CAPÍTULO 10

INVASIVE DINOFLAGELLATE *CERATIUM FURCOIDES* (LEVANDER) LANGHANS IN TWO LINKED TROPICAL RESERVOIRS

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ABSTRACT

Ceratium is a large freshwater mixotrophic dinoflagellate protected by rigid cellulose armor, characteristic summer inhabitant of temperate stratified lakes with low surface nutrient concentrations. Here we reported the occurrence of high biomass of *Ceratium furcoides* in Billings reservoir (São Paulo, Brazil), and we reported for the first time, the occurrence of *C. furcoides* in Guarapiranga reservoir (São Paulo, Brazil), however, in low biomass. Billings reservoir is used for electric power generation, leisure, fishery and navigation. Guarapiranga reservoir's main use is water supply. Since 2000, water from Billings is pumped to Guarapiranga during the dry season, when the water level of the last is low. Probably, *C. furcoides* population was transferred to Guarapiranga during this pumping. The lower *C. furcoides* biomass in Guarapiranga reservoir suggests that the colonization of *C. furcoides* in Guarapiranga is still in early stages comparing with the colonization in Billings or that Guarapiranga's environment is not convenient for *C. furcoides'* establishment and growth as it is in Billings reservoir. Thus, monitoring should be intensified, and more effective measures should be taken by the agencies responsible in order to eliminate the causes of the eutrophication process, the consequent development of phytoplankton blooms, and the transference of potential harmful organisms.

1 INTRODUCTION

Water storage is one the most ancient, important and efficient human intervention in natural systems (TUNDISI, 1996). These man-made reservoirs promote economic benefits due to hydroelectric power generation and due to water supply for irrigation and consumption, among others. Modern reservoirs can storage a large volume of water and also can have a very high capacity of water transfer between basins, affecting the water quality of the hydrographic basins involved (STRASKRABA; TUNDISI, 2000). In other words, reservoirs are inserted in a hydrographic basin and interact with it, capturing the human activities impacts along the basin (TUNDISI, 1996).

Eutrophication is a natural process that has been accelerated by human activities such as urbanization, industrialization and use of agricultural fertilizers (POMPÊO et al., 2005). The high nutrients concentration in the water, that characterized the eutrophication process, leads to great alteration in the aquatic ecosystem, affecting the biological communities and the biogeochemical cycles (MOSS, 1998). Phytoplankton blooms are one of the main symptoms of the eutrophication process. In tropical regions, during the last three decades, cyanobacteria blooms have been more and more frequent in water supply reservoirs (DI BERNARDO et al., 2002). However, very recently, blooms of an invasive dinoflagellate species are being frequently observed in tropical reservoirs.

Ceratium Schrank is a large freshwater mixotrophic dinoflagellate protected by a rigid cellulose armor (POPOVSKÝ; PFISTER, 1990). Because of these morphological characteristics, *Ceratium* is well protected from ingestion by herbivorous cladocerans (SOMMER et al., 2003). Inorganic nutrients are often cited as factors that trigger blooms of *Ceratium* (WHITTINGTON et al., 2000). Its occurrence can harm the environment since it can deplete resources (SANTOS-WISNIEWSKI et al., 2007). The genus *Ceratium* is a characteristic summer inhabitant of temperate stratified lakes with low surface nutrient concentrations (DOKULIL; TEUBNER, 2003; GRIGORSZKY et al., 2003). However, since 1999, reports of high densities of *Ceratium* in tropical and subtropical eutrophic waters became more frequent, such as Argentina (MACDONAGH et al., 2005), Chile (SOTO; LEMBEYE, 1999), South Africa (VAN GINKEL et al., 2001; HART, 2007), New Zealand (HART; WRAGG 2009) and Australia (WHITTINGTON et al., 2000; BALDWIN et al., 2003). Since 2007, *Ceratium* is frequently found in Brazilian environments (SANTOS-WISNIEWSKI et al., 2007; CETESB 2009; MATSUMURA-TUNDISI et al., 2010; OLIVEIRA et al., 2011). Here is reported and discussed the occurrence of *Ceratium furcoides* (Levander) Langhans in two linked Brazilian reservoirs.

