POLLUTION GRADIENT ON EPIPHYTIC ALGAE OF SOUTHERN BRAZIL COASTAL LAKES

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ABSTRACT

This study aimed to assess the relationships between abiotic variables and structure of epiphytic algae that colonize the 6th petiole macrophyte *Eichhornia azurea* (Sw.) Kunth, in three coastal lakes of Rio Grande do Sul, Brazil. We considered the density and composition algae and its relationship with the abiotic variables temperature, pH, alkalinity, conductivity, turbidity, dissolved oxygen, total nitrogen, nitrates, nitrites, ammonia, orthophosphate, total phosphorus and fecal coliforms. Samples were taken monthly from November/95 to May /96 up along a gradient of dilution and self-purification of pollution from the shallow Marcelino Lake dump that receives wastewater from the city of Osorio. The quantitative analysis of epiphyton identified 66 species of algae at the genus level, specific and infra-specific. The most representative classes were Bacillariophyceae, Cyanophyceae and Chlorophyceae. There was no influence of environmental variables on the epiphytic community, mainly on the class group of algae, as evidenced in the study of community structure. The cluster analysis with the densities of species of epiphytic algae revealed that the spatial distribution was more significant than the temporal variation. According to PCA there was a gradient showing the clearance of the degree of pollution of the lake in order to Marcelino and Peixoto and Pinguela with respect to the measured abiotic data. Finally, considering the biotic and abiotic measures, the main change in the race study followed the temporal variation of spatial variation.

Keywords: epiphyton, shallow lake, pollution gradient, community structure.

RESUMO

Este trabalho teve como objetivo conhecer as relações entre as variáveis abióticas e a estrutura de algas do perifíton que colonizam o 6º pecíolo da macrófita *Eichhornia azurea* (Sw.) Künth, em três lagoas costeiras do Rio Grande do Sul. Foi considerada a densidade e a composição de algas e sua relação com as variáveis abióticas (temperatura, pH, alcalinidade, condutividade, turbidez, oxigênio dissolvido, nitrogênio total, nitratos, nitritos, amônia, ortofosfato, fósforo total, coliformes fecais e totais). As amostragens foram mensais no período de novembro/95 até maio/96, ao longo de um gradiente de diluição e autodepuração da poluição, a partir da lagoa Marcelino que recebe os despejos de águas residuárias da cidade de Osório. Na análise quantitativa do

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perifíton foram identificadas 66 espécies de algas em nível genérico, específico e infra-específico. As classes mais representativas foram Bacillariophyceae, Cyanophyceae e Chlorophyceae. Houve influência das variáveis abióticas sobre a comunidade de algas perifíticas, principalmente sobre os grupo de classes de algas, evidenciada no estudo da estrutura da comunidade. A análise de cluster com as densidades de espécies de algas do perifíton revelou que a distribuição espacial foi mais significativa que a variação temporal. Segundo a PCA observou-se um gradiente mostrando a depuração do grau de poluição no sentido da lagoa Marcelino para a Peixoto e Pinguela com relação aos dados abióticos medidos. Por fim, considerando as variáveis bióticas e abióticas medidas, a principal variação corrida no estudo foi a variação temporal seguida da variação espacial.

Palavras-chave: algas, lêntico, gradiente de poluição, estrutura da comunidade

INTRODUCTION

Marcelino, Peixoto and Pinguela Lakes located in Osório (50°10'22"W, 50°16'36"W and 29º45'00"S, 29°53'59"S) and are part of a complex coastal lakes in northern Rio Grande do Sul (RS) Brazil (Figure 1). The study was conducted in these three shallow lakes that have a gradient of pollution and depuration from Marcelino Lake that receives wastewater discharges from the city of Osorio. The coastal plain of Rio Grande do Sul have been suffering the effects of increasing urbanization, especially the tourist attractions that this region represents. One of the likely impacts is the contamination of coastal shallow lakes in urban sewage. The Marcelino Lake had already hosted a major port lakeside, in the years 1920 to 1950, when transportation was mainly in the region through navigation (Silva, 1985). Local info realized that in 70 years, had already noticed the first signs of pollution by sewage released in that water body. These facts show that the changes of anthropogenic origin are longtime lakeside in this complex.

The periphyton plays a key role in aquatic ecosystems because it is primarily autotrophic (Lowe, 1996). Epiphyton in lentic ecosystems exhibit a spatial and temporal dynamics that varies according to climatic conditions, physical and chemical (Moschino-Carlos, 1996). According to Lowe (1996), by virtue of the joint work of important variables such as depth, type of substrate, amount of dissolved chemicals, light, temperature, turbulence and predation, the mechanisms that regulate the community structure of epiphyton have been little studied. Research on primary producers concentrate more heavily on phytoplankton, and rarer still is the inclusion of this community for the environmental assessment of aquatic systems (Rodrigues *et al.*, 2003). The scarcity of studies on this community prevails not only in Brazil but worldwide.

