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Phytoplankton composition of the Itaparica and Xingó reservoirs, São Francisco River, Brazil

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(With 3 figures)

Abstract

The installation of dams causes changes to the integrity of rivers and to the water cycle, performing an instrumental role in the organization of biological communities, including that of phytoplankton. In the present study, we analyzed the taxonomic composition of phytoplankton in two hydroelectric reservoirs on the São Francisco River, Itaparica and Xingó reservoirs. Samples were collected at quarterly intervals between December 2007 and September 2009, at 12 sampling stations in each reservoir, totaling 92 samples. We identified 110 species in the Itaparica reservoir and 136 in the Xingó reservoir, of which diatoms followed by green algae, played a major contribution to both reservoirs. Most of the species is rare and/or occasional. In the Itaparica reservoir, there were no very frequent species, although in the Xingó this category was represented by the diatoms *Aulacoseira granulata* (Ehrenberg) Simonsen and *Fragilaria crotonensis* Kitton. These results show that, despite the similarity in the composition of phytoplankton, the reservoirs studied certainly differed regarding their environmental conditions.

Keywords: check list, freshwater, hydroelectric reservoir, microalgae, Northeast.

Composição fitoplanctônica dos reservatórios de Itaparica e Xingó, Rio São Francisco, Brasil

Resumo

A instalação de barragens provoca alterações na integridade dos rios e no ciclo hidrológico, desempenhando papel decisivo na organização das comunidades biológicas, incluindo a fitoplanctônica. No presente estudo, foi realizada uma análise da composição taxonômica do fitoplâncton em dois reservatórios hidrelétricos do rio São Francisco, reservatórios Itaparica e Xingó. As coletas foram realizadas entre dezembro de 2007 e setembro de 2009, com intervalos trimestrais, em 12 estações de amostragem em cada reservatório, totalizando 192 amostras. Foram identificadas 110 espécies no reservatório de Itaparica e 136 no reservatório de Xingó, sendo observado, em ambos, maior contribuição das diatomáceas, seguidas pelas algas verdes. A maioria das espécies foi considerada esporádica e/ou pouco frequente. No reservatório de Itaparica, não foram registradas espécies muito frequentes, já no reservatório de Xingó esta categoria esteve representada pelas diatomáceas *Aulacoseira granulata* (Ehrenberg) Simonsen e *Fragilaria crotonensis* Kitton. Esses resultados mostram que, apesar da semelhança na composição fitoplanctônica, os reservatórios estudados, certamente, diferem nas condições ambientais.

Palavras-chave: check list, água doce, reservatório hidrelétrico, microalgas, Nordeste.

1. Introduction

The impacts of hydroelectric reservoirs on aquatic environments have been extensively studied (Kelly, 2001; Tundisi and Matsumura-Tundisi, 2003; Li et al., 2012), since the installation of dams causes changes to the integrity of Rivers and to the water cycle, playing an instrumental role in the organization of biological communities (Tundisi et al., 2002; Pringle, 2003; Silva and Cecy, 2004; Magilligan and Nislow, 2005).

Among the communities that best express the behavior of a water body is phytoplankton community, since they respond quickly to changing environmental conditions, both of natural and anthropogenic origin (Chellappa et al., 2009; Popovskaya et al., 2012). Thus, knowledge about the diversity and distribution of phytoplankton in water bodies is of fundamental importance for a better understanding of the functioning mechanisms of these ecosystems, possibly acquiring a predictive character about the possible changes that may occur in the environment (Huszar et al., 2000).

The São Francisco River, located in the main hydrographic basin of the semiarid region of Brazil, has seven dams along its course, built for electric power generation (ANA, 2013). The present study was conducted for two consecutive years, and two reservoirs (Xingó and Itaparica) were monitored in order to characterize the phytoplankton community in these environments, through the analysis of taxonomic composition, an important tool commonly used in monitoring programs to assess water quality worldwide.