2 MATERIALS AND METHODS

This study was carried out in September 14, 16 and 18th, 2009 in two linked Brazilian reservoirs in São Paulo metropolitan area: Billings (six superficial samples through Taquacetuba branch's longitudinal axis) and Guarapiranga (six superficial samples through Parelheiros branch's longitudinal axis) (Figure 1).

Billings reservoir was built in 1927 and its watershed covers an area of 560 km^2, storing 1.2 billion m^3 of water. Billings' uses include electric power generation, leisure, fishery, navigation, flow control, domestic and industrial wastewater reception, and water supply. Billings' limnological characteristics changed substantially since 1940, when part of the polluted water from the Tietê River (São Paulo city) started to flow into the Billings reservoir, aiming to increase the water flow and consequently, the electric power generation. This operation, along with the disorganized human occupation of the watershed, contributed to increase the eutrophication and consequently, the cyanobacterial blooms (SOUZA et al., 1998). Due to its peculiar shape, Billings reservoir is divided into eight units called branches. Taquacetuba branch has a particular use. In August of 2000, the São Paulo State Basic Sanitation Company (SABESP) began the transfer of raw water from Taquacetuba branch to Guarapiranga reservoir (Parelheiros branch), in order to increase the water volume of Guarapiranga reservoir during the dry season. This water transfer started with a license

for 2.0 m^3 s^{-1}; currently, it operates at a volume of 3.0 to 4.0 m^3 s^{-1}, contributing with 29% of the total water produced in Guarapiranga reservoir, which main use is water supply to southeastern São Paulo city at a rate of 1.2 billion L day^{-1} (WHATELY; CUNHA, 2006). Guarapiranga reservoir was constructed in 1908 and its watershed covers an area of 36 km^2, storing 194 million m^3 of water. According to the São Paulo State Environmental Agency (CETESB), the current main problem of both reservoirs is the excess of organic matter from clandestine domestic sewage input (CETESB, 2009). Consequently, phytoplankton blooms, especially cyanobacteria, are frequent in both reservoirs (NISHIMURA et al., 2008; MOSCHINI-CARLOS et al., 2009).

Figure 1: Location of São Paulo State and São Paulo metropolitan area. In detail, Guarapiranga and Billings reservoirs and the respective sampling points in Parelheiros and Taquacetuba branches. The dotted arrow represents the water path when water is being transferred from Billings to Guarapiranga reservoir.

Water temperature, pH, electric conductivity (EC) and dissolved oxygen (DO) were measured in each sampling station using standard electrodes (YSI 556). In each sampling station, maximum depth (Z_{max}) and Secchi disk depth (Z_{sd}) were measure and the euphotic depth (Z_{eu}) was estimated (AROCENA, 1999). Additionally, superficial water was gathered to analyze the following variables in the laboratory: ammonium, nitrite and nitrate (MACKERETH et al., 1978), silicate and soluble reactive phosphorus (STRICKLAND; PARSONS, 1960), total nitrogen and total phosphorus (VALDERRAMA, 1981); chlorophyll *a* corrected for phaeophytin using 90% acetone extraction (LORENZEN, 1967; WETZEL; LIKENS, 1991).

Superficial water samples for phytoplankton community analysis were preserved with lugol 4%. Phytoplankton species were identified based on specific bibliography and according to Van Den Hoek (1997), except for Cyanobacteria (KOMÁREK; ANAGNOSTIDIS, 1999; 2005) and Bacillariophyceae (ROUND et al., 1992) in a Carl Zeiss ScopeA1 microscope. Phytoplankton cells were counted using the settling technique (UTERMÖHL, 1958) in 2 mL settling chambers in a Carl Zeiss Axiovert 40C inverted microscope. Sedimentation time followed Lund et al. (1958). A minimum of 400 individuals (cells, colonies or filaments) was counted in each sample giving a

counting accuracy, expressed in terms of 95% confidence limits, of < 10% for the whole phytoplankton population (LUND et al., 1958). Biovolume was obtained by geometric approximation, multiplying each species' density by the mean volume of its cells considering, whenever possible, the mean dimension of 30 individual specimens of each species (HILLEBRAND et al., 1999). Algal biomass was estimated assuming a specific gravity for algal cells of 1 mg mm3. The phytoplankton species that contributed with more than 5% of the total biomass of the sample were considered a descriptors species of the community. Species that contributed with more than 50% of the total biomass of the sample were considered dominant (LOBO et al., 2002). To identify the species *Ceratium furcoides*, cells were clarified with NaClO 20% to see the plate tabulation (BOLTOVSKOY, 1995) and the specimens were observed in a Carl Zeiss ScopeA1 microscope. *Ceratium* species description was based on Popovský; Pfester (1990) and Lewis; Dodge (2002).