This study aims to describe the structure and dynamics of the algae epiphytic *Eichhornia azurea* in a temporal and spatial scale along a pollution gradient in three coastal shallow lakes of northern Rio Grande do Sul.

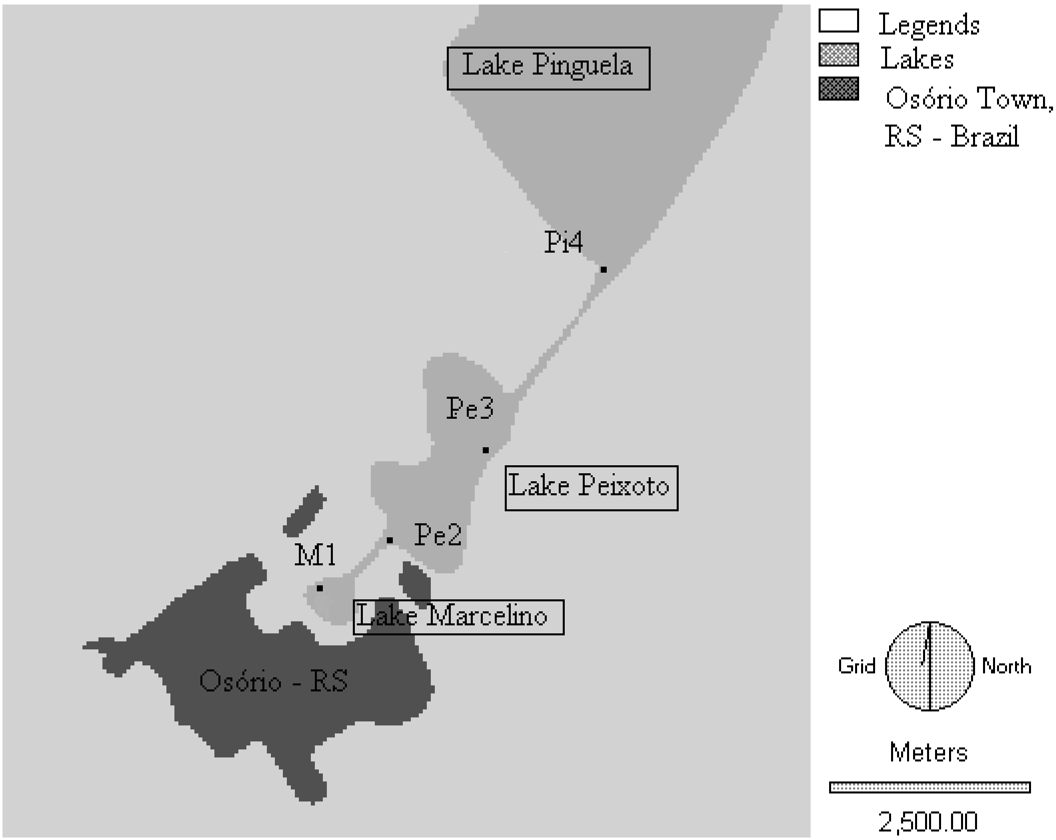

Figura 1. Sampling stations at Marcelino (M1), Peixoto (Pe2 e Pe3) and Pinguela (Pi4) Lakes, Osório, RS, Brazil.

MATERIAL AND METHODS

Samples were collected monthly water in four stations along Marcelino, Peixoto and Pinguela Lakes being called M1 (Marcelino), Pe2 (Peixoto), Pe3 (Peixoto) and Pi4 (Pinguela) (Figure 1), between November 1995 until May 1996. For each sample, were analyzed the water temperature, conductivity, turbidity, pH, ammonium, total nitrogen, dissolved oxygen, alkalinity, orthophosphate, nitrite and nitrate in water, according to APHA (1995). For total phosphorus used the method described by Golterman *et al*. (1978). Also held counting colonies of fecal coliform and total coliform second Coast, 1979.

The collections of algae epiphytic were simultaneous with the sampling of water and was used in two branches random, the petiole of the 6th leaf of *Eichhornia azurea* (n=2), corresponding to 32 days, on average, colonized epiphyton evaluated in pilot phase of this study. The samples were packed in glass jars with FAA solution (ethanol, distilled water, formaldehyde and acetic acid). The quantitative analysis was according Utermöhl (1958) and the results expressed in ind/cm^2 (Wetzel & Likens, 1979 and modified by Schwarzbold, 1992). The abundance of dominant species in each sample was determined using the criteria of Lobo & Leighton (1986). Permanent slides were made for species identification in the binocular microscope. For identification of Bacillariophyceae were also used permanent slides using the technique to Kobayasy &

Mayama (1982). The samples are tumbled in the Herbarium Prof. Dr. R. Alarich H. Schultz, the Museum of Natural Science Foundation Zoobotânica of Rio Grande do Sul, under the numbering HAS 34187 HAS 34274.

