Composition and temporal changes of phytoplankton community in Lake Quebra-Pote, MA, Brazil.

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ABSTRACT: Taxonomic composition and temporal changes in phytoplankton community of Lake Quebra-Pote (Maranhão State, Brazil). The phytoplankton of Lake Quebra-Pote was examined by intervals during a hydrological cycle, in order to record temporal changes in the species composition and in the abundance of main groups of algae. Physical and chemical characteristics of water were also analyzed. Five samplings were carried out in different periods of the hydrological cycle: drought (1997), rising water, flooding, water falling and drought (1998). A total of 102 taxa were found: 15 Bacillariophyceae, 26 Chlorophyceae, 1 Chrysophyceae, 19 Cyanophyceae, 1 Dinophyceae, 17 Euglenophyceae, 1 Xanthophyceae and 22 Zygnematophyceae; these data indicate a diversified algal community. Most taxa constitute new records for Maranhão, partly because phycological inventories are rare and partly due to the intrinsic peculiarity of the local flora, which was different from those in Lake Caçó and the interdunal lakes of Lençóis Maranhenses, inventoried in earlier papers. Turbulence, rainfall and water-level fluctuations were considered the main factors controlling the successional dynamics. The Cyanophyceae class was the most abundant and dominant group in three periods sampled quantitatively: water rising (38%), water falling (48%) and drought (54%). Bacillariophyceae was the most abundant class only in the flooding period, representing 48% of the phytoplankton community. Turbulence, precipitation and water-level fluctuations probably controlled this change. The highest algal densities occurred in the drought period. However the dominance of Cyanophyceae, a low-quality food resource, may conduct to a food chain via detritus, whereas during the flooding the abundant Bacillariophyceae may support a herbivorous food chain and higher secondary productivity.

Key-words: phytoplankton, floodplain lakes, flooding pulse, Lake Quebra-Pote, algae, biodiversity.

RESUMO: A composição taxonômica e as variações temporais na comunidade fitoplanctônica do lago Quebra Pote, MA, Brasil. O fitoplâncton do lago Quebra Pote, estado do Maranhão, foi estudado ao longo de um ciclo hidrológico, com relação às variações temporais na composição de espécies e na densidade dos principais grupos fitoplanctônicos. As características físicas e químicas da água foram também analisadas. Foram realizadas cinco amostragens, em diferentes fases do ciclo hidrológico: seca (1997), enchente, cheia, vazante e seca (1998). Foram registrados 102 táxons: 15 Bacillariophyceae, 26 Chlorophyceae, 1 Chrysophyceae, 19 Cyanophyceae, 1 Dinophyceae, 17 Euglenophyceae, 1 Xanthophyceae e 22 Zygnematophyceae, indicando ser esta uma comunidade bastante diversificada. Muitas espécies representam novas ocorrências para o estado do Maranhão, em parte pela escassez de inventários ficológicos e em parte pela peculiaridade da flora local, que foi diferente daquela do lago Caçó e de lagoas dos Lençóis Maranhenses, onde foram realizados estudos anteriores. A classe Cyanophyceae foi a mais abundante em três dos quatro períodos avaliados, com predominância nos períodos de seca (38%), vazante (48%) e enchente (54%). Somente na cheia, a classe Bacillariophyceae foi a mais abundante, representando 48% do total de organismos fitoplanctônicos. A turbulên-

cia, a precipitação e variações no nível d'água são os prováveis fatores controladores. As maiores densidades algais ocorreram no período de seca, no entanto a dominância de Cyanophyceae, um alimento de baixa qualidade, deve resultar numa cadeia alimentar via detrítica, ao passo que no período de inundação, as Bacillariophyceae, então abundantes, devem suprir uma cadeia alimentar de herbivoria e uma maior produtividade secundária.
Palavras-chave: fitoplâncton, lagos de planície, pulso de inundação, lago Quebra Pote, algas, biodiversidade.

Introduction

The phytoplankton is the main primary-producer community in the majority of aquatic ecosystems, thus constituting the base of the food-chain in the plankton as well as in other linked communities, such as benthos and nekton. Phytoplankton organisms range from prokaryote algae (Cyanophyta) up to the eukaryotes. Developed phytoplankton communities are restricted to lentic waters and large rivers with reduced flow-rates (Wetzel, 1975).