To explore the relationship between the limnological variables and the sampling stations, a Principal Components Analysis (PCA) was performed. To assess the contribution of each variable included in the PCA, the "equilibrium circle of descriptors" technique was applied (LEGENDRE; LEGENDRE, 1998). The variables inside the "equilibrium circle" were excluded from the analysis. Limnological data were standardized by ranging $[(x - x_{min})/(x_{max} - x_{min})]$ in order to keep the same amplitude to all variables and the PCA was carried out with the CANOCO for Windows 4.5 software and PCA plots were performed with CanoDraw for Windows (version 4.0) software.

3 RESULTS

Table 1 and Table 2 show the main physical, chemical and biological variables measured in all sampling stations in Billings and Guarapiranga reservoirs, respectively. The first two axis of the PCA explained 86.2% of the data variance (64.7% by the first axe and 21.5% by the second, Figure 2). The PCA plot showed a clear segregation by the first axis of the sampling stations from Billings and Guarapiranga reservoirs (Figure 2). Billings' sampling stations were close from each other in the ordination, indicating homogeneity among the stations. Moreover, Billings sampling stations were positively correlated with the variables related with nitrogen, electric conductivity, pH, DO and Zmax (Table 3). Guarapiranga's sampling stations were spread along the second axis, indicating heterogeneity among the stations. By the PCA ordination, it is possible detect a clear pattern of decreasing TN towards the central body of Guarapiranga reservoir (G1 → G6, Figure 2). G1 exhibited very distinct characteristics from the rest of the sampling spots, with very low depth and dissolved oxygen concentration, and high total phosphorous and ammonium concentrations. In G1 and G2 were observed the highest phytoplankton biomass (Figure 3). The high biomass in G1 was due to the dominance of the cyanobacteria *Sphaerocavum brasiliensis* (7.15 $mm^3\ L^{-1}$) and in G2, due to the dominance of the Dinophyceae *Peridiniopsis cunningtonii* (13 $mm^3\ L^{-1}$).

Altogether, 122 phytoplankton species were identified. Higher species richness was observed in Guarapiranga (81 species) compared to Billings (58 species). In Guarapiranga, 21 phytoplankton species were considered descriptors: four Chlorophyceae (*Botryococcus braunii* Kützing, *Coelastrum microporum* Nägeli, *Tetrastrum homoicanthum* (Huber-Pestalozzi) Comas and *Chlamydomonas* sp.), four Cyanophyceae (*Anabaena spiroides* Klebahn, *Synechocystis aquatilis* Sauvageau, *Coelomoron tropicale* P.A.C.Senna, A.C.Peres; J.Komárek and *Sphaerocavum brasiliensis* M.T.P. Azevedo; C.L. Sant'Anna), three Dinophyceae (*Ceratium furcoides* (Levander) Langhans, *Peridiniopsis cunningtonii* (Lemmermann) Popovský; Pfiester and *Peridinium gatunense* Nygaard), three Euglenophyceae (*Euglena agilis* H.J.Carter, *Trachelomonas similis* var. *spinosa* Huber-Pestalozzi and *Trachelomonas volvocinopsis* Svirenko), two Bacillariophyceae (*Nitzschia* sp. and *Urosolenia eriensis* (H.L.Smith) Round; R.M.Crawford), two Cryptophyceae (*Cryptomonas brasiliensis* A.Castro, C.Bicudo; D.Bicudo and *Cryptomonas ovate* (Ehrenberg), one Synurophyceae (*Synura* sp.), one Trebouxiophyceae (*Franceia droescheri* (Lemmermann) G.S.Smith) and one Zygnematophyceae (*Staurastrum anatinum* Cooke; Wills var. *anatinum* f. *anatinum*). In Billings 11 species were considered descriptors: four Dinophyceae (*Ceratium*

