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# Phytoplankton in Coqueiro Lake (Pantanal de Poconé, Mato Grosso, Brazil)

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## Resumo

**Fitoplâncton da baía do Coqueiro (Pantanal de Poconé, Mato Grosso).** Estudos sobre a composição florística são essenciais para compreender mudanças quali-quantitativas nas assembleias fitoplanctônicas ao longo do ano. A variação espaço-temporal da composição, riqueza, frequência de ocorrência e abundância (semiquantitativa) da comunidade fitoplanctônica foi analisada mensalmente (de abril de 2002 a maio de 2003), em três estações, na baía do Coqueiro (Pantanal, Mato Grosso). Foram registrados 256 táxons, representados principalmente por Zygnematophyceae (36%), Chlorophyceae (21%) e Euglenophyceae (14%). A maior abundância média ocorreu na estação limnética (2), porém, Bacillariophyceae, Cyanophyceae, Chlorophyceae e Zygnematophyceae prevaleceram nas três estações. A maior riqueza média foi obtida na estação litorânea (3), porém, essa estação apresentou abundância significativamente menor ($p < 0,05$) que as duas estações limnéticas. O sistema caracterizou-se por maiores contribuições de Chlorophyceae no período de vazante, Bacillariophyceae na estiagem, Cyanophyceae na enchente e Zygnematophyceae na cheia, e, em média, a maior riqueza e abundância foram registradas na estiagem (*Aulacoseira* spp., *Coelastrum* spp., *Anabaena* spp., *Aphanocapsa minutissima*, *Planktolyngbya* spp. e *Eutetramorus fottii*). Os atributos da comunidade fitoplanctônica apresentaram variações espaciais e temporais, influenciadas pela presença de macrófitas, mas definidas, sobretudo, pelas mudanças hidrológicas sazonais, causadas pelo pulso de inundação.

**Palavras-chave:** Biodiversidade; Composição florística; Lagoas rasas

## Abstract

Studies on floristic composition are key to understand qualiquantitative changes on phytoplankton assemblages over the year. Spatial-temporal variation in composition, richness, frequency of occurrence, and abundance (semi-quantitative) of the phytoplankton community was analyzed monthly (from April 2002 to May 2003), at 3 stations, in Coqueiro Lake (Pantanal, Mato Grosso, Brazil). We registered 256 taxa, mainly represented by Zygnematophyceae (36%), Chlorophyceae (21%), and Euglenophyceae (14%). The highest average abundance occurred at the limnetic station (2), but Bacillariophyceae, Cyanophyceae, Chlorophyceae, and Zygnematophyceae prevailed at the 3 stations. The highest average richness was obtained at the littoral station (3), but this station showed a significantly lower abundance ($p < 0.05$) than the 2 limnetic stations. The system was characterized for higher contributions of Chlorophyceae in the falling water period, Bacillariophyceae in the low waters, Cyanophyceae in the rising waters and Zygnematophyceae in the high waters, and, on average, the highest richness and abundance were registered in the drought (*Aulacoseira* spp., *Coelastrum* spp., *Anabaena* spp., *Aphanocapsa minutissima*, *Planktolyngbya* spp. and *Eutetramorus fottii*). The attributes of phytoplankton community showed spatial and temporal variations, influenced by the presence of macrophytes, but defined, above all, by seasonal hydrologic changes, caused by the flooding pulse.

**Key words:** Biodiversity; Floristic composition; Shallow lakes

## Introduction

In environments subject to seasonal floods, oscillations in water level are regarded as the driving force in plankton community dynamics (HUSZAR; REYNOLDS, 1997; HUSZAR et al., 1998; TRAIN; RODRIGUES, 1998; CARDOSO et al., 2012), where a set of synergistic environmental and spatial factors respond to these hydrologic variations and lead to changes in communities (LOVERDE-OLIVEIRA et al., 2012). Thus, phytoplankton population cycles are constantly changing, and this causes qualitative and quantitative responses by assemblages over the year (REYNOLDS, 1984). Therefore, knowing the floristic composition of a phytoplankton community is key to understand variations in biomass and density, describe functional groups, trophic status, and dynamics of an aquatic ecosystem (HUSZAR et al., 1998; NABOUT; NOGUEIRA, 2007).

Studies about algal communities in tropical regions are scarce and incipient (LOVERDE-OLIVEIRA et al., 2012), but it has been shown that quantitative and qualitative variations are related to the climatic and hydrologic regime (PAYNE, 1986; DIAS JR., 1990; ESPÍNDOLA et al., 1996; LOVERDE-OLIVEIRA; HUSZAR, 2007), and that phytoplankton dynamics is controlled by a combination of several hydrodynamic processes acting on different spatial and temporal scales (CALIJURI, 1988).

In Brazil, a few research groups on phytoplankton have been consolidated this decade (BICUDO; MENEZES, 2010; NASCIMENTO, 2010; LOVERDE-OLIVEIRA et al., 2011); in the state of Mato Grosso, studies on phytoplankton are focused on the Pantanal (JUNK et al., 2006; LOVERDE-OLIVEIRA et al., 2012) and they follow an ecological descriptive trend (TREMARIN et al., 2011). These studies are almost always related to the hydrologic flooding pulse (JUNK et al., 1989) and they use relative abundance (HECKMAN et al., 1993; DE-LAMONICA-FREIRE; HECKMAN, 1996; LIMA, 1996; MARÇAL, 2005), density and biomass (LOVERDE-OLIVEIRA, 2005; LOVERDE-OLIVEIRA; HUSZAR, 2007; CARDOSO et al., 2012; LOVERDE-OLIVEIRA et al., 2012), and primary productivity (BAMBI et al., 2008) to describe the communities. In all those studies, the composition and richness of phytoplankton species were considered. This is a major element regarding knowledge on biodiversity, used in applied studies (e.g. LOVERDE-OLIVEIRA et al., 2009) and floristic comparisons between different ecosystems (HUSZAR, 1996; LOVERDE-OLIVEIRA et al., 2011).

Along with floristic knowledge, there is a growing need to investigate phytoplankton ecology in the Pantanal (LOVERDE-OLIVEIRA et al., 2012), since this is a peculiar, wide, and complex system (BOZELLI; HUSZAR, 2003). Knowledge on qualitative and quantitative composition and phytoplankton productivity is crucial for better using these ecosystems (DIAS JR., 1990), as studying plankton organisms from marginal lakes may provide primordial information to develop ecological theories.

It is worth emphasizing that the current knowledge on epicontinental algae, with higher concentration of studies in the Brazilian South and Southeast regions and lower concentration in the North and Central-West regions (BICUDO; MENEZES, 2010), is very heterogeneous, not only when the geographic region is taken into account, but also when the taxonomic group is considered. Therefore, studies based on ecological compositional and diversity attributes are needed to boost applied and experimental research on phytoplankton. Thus, this study aimed to analyze the composition, species richness, frequency of occurrence, and abundance (semi-quantitative) of phytoplankton species at three sampling stations in Coqueiro Lake, at the different phases of the hydrological cycle in the Pantanal.

