACT. This study aimed to investigate patterns of spatial and temporal distribution of testate amoebae (Rhizopoda) abundance in plankton of different reservoirs of Paraná State and the importance of hydrodinamical and morphometrical factors on determining these patterns. Thirty reservoirs studied are located in six different watersheds, including environments with variable area, morphometry and age. Sampling were carried out in July and November 2001, dry and rainy seasons, respectively. Samples were obtained at the surface of reservoirs, in the lacustrine region, using a motorized pump (600 liters per sample) and a plankton net with a mesh size of 68μm. Testate amoebae were registered in 23 of 30 reservoirs.Higher density were observed in JMF, Salto do Meio, Melissa, Mourão and Salto do Vau reservoirs, during dry season, and JMF, Salto Osório, Salto do Meio and Melissa reservoirs, during wet season These reservoirs present similar characteristics, as reduced depth and morphometric dimensions Besides that, most of them have hydrodynamical features similar to lotic environments, due to presenting high current velocity. On the other hand, testate amoebae were absent or presented low density, in general, in reservoirs with higher dimensions and depth. Instead of expected, seasonally, higher densities values were observed during dry season, for the most of studied reservoirs. These results can be related to the fact that the reservoirs during dry season have a remarkable reduction of their dimentions (area and depth), determining a greater influence of the benthonic organisms to the composition and abundance of the protozooplankton community.

Key words: testate amoebae, abundance, plankton, reservoirs.

RESUMO. Abundância de tecamebas no plâncton de reservatórios do Estado do Paraná. Este trabalho teve o objetivo de investigar os padrões de distribuição espacial e temporal da abundância de tecamebas (Rhizopoda) no plâncton de diferentes reservatórios do Estado do Paraná bem como a importância de fatores hidrodinâmicos e morfométricos na determinação desses padrões. Os 30 reservatórios estudados estão localizados em seis diferentes bacias, incluindo ambientes com áreas, morfometrias e idades variáveis. As amostragens foram realizadas em julho e novembro de 2001, períodos de estiagem e chuvoso, respectivamente. As amostras foram obtidas à superfície dos reservatórios, na região lacustre, utilizando-se uma bomba (600 litros por amostra) e uma rede de plâncton com malhagem de 68 um. As tecamebas foram registradas em 23 reservatórios. Maiores densidades foram encontradas nos reservatórios JMF, Salto do Meio, Melissa, Mourão e Salto do Vau, durante o período de estiagem, e JMF, Salto Osório, Salto do Meio e Melissa, durante o período chuvoso. Esses reservatórios apresentam características similares, como reduzidas profundidades e dimensões morfométricas. Além disso, a maioria deles têm características hidrodinâmicas similares a de ambientes lóticos, por apresentarem alta velocidade de corrente. Por outro lado, as tecamebas foram ausentes ou presentes em baixas densidades, em geral, nos reservatórios com maiores dimensões e profundidade. Ao contrário do esperado, sazonalmente, maiores densidades foram observadas durante o período de estiagem, para a maioria dos reservatórios. Esses resultados podem estar relacionados com o fato de os reservatórios, nesse período hidrológico, apresentarem uma nítida redução de suas dimensões (área e profundidade), determinando uma maior influência de organismos bentônicos para a composição e abundância da comunidade protozooplanctônica.

Palavras-chave: tecamebas, plâncton, abundância, reservatórios.

Introduction

Although testate protozoans are organisms preferably associated to a substrate (marginal vegetation or sediment), these organims have been registered as frequent and some times abundant in potamoplankton as well as in lacustrine plankton (Arndt, 1993; Green, 1994).

Among the groups making up the protozooplankton communities in Brazilian freshwater ecosystems, the testate amoebae have been more intensively studied than ciliates and flagellates, probably related to the differences and dificulties in methodology as these two last groups are not sampled efficiently with nets or suitable preserved in formalin solutions (Gomes and Godinho, 2003). Among the studies which included testate protozoan in the plankton to become detached those developed by Rolla *et al.*(1992), Dabés (1995), Lansac-Tôha *et al.* (1997, 2000, 2004), Velho *et al.* (1999, 2003, 2004), Gomes and Godinho (2003) and Bini *et al.*(2003).

