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Differential Sedimentation of Algae Chlorococcales (*Scenedesmus, Coelastrum* and *Pediastrum*) in Lagoa de Cima, Campos dos Goitacazes Municipality (Rio de Janeiro, Brazil)

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Abstract - Fifteen surface sediment samples were collected at Lagoa de Cima lake (21°46'28" South and 41°31'15" West), situated in the Rio Imbé river micro basin, municipality of Campos, in the north of Rio de Janeiro, Brazil. They were collected in May 1999 following a northeast/southwest transect, along the same direction of the dominant winds. The results of the palynological analysis yielded new information about the recent richness, concentration and spatial depositional variation of the green algae genera *Coelastrum*, *Pediastrum* and *Scenedesmus* (Chlorococcales) on the bottom of the lake. In 30 g of analyzed sediments 4,182 individuals were counted, mainly from *Scenedesmus* species (94,1%). High ratios of *Scenedesmus* species (*S. acunae* Comas, *S. magnus* Meyen, *S. pannonicus* Hortob., *S. protuberans* and *S. ohauensis* (Lemm.) G.M. Smith) occurred almost everywhere in the analyzed sediments of the basin of the lake. *Coelastrum* (*C. reticulatum* Dang, *C. pulchrum* and *C. proboscideum* Bohlin) and *Pediastrum* (*P. duplex* Meyen var. *subgranulatum* Racib and *P. duplex* Meyen var. *duplex)* species were present near the area of drainage at the northeast boundary of the lake, always with low ratios. At the littoral sediment (stations 1 and 15) and in its deepest region (station 7) these algae do not occur.

Keywords - Chlorococcales, Recent Holocene, Lagoa de Cima lake, Brazil.

INTRODUCTION

In geological studies, the green algae of the order Chlorococcales of the genera *Coelastrum*, *Pediastrum* and *Scenedesmus*, among others, are indicators of freshwater habitats and/or of fluvial influence. Such evidences suggest that, depending on the concentration of these algae in the deposit, at some moment there had been an entrance of a larger portion of freshwater into that location.

The phytoplankton community in coastal ponds and lakes is conditioned by dynamic processes related to the physical-chemical water instabilities, among which the salinity fluctuations and the variations in the nutrients concentration stand out. These factors regularize the populations and interfere in the succession of phytoplankton. Such fluctuations are related to the circulation of water, which is the reflection of the local hydrographic system and of the concentration of the material in suspension in the water, besides being conditioned to the annual cycle of the entrance/exit system of water (evaporation/rainfall) (Margalef 1969; Huszar & Silva 1992). In large scale, the fluctuations of the populations of the phytoplankton in coastal ponds and lakes were conditioned to the variations of the level of the sea, since the origin of the pond until the present times. The entrance of water of higher salinity in the lake environment causes, on several occasions, a total change in the richness, diversity and density of certain genera of algae. The characteristics of phytoplankton in this ambient, when it is under direct marine influence, expresses high biomass, high productivity and low diversity (Margalef 1969). So, for the maintenance of the species in the plankton of the lake, it is necessary an elevated rate of multiplication, of such a form that overcomes the mixture rate between water of the lake and water of the sea. As a result, the phytoplankton communities in these ecosystems need a period of fast growth, due to the intense loss of individuals and consequently a low diversity. In periods of environmental stability in the lake there is a decrease in the relation production/biomass with a consequent increase in the diversity (Huszar & Silva 1992).

All chlorococcalean algae present an endogene vegetative reproduction, where the number of cleavages of the mother cell determines the number of daughter cells or the cell number of the colony. Some green algae have cells that lay isolated inside the colony (for example in Botryococcaceae), while in another algae the cells are united one with another

forming a coenobium (for example in Coelastraceae, Hydrodictyaceae and Scenedes-maceae). The vegetative spores of the coenobial forms in *Scenedesmus* and *Coelastrum* are non-motile and build a new coenobium with the same form as the mother cell, being called autospores. In *Pediastrum* a vesicle overcasts the vegetative spores as soon as they escape from the mother cell. For a certain period, the vesicle remains motile, being called zoospore before forming a new coenobium. The dimensions of the single cell (coenobia) and of the coenobium depend on the growth rate, which is constrained by environmental factors. Increasing the temperature, the average of the coenobium decreases and, the number of coenobia increase, and *vice-versa*. Also the chemical composition of the water influences the cell's growth. This way, the number of the single cells of coenobium reflects the environmental condition during the reproductive process and, the size of the coenobium reflects the conditions during the vegetative state (Brenner & Foster 1994).

Several recent genera of the algae assigned to the order Chlorococcales have resistant thin outer organic walls, composed by sporopollenin, as such they have the potential to be preserved in sediments and become a fossil. Some of them are from the suborder Chloreliineae (the hole family Chlorellaceae and the subfamily Botryococcoideae-family Botryococcaceae), some from the suborder Scenedesmineae (the families Coelastraceae and Scenedesmaceae) and, the suborder Hydrodictyoineae (family Hydrodictyaceae), being all thus the ones that extending back in the geological history more than 500 million of years' ago (Brenner & Foster 1994).