For analysis of the abiotic data was applied to principal components analysis (PCA) on covariance matrix with data transformation by the amplitude of variation (ranging: [(x - xmin) / (xmax - xmin)]. The data transformations were made from the program FITOPAC (Shepherd, 1996) and multivariate analysis by the program PC-ORD version 5.0 for Windows (McCune & Mefford, 1999). Biotic data: density of algae in the epiphyton ind/cm^{-2}, use it if cluster analysis "to the program PC-ORD version 5.0.

RESULTS AND DISCUSSION

Limnological characterization of the shallow lakes Marcelino, Peixoto and Pinguela

The values of physical and chemical properties of Marcelino, Peixoto and Pinguela Lakes are shown in Tables 1-4. On average, the values of turbidity, fecal coliforms were higher in shallow lakes Marcelino (M1) and Peixoto (Pe2), especially in the month of November (73.4, 635 and 3150 CFU/100 col/100ml, respectively) followed months of december to march. The lake is the receiving body Marcelino evictions home or hospital in the city and Osorio, and, thus, these values, especially coliforms, may be related to the nature of these dumps and the time of year (summer months) in which the Osório city receives a greater number of tourists. By Resolution Number 357 (CONAMA, 2005) Marcelino lake's waters are classified unfit for swimming by the values of fecal coliform found. The shallow lakes of the coastal region of Rio Grande do Sul are considered polymict second Schwarzbold & Schäfer (1984), which justifies a total mixture of water bodies, which may increase the turbidity values. Moreover, the spring and summer months present in this region with high wind regime type northeast (Tomazelli, 1993) which, together with shallow lake Marcelino (maximum 1.60m) provide the total mixture of water mass (Bruschi Jr. *et al*., 1998). Water temperatures measurements showed little variation over the months considered hot (spring and summer: 21.2^{o}C to 27.3^{o}C), and only the month of May (autumn) showed lower values (18.3^{o}C - 19.0^{o}C). Levels of nitrite, nitrate and ammonium were very low in general throughout the study, being mostly below the detection limit of the method. In a study of algal communities of phytoplankton in the same ponds, from 1994 until 1996 with two weekly collections, these values were also mostly low or not detected by the method (Salomoni & Schwarzbold, 2004 and Würdig *et al.* 1990). Total nitrogen was higher, on average, in the shallow lake until the last Marcelino reducing sampling station in the shallow lake Pinguela (3.1, 2.7, 1.82 and 1.32mg L^{-1}, respectively). The same occurred with total phosphorus (1165.6, 579.5, 287.4 and 90.86mg L^{-1}) and orthophosphate (194.17, 150.81, 28.08 and 34.81 mg L^{-1}). It can be inferred that, with high levels of phosphorus, nitrogen was probably a limiting factor for periphytic algal productivity, a condition also found in Salomoni & Schwarzbold (2004). Ph values ranged from 6.3 to 8.1 during the sampling period. The average pH values for the lake system north of the coastal state of Rio Grande do Sul is 6.1 (Kremer, 1985) to 8.9 (Fonseca, 1989, Bruschi Jr. *et al*., 1998 and Salomoni &

Schwarzbold , 2004). The oxygen contents were found inversely proportional to the temperature, which is expected by an environment without thermal stratification. Relating the levels of dissolved oxygen (DO) with the dominance of algal classes, the dominance of blue-green algae and green algae is greatest where DO levels are lower, as in february/96 (highest and lowest temperature recorded content OD) in the three lakes studied. This was also observed in studies with epiphytic communities in a natural (*Ricciocarpos natans*) in the lake in Argentina (Pozzobon & Tell, 1995).

Table 1. Limnological variables analyzed at a sampling station (M1-Marcelino lake) in Osório, RS, Brazil, from november 1995 to may 1996).

Variables / Months	Nov/95	Dec/95	Jan/96	Feb/96	Mar/96	Apr/96	May/96
Temp (^{o} C)	23	22,3	24,6	27,3	23	21,4	18,3
Ph	8,1	7,2	6,9	7,8	7,4	7	8,1
Alkalinity (mEq L^{-1})	0,56	1,14	0,44	1,4	0,87	1,29	1,62
Conductivity (µS/cm^{-1})	138,6	155,76	110,88	133,32	124,08	142,56	192,72
Turbidity (NTU)	76,5	40,3	41,7	21,6	27,9	18,1	31,3
DO (mg L^{-1})	8,3	4	6	2,6	8,5	6,4	7
Total N (mg L^{-1})	3,63	2,38	1,58	1,89	2,8	4,1	5,42
Nitrate (mg L^{-1})	0,12	0,09	0,12	0	0	0	0
Nitrite (µg L^{-1})	22,05	893,3	51,21	0	95,52	33,16	49,57
Ammonium (µg L-1)	100,33	39	65,03	0	0	0	0
Orthophosphato (µg L^{-1})	698,48	383,91	89,58	65,66	52,79	58,3	10,48
Total P (µg L^{-1})	1113,67	1739,13	830,2	131,33	1036,41	2059,22	1249,3
Faecal coliforms (UFC/100ml)	900	900	1000	1000	1000	240	240
Total coliforms (col/100ml)	5000	7000	10000	14300	1000	7000	4000

Table 2. Limnological variables analyzed at sampling station 2 (Pe2-Peixoto lake) in Osório, RS, Brazil, from 1995 november to 1996 may.