The results obtained in those surveys have taken us to predict that the testate amoebae abundance are, in general, related to current flow and environmental dimensions, responsible by a higher or lower fauna interchange between littoral and deep regions and plankton compartment. In this way, in the present study, we premise that, in in plankton of the lacustrine region of reservoirs, higher testate protozoans abundance must be observed in reservoirs with smaller dimensions (depth and width) and a higher current flow. Seasonally, higher densities should occur during rainy season, determined by increase of current flow and greater organisms displacement to plankton compartment, in this hydrological period.

This study aimed to investigate patterns of spatial and temporal distribution of testate amoebae abundance in plankton of different reservoirs of Paraná State and the importance of hydrodinamical and morphometrical factors on determining these patterns.

Material and methods

Study area

Thirty reservoirs studied are located in six different watersheds in Paraná State, including environments with variable area, morphometry and age (Figure 1; Table 1), and with different anthropogenical occupation degrees.

These reservoirs present variable priority uses, as electric power generation, water supply and enjoyment. Most of them, however, is used to generate electric power, and some of them present special social and economical importance because they are source of water supply to large urban centers. Physical and chemical characteristics of studied environments are presented in Pagioro *et al.* (in press).

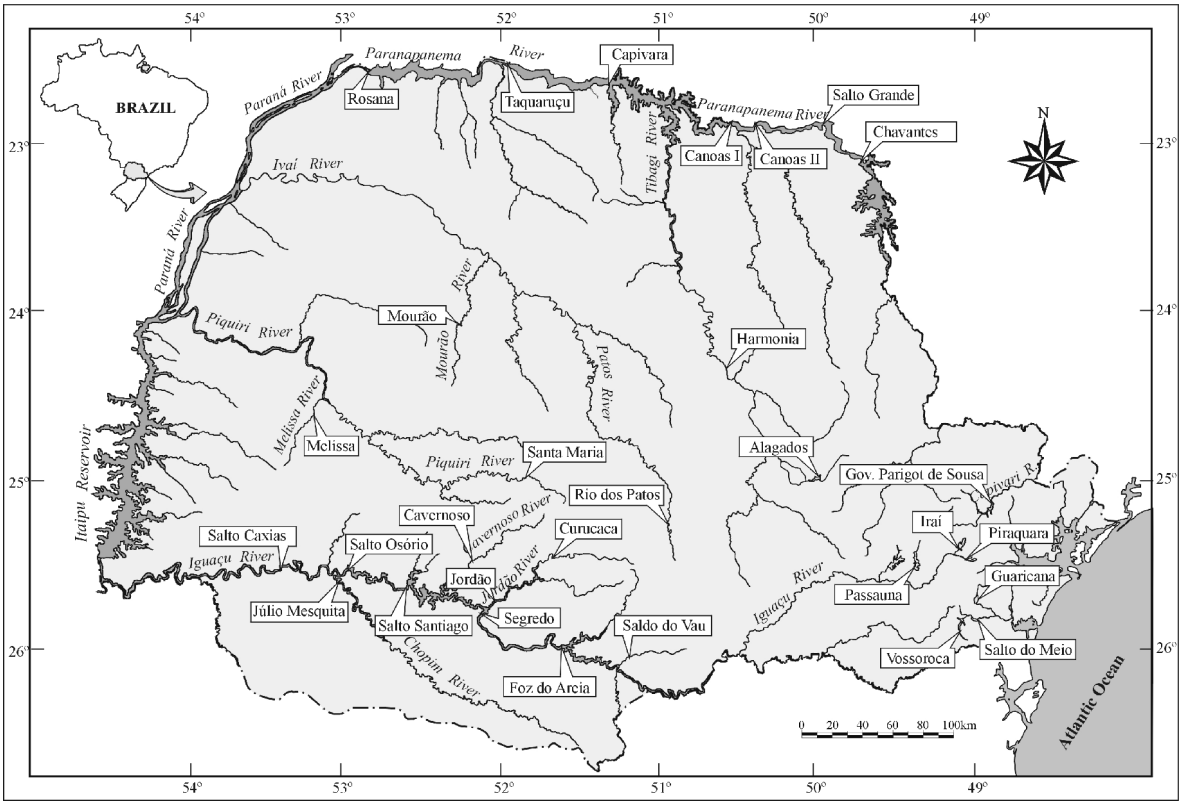

Figure 1. Paraná State map with the location of studied reservoirs.

Table 1. List of studied reservoirs, with their respective areas, age, mean depth and watershed where they are located.