furcoides, *Gymnodinium* sp., *Peridinium gatunense*, *Peridinium umbonatum* F.Stein), two Cryptophyceae (*Cryptomonas brasiliensis* and *Cryptomonas ovata*), two Cyanophyceae (*Synechocystis aquatilis* and *Planktothrix agardhii* (Gomont) Anagnostidis; Komárek), one Chlorophyceae (*Botryococcus braunii*), one Trebouxiophyceae (*Eremosphaera* sp.) and one Zygnematophyceae (*Staurastrum anatinum* Cooke; Wills var. *anatinum* f. *anatinum*). In general, phytoplankton biomass was higher in Guarapiranga reservoir compared to Billings (Figure 3).

Table 1: Mean values and standart deviation of the physical, chemical and biological variables measured in all sampling stations in Billings reservoir (B1-B6; n = 3, each sampling day in each sampling station). ["Total average" referres to the mean value and standart deviation of all samples in Billings reservoir (n = 18); Zmax = maximun depth; Zsd = Secchi disk depth; Zeu = euphotic depth; N:P = nitrogen:phosphorous molar ratio]

variables	Billings Reservoir						
	B1	B2	B3	B4	B5	B6	Total average
Zmax (m)	5.9 ± 0.1	8.0 ± 0.1	8.7 ± 0.6	10.1 ± 0.3	10.5 ± 0.1	10.7 ± 0.3	9.0 ± 1.7
Zsd (m)	1.1 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	1.5 ± 0.1	1.4 ± 0.1	1.5 ± 0.1	1.3 ± 0.2
Zeu (m)	3.0 ± 0.3	3.2 ± 0.3	3.3 ± 0.4	4.1 ± 0.4	3.8 ± 0.3	4.0 ± 0.3	3.6 ± 0.5
Zeu/Zmax	0.5 ± 0.1	0.4 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.4 ± 0.1
Temperature (°C)	21.0 ± 0.3	20.9 ± 0.3	21.0 ± 0.3	21.1 ± 0.2	21.3 ± 0.3	21.6 ± 0.8	21.1 ± 0.4
Dissolved oxygen (mg L^{-1})	8.4 ± 1.9	9.3 ± 0.5	8.9 ± 0.5	8.7 ± 0.5	8.1 ± 1.1	8.8 ± 0.7	8.7 ± 0.9
pH	7.6 ± 0.0	7.8 ± 0.5	7.9 ± 0.5	7.9 ± 0.3	7.9 ± 0.3	7.7 ± 0.4	7.8 ± 0.3
Conductivity (µS cm^{-1})	220 ± 9	221 ± 9	223 ± 6	226 ± 5	229 ± 5	231 ± 6	225 ± 7
Silicate (µg L^{-1})	2 ± 0	2 ± 0	3 ± 1	2 ± 0	2 ± 0	2 ± 0	2.0 ± 1
Phosphate (µg L^{-1})	< 10	< 10	< 10	< 10	< 10	< 10	-
Nitrite (µg L^{-1})	32 ± 15	35 ± 13	37 ± 13	41 ± 9	46 ± 13	45 ± 7	39 ± 11
Nitrate (µg L^{-1})	717 ± 138	812 ± 231	845 ± 250	902 ± 163	920 ± 91	942 ± 105	856 ± 161
Ammonium (µg L^{-1})	27 ± 7	44 ± 59	26 ± 28	38 ± 38	58 ± 65	60 ± 50	42 ± 40
Total nitrogen (µg L^{-1})	1371 ± 44	1380 ± 37	1363 ± 13	1415 ± 43	1511 ± 88	1506 ± 146	1424 ± 87
Total phosphorous (µg L^{-1})	42 ± 19	35 ± 19	33 ± 15	31 ± 16	33 ± 12	28 ± 8	34 ± 13
N:P	87 ± 49	117 ± 88	115 ± 72	133 ± 97	112 ± 51	130 ± 50	116 ± 60
Chlorophyll-a (µg L^{-1})	48 ± 7	42 ± 28	31 ± 12	24 ± 11	34 ± 18	27 ± 21	34 ± 14
Phaeophytin (µg L^{-1})	22 ± 1	57 ± 67	20 ± 15	15 ± 4	18 ± 5	15 ± 8	16 ± 4