# Material and Methods

## Study area

Coqueiro Lake (Figure 1) is located in the municipality of Nossa Senhora do Livramento (16º15'12"S; 56º22'12"W), within the sub-region Pantanal de Poconé, in the state of Mato Grosso, Brazil. It is a floodplain permanent lake, with elongated shape, 4 km long and 1 km wide (total area: < 2.5 km$^2$); it is shallow (maximum depth: 2.3 m) (LOVERDE-OLIVEIRA et al., 2007). During the drought, this lake remains isolated from the other water bodies and during the flood it is connected to Piraim river, a tributary on the right bank of Cuiabá river. The region climate (Köppen) is Aw type, warm and wet, with rainfalls in summer and low water in winter. Total annual rainfall (1,259 mm) and the annual average air temperature (27ºC) are within the climatological patterns within the region, when compared to the historical means (800-1,600 mm and 26ºC, respectively) (LOVERDE-OLIVEIRA et al., 2007).

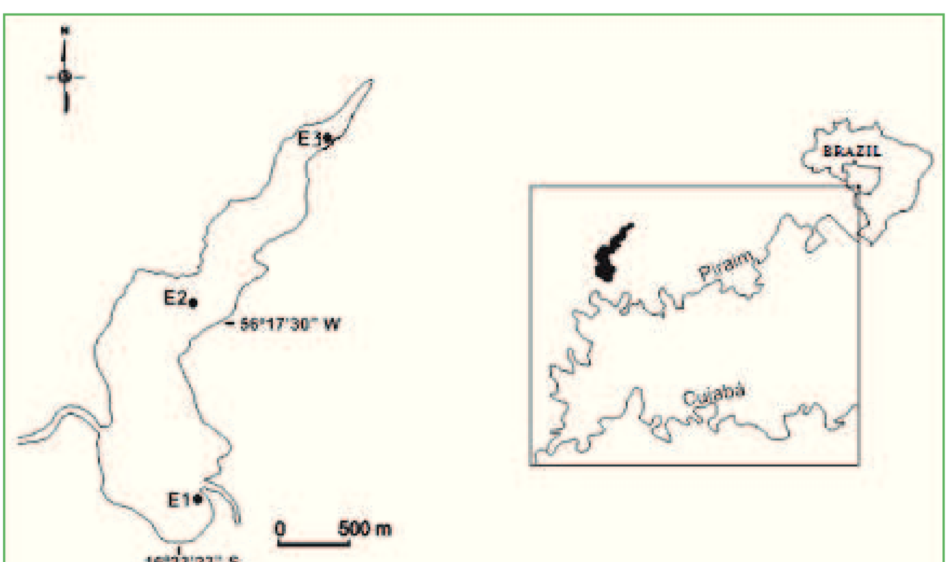
## Sampling and data analysis

Data on rainfall in the region was provided by the 9$^{th}$ Weather Forecast District of the National Institute of Meteorology (INMET), Cuiabá, Mato Grosso, Brazil.

Phytoplankton samples (n = 39) were taken monthly, from April 2002 to May 2003 using plankton net (25 µm) and they were preserved with Transeau (1:1). Samplings were accomplished through 10 vertical hauling on the water column at three sampling stations: site 1- on the limnetic region under lotic influence during the flood; site 2-on the deepest part from the limnetic region in the lake; and site 3- located on the littoral region close to aquatic macrophytes (*Eichhornia azurea* (SW.) Kunth, *E. crassipes* (Mart) Solms-Laubach, *Salvinia* sp. Weevil).

In order to determine the abundance and frequency of occurrence, samples were previously homogenized, and we used 0.5 mL by glass slide. The number of slides was previously determined through the curve species-area, totaling 15 slides/sample. Thus, the phytoplankton community was characterized qualitatively and semi-

FIGURE 1: Location of Coqueiro Lake within Pantanal de Poconé and the samplings sites.




Source: Loverde-Oliveira (2005).

quantitatively by counting of taxa and importance (numerical abundance) of each taxon in the samples, respectively.

For the qualitative analysis, the material was oxidized, according to Simonsen (1979), modified by Moreira-Filho and Valente-Moreira (1981). We adopted the classification system provided by Van den Hoek et al. (1997).

The species were regarded as abundant and dominant according to the criteria provided by Lobo and Leighton (1986). The frequency of occurrence (F) was expressed as the relationship between the occurrence of different species and the total number of samples. The species were classified as constant when F > 60%; common: 20% < F < 60%; and rare: F < 20% (GOMES, 1989).

Based on the results of rainfall and water level, 4 periods were established: period I-falling or decrease in water level (April to July 2002); period II-low water (August to November 2003); period III-rising or increase in water level (December 2002 and January 2003); and period IV-high water (February to May 2003).

Through the numerical abundance within seasonal periods and at the sampling stations, we conducted a Cluster Analysis (Systat 12) and a Friedman Analysis of Variance (α=0.05; BioEstat 5.0).

# Results

## Variations in rainfall and water level

The lower rainfall values within the Cuiabá region occurred during the falling (period I) and the higher ones, from October, with a maximum (297 mm) in January 2003, within period III. At this time, there was a flood in the Cuiabá river floodplain, with a consequent increase in water level in Coqueiro Lake. The period of high water (IV) was characterized by decrease in rainfall and higher values in average depth on the water column (Figure 2).

# Community attributes

## Species composition

In the phytoplankton community of Coqueiro Lake, 256 taxa were identified, distributed into 10 taxonomic classes: Zygnematophyceae (92), Chlorophyceae (58), Euglenophyceae (35), Cyanophyceae (33), Bacillariophyceae (25), Xantophyceae (6), Chrysophyceae (3), Dinophyceae (1), Oedogoniophyceae (2) and Cryptophyceae (1) (Figure 3; Appendix 1 and 2).

FIGURE 2: Variation in rainfall and mean depth in Coqueiro Lake from April 2002 to May 2003. (Periods: I-falling; II-low water; III-rising; IV-high water and beginning of the falling).