2. Material and Methods

2.1. Study area

The São Francisco River has an extension of 2.700 km and its basin is the third largest in Brazil, with an area of 638.576 km^2, accounting for 8% of the national territory. It extends through the Northeast, Southeast and Central West regions, including the Pernambuco, Alagoas, Sergipe, Bahia, Minas Gerais, Goiás States and the Federal District. It is divided into four physiographic regions (ANA, 2013) (Figure 1): Upper São Francisco, from the source to the municipality of Pirapora (Minas Gerais State), with an extension of 630 km; Middle São Francisco, from Pirapora to the municipality of Remanso (Bahia State) with an extension of 1090 km; Sub-Middle São Francisco, from Remanso to Paulo Afonso Falls (state of Bahia), with an extension of 686 km; Lower São Francisco, from Paulo Afonso Falls to the mouth in the Atlantic Ocean, on the border between the Alagoas and Sergipe State, with an extension of 274 km.

Itaparica reservoir (9°6'S and 38°19'W), belonging to the Luiz Gonzaga Hydroelectric Plant, is located on the Sub-Middle São Francisco, on the border between the Pernambuco and Bahia State, having an accumulated storage capacity of 10^9 m^3. Xingó reservoir (9°37' S and 37°47'W) is located on the Lower São Francisco, on the border between the Alagoas and Sergipe States, and has an accumulated storage capacity of 3.8^8 m^3 (Brasil, 2013).

2.2. Data collection and analysis

Samples were collected at quarterly intervals over two years, from December 2007 to September 2009, at 12 stations located along the longitudinal axis of each reservoir (Figure 1, Table 1). Samples were obtained by vertical hauls of the net along the euphotic zone, determined by a digital quantometer (Licor-250), using conical-cylindrical plankton nets with a 25µm mesh size. The material was preserved in 4% formaldehyde and then examined using an optical microscope and photographed with the aid of a microscope (Zeiss/Axioskop) coupled to a Samsung SCC833, Japan camera, using the software Imagelab (Softium, Brazil).

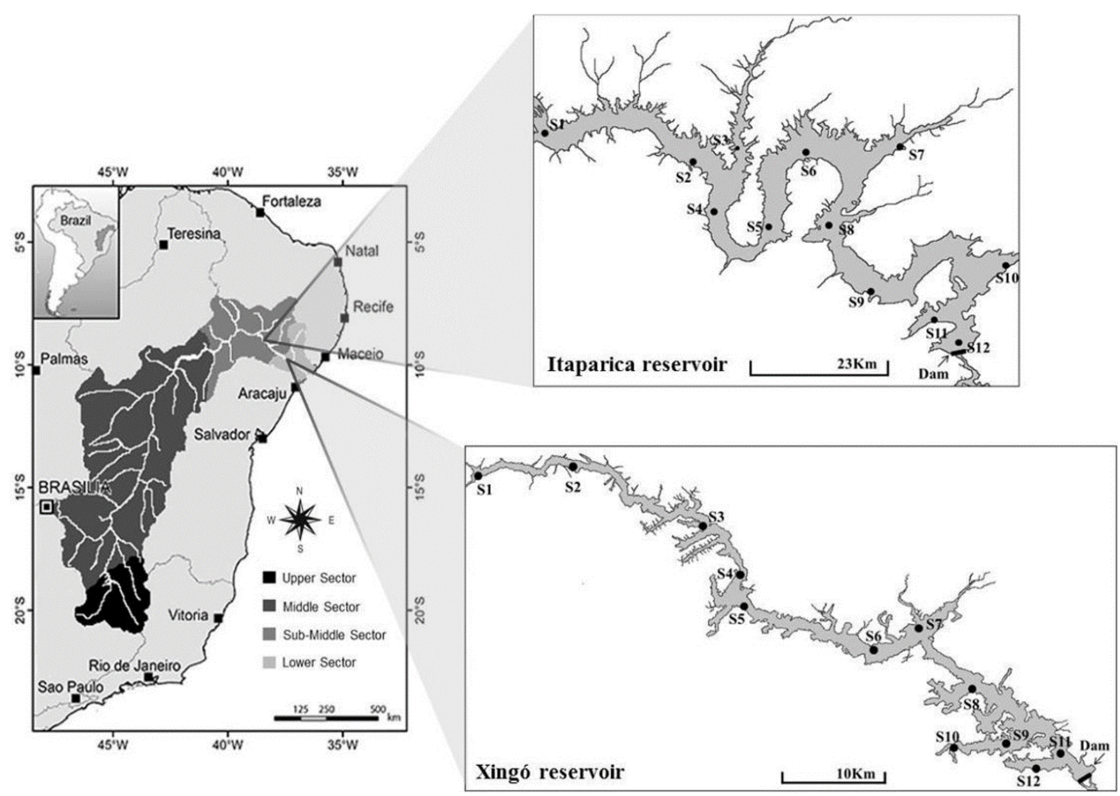

Figure 1. Location of the Itaparica and Xingó Reservoirs, São Francisco River, Brazil.