Table 2: Mean values and standart deviation of the physical, chemical and biological variables measured in all sampling stations in Guarapiranga reservoir (G1-G6; n = 3, each sampling day in each sampling spot). ["Total average" referres to the mean value and standart deviation of all samples in Guarapiranga reservoir (n = 18); Zmax = maximun depth; Zsd = Secchi disk depth; Zeu = euphotic depth; N:P = nitrogen:phosphorous molar ratio]

variables	Guarapiranga Reservoir						
	G1	G2	G3	G4	G5	G6	Total average
Zmax (m)	2.9 ± 0.2	4.7 ± 0.1	6.5 ± 0.2	8.0 ± 0.0	8.9 ± 0.6	8.5 ± 0.4	7.0 ± 2.2
Zsd (m)	1.3 ± 0.4	1.6 ± 0.1	1.5 ± 0.0	1.5 ± 0.0	1.3 ± 0.1	1.2 ± 0.2	1.4 ± 0.2
Zeu (m)	3.5 ± 1.0	4.4 ± 0.2	4.2 ± 0.1	4.0 ± 0.1	3.6 ± 0.3	3.3 ± 0.4	3.8 ± 0.5
Zeu/Zmax	1.2 ± 0.4	0.9 ± 0.1	0.6 ± 0.0	0.5 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.6 ± 0.3
Temperature (°C)	20.5 ± 0.6	20.4 ± 0.6	20.6 ± 0.3	21.1 ± 0.6	21.4 ± 0.4	21.3 ± 0.5	20.9 ± 0.6
Dissolved oxygen (mg L^{-1})	0.6 ± 0.5	3.7 ± 1.9	5.1 ± 0.9	7.1 ± 1.6	7.3 ± 1.1	8.1 ± 0.5	5.5 ± 2.6
pH	7.0 ± 0.0	7.1 ± 0.1	7.2 ± 0.0	7.4 ± 0.2	7.5 ± 0.1	7.7 ± 0.2	7.4 ± 0.3
Conductivity (µS cm^{-1})	129 ± 22	117 ± 10	112 ± 6	87 ± 11	108 ± 13	110 ± 7	112 ± 15
Silicate (µg L^{-1})	2 ± 0	2 ± 0	2 ± 0	2 ± 0	2 ± 0	2 ± 0	2 ± 0
Phosphate (µg L^{-1})	46 ± 34	12 ± 11	< 10	< 10	< 10	< 10	-
Nitrite (µg L^{-1})	13 ± 9	33 ± 10	31 ± 9	13 ± 7	20 ± 6	24 ± 9	22 ± 10
Nitrate (µg L^{-1})	150 ± 175	384 ± 95	456 ± 46	242 ± 69	414 ± 64	472 ± 29	385 ± 152
Ammonium (µg L^{-1})	505 ± 194	372 ± 197	252 ± 55	69 ± 56	118 ± 79	80 ± 7	218 ± 180
Total nitrogen (µg L^{-1})	1392 ± 357	1100 ± 77	1003 ± 150	655 ± 69	820 ± 74	932 ± 89	999 ± 253
Total phosphorous (µg L^{-1})	117 ± 53	45 ± 4	36 ± 13	24 ± 4	32 ± 5	39 ± 12	49 ± 34
N:P	29 ± 9	54 ± 8	66 ± 20	63 ± 17	57 ± 9	56 ±15	54 ± 17
Chlorophyll-a (µg L^{-1})	12.7 ± 6.8	15.9 ± 10.2	18.7 ± 11.3	20.4 ± 10.7	21.2 ± 6.0	36.9 ± 5.7	17 ± 13
Phaeophytin (µg L^{-1})	14.3 ± 6.4	29.5 ± 19.7	14.8 ± 1.0	19.4 ± 8.5	33.3 ± 21.4	32.6 ± 12.1	15 ± 7

Table 3: Biplot scores of the selected environmental variables applied in the principal components analysis (PCA) in Billings and Guarapiranga reservoirs' sampling stations

variables	1st axis	2nd axis
Zmax	-0.8678	0.2929
Zeu/Zmax	0.8837	-0.4416
T	-0.7008	0.4215
DO	-0.9265	0.2988
pH	-0.9515	0.0512
EC	-0.7904	-0.5852
SRSi	0.3100	-0.4362
SRP	0.7619	-0.5431
NO_2	-0.7973	-0.4074
NO_3	-0.9400	-0.3256
NH_4^+	0.8890	-0.3606
TN	-0.4460	-0.8754
TP	0.7198	-0.5624
N:P	-0.9283	-0.2689