A set of interacting environmental factors regulates the population growth and the spatial and temporal distribution of phytoplankton. Besides the basic requirements of temperature and light which control the permanence of the organisms in the euphotic zone, the availability of micro and macronutrients have critical roles in the succession of algal populations (Reynolds, 1984; Harris, 1987). Information about both the species composition and patterns of phytoplankton occurrence, have great relevance for the understanding of functioning of aquatic ecosystem as a whole.

Among the numerous habitats colonized by algae, the floodplain lakes are peculiar as a consequence of the strong interaction with the fluvial system. In such lakes the hydrological cycle is often the main factor controlling the biological events and usually two well-defined periods can be distinguished: one starting with the movement of the water from the river towards the floodplain and extending until fluvial water will be back to the river channel – the potamophase, and the other when the floodplain receives no material or energy from the river – the limnophase (Neiff, 1990). During the changes from one phase to the next, there are the transition periods, when the water level is rising or falling. In accordance with the water level fluctuations, there are thus four distinguishable periods: water rising; flood; water falling and drought (Huszar, 1994).

The flood-pulse concept has been developed and particularly applied to tropical floodplain rivers (Junk et al., 1989; Neiff, 1990), showing that the dynamic of interactions between terrestrial and aquatic systems is determined by community organization and production patterns.

The natural fields of the "Baixada Maranhense" (Maranhão lowlands) in the Turiaçu river floodplain are examples of ecologically complex systems dominated by the flood-pulse regime. Great changes in water level across the plains of Baixada Maranhense occur seasonally as a consequence of well-defined dry and wet seasons (Barbieri et al., 1989). Studies on the biological communities are in early stage considering the lakes myriad in the area, and that most of them have not been studied. The present work focuses on the phytoplankton community in Lake Quebra-Pote, one of the lakes of Turiaçu River floodplain. The taxonomic composition, the temporal changes in density of the main taxa and related physical and chemical variables are analysed.

Material and methods

Lake Quebra-Pote is located at the middle portion of Turiaçu River basin (2°15´S, 45°19´W), a river of equatorial regime with headwaters originating in the

Serra do Tiracambu, the Northern highlands of Maranhão State, North of Brazil (Fig. 1). The lake has an area of approximately 0.37 km², length 750m; width 500m and maximum and minimum depths of 6.0m and 0.50m, respectively. The surrounding soil is hydromorphic.

The regional weather is equatorial or tropical (Am and Aw, in the Köppen system), with a mean annual temperature of 26°C and an annual range of 2 – 3°C. Annual rainfall varies between 1000 and 2000mm.