Table 1. Geographic location of the sampling stations in the Itaparica and Xingó Reservoirs, São Francisco River, Brazil.

Stations	Reservoirs			
	Itaparica		Xingó	
1	8°47'52.6" S	38°57'71.9" W	9°26'26.09" S	38°09'18.11" W
2	8°50'18.6" S	38°43'65.5" W	9°26'13.16" S	38°05'51.72" W
3	8°49'23.1" S	38°39'44.3" W	9°28'16.57" S	38°01'20.96" W
4	8°54'37.3" S	38°41'10.4" W	9°29'57.41" S	37°59'58.52" W
5	8°55'73.7" S	38°36'34.2" W	9°31'33.24" S	37°59'22.24" W
6	8°48'72.0" S	38°33'25.2" W	9°32'44.05" S	37°55'09.52" W
7	8°49'23.1" S	38°25'21.5" W	9°31'40.33" S	37°53'22.81" W
8	8°55'99.6" S	38°31'02.3" W	9°34'06.96" S	37° 51'43.63" W
9	9°01'96.0" S	38°27'13.3" W	9°36'01.94" S	37°50'35.81" W
10	8°59'81.7" S	38°14'17.0" W	9°36'22.57" S	37°52'48.64" W
11	9°05'06.0" S	38°21'26.1" W	9°36'24.91" S	37°52'47.78" W
12	9°07'72.8" S	38°18'57.7" W	9°36'54.18" S	37°48´03.96" W

Permanent slides for identifying diatoms were prepared following the methodology proposed by Carr et al. (1986), using Naphrax.

The classification system adopted followed Van den Hoek et al. (1995) for the classes Cryptophyceae, Dinophyceae, Chrysophyceae, Euglenophyceae, Chlorophyceae and Zygnematophyceae. Round et al. (1990) was used For Coscinodiscophyceae, Fragilariophyceae and Bacillariophyceae, while for Cyanobacteria, Komárek and Anagnostidis (2000, 2005) were used. Following the taxonomic analysis and photomicrographs, samples were deposited in the Herbarium Professor Vasconcelos Sobrinho, Federal Rural University of Pernambuco.

The frequency of occurrence of taxa was calculated according to Matteucci and Colma (1982), considering the number of samples in which the taxon occurred in relation to the total number of samples collected, using the formula: $F = Px100/p$, where P = number of samples in which the taxon was recorded and p = total number of samples collected. The following criteria were established: very frequent ($\geq$ 70%), frequent ($\geq$ 40% <70%), occasional ($\geq$ 10% <40%) and rare (<10%).

3. Results and Discussion

The phytoplankton community was made up of 165 species belonging to 10 classes, 28 orders, 49 families and 83 genera (Table 2). One hundred and ten species were recorded in the Itaparica reservoir and 135 in the Xingó reservoir (Table 2). In both reservoirs, diatoms (Coscinodiscophyceae, Bacillariophyceae and Fragilariophyceae) had the highest number of species, followed by green algae (Chlorophyceae and Zygnematophyceae) and cyanobacteria (Cyanobacteria) (Figure 2, Table 2).

This number of identified species is considered high when compared to that observed by Franca and Coimbra (1998), who recorded 54 species in the Itaparica reservoir, and Melo-Magalhães et al. (2000), who identified 78 species in the Xingó reservoir. However, this is compatible to that observed in other reservoirs used for power generation (Pérez et al., 1999; Calijuri et al., 2002; Atici and Obali, 2006; Nogueira et al., 2010; Popovskaya et al., 2012). Certainly, the greater sampling effort exerted in this study, compared to that of Franca and Coimbra (1998) and Melo-Magalhães et al. (2000), made it possible to evaluate the true phytoplankton biodiversity in the studied environments.