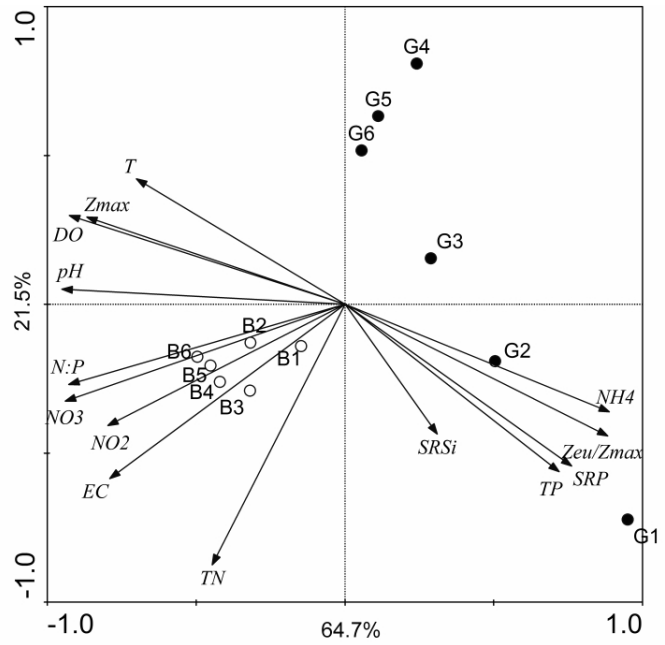

Figure 2: T=temperature; Zmax=maximum depth; DO=dissolved oxygen; pH; NO3=nitrate; NO2=nitrite; K=conductivity; TN=total nitrogen; SiO3=silicate; TP=total phosphorous; NH4=ammonium; Zeu=Euphotic depth) standardized by ranging in Billings (B1-B6) and Guarapiranga reservoirs (G1-G6).

Ceratium furcoides specimen was identified among the phytoplankton community. The cells were narrowly spindle-shaped, strongly dorsiventrally flattened, 42–54 µm wide, 114–154 µm long; epitheca formed into a narrow horn without shoulders; hypotheca broad and short, drawn out into two posterior horns of different lengths; plates smooth and with shallow net-like ornamentation. The apical plate's tabulation was crucial to confirm the specimen as *C. furcoides*: the fourth apical plate does not reach apex of epitheca (Figure 4).

C. furcoides was found in all 18 samples from Billings and only in four out of 18 samples from Guarapiranga. Higher *C. furcoides* biomass was observed in Billings reservoir (Figure 3). In Billings, *C. furcoides* biomass ranged from 0.2 to 5.7 $mm^3 L^{-1}$, comprising up to 44% of the mean total biomass in B5. In Guarapiranga, *C. furcoides* biomass was lower, ranging from 0 to 2.6 $mm^3 L^{-1}$ and comprising up to 15% of the mean total biomass in G3. *C. furcoides* was not found in the sampling spots G1 and G2, where low DO concentration, low maximum depth, high ammonium and total phosphorous concentrations were observed. Additionally, in these two sampling stations,

dominance of other species was observed (*Sphaerocavum brasiliensis* and *Peridiniopsis cunningtonii*), as mentioned previously.