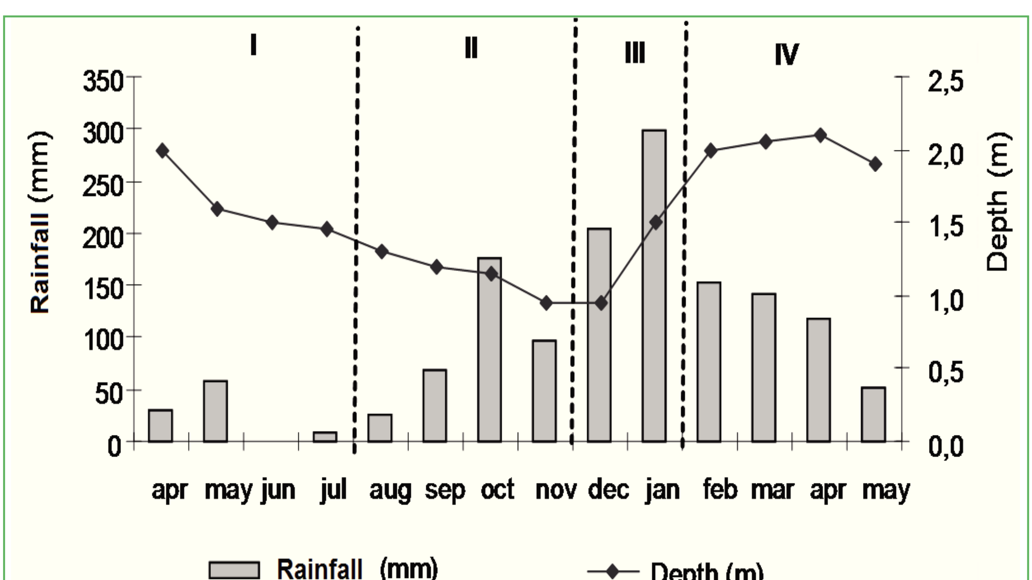
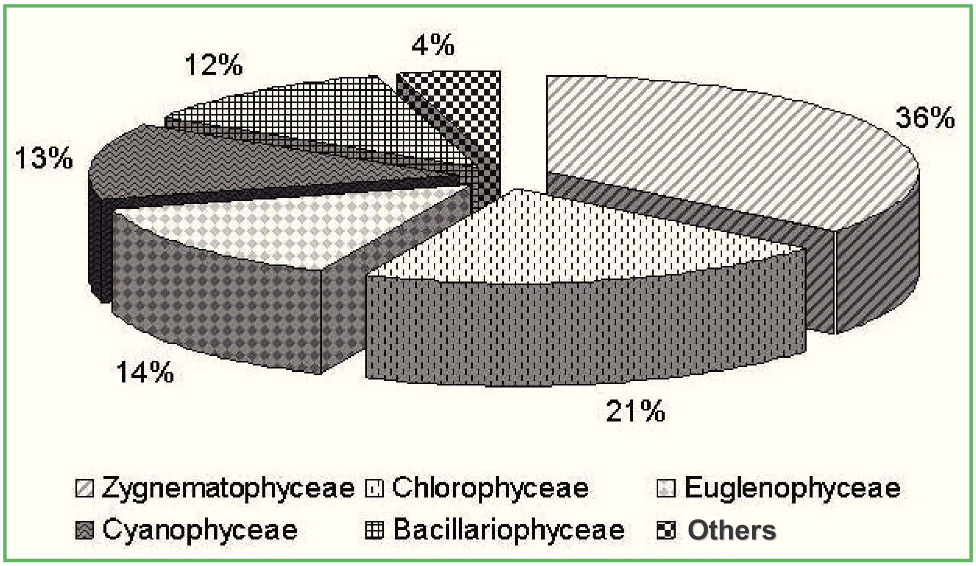


FIGURE 3: Relative contribution of taxonomic classes to the phytoplankton from Coqueiro Lake.




## Richness, abundance and dominance

Species richness in the limnetic site (1) ranged from 37-113 taxa sample$^{-1}$; at the other limnetic site (2) this attribute had values between 27-110 taxa sample$^{-1}$; and the littoral site (3) was characterized by the highest average of species richness, varying between 58-159 taxa sample$^{-1}$ (Table 1; Figure 4).

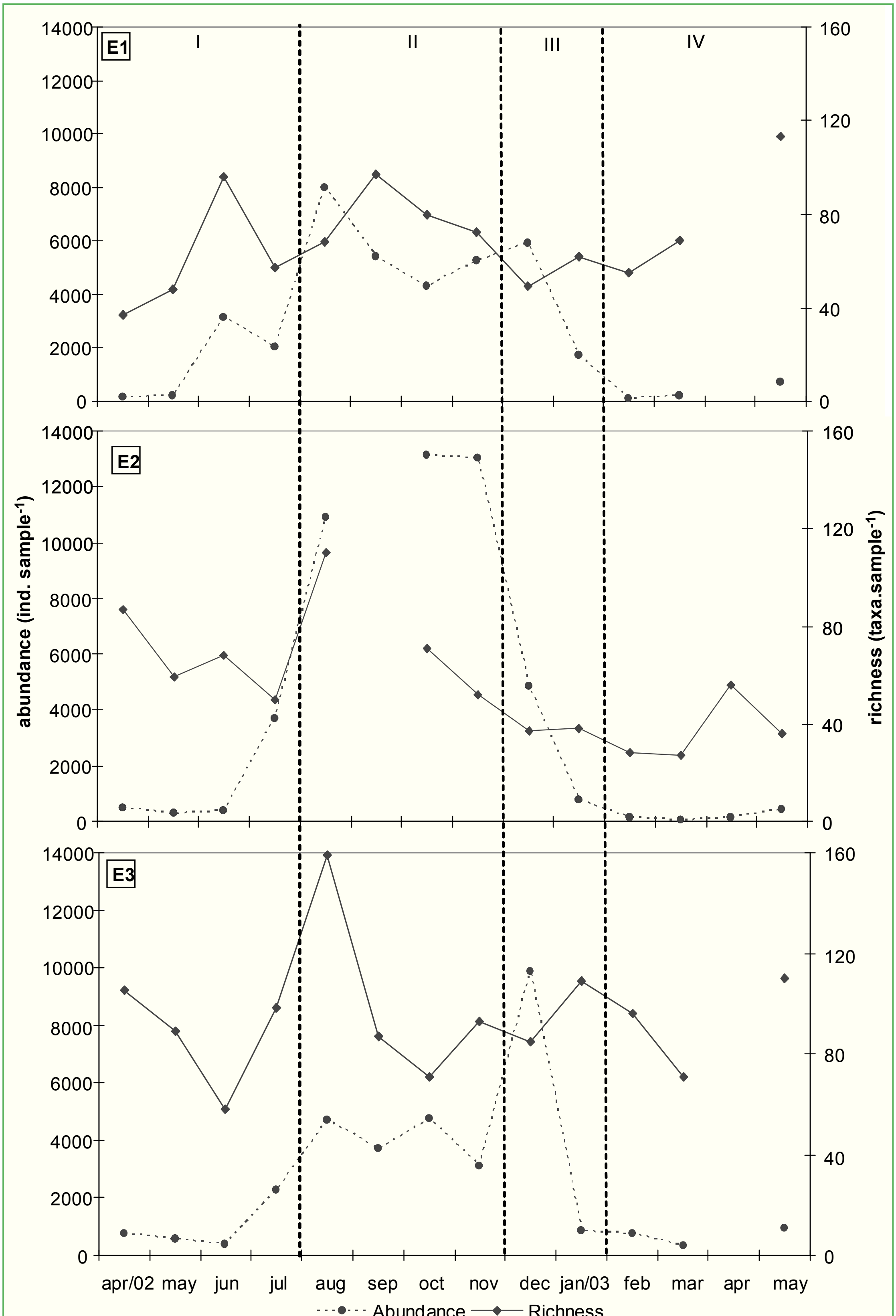
Considering temporal variation in species richness, within period II, the highest average of species richness was registered (87±29 taxa sample$^{-1}$) with the emergence of Chlorophyceae [*Kirchneriella contorta* Schmidle, *Scenedesmus acuminatus* (Lagerh.) Chodat] (Table1; Figure 4; Appendix 2). Within periods I, III, and IV, we observed the highest contribution of periphytic algae for the species richness, mainly the [*Hyalotheca dubia* (Kutzing)] (period I), *Spirogyra* sp., *Mougeotia* sp., *Hyalotheca dissiliens* (Smith) Brébisson, *Closterium setaceum* (Ehrenberg) Ralfs and *Nitzschia* sp. mainly in the littoral site (period III) and Zygnematophyceae as [*Gonatozygon monotaenium* (De Bary), *Teilingia wallichi* (Jacobsen) *Bourrelly* var. *anglica* (W. and West) Foster] (period IV) (Table 1; Figure 4; Appendix 2).