The dominance, in terms of richness, of diatoms and green algae is considered almost standard in phytoplankton communities of most reservoirs in temperate (Pérez et al., 1999; Atici, 2002; Atici and Obali, 2006; Malaiwan and Peerapornpisal, 2009; Popovskaya et al., 2012), tropical (De León and Chalar, 2003) and subtropical (Çetin and Şen, 1998) regions. In Brazil, the same result was observed in the reservoirs Jurumirim and Bonita in the São Paulo State (Nogueira, 2000; Calijuri et al., 2002); the reservoirs Capivara, Foz do Areia, Salto Caxias, Salto Osório, Salto Santiago and Segredo, in the Paraná State (Silva et al., 2005; Borges et al., 2008); and in the Cachoeira Dourada reservoir, in the states of Goiás/Minas Gerais (Oliveira et al., 2011).

The success of diatoms and green algae in these aquatic ecosystems has been associated to the great morphological and habitat diversity presented by the species (Wetzel, 1993; Franceschini et al., 2010). Diatoms are widely distributed in nature, occurring in all aquatic ecosystems, although they are more abundant in the marine environment (Van den Hoek et al., 1995; Reviers, 2006). Currently, there are about 250 genera and approximately 100,000 described species, 1,600 of which are found in freshwater environments. Green algae are a very diverse group, consisting of about 8,000 species, approximately 90% of which are found in freshwater environments (Van den Hoek et al., 1995).

Both groups are represented mostly by plankton species, although many are periphytic (Fontana and Bicudo, 2009; Felisberto and Rodrigues, 2010) or are associated with the bottom, living in the sediment, as in the case of diatoms (Silva et al., 2010). Climatological and hydrological events that promote turbulence in the system play an important role in the dynamics of these populations and in the increase in the number of phytoplanktonic species, since they can

Table 2. Synopsis and frequency of occurrence (%) of phytoplankton in the Itaparica and Xingó Reservoirs, São Francisco River, Brazil, between December 2007 and September 2008.

Taxa	Reservoirs	
	Itaparica	Xingó
Cyanophyceae		
Order: Chroococcales		
Family: Merismopediaceae		
Aphanocapsa elachista W. West & G.S. West	11.5	16.7
Aphanocapsa incerta (Lemmermann) Cronberg & Komárek	-	4.4
Aphanocapsa sp.	5.2	11.1
Merismopedia sp.	2.1	-
Family: Microcystaceae		
Microcystis aeruginosa (Kützing) Kützing	2.1	3.3
Microcystis panniformis J. Komárek. J. Komárková-Legnerová. C.L. Sant'Anna. M.T.P. Azevedo. & P.A.C. Senna	-	1.1
Microcystis wesenbergii (Komárek) Komárek	24.0	16.7
Microcystis sp.	12.5	4.4
Family: Chroococcaceae		
Chroococcus limneticus Lemmermann	1.0	-
Chroococcus minutus (Kützing) Nägeli	-	3.3
Chroococcus turgidus (Kützing) Nägeli	2.1	8.9
Chroococcus sp.	-	2.2
Cyanosarcina burmensis (Skuja) Kovácik	-	3.3
Order: Oscillatoriales		
Family: Oscillatoriaceae		
Lyngbya sp.	2.1	1.1
Oscillatoria princeps Vaucher ex Gomont	-	5.6
Oscillatoria sancta Kützing ex Gomont	1.0	3.3
Oscillatoria sp.	34.4	11.1
Family: Pseudanabaenaceae		
Geitlerinema amphibium (C. Agardh) Anagnostidis	27.1	42.2
Geitlerinema splendidum (Greville) Anagnostidis	-	1.1
Geitlerinema sp.	9.4	-
Pseudanabaena catenata Lauterborn	4.2	1.1
Pseudanabaena limnetica (Lemmermann) Komárek	-	2.2
Pseudanabaena sp.	3.1	2.2
Family: Phormidiaceae		
Phormidium sp.	3.1	4.4
Planktothrix agardhii (Gomont) Anagnostidis & Komárek	24.0	16.7
Order: Nostocales		
Family: Nostocaceae		
Anabaena circinalis Rabenhorst	35.4	33.3
Anabaena constricta (Szafer) Geitler	26.0	15.6
Anabaena sp. 1	14.6	16.7
Anabaena sp. 2	-	3.3
Anabaenopsis sp.	-	1.1
Aphanizomenon sp.	3.1	4.4
Cylindrospermopsis raciborskii (Woloszynska) Seenaya & Subba Raju	41.7	56.7
Coscinodiscophyceae		
Order: Thalassiosirales		
Family: Stephanodiscaceae		
Cyclotella meneghiniana Kützing	-	4.4
Cyclotella stelligera Cleve & Grunow	-	1.1

- = absence of species.