Variables / Months	Nov/95	Dec/95	Jan/96	Feb/96	Mar/96	Apr/96	May/96
Temp (^{o} C)	21,2	23	24,6	27,1	24	21	18,4
Ph	6,3	7,2	7,1	7,3	7,2	7,1	8
Alkalinity (mEq L^{-1})	0,46	0,89	0,38	1,72	0,54	1,62	1,51
Conductivity (µS/cm^{-1})	121,44	171,6	85,8	124,74	96,36	130,68	183,48
Turbidity (NTU)	70,2	51,5	39,6	20,9	22,2	17,4	28,5
DO (mg L^{-1})	7,5	6,6	3,4	2,1	6,1	5,3	7
Total N (mg L^{-1})	2,05	1,26	1,26	3	2,1	3,8	5,74
Nitrate (mg L^{-1})	0	0	0	0	0	0	0
Nitrite (µg L^{-1})	18,44	59,77	8,93	0	0	24,02	57,78
Ammonium (µg L-1)	0	0	0	0	0	76,82	70,91
Orthophosphato (µg L^{-1})	358,16	475,89	74,86	39,91	39,91	27,03	39,91
Total P (µg L^{-1})	771,51	168,12	124	79,82	123,97	142,37	2647,3
Faecal coliforms (UFC/100ml)	370	880	500	100	1100	100	1000
Total coliforms (col/100ml)	1300	3300	5000	14300	3300	1000	1000

Table 3. Limnological variables analyzed at sampling station 3 (Pe3-Peixoto lake) in Osório, RS, Brazil, from november 1995 to may 1996.

Variables / Months	Nov/95	Dec/95	Jan/96	Feb/96	Mar/96	Apr/96	May/96
Temp (^{o} C)	21,4	24	24,8	27	23	21,3	19
Ph	6,4	7,1	7	7,3	7,3	7,2	7,2
Alkalinity (mEq L^{-1})	0,4	0,62	0,34	1,18	0,38	1,08	0,97
Conductivity (μS/cm^{-1})	75,24	100,32	75,9	93,72	66	73,92	85,8
Turbidity (NTU)	34,8	30	42,4	24,3	22,2	23	18,1
DO (mg L^{-1})	8,3	3,2	5,2	2	3,5	4,6	7,2
Total N (mg L^{-1})	1,1	1,12	0,94	1,34	1,7	2,2	4,46
Nitrate (mg L^{-1})	0,1	0	0	0	0	0	0
Nitrite (μg L^{-1})	0,72	0	0	0	0	0	9,58
Ammonium (μg L-1)	90,03	0	0	0	0	0	0
Orthophosphato (μg L^{-1})	12,32	76,7	21,51	25,19	19,67	17,83	23,35
Total P (μg L^{-1})	201,24	609,62	330,5	50,39	642,74	116,61	61,43
Faecal coliforms (UFC/100ml)	900	500	500	1000	1000	240	220
Total coliforms (col/100ml)	5000	1000	880	9000	1000	7000	4000

Table 4. Limnological variables analyzed at sampling station 4 (Pi4-Pinguela lake) in Osório, RS, Brazil, from november 1995 to may 1996.

Variables / Months	Nov/95	Dec/95	Jan/96	Feb/96	Mar/96	Apr/96	May/96
Temp (^{o} C)	23	23,4	24,8	27	22,8	20,7	19
Ph	6,4	7,2	7	7,2	7,2	7,2	7,1
Alkalinity (mEq L^{-1})	0,44	0,42	0,22	1,08	0,21	1,18	1,08
Conductivity (μS/cm^{-1})	53,46	91,08	52,14	93,72	68,64	72,6	83,82
Turbidity (NTU)	48,4	50,7	29,7	27,9	22,2	25,7	29,2
DO (mg L^{-1})	8	6	5,6	4,9	5,7	6,1	8,4
Total N (mg L^{-1})	0,94	0,84	0,79	1,58	1,4	1,59	2,1
Nitrate (mg L^{-1})	0,1	0	0	0	0	0	0
Nitrite (μg L^{-1})	0	0	0	0	0	5,97	9,91
Ammonium (μg L-1)	0	0	0	0	0	0	0
Orthophosphato (μg L^{-1})	67,5	21,51	27,03	23,35	39,91	38,07	27,03
Total P (μg L^{-1})	35,67	105,58	76,15	46,71	123,97	160,76	87,18
Faecal coliforms (UFC/100ml)	0	20	1100	33	20	20	1000
Total coliforms (col/100ml)	220	100	660	330	1100	40	1000

To evaluate the main trends of variation in abiotic limnological characteristics along the three lakes studied, we applied principal component analysis (PCA). The analysis summarized 63,9% of data variability in its first two axes (Fig.2, Tab.5). In a principal coordinate (39,9%) sample units that were positioned on the right axis are associated with higher levels of total nitrogen, ammonium and total phosphorus found in the study (Tab.1-4). These variables showed correlations with this axis, respectively, with values of 0,51, 0,49 and 0,47. The sampling units for the month of February (fM1, fPe2, fPe3, fPi4) were associated with higher water temperature (r=-0,47 and -0,48 in the axes 1 and 2 respectively) and total coliform levels (r=-0,70 axis 2) (Fig.2, Tab.1-4).