Abundance at the limnetic site (1) varied between 125-8007 ind.sample$^{-1}$; at the limnetic site 2, it ranged from 63-13114 ind.sample$^{-1}$, thus it had the highest mean value (3712±5157 ind.sample$^{-1}$), and at the littoral site (3) we found the variation of 347-9858 ind. sample$^{-1}$, representing the lowest average abundance by site (2538±2742 ind.sample$^{-1}$) (Table 1; Figure 4). Phytoplankton abundance was similar between the limnetic sites ($p$ = 0.4769) and significantly different when compared to the littoral site ($p < 0.05$).

TABLE 1: Mean variation and standard deviation of species richness and numerical abundance for the periods I, II, III, and IV and sampling sites E1, E2 and E3 in Coqueiro Lake.

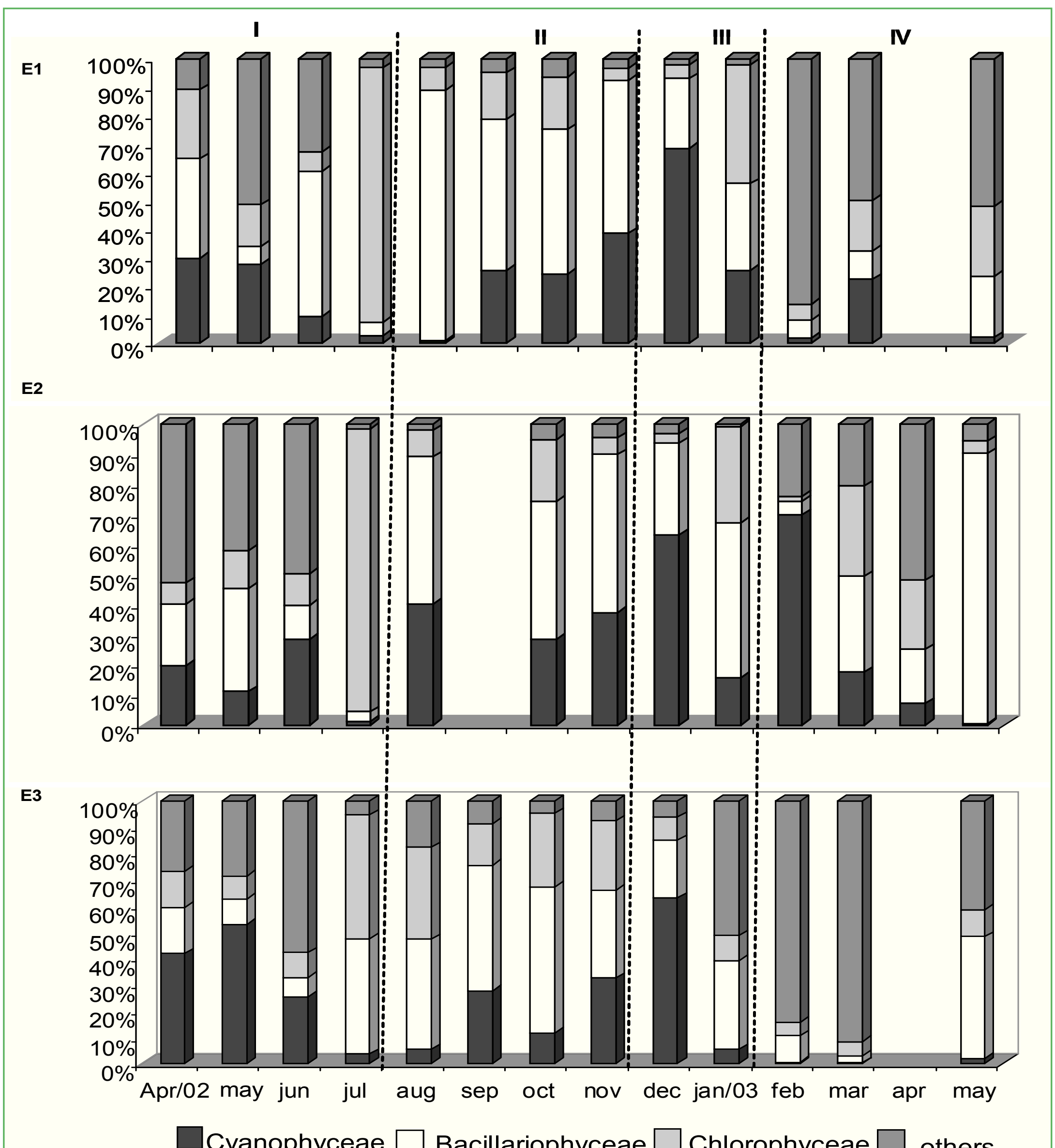
| Variables | Periods | | | | Sites | | |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | 1 | 2 | 3 |
| Richness (taxa/sample) | 71±23 | 87±29 | 64±30 | 67±32 | 69±22 | 55±24 | 96±25 |
| Abundance (ind. sample$^{-1}$) | 1197±1243 | 6930±3728 | 3990±3585 | 376±307 | 2850±2673 | 3712±5157 | 2538±2742 |

FIGURE 4: Variation in numerical abundance and taxa richness at sites E1, E2, and E3; periods: I- falling; II- low water; III- rising; IV- high water and beginning of the falling.



Abundance within periods I and II was significantly different from that registered within periods III ($p < 0.0161$ and $p < 0.0001$) and IV ($p < 0.0001$ and $p < 0.0249$). The highest contributions to abundance were registered within periods II (6930±3728 ind.sample$^{-1}$) with occurrence of Bacillariophyceae [*Aulacoseira granulata* Ehrenberg (Simonsen) var. *granulata*, *Aulacoseira ambigua* (Grunow) Krammer, *Aulacoseira granulata* Ehrenberg (Simonsen) var. *angustissima*] and Cyanophyceae [*Planktolyngbya circuncreta* (G. S. West) Anagnostides and Komárek, *Anabaena planctonica* Brunnthaler, *Aphanocapsa minutissima* (W. & W.) Kom.-Leg. & Cronb., *Planktolyngbya* sp.], along with Chlorophyceae [*Coelastrum pulchrum* Shimidle, *Coelastrum reticulatum* (Dangeard) Senn, *Eutretramorus fottii* Hindak]. Within period III (1197±1243 ind.sample$^{-1}$), we observed a predominance of Cyanophyceae [*P. circuncreta*, *Planktolyngbya* sp., *A. minutissima*], Bacillariophyceae [*A. granulata* var. *granulata*, *A. granulata* var. *angustissima*] and Chlorophyceae [*Coelastrum indicum* Turner, *E. fottii, C. reticulatum*] (Table 1; Figure 5; Appendix 2).

FIGURE 5: Relative abundance of taxonomic classes at the sites E1, E2, and E3; periods: I-falling; II-low water; III-rising; IV-high water and beginning of the falling.