The recent differential sedimentation of algae of the genera *Coelastrum* (family Coelastraceae), *Pediastrum* (family Hydrodictyaceae) and *Scenedesmus* (family Scenedesmaceae) was studied along a transect in the Lagoa de Cima lake located near to the Atlantic coast, north of the state of Rio de Janeiro, Brazil. The results to be obtained may be compared with the sedimentary sequences of the Lagoa de Cima lake. These algae are useful to make palaeoenvironmental reconstitutions of mostly freshwater or low salinity habitats because these algae are good indicators of temperature, salinity and pH of water. In the studied region these reconstitutions are related to regressive and transgressive regional marine events that affected the water level of the lake during the Holocene (Luz *et al*. 1999; Luz & Barth 2000).

Some authors have described the taxonomic genera of Cholorococcales of the phytoplankton collected with a mesh net in the surface waters of the Lagoa de Cima lake (PROAGRO 1975; Huszar *et al*. 1987 and Huszar & Silva 1992), however none of them evaluated the recent spatial depositional variation of the green algae along the bottom of the lake.

In the present paper the data of the recent spatial depositional variation of the algae *Scenedesmus*, *Coelastrum* and *Pediastrum* (Chlorococcales) in surface samples of the sediments of the Lagoa de Cima lake were obtained through the palynological analysis of 15 samples from the upper five centimeters of the bottom of the lake. They were taken in a transect from edge to edge of the lake, in the northeast-southwest direction. A differential rate of sedimentation in relation to the genera of the green algae in the analyzed sediments was confirmed.

Description of the study area

The Lagoa de Cima lake is located 50 km from the coast line to the west (21°46'28" South and 41°31'15" West), in the deltaic plain of the river Paraíba do Sul and situated at an altitude of about 30 m, in the bordering portion of the Crystalline System in the region of the Barreira Formation, southwest of the Paraíba do Sul river delta. It is in contact with the flattened littoral sediments of the Quaternary coastal plain, which recovers the cretaceous layers of the Campos Basin (Fig. 1). The Lagoa de Cima lake would have its probable origin in the limit from the Pleistocene to the upper Tertiary, when fluvial sediments deriving from the river Paraíba do Sul, together with detritus sediment formers of the Barriers Group, carried from the steeper relief of the micro basin, piled up and barred the direct communication of a Ururaí Palaeolagoon with the sea (Lamego 1955). This would be the oldest lake in the north of the state of Rio de Janeiro.

The Lagoa de Cima lake is an open system which receives permanent inflowing streams of the last imposing portion of the basement, in the eastern slope of Serra do Mar mountains (the rivers Imbé and Urubu), which penetrate in its southwest margin. In the northwest boundary of the Lagoa de Cima lake there is a beach with round format and in the northeast margin of the lake its waters are channeled into the river Ururaí, in the direction to the Lagoa Feia lake located in the quaternary coastal plain. This last lake is connected to the sea by a channel (vide Fig. 1).

The topography of the bottom of the Lagoa de Cima lake is practically plain, with an average depth of around 2 m and a maximum of 3,4 m at the center of the lake. It has a maximum width of 4 km