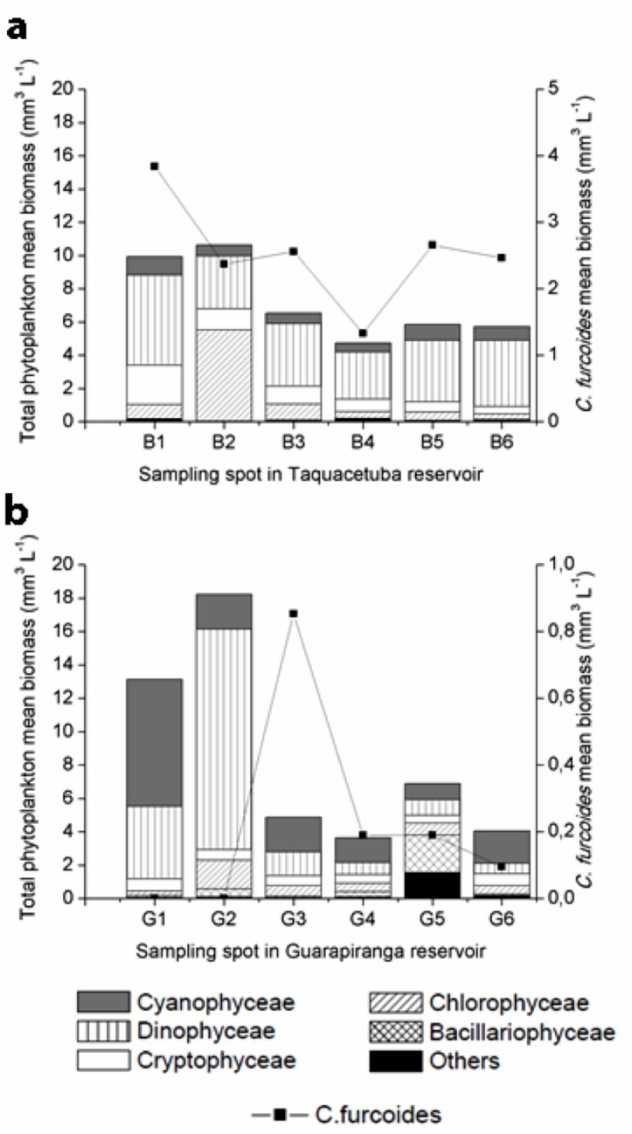

Figure 3: Total phytoplankton mean biomass (n = 3, each sampling day per sampling spot) per taxonomical class and *Ceratium furcoides* mean biomass (n = 3, each sampling day per sampling spot) in each sampling spot in (a) Billings and (b) Guarapiranga reservoirs.

4 DISCUSSION

Billings and Guarapiranga reservoirs were physically, chemically and biologically distinct, as shown by the PCA ordination. Billings exhibited a very homogenous environment, while Guarapiranga was spatially heterogeneous along the branch longitudinal axis, displaying higher nutrient content near the water inflow (sampling stations G1 and G2). Previous works have already evidenced the spatial heterogeneity in Guarapiranga reservoir in relation to water quality (CARDOSO-SILVA, 2008), metals in sediment (PADIAL, 2008) and in water (CARDOSO-SILVA, 2008), and aquatic macrophytes (RODRIGUES; 2011).

C. furcoides biomass in Billings were high compared to those recorded by Santos-Wisniewski et al. (2007) in the first report of *C. furcoides* in Furnas reservoir (Minas Gerais, Brazil) (maximum mean density of 12 cells mL^{-1}). *C. furcoides* was first recorded in Billings in 2008 (CETESB, 2009). The authors suggested that the appearance of *C. furcoides* caused the reduction of cyanobacteria density. Matsumura-Tundisi et al. (2010) reported a *C. furcoides* bloom (535-21455

cells mL^{-1}) in Taquacetuba branch (Billings reservoir) in 2008, period prior to this study. The authors, pointed out as the possible cause of the *C. furcoides* bloom the turbulence induced by wind, that caused the water column mixing, along with *Ceratium* cysts from the sediments and nutrients. In the present study, high *C. furcoides* biomass was observed in Billings reservoir, long with low cyanobacteria biomass and high nutrients concentrations. Further studies are required to explore *C. furcoides*-Cyanobateria interaction in detail.