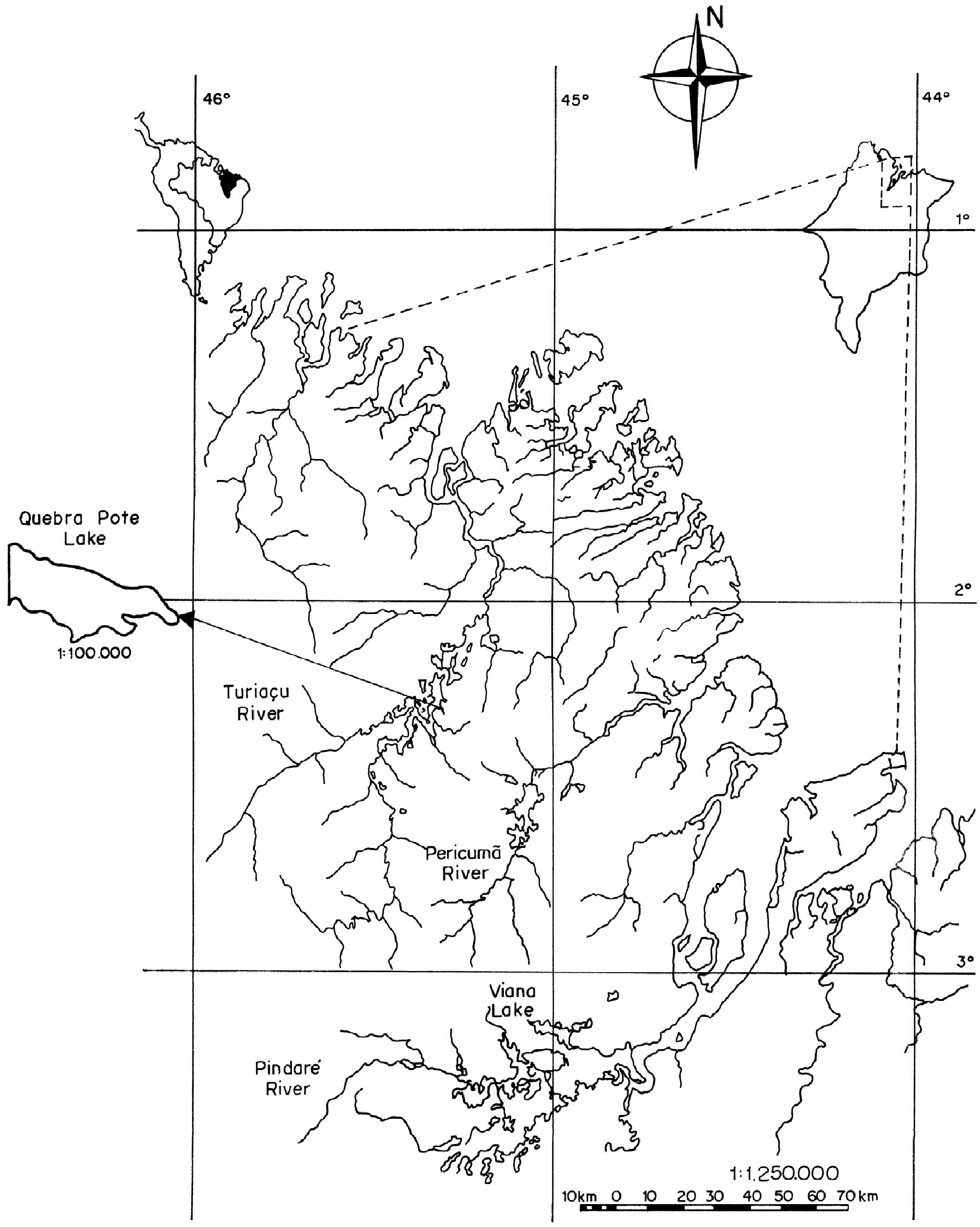

Figure 1: Map showing State of Maranhão in Brazil and South America, partial hydrography of the State and the location of Lake Quebra-Pote in Turiaçu River.

Sampling was carried out in five different periods for qualitative analysis: drought (November, 1997); rising water (March, 1998), flood (May, 1998) falling water (August, 1998) and drought (December, 1998); and four for quantitative analysis, except the drought period of 1997, when as a consequence of extremely low water level it was not possible to collect samples for quantitative analysis of phytoplankton. Samples were taken at a single point in the central region of the lake, at two depths: in the surface and near the bottom (0.2m above sediment). Simultaneous in situ measurements of water transparency (Secchi Disk), pH, electrical conductivity and dissolved oxygen concentration were measured by using a multisensor (Horiba U10) equipment. Water samples were analysed in the laboratory to determine nutrient concentrations: total nitrogen, nitrite, nitrate, ammonium, dissolved total phosphorus, dissolved inorganic phosphorus, dissolved organic phosphorus and reactive silica following the procedures described in Mackereth et al. (1978) and Golterman et al. (1978).

For phytoplankton qualitative analyses, horizontal net hauls were carried out with a 20mm net and samples were preserved in 4% formalin solution. Observations were performed under high-magnification photomicroscope (1600x magnification). Individual dimensions were measured, drawings made and photos taken (Nogueira, 2003). For taxonomical identification, permanent slides were mounted with both, natural and oxidized material, as described in Moreira-Filho & Valente-Moreira (1981). Samples and permanent mounted slides are kept at the Phytoplankton Laboratory of the Federal University of Maranhão and will be incorporated to Herbarium of the Pharmacy Department. The following specialized literature was referred to, according to the algal group: Geitler (1932); Senna (1982); Komárek & Fott (1983); Bicudo & Samanez (1984); Croasdale & Flint (1986; 1988); Anagnostidis & Komárek (1988); Komárek & Anagnostidis (1989; 1999); Bicudo & Castro (1994); Croasdale et al. (1994) and Menezes (1994). Quantitative samples were collected with a four litre Van Dorn bottle and 250mL samples were preserved in acidic Lugol solution (1% solution). Individuals (cell, colony, filament, or cenobium) were counted using an inverted CARL ZEISS microscope, as described by Utermöhl (1958), in random microscopic fields (Uhelinger, 1964).