Reservoirs	Watershed	Depth (m)	Area (km^2)	Age (years)

Rosana	Paranapanema	26	220	18
Taquaruçu	Paranapanema	26,5	40,8	12
Capivara	Paranapanema	52,5	515	29
Canoas I	Paranapanema	26	30,85	5
Canoas II	Paranapanema	16,5	22,54	4
Salto Grande	Paranapanema	9,2	8,4	46
Chavantes	Paranapanema	87	242	34
Harmonia	Tibagi	12	0,64	62
Alagados	Tibagi	9,25	7,31	85
Parigot de Souza	Leste	43	13	34
Guaricana	Leste	17	0,86	47
Salto do Meio	Leste	6,2	0,12	73
Voçoroca	Leste	12,5	5,1	55
Iraí	Iguaçu í	8,5	14,4	5
Piraquara	Iguaçu	18	3,3	25
Salto do Vau	Iguaçu	3,75	0,4	45
Foz do Areia	Iguaçu	135	139	24
Salto Segredo	Iguaçu	101	80,4	12
Salto Santiago	Iguaçu	78	208,0	24
Salto Osório	Iguaçu	43	62,9	29
Salto Caxias	Iguaçu	53	141,43	6
Jordão	Iguaçu	60	3.35	8
Curucaca	Iguaçu	10,5	0,8	22
Cavernoso	Iguaçu	8,3	0,05	39
JMF	Iguaçu	6	0,45	34
Rio dos Patos	Ivaí	5.75	1,3	55
Santa Maria	Piquiri	4.3	0.05	30
Melissa	Piquiri	5,3	0,05	42
Mourão	Ivaí	12.7	11.2	40

Sampling and laboratorial analysis

Sampling were carried out in 30 reservoirs in Paraná State (Figure 1; Table 1), in July and November 2001, dry and rainy seasons, respectively. Samples were obtained at the surface of reservoirs, in the lacustrine region, using a motorized pump (600 liters) and a plankton net with a mesh size of 68 μm. Collected material was preserved with 4% formalin buffered with calcium carbonated and counted under a compound microscope using Sedgwick-Rafter chambers. Samples were stained with Rose Bengal and only organisms with colored protoplasm within the thecae were counted, assuming that such individuals were alive at the time of sampling.

Data analysis

To infer relationships between abiotic factors and distribution of testate amoebae density, in the reservoirs studied, Pearson Correlation Analyses were employed using STATISTICA software version 5.0 (Statsoft Inc, 1997). Abiotic and biotic data were log (x+1) transformed to approximate normal distribution and to stabilize variances. Besides that, since the lack of current velocity data, correlations with inorganic suspended material were carried out considering the existence of strong correlation between these two last variables. To determine inorganic suspended material ($mg.L^{-1}$) (APHA, 1985), samples were filtered in Whatman GF/C filters.

Results and discussion

Testate amoebae were registered in 23 of 30 studied reservoirs. Abundance values ranged from 4 to 2484 $ind.m^{-3}$. Higher density values were observed in JMF (Júlio Mesquita Filho), Salto do Meio, Melissa, Mourão and Salto do Vau reservoirs, during dry season, and JMF, Salto Osório, Salto do Meio and Melissa reservoirs, during wet season (Figure 2). These reservoirs present similar characteristics, as reduced depth and morphometric dimensions (Table 1). Besides that, most of them have hydrodynamical features similar to lotic environments, due to presenting high current velocity. On the other hand, testate amoebae were absent or presented low density values, in general, in reservoirs with higher dimensions and depth.

According to Lansac-Tôha *et al.* (1999, 2000), in large and deep reservoirs the compartments are isolated, limiting faunal interchange among benthos, littoral and plankton communities. In such reservoirs, testate amoebae occur mainly in the main river, tributaries and in the fluvial zone.

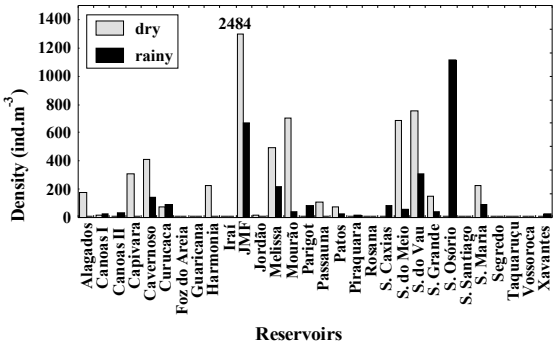

Figure 2. Testate amoebae densities registered in 30 studied reservoirs in different hydrological periods (dry and rainy seasons).