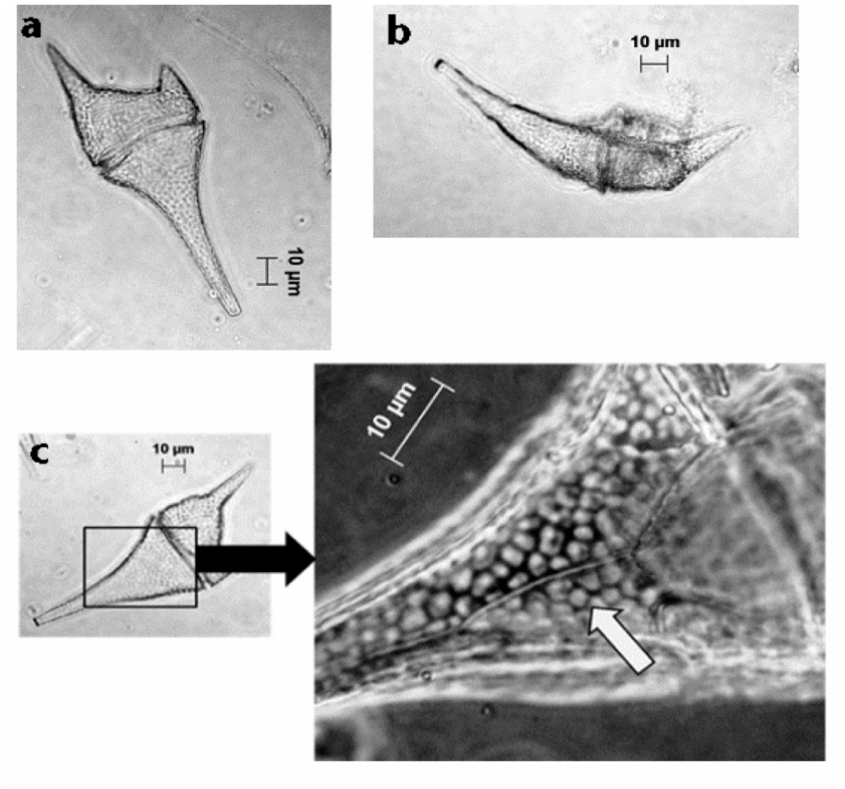

Figure 4: *Ceratium furcoides* (Levander) Langhans from Billings and Guarapiranga reservoirs: a) ventral view; b) lateral view; c) ventral view with 4' plate in detail (white arrow) in phase contrast.

Here, we reported the first occurrence of *C. furcoides* in Guarapiranga. Since 2000, water from Billings (Taquacetuba branch) is pumped to Guarapiranga (Parelheiros branch) during the dry season, when the water level of the last is low. Probably, *C. furcoides* population was transferred to Guarapiranga during this pumping. The lower frequency and biomass of *C. furcoides* observed in Guarapiranga, suggest that the colonization of *C. furcoides* in Guarapiranga is still in early stages comparing with the colonization in Billings or that Guarapiranga's environment is not convenient for *C. furcoides'* establishment and growth as it is in Billings reservoir.

An important observation is that in the only two sampling stations where *C. furcoides* was not observed (G1 and G2), were the only two sampling spots where other phytoplankton species were dominant (*Sphaerocavum brasiliensis* and *Peridiniopsis cunningtonii*, respectively). All other sampling stations where *C. furcoides* was recorded, no dominance was observed. This fact can suggest that *C. furcoides* population is important for the maintenance of the phytoplankton community non-equilibrium (ROJO; ÁLVAREZ-COBELAS, 2003). Further studies are required to investigate: (1) the interaction of this dinoflagellate with the phytoplankton and zooplankton community; (2) how this species is being dispersed; and (3) what are the consequences of the *C. furcoides* colonization for the water supply.

Invaders can alter fundamental ecological properties such as the dominant species in a community and an ecosystem's physical features, nutrient cycling, and primary productivity (MACK et al., 2000). In this context, the presence of high densities of the invasive dinoflagellate *C. furcoides* in tropical waters is of great concern, especially in water supply reservoirs, such as

Billlings and Guarapiranga. The water in Billings's reservoirs (Taquacetuba branch) is not treated nor managed before being transferred to Guarapiranga reservoir. Thus, monitoring should be intensified, and more effective measures should be taken by the agencies responsible in order to eliminate the causes of the eutrophication process, the consequent development of phytoplankton blooms, and the transference of potential harmful organisms. Furthermore, the occurrence and dispersal of *C. furcoides* needs be carefully monitored in tropical and subtropical reservoirs, especially those where the colonization process is still in early stages, such as Guarapiranga reservoir. The findings in this project point out the need for further studies on *C. furcoides* population in order to better understand its role in the ecosystem and, consequently, to prevent possible alterations in the ecosystem ecological properties and also, to prevent losses for human activities, especially water supply.

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