Chlorophyll a was determined by extracting in 90% aceton (Golterman et al., 1978, modified by Wetzel & Likens, 1991) and concentrations of nutrients (silicate, nitrogen and phosphorus) were quantified according to the methods described in Golterman et al. (1978).

Inorganic suspended solids (ISS) were determined through gravimetrical method.

Precipitation data were obtained from the Center for Meteorology and Hydric Resources of the Maranhão State University.

Phytoplankton taxon composition of Quebra Pote Lake was compared to those of Caçó and interdunal lakes of Lençóis Maranhenses formation by Cluster analysis using presence and absence data (unweighetd pair group method based on the Jaccard's coefficient).

Results

The main physical and chemical characteristics of Lake Quebra-Pote, during the period of study, are summarized in Tab. I. The water pH is close to neutral, showing little variation throughout the year, and no seasonal pattern. Electrical conductivity was quite high during the dry period (210.0mS.cm^{-1}), probably due to the effect of mineral concentration in water in such period. Water temperature also had a very small seasonal range (28.0 to 32.0°C), with the lowest values during the dry period (November/December) and the highest during the flood. The values obtained for dissolved-oxygen concentration indicated the existence of oxygenated water column, with a minimum of 5.27mg.L^{-1} in the dry period (December, 1998) and a maximum of 7.61mg.L^{-1} during the falling water period, in August, 1998.

Table I: Physical and chemical parameters in the surface layer of Lake Quebra-Pote during different phases of the hydrological cycle. T = temperature; Con = conductivity; DO= dissolved oxygen, ISS = inorganic suspended material. nd = non-determined; ¾ = lost sample.

Variables	Nov. 1997 Drought	Mar 1998 Rising water	May, 1998 Flood	Aug. 1998 Falling Water	Dec. 1998 Drought
Lake depth (m)	0.5	4.65	6.0	1.9	1.5
Secchi depth (m)	0.15	0.40	0.85	0.33	nd
pH	6.74	6.9	6.7	6.7	7.4
Con (mS.cm^{-1})	140	___	50	65	210
T (^{o}C)	28	31	30	32	29.5
DO (mg.L^{-1})	6.29	nd	5.27	7.61	5.75
ISS (mg.L^{-1})	137	15.8	nd	31	150.5

During the study, the great fluctuation in the water level was related to the regional rainfall cycle, shown in Fig. 2. The depth of the lake varied from a minimum of 0.5m in dry season (November, 1997) to a maximum of 6.0m in flood period (May, 1998). The highest concentrations ofinorganic suspended solids were found in the dry periods (Tab. I).

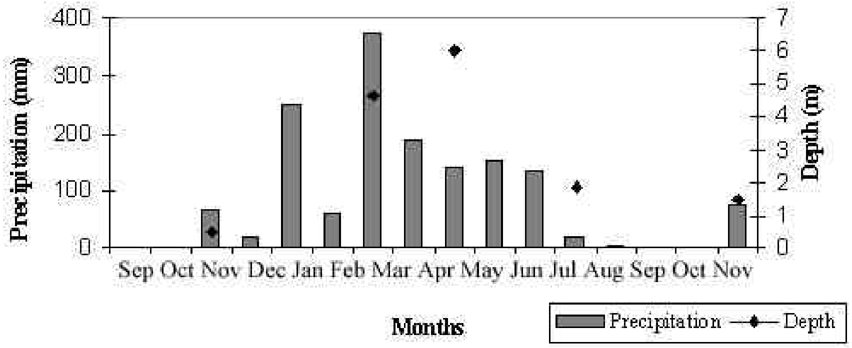

Figure 2: Monthly total rainfall (mm) for the period September 1997 to December 1998 in Santa Helena district, MA, Brazil and Lake Quebra-Pote depth (m) recorded at each phase of the hydrological cycle.

The qualitative analysis of samples taken in the five hydrological phases revealed that the phytoplankton community of Lake Quebra-Pote, was represented by a total of 102 taxa (species or genus). The Chlorophyta group, encompassing Chlorophyceae and Zygnematophyceae, had the highest richness, represented by 26 and 22 taxa, followed by Cyanophyta (Cyanophyceae) with 19 taxa, as illustrated in Tab. II. The temporal analysis of the phytoplankton community revealed great changes in species richness (Tab. II), the greatest being found during rising water (March, 1998) and flood (May, 1998) with 54 taxa recorded in each period.