Table 2. Continued...

Taxa	Reservoirs	
	Itaparica	Xingó
Order: Melosirales		
Family: Melosiraceae		
Melosira varians C. Agardh	-	1.1
Order: Aulacoseirales		
Family: Aulacoseiraceae		
Aulacoseira ambigua (Grunow) Simonsen	49.0	50.0
Aulacoseira granulata (Ehrenberg) Simonsen	56.3	72.2
Aulacoseira granulata var. *angustissima* (O.F. Müller) Simonsen	-	2.2
Aulacoseira herzogii (Lemmermann) Simonsen	-	1.1
Order: Triceratiales		
Family: Triceratiaceae		
Pleurosira laevis (Ehrenberg) Compère	1.0	-
Order: Rhizosoleniales		
Family: Rhizosoleniaceae		
Urosolenia eriensis (H.L. Smith) F.E. Round & R.M. Crawford	4.2	12.2
Urosolenia longiseta (Zacharias) Bukhtiyarova	39.6	42.2
Fragilariophyceae		
Order: Fragilariales		
Family: Fragilariaceae		
Fragilaria crotonensis Kitton	-	80.0
Fragilaria capucina Desmazières	1.0	-
Fragilaria capucina var. *fragilarioides* (Grun.) Ludwig et Flores	-	3.3
Fragilaria sp.	7.3	13.3
Synedra acus Kützing	-	1.1
Synedra sp.	-	1.1
Ulnaria ulna (Nitzsch) P. Compère	14.6	14.4
Bacillariophyceae		
Order: Eunotiales		
Family: Eunotiaceae		
Eunotia sp.	1.0	1.1
Order: Cymbellales		
Family: Cymbellaceae		
Encyonema silesiacum (Bleisch) D.G.Mann in Round. Crawford & Mann	1.0	-
Encyonema sp.	1.0	-
Family: Gomphonemataceae		
Gomphonema parvulum (Kützing) Grunow	-	2.2
Gomphonema sp.	2.1	1.1
Order: Naviculales		
Family: Stauroneidaceae		
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	-	1.1
Family: Pinnulariaceae		
Pinnularia maior (Kützing) Cleve	1.0	1.1
Pinnularia sp.	9.4	2.2
Family: Amphipleuraceae		
Amphipleura pellucida (Kützing) Kützing	1.0	-
Frustulia rhomboides (Ehrenberg) De Toni	3.1	-
Family: Naviculaceae		
Navicula sp.	4.2	5.6
Family: Pleurosigmataceae		

- = absence of species.

Table 2. Continued...

Taxa	Reservoirs	
	Itaparica	Xingó
Gyrosigma spenceri (W. Smith) Griffith & Henfrey	2.1	1.1
Order: Bacillariales		
Family: Bacillariaceae		
Nitzschia paleaeformis Hust	-	2.2
Order: Rhopalodiales		
Family: Rhopalodiaceae		
Epithemia sorex Kützing	2.1	3.3
Epithemia sp.	1.0	1.1
Order: Surirellales		
Family: Surirellaceae		
Surirella robusta Ehrenberg	7.3	-
Surirella sp.	2.1	2.2
Chrysophyceae		
Order: Monosigales		
Family: Synuraceae		
Mallomonas caudata Ivanov	-	1.1
Order: Ochromonadales		
Family: Dinobryaceae		
Dinobryon sertularia Ehrenberg	10.4	8.9
Cryptophyceae		
Order: Cryptomonadales		
Family: Cryptomonadaceae		
Cryptomonas ovata Ehrenberg	5.2	10.0
Cryptomonas subovalis Ehrenberg	2.1	4.4
Cryptomonas sp.	-	3.3
Order: Pyrenomonadales		
Family: Pyrenomodaceae		
Rhodomonas lacustris Pascher & Ruttner	1.0	3.3
Rhodomonas sp.	1.0	-
Dinophyceae		
Order: Peridiniales		
Family: Gymnodiniaceae		
Gymnodinium sp.	-	1.1
Family: Peridiniaceae		
Peridinium cinctum (O.F. Müller) Ehrenberg	-	11.1
Peridinium sp.	5.2	8.9
Euglenophyceae		
Order: Euglenales		
Family: Euglenaceae		
Euglena acus Ehrenberg	-	1.1
Euglena oxyuris Schmarda	-	1.1
Euglena sp.	2.1	4.4
Phacus longicauda (Ehrenberg) Dujardin	1.0	1.1
Trachelomonas armata (Ehrenberg) F.Stein	2.1	
Trachelomonas obesa Ehrenberg	-	7.8
Trachelomonas oblonga Ehrenberg	3.1	3.3
Trachelomonas volvocina Ehrenberg	7.3	12.2
Trachelomonas sp.	10.4	6.7

- = absence of species.