Within period I, we registered an expressive occurrence of Chlorophyceae [*C. reticulatum*], Bacillariophyceae [*A. ambigua*, *A. granulata* var. *granulata*, *Aulacoseira italica* Ehrenberg (Simonsen), *Surirella robusta* Ehrenberg], Zygnematophyceae [*H. dubia* and *Staurastrum leptocladum* Nordstedt] and Cyanophyceae [*Oscillatoria tenuis* C. Agardh (Gomont), *Oscillatoria sancta* Kutzing (Gomont), Oscillatoriales 1]. In the period IV, the expressive occurrence of Zygnematophyceae [*H. dissiliens*], Bacillariophyceae [*A. ambigua*, *Fragillaria* sp., *Surirella* sp4.], Euglenophyceae [*Trachelomonas* cf. *volvocinopsis* Swirenko] and Chlorophyceae [*E. fottii*] was registered (Figure 5; Table 1).

There was higher similarity in the variation of phytoplankton abundance between the sites E1 and E2, and E3 was the most distinct in comparison to the other two. Between the periods from the hydrological cycle, periods I and IV were more similar, as well as periods II and III (Figure 6). Concerning spatial variation in species classified as abundant and dominant, we observed maximum values of *A. granulata* var. *granulata* in August 2002 (50%) and September 2002 (79%), both at the limnetic site (1) and that of Chlorophyceae *C. reticulatum* (87%) in July 2002 also at the site (1) (Appendix 2). In July 2002, *C. reticulatum* also contributed with 92% to abundance at the limnetic site (2) and *Aphanothece smithii* Komárková-Legnerová & Cronberg., represented 68% from the total of the community abundance in February 2003, at this site. In relation to the littoral site, there was no abundant and dominant species, but *A. ambigua* contributed with around 40% to abundance in October 2002, and *Lepocinclis ovum* (Ehrenberg) Lemmermann, *A. ambigua* and *E. fottii* were constant throughout the seasonal cycle at this site (Figure 5). Furthermore, we registered species constancy and dominance of *Aulacoseira* spp. throughout the hydrological cycle.

## Frequency of occurrence

When considering the frequency of occurrence, at the first limnetic site, 58% of the species were considered as rare, 34% as common, and 8% as constant. At the site (2), 69% of the species were classified as rare, 27% as common and 4% as constant. The littoral site (3) consisted in 42% of rare species, 48% common, and 10% constant (Figure 7).

Out of the total number of species identified (256 taxa), 111 were rare, 45 were common, and 7 species were registered as constant for the 3 sites. Most of the rare species belong to the Zygnematophyceae class, such as

FIGURE 6: Dendrograms of Sorensen similarity for numerical abundance among the sites (E1, E2, and E3) and between the periods (PI, PII, PIII, and PIV).

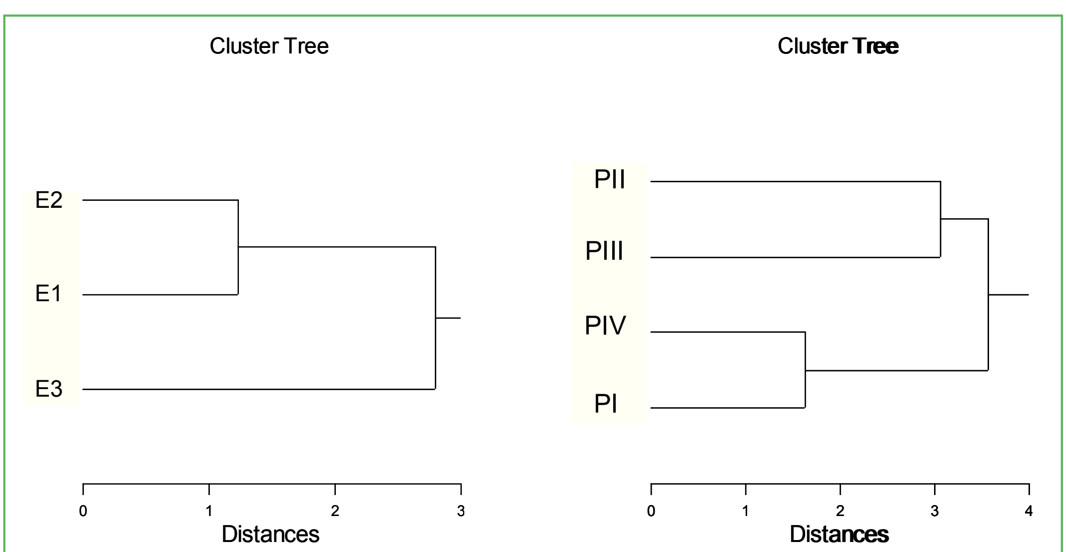
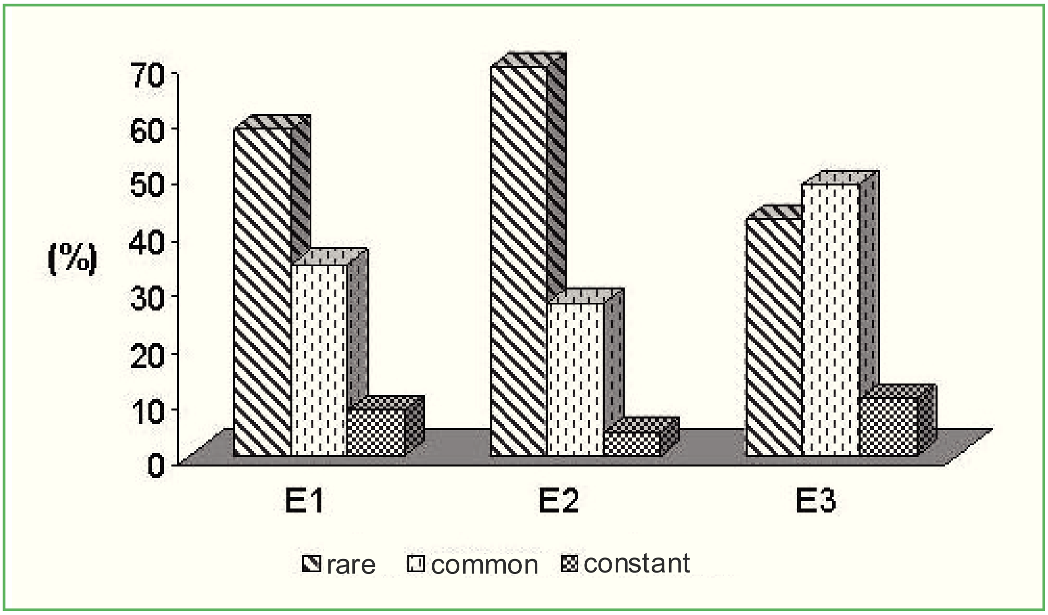


FIGURE 7: Frequency of occurrence of species rare, common and constant, at the 3 sites from April 2002 to May 2003.




*Closterium acutum (Brébisson) Ralfs*, *G. monotaenium*, *Cosmarium lagoense* (Nordstedt) Nordstedt; regarding the common species, the highest number belongs to the classes Cyanophyceae [*A. planctonica*] and Chlorophyceae [*K. contorta*, *Crucigeniella crucifera* (Wolle) Komárek, *Oocystis lacustris* (Chodat) and *Pandorina morum* (Muller) De Bary]. The following Cyanophyceae species were constant at all sites: *P. circuncreta*, and *Planktolyngbia* sp.; as well as Bacillariophyceae species [*A. ambigua*, *A. granulata* var. *granulata*] and Chlorophyceae species [*C. reticulatum* and *E. fottii*] (Appendix 2).