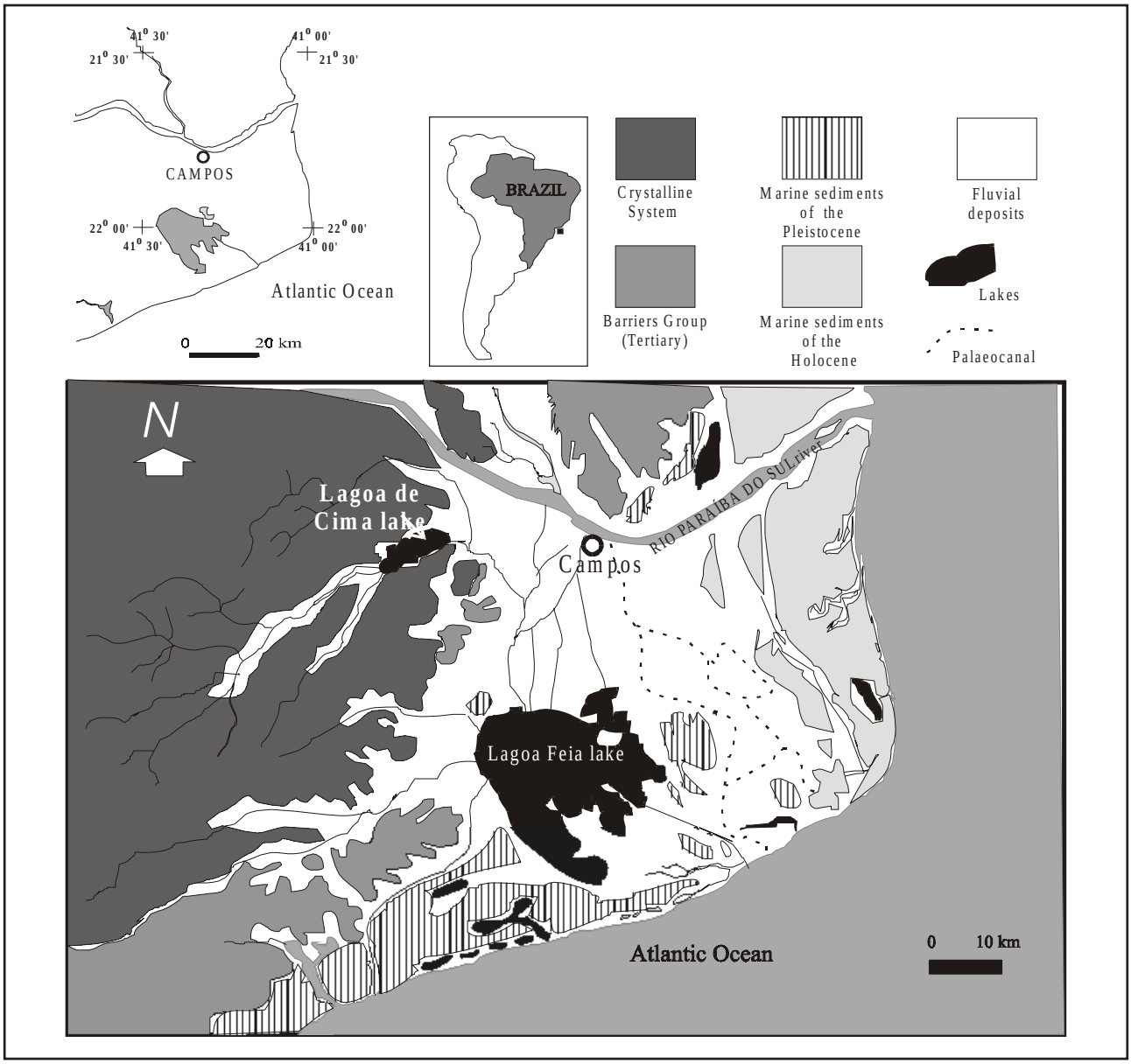

Figure 1 - Localization map of the study area and geology of the deltaic plain of the river Paraíba do Sul.

and a maximum length of 7,5 km (Fig. 2). Its waters are sweet (salinity = 0,05%), with low conductivity (conditioned by the predominantly fluvial processes on its formation, with no influence of the sea at present time and, by the influence of the rainfall), varying from slightly acid to slightly alkaline (pH= 5,6 - 7,4). They are clear and relatively transparent, presenting reddish tonality due to humus contributions. It presents a low percentage of calcium, and a higher percentage of silica, beside others ions. The Lagoa de Cima lake shows an absence of thermal stratification and its waters have an average temperature of around 30ºC. The euphotic zone reaches the entire water column. Its sediments belong to the inorganic type of silt with sand of medium to fine size and, to the organic type of a very fine clay, without sand, rich in humus material. Diatomite deposits are present at its margins (PROAGRO 1975; Esteves *et al*. 1984; Reid & Esteves 1984).

Regarding the region of study, the total environment has a hot and humid climate. The rain precipitations are concentrated especially in summer, with indexes above 200 mm per month. Winter is relatively dry. The driest period extends from May to September. The average annual rainfall is around 1,250-1,500 mm. The average annual temperature is around 22°C (RADAMBRASIL PROJETO 1983).

MATERIAL AND METHODS

Fifteen samples were analyzed, collected in a transect of 500 m by 500 m from edge to edge of the lake, in the northeast-southwest direction, that is the direction of the dominant winds in the region (vide Fig. 2). They were collected in May 1999, in the upper five centimeters of the sediment of the bottom of the lake. Sample 1 was collected in a distance of 500 m from the northeast edge of the lake. Samples 6, 7 and 8 were collected in the center of the lake, in its deepest region (3,4 m of depth). Sample 15 was sampled next to the southwest edge of the lake, at the boundary of a sand bank, which is located between the entrances of the two rivers Imbé and Urubu.

For the quantitative analysis of the samples, fractions of the sediment were treated according to the purposed palynological standard method of preparation of Quaternary sediments (Ybert *et al*. 1992). They were subjected to KOH, HCL, HF and acetolysis treatments. The separation of the inorganic from the organic fraction was done using a $ZnCl_2$ aqueous solution, with 2.3 density. Microscope slides were prepared using glycerine gelatin. They have been kept in the slide collection of the Laboratory of Palynology, Department of Geology, Institute of Geosciences, Federal University of Rio de Janeiro. The absolute values and percentages of the algae of the genera *Coelastrum*, *Pediastrum*, *Scenedesmus* and others algae, were presented in this study. "Others" comprise a lower absolute number of individuals of *Mougeotia* and Diatomaceae and not identified algae (called "Indeterminates"), which are included in the graphs. The percentage of each genus was calculated and plotted by the Excel program of Microsoft Corporation (Figs. 3, 4). The concentration of each type of algae in each sample was plotted by the Tilia program (Grimm 1987) (Fig. 5). The calculations were based upon the number of each type of algae counted in relation to the counted number of marker spores (*Lycopodium clavatum*) per gram of sediment (Stockmark 1971). The spore marker was introduced into each sample through tablets, which have a known number of spores.

For the qualitative analysis of the samples, other fractions of the sediments were prepared by the direct method, without application of chemical reagents, when the sediments were diluted in distilled water and set up in microscope slides. The description of the sediments of each sample, location and a list of the algae species and genera were presented in Box 1.

The Figure 6 show photomicrographies of species and genera of observed algae in the analyzed samples.