Table 2. Continued...

Taxa	Reservoirs	
	Itaparica	Xingó
Chlorophyceae		
Order: Sphaeropleales		
Family: Radiococcaceae		
Radiococcus planktonicus J.W.G. Lund	4.2	10.0
Family: Hydrodictyaceae		
Monactinus simplex (Meyen) Corda	31.3	34.4
*Pediastrum boryanum (*Turpin) Meneghini	1.0	2.2
Pediastrum duplex Meyen	54.2	28.9
Stauridium tetras (Ehrenberg) Hegewald	5.2	-
Family: Oocystaceae		
Dactylococcus infusionum Nägeli	3.1	-
Nephrocytium agardhianum Nägeli	-	2.2
Oocystis elliptica W. West	2.1	4.4
Oocystis lacustris Chodat	-	4.4
Oocystis pusilla Hansgirg	1.0	5.6
Oocystis sp.	-	4.4
Oonephris obesa (W. West) Fott	1.0	4.4
Planktosphaeria gelatinosa G.M. Smith	55.2	50.0
Family: Golenkiniaceae		
Golenkinia paucispina W. West & G.S. West	3.1	5.6
Golenkinia radiata Chodat	-	2.2
Family: Micractiniaceae		
Micractinium sp.	-	1.1
Phytelios viridis Frenzel	-	4.4
Family: Chlorococcaceae		
Chlorococcum infusionum (Schrank) Meneghini	1.0	2.2
Chlorococcum minutum R.C. Starr		1.1
Tetraedron gracile (Reinsch) Hansgirg	2.1	-
Family: Scenedesmaceae		
Crucigenia fenestrata (Schmidle) Schmidle	-	2.2
Crucigenia quadrata Morren	1.0	2.2
Desmodesmus quadricauda (Turpin) Hegewald	6.3	2.2
Scenedesmus acuminatus (Lagerheim) Chodat	-	1.1
Scenedesmus bijugus (Turpin) Kützing	1.0	2.2
Scenedesmus obliquus (Turpin) Kutzing var. *dimorphus* (Turpin) Hansgirg	1.0	-
Family: Coelastraceae		
Actinastrum hantzschii Lagerheim	2.1	1.1
Coelastrum microporum Nägeli	9.4	6.7
Coelastrum reticulatum (P.A. Dangeard) Senn	24.0	35.6
Family: Botryococcaceae		
Dictyosphaerium ehrenbergianum Nägeli	2.1	-
Dictyosphaerium granulatum Hindák	-	2.2
Dictyosphaerium pulchellum H.C. Wood	10.4	25.6
Dictyiosphaerium sp.	-	1.1
Family: Chlorellaceae		
Ankistrodesmus falcatus (Corda) Ralfs	-	1.1
Ankistrodesmus fusiformis Corda ex Korshikov	1.0	
Ankistrodesmus gracilis (Reinsch) Korshikov	-	2.2

- = absence of species.

Table 2. Continued...