Correlations results between testate amoebae densities and morphometrical and hydrodinamical characteristics of reservoirs are showed on Figure 3. Significant correlations were observed to depth ($p=0.48$; $r=-0.323$), area ($p=0.001$; $r=-0.54$) and results of inorganic suspended material ($p=0.01$; $r=0.51$), evidencing a tendency to observe higher values of testate amoebae densities in smaller reservoirs, shallower and with higher current flow (Figure 3). As predicted, results suggest that reservoir dimensions and current velocity are relevant factors in determining spatial distribution patterns of testate amoebae abundance in studied reservoirs.

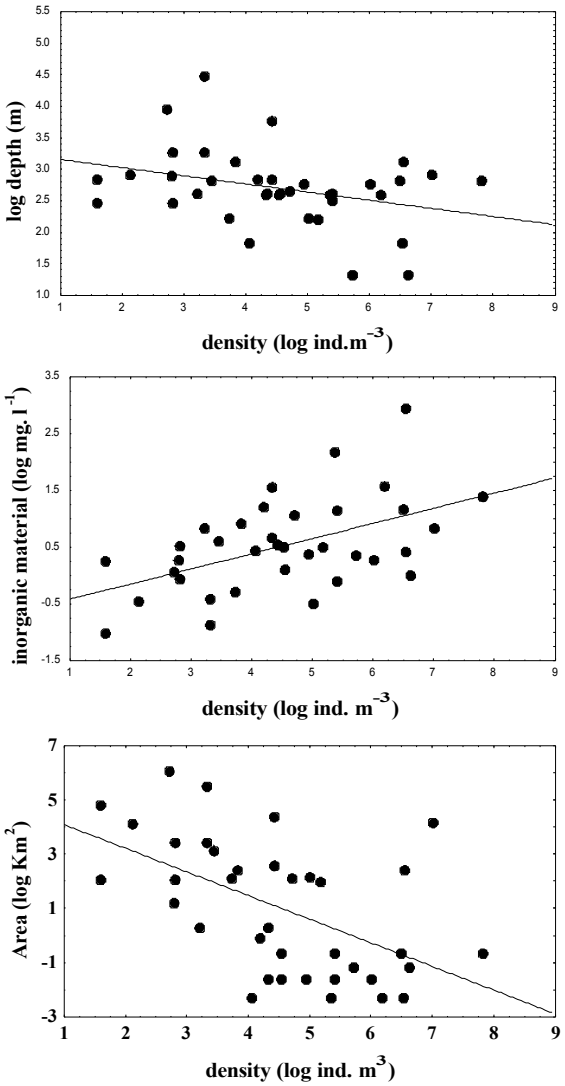

Figure 3. Relationships between testate amoebae and (a) reservoir area; (b) depth and (c) inorganic suspended material in 30 studied reservoirs.

Instead of expected, seasonally, higher densities values were observed during dry season, for the most of studied reservoirs (Figures 2 and 4).

Gomes and Godinho (2003), studying the structure of the protozooplankton community in a tropical reservoir observed a seasonal variation where higher densities of testate amoebae were detected in the warm-wet season. In the same way, in the Corumbá reservoir, State of Goiás, higher values of density were observed during rainy season (Lansac-Tôha *et al.*, 2000). According to these authors, the increase in the flow velocity and discharge in this hydrological period causes a re-suspension of the organisms associated with the sediment and the washout of the marginal vegetation, carrying the testate amoebae to the water columm.

In contrast, the results obtained in the present study can be related to the fact that the reservoirs which show high values of density during dry season have a remarkable reduction of their dimentions (area and depth) in this period, determining a greater influence of the benthonic organisms to the composition and abundance of the protozooplankton community.

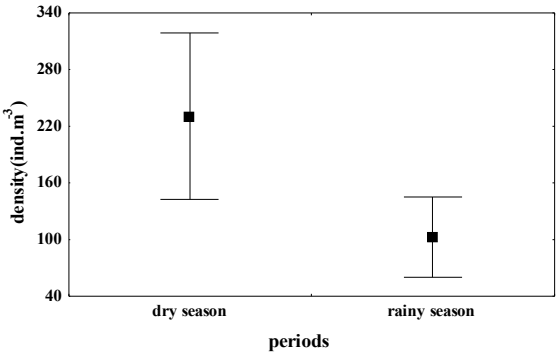

Figure 4. Differences of testate amoebae densities (ind.m^{-3}) between dry and rainy seasons (symbol=mean; bar= standard error).

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