In summary, the axis indicated a spatial variability of the sampling sites Pinguela lake and Peixoto and Marcelino Lakes, attributed mainly by the concentrations of nutrients. But, in the second axis, the ordination was temporal, separating the units of the hottest months with higher water temperature months with lower temperatures, especially in may.

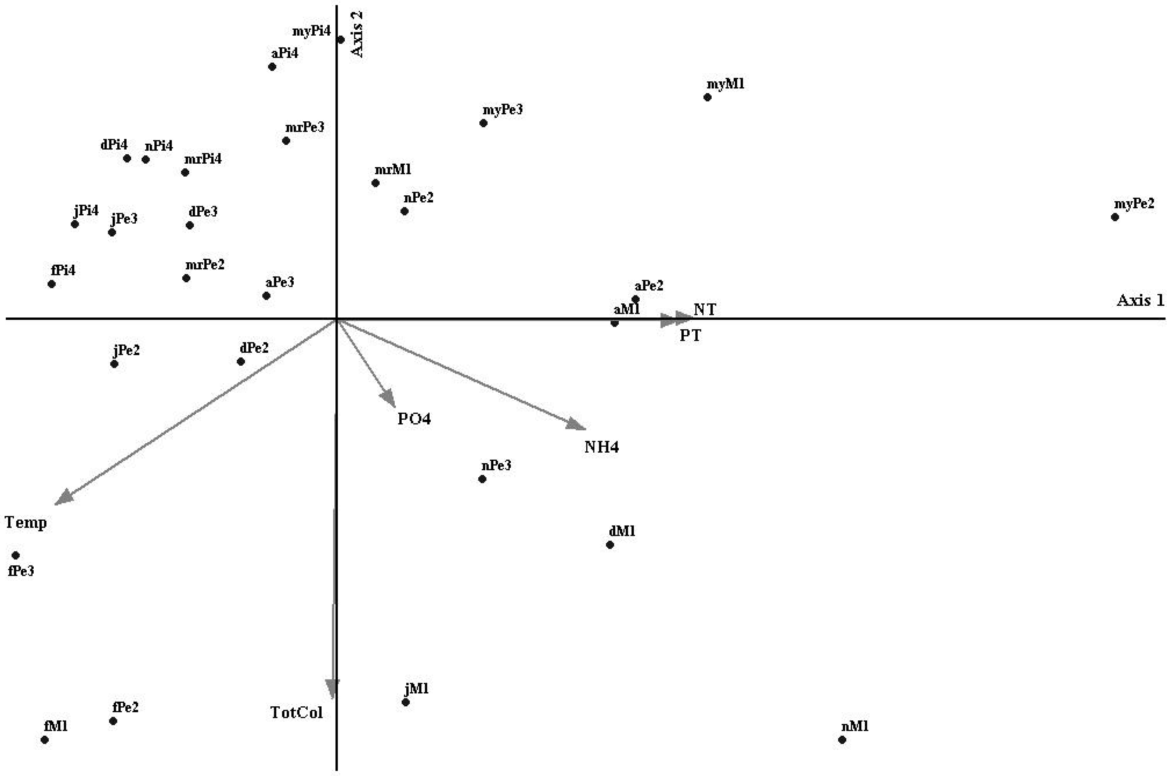

Figura 2. Biplot of PCA for samples units (M= Marcelino lake, Pe= Peixoto lake e Pi= Pinguela lake) during study period (n= november, d= december, j= january, f= february, mr= march, a = april e my = may). Legends for variables: NH_4=ammonium; PO_4= orthophosphato; Temp= temperature da água; TP= total P; NT= total N, TotCol= total coliforms.

Table 5. Correlation of abiotic variables with axes 1 and 2. Bold, r≥0,5.