Taxa	Reservoirs	
	Itaparica	**Xingó**
Ankistrodesmus spiralis (W.B. Turner) Lemmermann	-	1.1
Ankistrodesmus sp.	1.0	1.1
Chlorella vulgaris Beijerinck	16.7	21.1
Kirchneriella lunaris (Kirchner) K. Möbius	1.0	1.1
Kirchneriella obesa (G.S. West) Schmidle	1.0	2.2
Monoraphidium arcuatum (Korshikov) Hindák	1.0	-
Monoraphidium contortum (Thuret) Komàrková-Legnerová	2.1	4.4
Pseudoquadrigula sp.	-	1.1
Quadrigula chodatii (Tanner-Füllemann) G.M. Smith	9.4	15.6
Quadrigula lacustris (Chodat) G.M. Smith	-	4.4
Order: Tetrasporales		
Family: Tetrasporaceae		
Tetraspora sp.	-	1.1
Order: Palmellaceae		
Sphaerocystis schroeteri Chodat	21.9	45.6
Order: Oedogoniales		
Family: Oedogoniaceae		
Oedogonium sp.	1.0	-
Order: Volvocales		
Family: Volvocaceae		
Eudorina elegans Ehrenberg	5.2	8.9
Eudorina sp.	-	2.2
Volvox sp.	-	2.2
Zygnematophyceae		
Order: Zygnematales		
Family: Zygnemataceae		
Mougeotia sp.	2.1	8.9
Spirogyra sp.	2.1	1.1
Family: Closteriaceae		
Closterium sp.	2.1	-
Order: Desmidiales		
Family: Desmidiaceae		
Cosmarium margaritatum (P. Lundell) J. Roy & Bisset	-	6.7
Cosmarium sp.	5.2	4.4
Desmidium sp.	9.4	7.8
Euastrum sp.	1.0	-
Onychonema laeve Nordstedt	9.4	8.9
Pleurotaenium trabecula Nägeli	1.0	-
Staurastrum angulatum West	1.0	-
Staurastrum cuspidatum Brébisson in Ralfs	1.0	-
Staurastrum gracile Ralfs ex Ralfs	1.0	2.2
Staurastrum leptocladum L.N. Johnson	17.7	2.2
Staurastrum leptacanthum Nordstedt	-	25.6
Staurastrum pseudosebaldi Wille	-	2.2
Staurastrum rotula Nordstedt	15.6	36.7
Staurastrum tetracerum Ralfs	-	2.2
Staurastrum triangularis (Lagerheim) Teiling	1.0	-
Staurastrum sp. 1	8.3	31.1
Staurastrum sp. 2	-	3.3

- = absence of species.

Table 2. Continued...

Taxa	Reservoirs	
	Itaparica	Xingó
Staurodesmus cuspidatus (Brébisson) Teiling	1.0	-
Staurodesmus mamillatus (Nordstedt) Teiling	1.0	-
Staurodesmus subulatus (Kützing) Thomasson	-	2.2
Staurodesmus triangularis (Lagerheim) Teiling	-	1.1
Staurodesmus sp.	5.2	7.8
Family: Peniaceae		
Gonatozygon monotaenium De Bary	2.1	6.7
Gonatozygon pilosum Wolle	-	3.3
Gonatozygon sp.	1.0	-

- = absence of species.

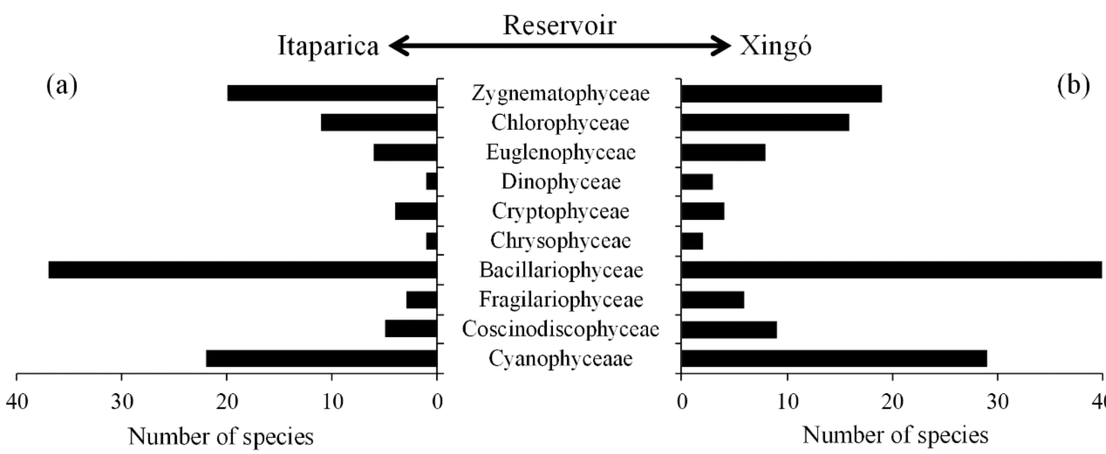

Figure 2. Species richness of phytoplankton in the (a) Itaparica and (b) Xingó Reservoirs, São Francisco River, Brazil, between December 2007 and September 2008.

cause displacement of typically periphytic organisms or those that live in the sediment to the surface layers of the water column (De León and Chalar, 2003).