## Discussion

Coqueiro Lake has a floristic composition similar to the other aquatic systems in the Pantanal, but different from the other rising lakes (LIMA, 1996; DE-LAMONICA-FREIRE; HECKMAN, 1996), due to the high values of species richness and abundance.

Zygnematophyceae was relevant due to the higher number of species mainly within the rising period, as evidenced for floodplain lakes in the Pantanal under the influence of Paraguay river (DE-LAMONICA-FREIRE; HECKMAN, 1996), Mogi-Guaçu river (DIAS JR., 1990), floodplain lakes in the Amazon region (HUSZAR et al., 1998) and middle Paraná river, where this class presents selective advantage in more protected systems with low flow (RODRIGUES et al., 2001; 2002). The higher contribution of the Chlorophyceae class for species richness is widely evidenced in the floodplains of Paraná river (TRAIN; RODRIGUES, 1998; TRAIN et al., 2001; RODRIGUES et al., 2002; ZALOCAR DE DOMITROVIC, 2003), Paraguay river (OLIVEIRA; CALHEIROS, 2000; SILVA et al., 2000; ZALOCAR DE DOMITROVIC, 2002) and Cuiabá river in the Pantanal (LIMA, 1996; LOVERDE-OLIVEIRA, 2005).

Great contributions by Zygnematophyceae, in the high water period, are related to the high number of representatives from the periphytic community [*Gonatozygon monotaenium*, *Hyalotheca dissiliens*, *Bambusina borreri*, *Staurodesmus clepsydra* Teiling and *Teilingia wallichi*], also described by Camargo et al. (2009). The occurrence of these species on plankton may be related to water turbulence, which causes the detachment of these organisms from the substrate, contributing to the increased species richness on phytoplankton. According to Train (1998), interrelations between phytoplankton and periphyton, with several species regularly occurring in both biotopes, are frequently observed in shallow lakes colonized by aquatic macrophytes.

The great contribution by Chlorophyceae to species richness, after the rising period, may have occurred due to the higher availability of light on the water column, since Coqueiro Lake, during the high water in the hydrological cycle, has a deep euphotic zone (LOVERDE-OLIVEIRA, 2005). Euglenophyceae were benefited by the increased availability of organic matter within the rising period, where there is a great input of allochthonous material in the lakes of Pantanal, coming from adjacent lotic systems (NOGUEIRA, 1989) and the floodplain. The higher contribution by Euglenophyceae was registered under conditions of low hydrometrical level and reduced water transparency (RODRIGUES et al., 2002). In the Paraguay river and Tamengo Channel in the Pantanal of Mato Grosso do Sul, a greater species richness of this group was observed during the rising, with contributions by *Trachelomonas volvocina* Ehernberg and *Trachelomonas volvocinopsis* (SILVA et al., 2000).

Greater richness in the dry season and lowest richness in the rising and high water also have been reported by Loverde-Oliveira (2005) and Loverde-Oliveira and Figueiredo (2009). The greater abundance in floodplain lakes during the low water are due to the reduced depths and wind action that, among other factors, are determinant of conditions involving high turbulence, turbidity, and high availability of nutrients (LOVERDE-OLIVEIRA, 1999; TRAIN et al., 2001). The flood is responsible for decreased phytoplankton abundance, primarily due to the dilution effect, which determines a decrease in planktonic populations (LOVERDE-OLIVEIRA; HUSZAR, 2007), along with a increase in the number of taxa and diversity (TRAIN et al., 2001).

Abundance was represented by few species (*Aulacoseira* spp., *Coelastrum reticulatum*, *Planktolyngbya* sp., *Anabaena* spp. and *Eutetramorus fottii*). This finding was expected, because the communities consist of a small number of species with many individuals or, sometimes, by only one species that prevails along with several species with lower representativeness (MARGALEF, 1983). The temporal distribution pattern shown by abundance accompanies the hydrometric fluctuation generated by the flood pulse, with periods in the hydrological cycle significantly different, whose maximum lies on the low waters and the minimum on the high waters.

Among the centric diatoms registered in the Coqueiro Lake, *Aulacoseira granulata* has shown high abundance values regardless of the period in the seasonal cycle, however, the conditions found in the low water are key for the establishment and reproductive success of these algae (REYNOLDS, 1984), as they are characterized by dominance in environments with constant movements in the water column, facilitating permanence in the euphotic zone, besides nutrient availability (MOURA, 1997). The dominance of *Aulacoseira granulata* and its varieties were registered in Sá Mariana Lake (LOVERDE-OLIVEIRA, 1999) and Recreio (LIMA, 1996), in the Pantanal; Patos Lake, in the Upper Paraná river floodplain (RODRIGUES et al., 2002), and also in Paraguay river (SILVA et al., 2000).

The high abundance among Cyanophyceae populations, including along with blooms, has been evidenced at the phases of the hydrological cycle when the shallow lakes in Paraná and the Pantanal showed lower depth (LIMA, 1996; LOVERDE-OLIVEIRA, 1999; TRAIN et al., 2001; RODRIGUES et al., 2002; LOVERDE-OLIVEIRA; HUSZAR, 2007). Increased concentrations of *Anabaena* spp. coincides with lower hydrometric levels, turbid water, and high water temperature and nutrient availability (HUSZAR et al., 1998; LOVERDE-OLIVEIRA, 2005, LOVERDE-OLIVEIRA et al., 2009).

The higher influence of a river at the limnetic sites may explain the lower species richness on phytoplankton when compared to the littoral site with lower current flow and close to aquatic macrophyte stands. The greater number of rare species may have occurred due to the connectivity with to lotic systems that increase the flow of individuals coming from other niches. The inflow of the river to the marginal lakes causes changes in the physical and chemical characteristics of the water in the lakes, and thus changing the distribution, the composition and abundance of phytoplankton (DIAS JR., 1990).

The greater number of common species and species richness, mainly consisting in Zygnematophyceae and

Euglenophyceae, were registered at the littoral site and this finding is associated with closeness to aquatic macrophytes that provide a constant supply of species detached from the periphyton and occurring on plankton, as the floristic composition of plankton from lentic and shallow biotopes, with or without connection to rivers or secondary channels, has phytoplankton complexity and similarity between diversity in the littoral and limnetic zones. The similarity between some biotopes with higher species richness in the littoral zone, when compared to the limnetic zone, is due to addition to the plankton of metaphytic and periphytic algae, mainly desmidiales and diatom (TRAIN et al., 2001). Thus, corroborating Loverde-Oliveira et al. (2012), the composition of phytoplankton community in marginal lagoons has a strong relation to habitat quality and it reflects the availability of niches in the aquatic ecosystem.

In general, the flood pulse was key to the variation in phytoplankton abundance in the Coqueiro Lake. The frequency of occurrence of rare, constant, and common species is also associated with oscillations in water level, corroborating the information that, in shallow lakes, seasonal variations in structure and abundance of plankton communities are generally combined to hydrometrical changes (LIMA, 1996).

The groups of phytoplankton algae had their abundance influenced by the hydrological cycle, with decrease during the high water and increase during the low water, probably responding to factors such as lotic influence, close to stands of aquatic macrophytes, among other physical and chemical factors of water. Variations in abundance, species richness, and frequency of occurrence evidenced that the dynamics of this community tends to be similar to other rising lakes driven by the flood pulse, but they keep peculiar characteristics of each aquatic system.