In relation to the relative abundance of phytoplankton groups (Fig. 3), Cyanophyceae was dominant in three among four periods, except during the flood period (May, 1998), when Bacillariophyceae was dominant.

There were also great changes in phytoplankton densities. The highest densities occurred in dry and rising water periods (Tab. III). The values obtained for chlorophyll a concentrations indicated similar changes in phytoplankton biomass, with highest values in the same periods. (Tab. IV).

The nutrient concentrations (dissolved and total) are shown in Tab. IV. For total nitrogen the samples from May 1998 were lost and are referred as nd (non-determined). It can be observed that the highest concentration of total nitrogen and total phosphorus occurred in the dry period with maximum values of 2369.3mg.L^{-1} and 220.3mg.L^{-1}

respectively, recorded in the dry period of November 1997. A similar tendency of highest concentrations in dry periods was found for ammonium, nitrite and inorganic phosphorus.

Table II: Taxonomic composition, richness and occurrence of phytoplankton taxa in the different phases of the hydrological cycle, in Lake Quebra-Pote, MA, for the period of November, 1997 to December, 1998.

Taxa	Nov 1997	Mar 1998	May 1998	Aug. 1998	Dec 1998
Bacillariophyceae					
Achnanthes sp	X	X	X		X
Aulacoseira italica			X		X
Aulacoseira granulata	X	X	X	X	X
Aulacoseira granulata var. Angustissima	X	X	X	X	X
Aulacoseira sp		X	X		
Cocconeis sp					X
Coscinodiscus oculusiridis	X				
Cyclotella sp	X				
Eunotia sp		X			
Nitzschia sp	X	X	X		
Pinnularia sp	X			X	X
Skeletonema costatum		X			
Surirella linearis	X	X			X
Surirella robusta	X			X	X
Synedra sp			X		
Subtotal	**9**	**8**	**7**	**4**	**8**
Chlorophyceae					
Coelastrum pulchrum	X	X	X	X	
Coelastrum sp	X			X	
Crucigenia crucifera	X	X			
Dictyosphaerium sp	X		X		
Dimorphococcus sp	X				
Eudorina elegans		X	X	X	
Golenkinia radiata	X	X	X		
Kirchneriella cf. lunaris				X	
Kirchneriella obesa					X
Micractinium sp			X		
Monoraphidium sp			X		
Oocystis borgei	X	X			X
Pediastrum duplex	X	X	X	X	X
Pediastrum duplex var duplex					X
Pediastrum duplex var. reticulatum	X	X	X	X	
Pediastrum duplex var. subgranulatum	X				X
Pediastrum tetras	X	X			X
Scenedesmus bicaudatus	X	X			
Scenedesmus javanensis	X	X	X		
Scenedesmus producto-capitatus	X	X	X		
Scenedesmus quadricauda var. quadricauda	X	X	X		X
Scenedesmus sp	X	X	X		
Tetraëdron gracile	X	X			
Tetraplektron laevis		X	X		
Treubaria triappendiculata	X	X	X		
Tetrastrum sp		X			
Subtotal	**18**	**17**	**14**	**6**	**7**

Table II: Cont.

Chrysophyceae					
Dinobryon sp			X		
Subtotal	**0**	**0**	**1**	**0**	**0**
Cyanophyceae					
Anabaena aphanizomenoides				X	X
Anabaena flos-aquae	X			X	X
Anabaena planctonica	X				X
Aphanizomenon gracile					X
Aphanizomenon tropicale	X				
Aphanocapsa delicatissima	X			X	X
Chroococcus sp	X				X
Cylindrospermopsis raciborskii					X
Dactylococcopsis sp	X				
Leptolyngbya sp				X	
Microcystis aeruginosa	X				X
Microcystis ichthyobable					X
Microcystis wesenbergii	X		X		
Microcystis sp	X				X
Oscillatoria sp1			X		
Phormidium retzii	X				X
Phormidium simplicissimum					X
Planktolyngbya circuncreta	X	X	X	X	X
Planktothrix mougeotii	X			X	X
Subtotal	**12**	**1**	**3**	**6**	**14**
Dinophyceae					
Peridiniopsis sp	X	X	X		
Subtotal	**1**	**1**	**1**	**0**	**0**
Euglenophyceae					
Euglena acus	X	X	X		X
Euglena oxyuris	X		X		X
Euglena sp		X	X		
Lepocinclis sp		X	X		
Phacus curvicauda		X	X		
Phacus ephippion	X				
Phacus longicauda	X	X	X		
Phacus orbicularis	X				
Phacus sp	X		X		
Strombomonas ensifera		X	X		
Strombomonas fluviatilis	X	X	X		
Strombomonas verrucosa	X				
Strombomonas sp	X		X		
Trachelomonas armata		X	X		
Trachelomonas volvocina		X	X		
Trachelomonas sp1		X		X	
Trachelomonas sp2		X	X		
Subtotal	**9**	**11**	**13**	**1**	**2**
Xanthophyceae					
Centritractus sp				X	
Subtotal	**0**	**0**	**0**	**1**	**0**