RESULTS

There is a sediment accumulation tendency of larger granulometry (medium sand) in the littoral and in the deeper and central area of the lake (samples 1, 2, 7 and 15) (Box 1). The water flow entrance of the rivers Imbé and Urubu "pushes" the surface of the sediments towards the northern boundary of the lake, at the output of the waters by the river Ururaí.

The residual organic fraction of the treated samples showed pollen and spores of Pteridophytae and Bryophytae, besides zygospores, coenobiums and colonies of algae. In a total of 30 g of sediments, the algae *Coelastrum*, *Pediastrum* and *Scenedesmus* comprised 4,182 individuals; other algae reached only 50 individuals.

In relation to the number of individuals counted of microscope slide preparations (Fig. 3), the largest deposition of *Coelastrum*, *Pediastrum* and *Scenedesmus* algae occurred in samples 3, 4, 5, 6, 9 and 11. In samples 1 and 15, located respectively in the northeast and southwest boundaries of the lake, and in the sample 7, algae were not observed. In the deepest area of the lake (sample 8) and in samples 2, 10, 12, 13 and 14, a substantial sedimentation of these algae in relation to counted individuals was not observed, that is less than 150 individuals per sample. *Coelastrum* was not observed in the samples 8, 10 and 12. *Coelastrum* was observed in a low count of individuals in samples 9, 11, 13 and 14, that is less than 20 individuals per sample. *Pediastrum* was not observed in samples 9, 10, 11, 12, 13 and 14. *Pediastrum* was observed in a low count of individuals in the samples 2, 4, 5, 6 and 8, that is less than 10 individuals per sample. *Scenedesmus* was observed in a low count of individuals in samples 2, 12, 13 and 14, that is less than 20 individuals per sample. Diatomaceae were observed in low count of individuals in samples 3, 4, 11 and 14, that is less than 3 individuals per sample. *Mougeotia* was observed only in sample 10, with just 1 individual.

According to the results of percentage analysis, *Scenedesmus* was observed with high values in almost all the samples. Only samples 2 and 12 showed less than 50% of *Scenedesmus* in relation to the total of counted algae (Fig. 4). Diatomaceae were always observed in low percentages in sample 3 (0,7%), sample 4 (0,2%), sample 11 (0,3%) and sample 14 (4,5%); *Mougeotia* only in sample 10 (0,7%).

According to the results of concentration analysis of the algae, samples 3, 4, 5, 6, 8, 9 and 11 had the largest sedimentation, with more than 300,000 individuals/g^{-1} of sediments (Fig. 5). *Coelastrum* showed a lower concentration in the

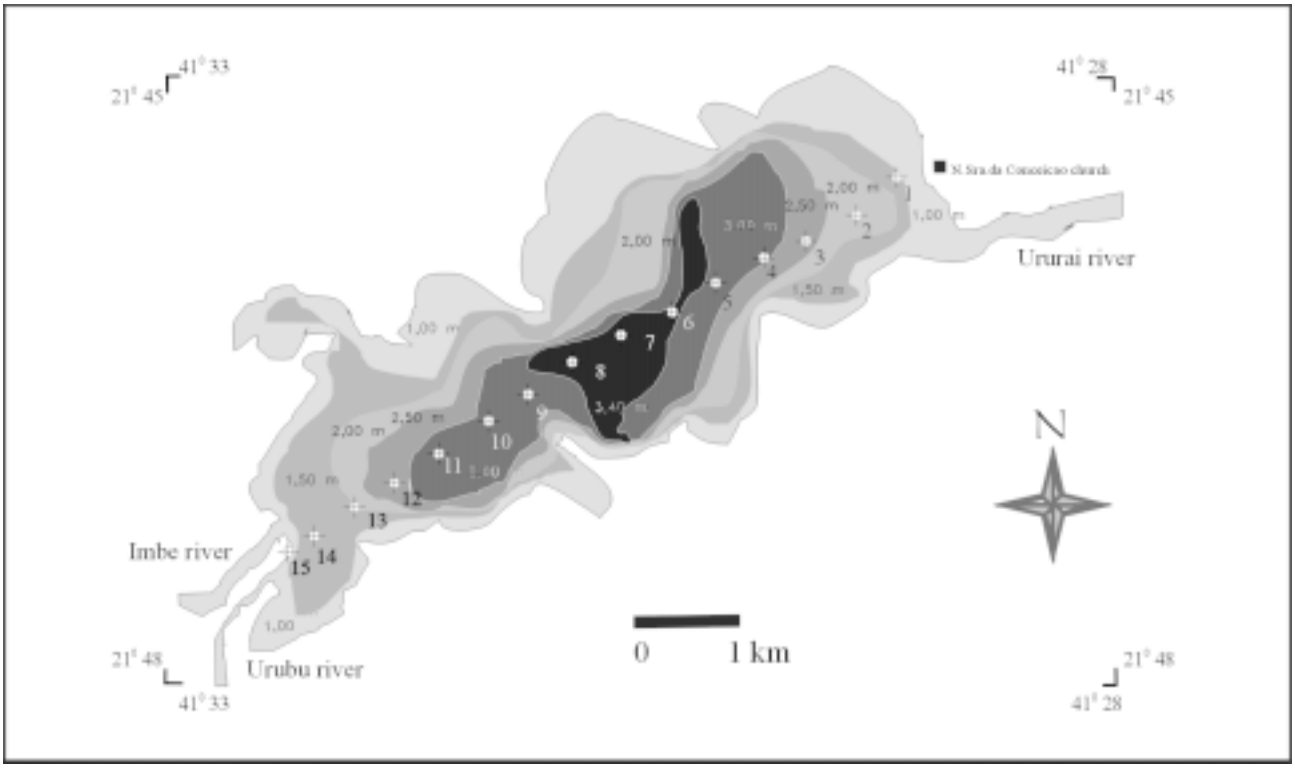

Figure 2 - Topography map of the bottom of the Lagoa de Cima lake and localization of each point sampled (modified from PROAGRO, 1975).