Analysis of the frequency of occurrence showed that in both reservoirs studied, most species were rare and occasional (Figure 3, Table 2). There were no very frequent species in the Itaparica reservoir. However, in the frequent category, the following species were observed: the cyanobacteria *Cylindrospermopsis raciborskii* (Woloszynska) Seenaya & Subba Raju, the diatoms *Aulacoseira ambigua* (Grunow) Simonsen and *A. granulata* (Ehrenberg) Simonsen and the green algae *Pediastrum duplex* Meyen and *Planktosphaeria gelatinosa* G.M. Smith (Table 2).

In the Xingó reservoir, *Aulacoseira granulata* and *Fragilaria crotonensis* Kitton were considered very frequent, while the cyanobacteria *Cylindrospermopsis raciborskii* and *Geitlerinema amphibium* (C. Agardh) Anagnostidis, the diatoms *Aulacoseira ambigua* and *Urosolenia longiseta* (Zacharias) Bukhtiyarova and the green algae *Planktosphaeria gelatinosa* and *Sphaerocystis schroeteri* Chodat were frequent (Table 2). The very frequent and/or frequent species in both reservoirs, *C. raciborskii*, *A. granulata*,

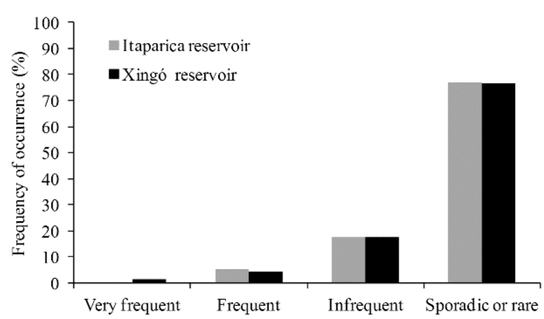

Figure 3. Frequency of occurrence of phytoplankton in the Itaparica and Xingó Reservoirs, São Francisco River, Brazil, between December 2007 and September 2008.

A. ambigua and *P. gelatinosa*, are cosmopolitan, widely distributed in freshwater ecosystems. *C. raciborskii* is widely studied since it forms dense blooms in water bodies and has the potential to produce toxins that are harmful to humans and other animals. It presents multiple adaptive strategies that enable it to tolerate wide ranges of environmental conditions, such as resistance to herbivory, tolerance to low light intensity, ability to migrate in the water column, ability to store and use intracellular stores, and the ability to fix atmospheric nitrogen (Ogawa and Carr, 1969; Bittencourt-Oliveira et al., 2011).

The occurrence of *C. raciborskii* has been observed in eutrophic environments with high temperature (Padisák and Reynolds, 1998), reduced water transparency (Pádisak and Reynolds, 1998; Bouvy et al., 1999; Mischke and Nixdorf, 2003) and low N/ P ratio (Briand et al., 2002).

Centric diatoms of the genus *Aulacoseira* inhabit mixed environments with high trophic levels (Reynolds et al., 2002 and Pádisák et al., 2009). The genus includes the species *Aulacoseira granulate*, one of the few diatoms that form blooms in hypereutrophic freshwater environments (Vieira et al., 2008). The cylindrical cells of these organisms are linked together to form long filaments that exhibit high sedimentation rate due to the frustule which is denser than the surrounding water (Wolin and Duthie, 1999). Therefore, the presence of this diatom in the light layers of the water column often depends on the occurrence of events that keep the mixture in suspension (Siqueiros-Beltrones, 1988; De León and Chalar, 2003).

P. gelatinosa occurs in environments with a clear epilimnion, low nutrient concentration and high turbidity (Reynolds et al., 2002; Padisák et al., 2009). According to Chamixaes (1990), green algae are commonly found in places with lower degrees of eutrophication.

Although the taxonomic composition in the Itaparica and Xingó reservoirs is similar, there was a difference in the occurrence of frequent and very frequent species, suggesting differences, in the environmental conditions of each reservoir, that may be related to the actual morphometry and hydrodynamics of the reservoirs, as well as to the presence of vegetation and human activities on the banks.

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