Table II: Cont.

Zynematophyceae					
Cosmarium sp		X		X	
Closterium aciculare		X			
Closterium leibleinii		X			
Closterium sp			X		X
Euastrum sp		X			
Gonatozygon aculeatum			X		
Gonatozygon sp		X	X		
Mougeotia sp1			X	X	
Mougeotia sp2				X	
Onychonema laeve		X	X		
Pleurotaenium					
Spirogyra sp		X	X		
Staurastrum glabribrachiatum			X		
Staurastrum leptacanthum		X	X	X	
Staurastrum leptocladum var. smithii	X	X	X	X	X
Staurastrum paradoxum		X			
Staurastrum setigerum		X	X		
Staurastrum tohopekaligense		X	X		
Staurastrum sp1	X	X	X		
Staurastrum sp2		X	X		
Staurodesmus sp1		X	X		
Staurodesmus sp2		X	X	X	
Subtotal	**2**	**16**	**15**	**6**	**2**
Total	**51**	**54**	**54**	**24**	**33**

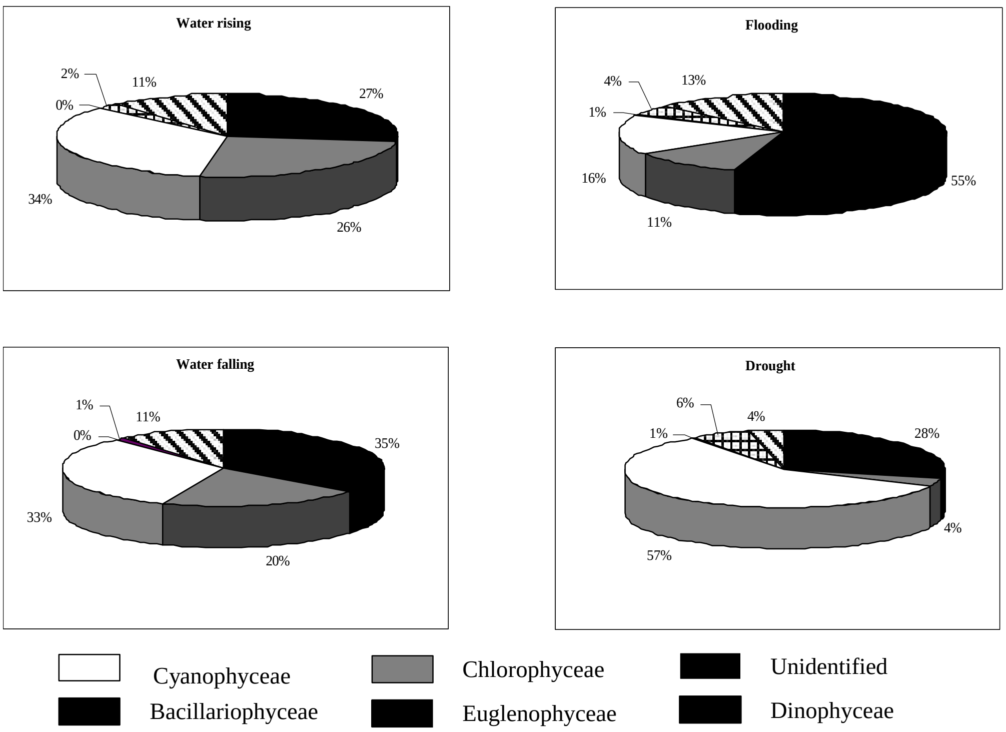

Figure 3: Relative abundance of phytoplankton groups in Lake Quebra-Pote at different phases of the hydrological cycle during the period from November 1997 to December 1998

Table III: Phytoplankton total density (individuals.mL^{-1}) registered in surface and bottom layers of Lake Quebra Pote, at different phases of the hydrological cycle during the period from March 1998 to December 1998; S = surface, B = near bottom. ¾ = lost sample.