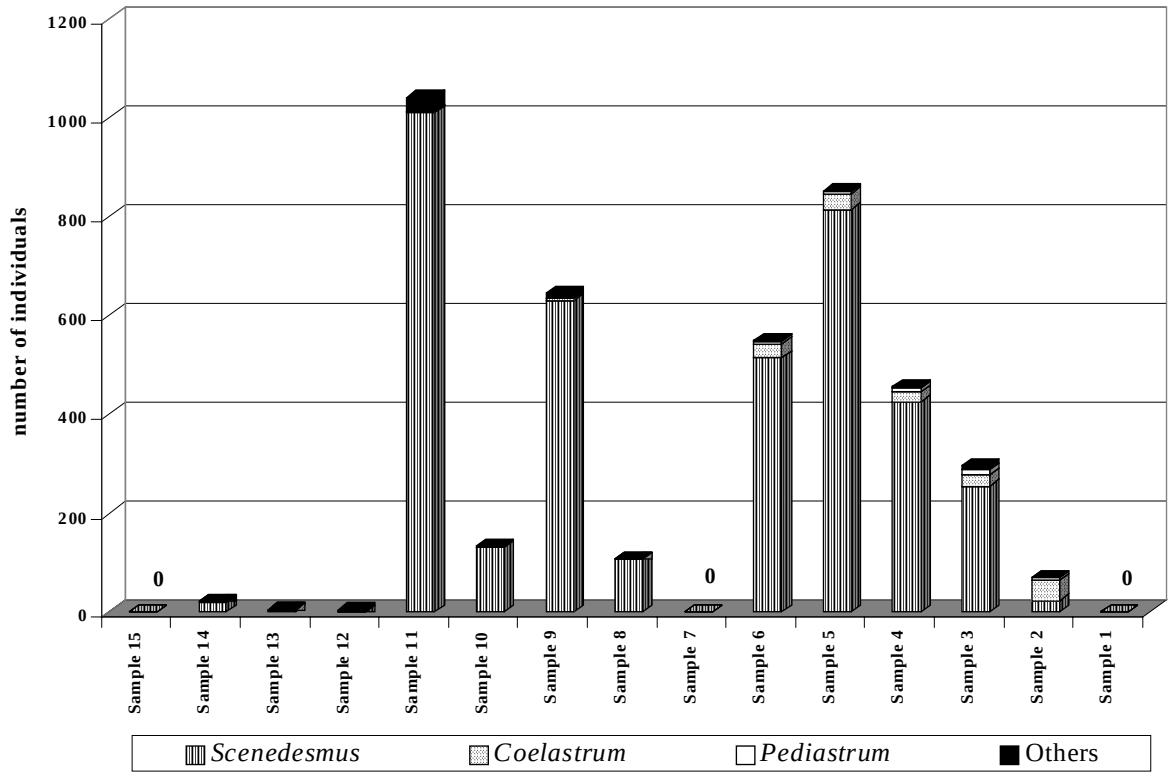

Figure 3 – Algae diagram - number of individuals.