Variables	Principais Components	
	1	**2**
Temp	-0,472	-0,485
TN	0,519	0,035
NH_4	0,500	-0,426
PO_4	0,180	-0,288
PT	0,474	-0,047
Total coliforms	-0,055	-0,704
Variation Explicable	**39,9%**	**23,9%**

Composition, Density and Dominance of Algae Epiphytic

The Bacillariophycea was clearly the best represented group in terms of density units in almost all stations in the three lakes studied. Marcellin in the lake (station 1), the classes were more abundant Chlorophyceae, Bacillariophyceae and Cyanophyceae. The density of different classes ranged from 2.472 to 53.547 ind/cm^2 in may /96 ind/cm^2 in january/95. Three species of algae were dominant: *Oedogonium* sp. in January/96 - accounting for the high density observed (Fig. 3), representing 55% of the community, in *Chroococcus turgidus* february/96 representing 70.2% and *Aulacoseira granulata* var *angustissima* f. *curvata* in may/96 with 50,5% (Fig. 3). The cyanophyceae *Leiblein epiphytica* was present in all sampled months are abundant in november, and december/95 and march/96. Peixoto in the lake (station 2), with higher abundance classes were Bacillariophyceae, Cyanophyceae and Chlorophyceae. The density of different classes ranged from 6.900 to 38.554 ind/cm^2 in february/96 ind/cm^2 in april/96. No species were dominant this season, however, there was plenty of bacilariofíceas several, among them *Cryptotenella navicula*, *Synedra ulna*, *Aulacoseira ambigua*, *A. granulata*, *A. granulata* var *angustissima* and *A. granulata* var *angustissima* f. *curvata*. In the class Cyanophyceae, two stand out: *Leibleinia epiphytica* was present in all months except in march, being abundant in november, december and may and *Aphanocapsa fusco-lutea* abundant in december (Fig. 3). In the third sampling sites, still in the lake Peixoto, classes with high abundance were Bacillariophyceae, Chlorophyceae and Cyanophyceae. The density varied in different classes in 7.938 ind/cm^2 january/96 to april/96 in ind/cm^2 60.788. *Aulacoseira granulata* var *angustissima* f. *curvata* may/96 was dominant with 69,3% increasing the density of the class this month Bacilariophyceae collection. This class was well represented also by several species on april/96 that showed abundant (Tab. 6, Fig. 3). *Aulacoseira granulata* is considered a typically periphytic algae, coastal and freshwater, and their own environments with high pollution, according to Fürstenberger & Moro (1997) and morphological characteristics as mucilage and presence of filaments promote adhesion to the substrate. A study of phytoplankton communities in the same lakes in this study, Salomoni & Schwarzbold (2004) also found the species *Aulacoseira ambigua* and *A. granulata* var. *angustissima* as abundant in the three coastal shallow lakes. Among the cyanobacteria in the sample station Pe3, *Leibleinia epiphytica* presented abundant in december, january and april and the green algae *Oedogonium* sp. was abundant in january and march (Tab. 6). *Leibleinia epiphytica* and *Aulacoseira granulata* var *angustissima* were presented abundant in the petioles of the 6th leaf of *Eichhornia azurea*. However, as verified by Fermino & Schwarzbold (1999), studied at different stages of leaf *Eichhornia azurea* in Marcelino Lake, these two species were found in all leaf stages with a 60% representation of the density in the samples. The last sampling sites, the farther from the pollutant discharge in coastal lakes of Osorio, the lake Pinguela (season 4), the density of different classes ranged from 1.850 to 99.123 ind/cm^2 in novembro/95 ind/cm^2 in april/96. It was very well represented by Bacillariophyceae, followed by Cyanophyceae and Chlorophyceae. It is worth mentioning the species *Nitzschia sigma*, with 38.875 in april/96 ind/cm^2 representing 39,2%, the highest density of algae in this study all along the three lakes sampled, with typical species of non-polluted environments (Patrick & Palavage, 1994). Three species were dominant this season: the chlorophytes *Gongrosira inscrustans* in dezember/95 with 85,2% contribution, and the cyanobacteria *Microcystis aeruginosa* in 77% and march/96 *Leibleinia epiphytica* may/96 in 57% (Tab.6, Fig.3). *Microcystis aeruginosa* is a common species in the estuary of Patos Shallow lake (RS), especially during summer and autumn (Mathiensen *et al*.1999).