Depth	March 1998 Water rising	May 1998 Flooding	August 1998 Falling water	December 1998 Drought
S (0m)	4910	1894	1958	3682
B (1.30-5.80m)	3221	1740	2177	___

Table IV: Nutrients and chlorophyll a recorded in Lake Quebra-Pote in different phases of the hydrological cycle, during the period November 1997 to December 1998. (N-NO_2 = nitrite; N-NH_4 = ammonium; TN = total nitrogen; TP = total phosphorus; DIP = dissolved inorganic phosphorus; PO_4 = dissolved organic phosphorus; SiO_4 = silicate and Chl a = chlorophyll a. S = surface, B = bottom).

Variables		Nov 1997 Drought	Mar 1998 Water rising	May 1998 Flooding	Aug 1998 Falling Water	Dec 1998 Drought
N-NO_2($mg.L^{-1}$)	S	10.3	3.9	3.2	2.6	21.8
	B	___	2.5	3.9	1.8	___
N-NH_4 ($mg.L^{-1}$)	S	194.6	47.5	96.9	25.0	326.3
	B	___	43.0	106.8	24.1	___
TN ($mg.L^{-1}$)	S	2369.3	480.3	Nd	176.7	124.0
	B		450.5	Nd	149.0	___
TP ($mg.L^{-1}$)	S	220.3	22.1	42.6	45.0	264.2
	B	___	___	40.6	38.5	___
PO_4 ($mg.L^{-1}$)	S	73.8	20.8	14.8	13.8	247.9
	B	___	19.3	18.2	8.1	___
SiO_4 ($mg.L^{-1}$)	S	1.0	1.8	4.0	0.8	3276.1
	B	___	3.2	4.2	2.7	___
Chl a ($mg.L^{-1}$)	S	40.7	26.1	7.35	7.3	27.5
	B	___	29.5	5.9	5.9	___

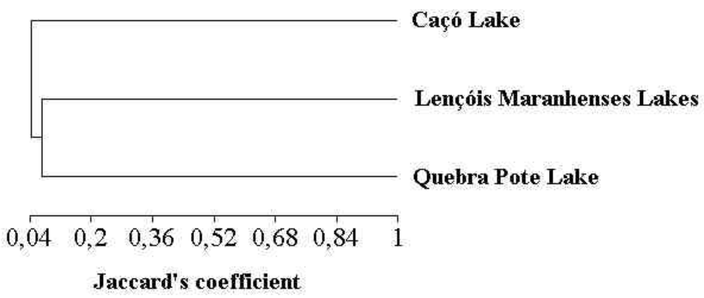

Figure 4: Cluster analysis comparing phytoplankton taxon composition (presence – absence) among the lakes Quebra Pote, Caçó and interdunal lakes in Lençóis Maranhenses, Maranhão State.

Discussion

Lake Quebra Pote is a shallow, turbid and warm tropical lake. Its waters have pH nearly neutral, are oxygenated and have moderate conductivity during periods of high water levels (flood and falling water periods). Conductivity and inorganic suspended solid concentrations increase considerably during dry periods, probably as a consequence of sediment re-suspension under low water levels. This is also a possible explanation for the very high nutrient levels found during dry periods.

The phytoplankton community of Lake Quebra Pote was represented in the samples by numerous genera and species among Chlorophyta (from both Classes

Chlorophyceae and Zygnematophyceae). Cyanobacteria (Cyanophyceae) also contributed significantly to the richness of taxa. The combination of these groups as main contributors to the richness of phytoplankton communities is frequently observed in tropical ponds, lakes and reservoirs in many regions in Brazil (Xavier et al., 1985; Huzsar, 1994; Marinho, 1994; Silva, 1995; Beyruth, 1996; Branco & Senna, 1996; Espíndola et al., 1996; Ferreira, 1998; Calijuri, 1999; Henry & Nogueira, 1999; Menezes, 1999; Nogueira, 1999 and Souza, 2000).