Based on our results, it was possible to verify a high richness of species of phytoplankton algae in the Coqueiro Lake. The composition and number of phytoplankton species in the lagoon proved to be influenced by closeness of macrophytes, promoting a interrelationships between phytoplankton and periphyton, and also by increased hydrological stability within the drought period. Just as underlined by the literature, the limnetic region shows a higher abundance of phytoplankton algae. The number of individuals (numerical abundance) was directly related to seasonal hydrological variations of the system, with its apex within the dry period, reasserting the flood pulse as the defining factor of the temporal and spatial distribution of richness and abundance.

Some authors (ALHO, 2011; ALHO, et al., 2011) have confirmed the importance of the increasing number of studies addressing floristic composition and spatial-temporal variations, which are key to improve knowledge on biodiversity in the Pantanal, a system requiring further investigation, as it has been increasingly threatened by anthropogenic pressures.

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APPENDIX 1: List of species of phytoplankton flora of the Coqueiro Lake

**Cyanophyceae**
*Anabaena circinalis* Ranhorst ex. Bornet & Flahault
*Anabaena flos aquae* Lyngberg Brébissonii
*Anabaena planctonica* Brunnthaler
*Anabaena variabilis* Kutzing
*Aphanocapsa incerta* (Lemmermann) Cronberg & Komarek
*Aphanocapsa holsatica* (Lemmermann) Cronberg & Komarek
*Aphanocapsa minutissima* (W. West) Komarkova-Legrenova & Cronberg
*Aphanocapsa planctonica* (G. M. Smith) Komárek & Anagnostidis
*Aphanothece smithii* Komarekova-Legrenova & Cronberg
*Calothrix* sp.
*Coelosphaerium* sp.
*Chroococcus* sp.
*Cyanosarcina* sp.
*Geitlerinema amphybium* Gommot
*Gloeocapsa* sp.
*Merismopedia tenuissima* (W. West) Komarkova-Legrenova & Cronberg
*Microcystis cf. ichthyoblabe* Kutzing
*Oscillatoria annea* Van Gorr
*Oscillatoria articulata* Gardner
*Oscillatoria granulata* (Gardner)
*Oscillatoria ornata* (Kutzing) Gomont
*Oscillatoria sancta* (Kutzing) Gomont
*Oscillatoria tenuis* (C. Agardh) Gomont
*Phormidium* sp.
*Planktolyngbia cf. circuncreta* (G. S. West) Anagnostidis & Komarkova
*Pseudoanabaena limnetica* Lemmermann
*Rabdoglea* sp.
*Raphydiopsis* sp.
Spirulinoideae
Stigonematales
*Synechococcus sp.*
*Synechocystis aquatilis* Sauvageu
*Trichodesmium iwanoffianum* Nygaard
**Chrysophyceae**
*Dinobryon sertularia* Ehrenberg
*Mallomonas sp.*
*Synura* sp.
**Xanthophyceae**
*Centritractus* sp.
*Isthmochloron lobulatum* Nageli
*Ophiocytium* sp.
*Pseudostaurastrum* sp.
*Tetraedriella* sp.
*Tetraplektron torsum* (Skuja) Dedusenko Scegoleva
**Bacillariophyceae**
*Actnella* sp.
*Asterionella* sp.
*Aulacoseira ambigua* (Grunow) Krammer
*Aulacoseira distans* (Ehrenberg) Simonsen
*Aulacoseira granulata* (Ehernberg) Simonsen*.var. angustissima*
*Aulacoseira granulata* (Ehernberg) Simonsen*.var. granulata*
*Aulacoseira italica* (Eherberg) Simonsen
*Aulacoseira pseudogranulata* (A. Cleve-Euler)
*Cyclotella sp.*
*Cymbella* sp.
*Entomoneis sp.*
*Eunotia camelus* Ehrenberg
*Eunotia flexuosa* Brébisson
*Eunotia formica* Ehrenberg
*Eunotia monodon* Ehrenberg
*Eunotia sudetica* (O.F. Müller)
*Fragilaria virescens* Ralfs
*Gomphonema* sp.
*Navicula cuspidata* (Kutzing) Kutzing
*Nitzschia* sp.
*Pinnularia* sp.
*Surirella bisseriata* Brébisson
*Surirella robusta* Ehrenberg
*Surirella* sp.
*Urosolenia* sp.
**Cryptophyceae**
*Cryptomonas ovata* Ehrenberg
**Dinophyceae**
*Peridinium cf. umbonatum* Stein
**Euglenophyceae**
*Euglena acus* Ehrenberg
*Euglena fusca* (Klebs) Lemmermann
*Euglena oxyurus* Schmarda
*Euglena spiroides* Lemmermann
*Euglena spirogyra* Ehrenberg
*Lepocinclis caudata* Da Cunha
*Lepocinclis ovum* (Ehrenberg) Lemmermann
*Lepocinclis piriformis* Da Cunha
*Lepocinclis salina* Da Cunha
*Lepocinclis tubiniformis* De flandre
*Phacus caudatus* Hubner
*Phacus contortus* Bourrelly
*Phacus helicoides* Pochmann
*Phacus longicauda* (Ehrenberg) Dujardin
*Phacus onys* Pochmann