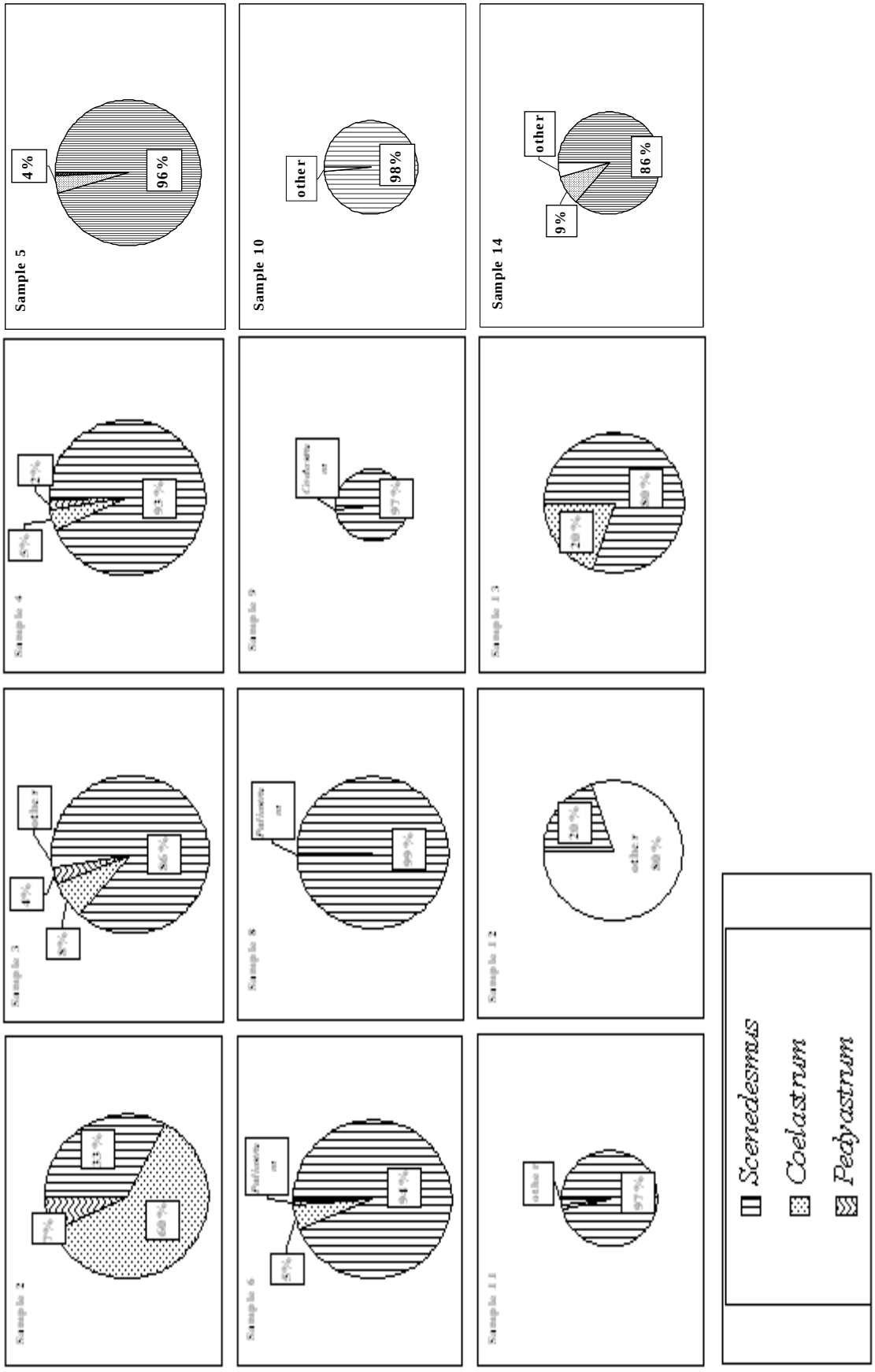

Figure 4 - Algae diagram – percentage of each type of algae.