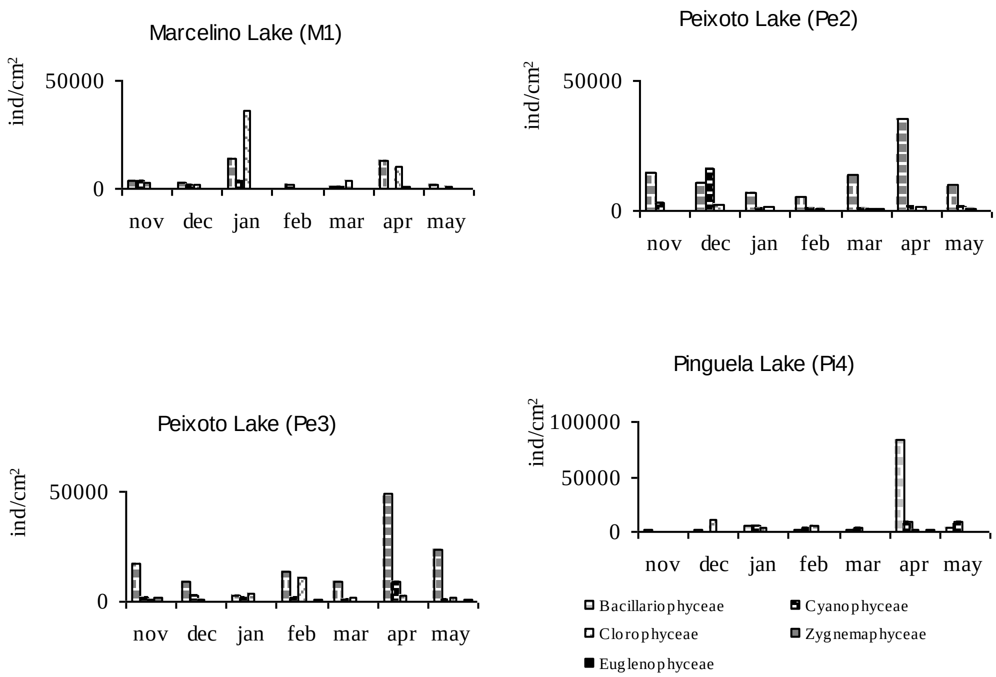

Figure 3. Seasonal variation of november/95 to may/96 until the average density (n = 2) of epiphytic algae (in ind/cm^2) in the various classes of algae found in Marcelino Lake (M1), Peixoto (Pe2 and Pe3) and Pinguela (Pi4). (The Last graphic is with different scale and with the previous legend).

Table 6: Quantitative analysis of epiphytic algae community (ind/cm^2) in Marcelino, Peixoto and Pinguela, Osório Lakes, RS, Brazil.

Division / species / ind/cm^2	**Marcelino Lake (estação 1)**							**Peixoto Lake (estação 2)**						
Months	**nov**	**dec**	**jan**	**fev**	**mar**	**apr**	**may**	**nov**	**dec**	**jan**	**fev**	**mar**	**apr**	**may**
Division: Cyanophyta														
Anabaena constricta						749								
Aphanocapsa fusco-lutea									10649					
Chroococcus turgidus				1933	119									
Leibleinia epiphytica	4127	1900	3926	250	543			3143	5380	848	564		1543	1430
Snowella lacustris												1116		
Division: Bacillariophyta														
Amphipleura lindheimerii	192												1543	817
Amphipleura pellucida		595												
Amphora ovalis														533
Aulacoseira ambígua	192	170		142	309	749	144	841	1653	21	469	1491	2624	1947
Aulacoseira granulata	115	212	3486	144	172	749	143	3114	1653	25	324	767	1543	
A. granulata var angustissima	459	133	21	142	113	2862	143	2768	4719	5645	334	765	1543	533
A. granulata var angustissima f. curvata	192					6384	1250					765	16245	533
Caloneis bacillum					113									
Cyclotella meneghiniana														472
Cymbela ventricosa			3486											
Cymbella túmida														533
Eunotia pectinalis											324		1543	533
Gomphonema acuminatum	220				113									533
Gomphonema augur					167									
Gomphonema angustatum					214									
Gomphonema constrictum											382			849
Gomphonema gracile	220		3486		113	755				21		764	1108	
Gomphonema parvulum						749								
Melosira varians												1491		
Navicula anglica		505												
Navicula cryptotenella								305			2831	3875	1936	
Navicula halophila		595												
Nitzschia palea	164	512							2585				4131	2770
Nitzschia sigma	1751													
Pinnularia superba		133												
Planothidium lanceolatum											314			
Schizostauron crucicola			3486			749								
Synedra acus										646			1706	
Synedra rumpens		170									334	765		
Synedra ulna								7267		643		4876	1546	
Division Clorophyta														
Ankistrodesmus falcatus	115		2490		113	4140	506							
Closterium jenneri	205			142	113	749								
Dermatophyton radians	200													
Gongrosira fluminensis					512									
Oedogonium sp.	1713		29386			5970				725		797		986
Protoderma viride										25				
Scenedesmus dimorphus		512							1964	485	382			
Scenedesmus opoliensis							143						1543	
Scenedesmus quadricauda		219	3780											
Stigeoclonium glomeratum					635									

Pediastrum duplex	192	585									328			
Pediastrum simplex	191													
Division: Euglenophyta														
Trachelomonas scabra							143				314	765		