Among the Cyanophyceae recorded in Lake Quebra-Pote the species Microcystis aeruginosa, Microcystis wesenbergii, Anabaena flos-aquae, Anabaena planctonica, Aphanizomenon tropicale and Cylindrospermopsis raciborskii, deserve special attention, as Sant' Anna & Azevedo (2000) warned recently, due to their potential to produce toxins.

When the Lake Quebra-Pote phytoplankton was compared with those of other lakes in Maranhão State it was found that its phycological flora is quite distinctive and that very rich in species. Only one among the 170 species from Lake Quebra-Pote algae also occurred in Lake Caçó (107 species), which is located in the Northeast of the state, Primeira Cruz district, at a distance of 100 Km from the sea (Dellamano, 2001). Nevertheless, the two samples belonged to different varieties: Staurastrum leptocladum var. cornutum in Lake Caçó and Staurastrum leptocladum var. smithii in Lake Quebra-Pote. In Lençóis Maranhenses interdunal ponds, close to Barreirinhas district, among the 68 taxa recorded by Araújo (2000), only 5 species were shared with Lake Quebra-Pote: Pediastrum duplex, Pediastrum tetras, Scenedesmus acuminatus, Scenedesmus quadricauda var. quadricauda and Phacus longicauda. In the same region, Espíndola et al. (1998) recorded 124 taxa, among which four (Scenedesmus acuminatus, S. quadricauda, Pediastrum tetras and Staurastrum leptocladum) were also found in Lake Quebra-Pote. From the Boa Esperança Reservoir (Maranhão-Piauí border) Pompêo et al. (1998) identified 102 taxa, ten of which also occurred in Lake Quebra-Pote (Microcystis aeruginosa, Ankistrodesmus falcatus, Scenedesmus acuminatus, Tetraëdron gracile, Sphaerozosma (Onychonema) laeve, Staurastrum leptacanthum, Staurastrum leptocladum, Staurastrum clepsydra, Aulacoseira granulata and Surirella linearis).

In many tropical and subtropical waterbodies, the Cyanophyceae can be the predominant group in the phytoplankton during some periods of the year, forming dense blooms and dominating in numbers as well in biomass.

In Lake Quebra-Pote, Cyanophyceae was, numerically, the most abundant group of phytoplankton in three of the periods analyzed. Only during the flood period Bacillariophyceae was predominant, probably due to the instability generated by the rainfall. Being S-strategists (Reynolds, 1984) Cyanophyceae can grow at the lower light intensities found in periods of low water level and high turbidity. According to Ibañez et al. (2000) the lakes in the floodplain of River Turiaçu receive a great amount of suspended particles, both inorganic, mainly transported by the river, and organic, from the riparian vegetation. Turbidity created by the entrance of these allochthonous material could perhaps favor this kind of algae. The maximum phytoplankton densities in Lake Quebra-Pote occurred in the dry or rising water periods associated with Cyanophyceae blooms. Concentrations of nitrogen and phosphorus nutrients and of chlorophyll also occurred in the dry period, indicating that availability of nutrients and the highest phytoplankton biomass were temporally related. These densities were similar to those recorded by Dellamano (2001) in Lake Caçó, a large, old interdunal lake, also in Maranhão State. Train & Rodrigues (1997) also found that in the shallow lakes of the Paraná River floodplain (Southeast Brazil) the highest density and biomass of phytoplankton were associated with Cyanophyceae blooms. Considering the great fluctuation in water level occurring in Lake Quebra-Pote (0.5 to 6.0m, see Tab. I), along the hydrological cycle, it would be possible that the total phytoplankton in the lake as a whole could be highest at the highest water level, during the flood period, although the relative densities were highest in the dry period, due to the greatly reduced water column. However, this cannot be checked at the present because lake volume is not known yet. It is also in the flood period that diatoms predominate and that the algal food has a better quality. It is well known that cyanobacteria are low quality algal food (Engström-Öst, 2002; Becker & Boersma, 2003) whereas diatoms can be consumed by many zooplankton species (Porter & Orcutt, 1997). Although this seems to correlate with the high biomasses of fishes taken by local fisheries during the flooding periods in Baixada Maranhense lakes (Sematur, 1991), there is no information on fish feeding habits so far. During other periods, with lower water level and predominance of Cyanophyceae, which is already recognized as a poor quality food, direct herbivory is probably reduced and the detritus route might be the most important route for energy transference in food-chains.

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