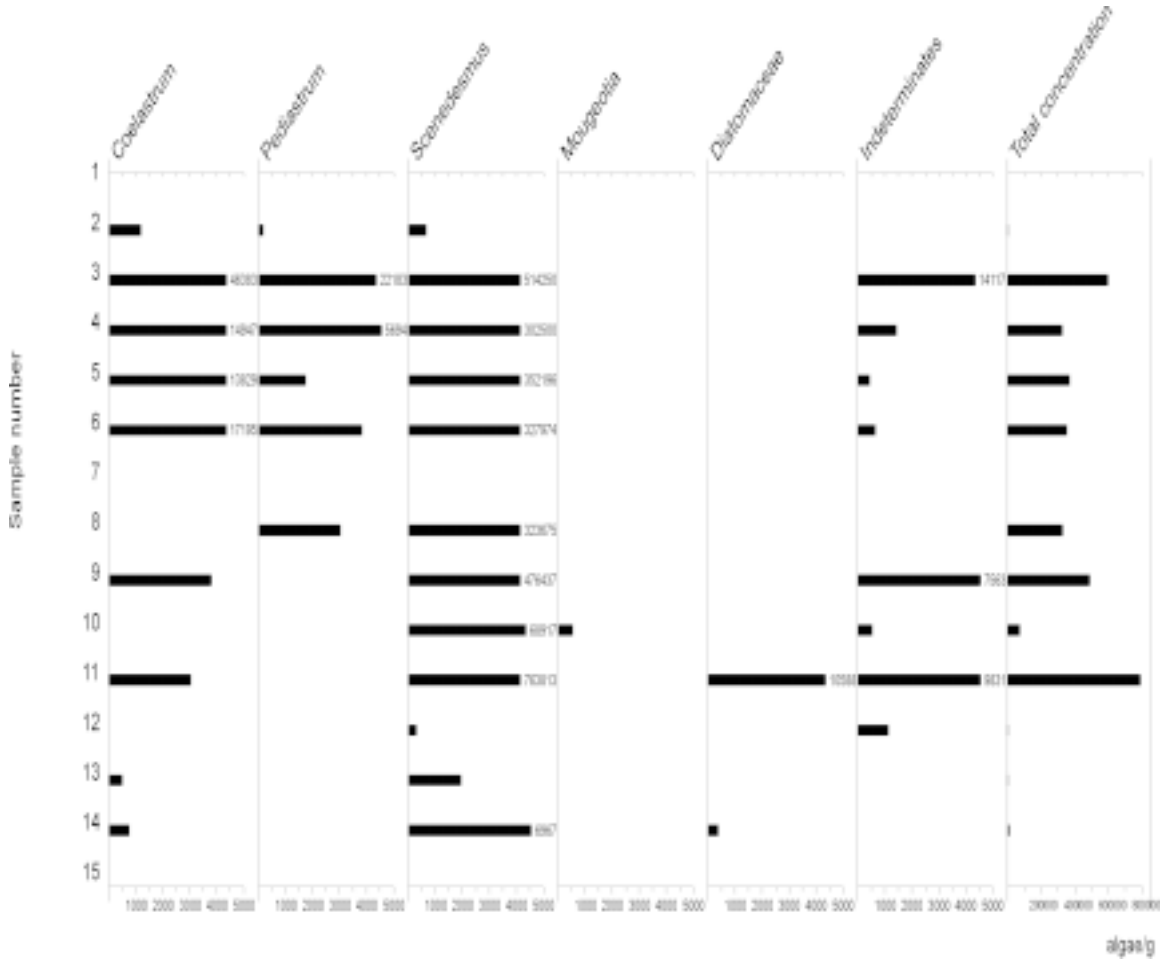

Figure 5 - Algae diagram – concentration of algae in 1 gram of sediment.

samples 2, 13 and 14, that is less than 2,000 individuals/g^{-1} of sediments, and showed its largest concentration in the samples near the northeast boundary of the lake (samples 3, 4, 5 and 6), that is more than 12,000 individuals/g^{-1} of sediments. *Pediastrum* showed large concentration in the samples near the northeast boundary (samples 3, 4, 5 and 6) and in the sample of the center of the lake (sample 8), although in this sample, absolute values were very low. *Scenedesmus* was observed in high concentrations in almost all the samples, however the biggest values were found mostly in the areas corresponding to samples 3, 4, 5, 6, 8, 9 and 11, with more than 300,000 individuals/g^{-1} of sediments. Diatomaceae were observed in high concentrations in sample 11, with more than 10,000 individuals/g^{1} of sediments; *Mougeotia* in sample 10, with about 500 individuals/g^{-1} of sediments.

The results of the qualitative analysis (Box 1) obtained from the preparations without use of chemical reagents demonstrated a great richness of algae in the surface sediments of the bottom of the Lagoa de Cima lake, reaching 43 taxa in the total of the 15 samples, distributed as follows: 11 taxa of Chlorophyceae; 1 taxon of Zygnemaphyceae (Desmidiaceae) and, 31 taxa of Bacillariophyceae (Diatomaceae). Diatomaceae were observed in all samples. It was found in the qualitative analysis that algae of the genus *Aulacoseira* dominate the littoral sediment of the lake. *Scenedesmus* was not observed in samples 1, 12, 13 and 15. *Coelastrum* was observed only in the samples 4 and 7. *Pediastrum* was observed only in the sample 7.

DISCUSSION

In the environmental studies developed in the Lagoa de Cima lake by PROAGRO (1975) the plankton was collected with a net of 50 ìm meshes. A total of 17 phytoplankton taxa and predominance of the genus *Scenedesmus* (68,1%) has been observed. *Pediastrum boryanum* (0,8%) and *Pediastrum* spp. (0,1%) presented low percentages of the total of observed algae, as well as other algae that were not considered in our study. They also mentioned the registration of several Bacillario-phyceae (Diatomaceae) with