Division / species / ind/cm^2	**Peixoto Lake (estação 3)**							**Pinguela Lake (estação 4)**						
Months	**nov**	**dec**	**jan**	**fev**	**mar**	**apr**	**may**	**nov**	**dec**	**jan**	**fev**	**mar**	**apr**	**may**
Division: Cyanophyta														
Anabaena constricta					457	2362	1072			6291			2215	
Anabaena circinalis	522	302	232	1129										
Leibleinia epiphytica	941	2350	1352	1123		6899					1860		6370	7310
Microcystis aeruginosa											1258	3297		581
Division: Bacillariophyta														
Amphipleura lindheimerii	540					2362		85	400				2215	480
Amphipleura pellucida	499			948		2362							2215	
Amphora ovalis				948	278									
Aulacoseira ambígua	10145	4243	210	950	797	7909	1072	393	381	513	379	496	15896	480
Aulacoseira granulata	499		195	948	278	2362		82	401	513			2215	480
A. granulata var angustissima	540	385		948	278	2362	1072						2215	
A. granulata var angustissima f. curvata	520						19380	56			377	496	2215	
Cocconeis placentula								106						
Cyclotella meneghiniana								47						
Cymbela ventricosa	520		190		278	2362		85		513	375			480
Cymbella túmida	499			948		2362								
Eunotia alpina										513			2215	480
Eunotia exígua						2362								
Eunotia tenella						1347	1072							
Gomphonema acuminatum	499	302	210	948	278								2215	
Gomphonema angustatum						5927		120		858			5034	1340
Gomphonema constrictum				1068									3822	
Gomphonema gracile	499	355			278		1071	80		513			2215	
Gomphonema intricatum				1122										
Gomphonema parvulum								85						
Melosira varians	580							59						
Navicula cryptotenella			434		409				498					
Navicula fragilarioides					2561				334					
Navicula imbricata						2362								
Neidium iridis	560													
Nitzschia clausii				1533		4417					713			
Nitzschia palea		3910		1122	553									
Nitzschia sigma										2427			38875	
Planothidium lanceolatum						2362							2215	
Schizostauron crucicola		302			278									
Stephanodiscus dubius	545													
Surirela tenera	499							55						
Synedra acus	594		1825	2347	1117	8301		390						594
Division Clorophyta														
Ankistrodesmus falcatus			210	8770							584			
Cosmarium pachydermum											599			
Dermatophyton radians			190		278									
Chlorella sp.											746			
Gongrosira incrutans									11676	1218				
Oedogonium sp.		850	2700	1068	1440	2368		152		2383	4326		2546	581

Protoderma viride				948			374	
Scenedesmus armatus		365	190		1072			
Scenedesmus opoliensis	530				1072			2215
Pediastrum duplex						55		
Spirogyra sp.	1703							
Division: Euglenophyta								
Trachelomonas scabra				949	1072			2215

The analysis of cluster density of algal epiphytic resulted in two groups first: a group where all collection months in the lake Pinguela sampling sites (November 1994 through May 1995) and Pe3 (Peixoto Lake) in April and the second group with the other stations in all months in lakes Marcelino and Peixoto (Fig.4).

The Pinguela Lake differentiated itself from other lakes and sampling sites in the cluster analysis by the lower density of algae found in generally the same with many species in common descriptors of the community, as *Leibleinia epiphytica*, *Aulacoseira ambigua*, *A. granulata*, *A. granulata* var *angutissima*, *A. granulata* var *angustissima* f. *curvata* and *Oedogonium* sp., those present in up to 85% of the collection months, while in other lakes was observed from 85 to 100% occurrence. The proximity observed in the statistical analysis of the station Pinguela throughout the study and the station Pe3 (Peixoto) in april is justified mainly by the high densities of species *Leibleinia epiphytica*, *Aulacoseira granulata* and *A. granulata* var *angustissima* and lower densities or non-occurrence in the remaining months of collections and seasons (Marcelino and Peixoto - Pe2) (Tab.6).

Analyzing the abiotic data, especially the total nitrogen, fecal coliforms, and compared over months and collection stations, one sees a clear distinction between the lake and Pinguela other lakes studied, suggesting the clearance along the four sampling sites studied and the response of epiphytic algal groups facing this clearance.

Figura 4. Cluster analysis (Euclidean distances) of the sampling units, based on the microbiological variables (density algal – ind/cm^{-2}) in Marcelino (M1), Peixoto (Pe2 and Pe3) and Pinguela (Pi4) lakes, Osório, RS, Brazil from November 1995 to may 1996.

CONCLUDING REMARKS

The methodological design used in this study allowed to evaluate the effects of pollution gradient in community structure and dynamics of algal epiphytic of *Eichhornia azurea* in a temporal and spatial scale studied in three coastal shallow lakes in the northern Rio Grande do Sul.

The similarity of community composition of epiphyton was primarily constrained by the abiotic variables across groups of classes of algae and their densities, as evidenced in the study of structure and community dynamics. The community descriptions species (most abundant) were strongly related to environmental conditions (*Aulacoseira ambigua*, *A. granulata*, *A. granulata* var *angustissima*, *A. granulata* var *angustissima* f. *curvata*, *Leibleinia epiphytica* and *Oedogonium* sp.).

It was found a gradient reduction of pollution load discharged into the Marcelino Lake, and along the studied system. This dilutes the pollutant load in the Pinguela and Peixoto Lakes, helped also by the much larger dimensions of the latter two. Considering the biotic and abiotic measures, the main race variation in the study was followed by the spatial temporal.

Finally, it reinforces the use of epiphyton as a sensor of eutrophication, contributing to proposals for prevention and rehabilitation of coastal ecosystems lake.

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