*Phacus orbiculares* Hubner
*Phacus suecicus* Lemmermann
*Phacus tortus* (Lemmermann) Skv
*Phacus undulatus* (Skvortzov) Pochmam
*Strombomonas cf. argentinensis* G. de Emiliani
*Strombomonas maxima* (Skv.) Deflandre
*Strombomonas ovalis* (Playfir) Deflandre
*Trachelomonas abrupta (*Swirenko) Deflandre
*Trachelomonas armata (*Ehrenberg) Stein
*Trachelomonas dastuguei* Balech
*Trachelomonas dubia* (Swirenko) Deflandre
*Trachelomonas hirta* Da Cunha
*Trachelomonas megalacantha* Da Cunha
*Trachelomonas raciborskii* (Woloszynska) Conrad
*Trachelomonas robusta (*Swirenko) Deflandre
*Trachelomonas rugulosa (*Stein) Deflandre
*Trachelomonas similis* Stokes
*Trachelomonas verrucosa* Stokes
*Trachelomonas volvocina* Ehrenberg
*Trachelomonas volvocinopsis* Swirenko
**Chlorophyceae**
*Actinastrum aciculare* Playfir
*Actinastrum hantzschii* Lagerheim
*Ankistrodesmus bibraianus* (Reinsch) Korsikov
*Actinastrum falcatus* (Corda) Ralfs
*Actinastrum fusiformis* Corda
*Actinastrum gracilis* (Reinsch) Korsikov
*Botryococcus braunii* Kutzing
*Chaetosphaeridium* sp.
*Chlamydomonas* sp.
*Coelastrum indicum* Turner
*Coelastrum proboscideum* Bohlin
*Coelastrum pulchrum* Shimidle
*Coelastrum pulchrum var. colfer* (Kammerer) Kom.
*Coelastrum reticulatum* (Dangeard) Senn
*Coenocystis subcylindrica* Korsikov
*Crucigenia fenestrata (*Schmidle) Schmidle
*Crucigenia quadrata* Morren
*Crucigeniella crucifera* (Wolle) Komárek
*Crucigeniella saguei* Komárek
*Dictyosphaerium ehrenbergianum* Nageli
*Dictyosphaerium elegans* Nageli
*Dictyosphaerium pulchellum* Wood
*Dimorphococcus* sp.
*Eudorina* sp.
*Eutetramorus fottii* Hindák
*Golenkinia* sp.
*Hydrodictyon* sp.
*Kirchneriella contorta* Schmidle
*Kirchneriella* dianae (Bohling) Comas
*Kirchneriella lunaris* (Kirchner) Moebius
*Monoraphidium caribeum* Hindák
*Monoraphidium contortum* (Turner) Komarkova-Legnerova
*Monoraphidium minutum* (Nageli) Komarkova-Legnerova
*Monoraphidium tortile* (W. & G. S. West) Komarkova-Legnerova
*Oocystis lacustris* Chodat
*Pachycladella* sp.
*Pandorina morum* (O. F. Muller) Bory
*Pediastrum argentiniense* Bourr & Tell
*Pediastrum duplex* Meyen
*Pediastrum tetras* (Ehrenberg) Ralfs
*Pleudorina* sp.
*Radiococcus bavaricus* (Skuja) Komm.
*Radiococcus nimbatus* (De-Wildem) Schmidle
*Scenedesmus acutus* Meyen
*Scenedesmus acuminatus* (Lagerh) Chodat
*Scenedesmus alternans* Reinsch
*Scenedesmus ecornis* (Ehrenberg) Chodat
*Scenedesmus ellipticus* (W. & G. S. West) Chodat
*Scenedesmus intermedius* Chodat *var. intermedius*
*Scenedesmus perforatus* Lemmermann
*Schroederia* sp.
*Selenastrum* sp.
*Sorastrum* sp.
*Tetraedron* sp.
*Tetrastrum punctatum* (Schmidle) Ahlstrom & Tiffany
*Treubaria* sp.
*Trochiscia* sp.
*Ulothrix variabilis* Kutzing
**Oedogoniophyceae**
*Bulbochaete* sp.
*Oedogonium* sp.
**Zygnemaphyceae**
*Actinotaenium wollei* (Nageli) Teiling
*Bambusina borreri* Ralfs (Cleve)
*Closterium aciculare* West
*Closterium acutum* (Brébisson) Ralfs
*Closterium correctum* Meneghini
*Closterium gracile* Brébisson
*Closterium lineatum* Ehrenberg
*Closterium regulare* Brébisson
*Closterium setaceum* (Ehrenberg) Ralfs
*Cosmarium commissurale* Brébisson
*Cosmarium denticulatum* Borge
*Cosmarium lagoense* (Nordstedt) Nordstedt
*Cosmarium obsoletum* (Hantzsch) Reinsch
*Cosmarium paraguayense* Borge
*Cosmarium pseudopyramidatum* Lundell
*Cosmarium quadrum* Borge
*Cosmarium redimitum* Borge
*Cosmarium subspeciosum* Borge

*Desmidium cylindricum* Greville
*Desmidium grevillii* (Kutzing) De Bary
*Euastrum ansatum* Ehrenberg
*Euastrum divergens* Joshua
*Euastrum dubium* Nageli
*Euastrum evolutum* (Nordstedt) West & West
*Euastrum gemmatum* (Brébisson) Ralfs
*Euastrum obesum* Joshua
*Euastrum subintegrum* Nordestedt
*Gonatozygon aculeatum* Hastings
*Gonatozygon monotaenium* De Bary
*Gonatozygon pilosum* Wolle
*Haplotaenium ehrenbeergii* (Brébisson) De Bary
*Haplotaenium minutum* (Ralfs) Delponte
*Haplotaenium nodosum* (Bailey) Lundell
*Haplotaenium tridentulum* (Wolle) West & West
*Haplotaenium trabecula* (Ehrenberg) Nageli
*Hyalotheca dissiliens* (Smith) Brébisson
*Hyalotheca dubia* Kutzing
*Hyalotheca indica* Turner
*Micrasterias abrupta* (W. e G.S. West)
*Micrasterias borgei* Krieger
*Micrasterias foleacea* Bailey
*Micrasterias furcata* Ralfs
*Micrasterias laticeps* Nordstedt
*Micrasterias mahabuleshwarensis* Hobsen
*Micrasterias radiata* Hassal
*Micrasterias radiosa* Ralfs
*Micrasterias toreyi* Bailey
*Micrasterias tropica* Nordstedt
*Mougeotia* sp.
*Netrium* sp.
*Onychonema laeve* Nordsted *var latum* West & West
*Penium* sp.
*Phymatodocis* sp.
*Spirogyra* sp.
*Spondylosium panduriforme* (W. & G. S. West) Teiling
*Spondylosium pulchellum* Archer
*Spondylosium pulchrum* (Bailey) Archer
*Staurastrum cf. bidentulum* Nordstedt
*Staurastrum boergesenii* Raciborski
*Staurastrum brasiliensis* Nordstedt
*Staurastrum leptocanthum* Nordstedt
*Staurastrum leptocladum* Nordstedt
*Staurastrum margaritaceum* (Ehrenberg) Meneghini
*Staurastrum minnesotense* Wolle
*Staurastrum nudibrachiatum* Borge
*Staurastrum pinnatum* Turner
*Staurastrum quadrangulare* Brébisson
*Staurastrum rotula* Nordstedt
*Staurastrum sebaldi* Reinsch
*Staurastrum setigerum* Cleve
*Staurastrum sexangulare* (Bulnheim) Rabenhorst
*Staurastrum tetracerum* Ralfs
*Staurastrum trifidum* Nordstedt
*Staurodesmus clepsydra* (Nordstedt) Teiling
*Staurodesmus convergens* (Ehrenberg) Teiling
*Staurodesmus cornutus* (Wolle) Teiling
*Staurodesmus dejectus* (Brébisson) Teling
*Staurodesmus lobatus* Borgesen
*Staurodesmus mamillatus* (Nordestedt) Teiling
*Staurodesmus maximus* Borge
*Staurodesmus megacanthus* (Lundell) Thummark
*Staurodesmus subulatus* (Kutzing) Croasdale
*Staurodesmus triangularis* (Lagerheim)
*Staurodesmus validus* (W. & G.S. West) Thomasson
*Teilingia wallichi* (Jac.) Bou *var. anglica* (W. & W.) Foster
*Triploceras gracile* Bailey
*Xanthidium amazonense* Scott & Croasdale
*Xanthidium canadense* Joshua
*Xanthidium cristatum* Brébisson
*Xanthidium mamillosum* Gronblad
*Xanthidium sexangulare* Gronblad
*Xanthidium trilobum* Nordstedt

APPENDIX 2: **A – Bacillariohyceae** (1A) *Aulacoseira ambigua*, (2A) *Aulacoseira granulata* var. *granulata*; **B – Cyanophyceae** (1B) *Microcystis ichthyoblabe*, (2B) *Planktolyngbia* cf. *circuncreta*, (3B) *Anabaena planctônica*; **C – Euglenophyceae** (1C) *Trachelomonas volvocina*, (2C) *Trachelomonas* cf. *volvocinopsis*; **D – Chlorophyceae** (1D) *Botryococcus braunii*, (2D) *Coelastrum indicum*, (3D) *Coelastrrum pulchrum*, (4D) *Crucigeniella crucifera*, (5D) *Eudorina* sp.