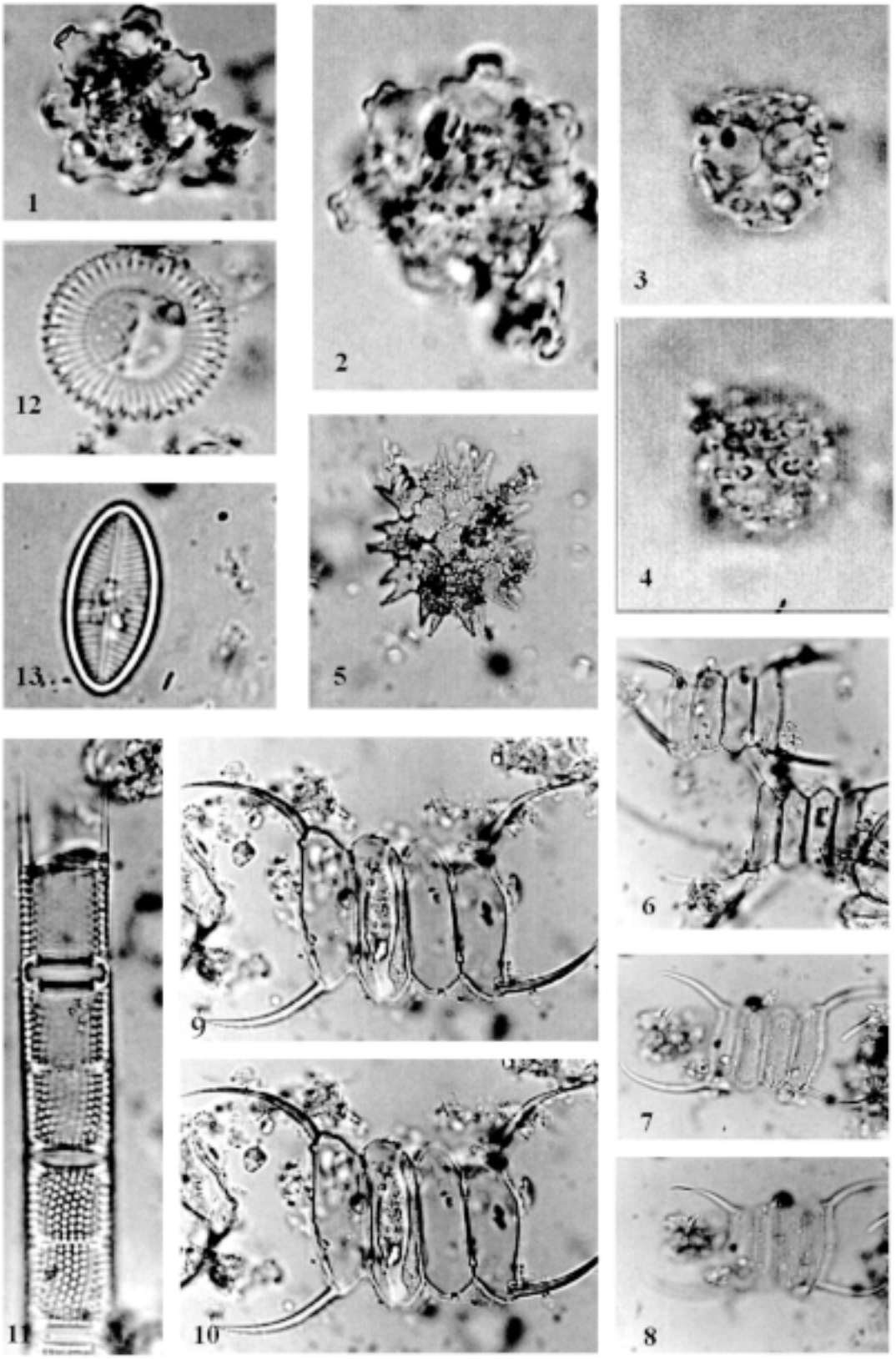

Figure 6 - 1) *Coelastrum proboscideum* (400 X); 2) *C. pulcrum* (100 X); 3) *C. reticulatum* (surface cells of the cenobium) (100 X); 4) *C. reticulatum* (central cells of the cenobium) (100 X); 5) *Pediastrum duplex* var. *subgranulatum* (400 X); 6) *Scenedesmus magnus* (1000 X); 7) *S. ohauensis* (1000 X); 8) *S. ohauensis* (1000 X); 9) *S. protuberans* (1000 X); 10) *S. protuberans* (1000 X); 11) *Aulacoseira* sp.(1000 X); 12) *Ciclotella meneghiniana* (1000 X); 13) *Luticula* sp. (1000 X).

Box 1 - Localization of the samples, types of sediments of each sample and *taxa* occurrence of the observed algae in each analyzed sample of the Lagoa de Cima lake.

SAMPLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LATITUDE (S)	21º45' 23"	21º45' 34"	21º45' 42"	21º45' 47"	21º45' 55"	21º46' 03"	21º46' 45"	21º46' 19"	21º46' 27"	21º46' 37"	21º46' 45"	21º46' 54"	21º47' 02"	21º47' 11"	21º47' 16"
LONGITUDE (W)	41º29' 11"	41º29' 25"	41º29' 44"	41º29' 55"	41º30' 11"	41º30' 28"	41º30' 42"	41º30' 59"	41º31' 14"	41º31' 28"	41º31' 44"	41º31' 59"	41º32' 12"	41º32' 25"	41º32' 34"
Meters from the northeast boundary	±30	±530m	±1030	±1530	±2030	±2530	±3030	±3530	±4030	±4530	±5030	±5530	±6030	±6530	±7030
TYPE OF SEDIMENT	sand	sand	clay	clay	clay	clay	sand	clay	clay	clay	clay	clay	clay	clay	sand
Chlorophyceae															
Coelastrum proboscideum							X								
Coelastrum pulchrum				X											
Coelastrum reticulatum				X											
Pediastrum duplex var. *subgranulatrum*							X								
Scenedesmus acunae			X						X						
Scenedesmus westii						X				X					
Scenedesmus magnus			X	X	X	X			X	X	X				
Scenedesmus ohauensis		X				X	X		X		X			X	
Scenedesmus pannonicus						X			X						
Scenedesmus protuberans				X	X	X	X	X		X				X	
Scenedesmus sp			X		X										
Zygnemaphyceae															
Staurodesmus sp		X												X	
Bacillariophyceae															
Achnanthes sp				X											
Amphipleura sp															X
Amphora sp													X		
Arachnoidiscus-(??)		X													
Aulacoseira granulata			X	X	X	X	X	X	X		X			X	
Aulacoseira granulata var. angustissima														X	
Aulacoseira italica			X	X	X	X	X	X	X		X	X			
Aulacoseira sp	X		X	X					X	X	X				
Caloneis sp													X		
Ciclotella meneghiniana		X	X		X	X	X		X						
Diploneis sp											X				
Encyonema silesiacum													X		
Eunotia sp	X									X	X		X	X	X

(Continuação)

Fragillaria pseudocons-truem var. *rhombica*						X									
Fragillaria sp														X	
Frustulia crassinervea													X	X	X
Gomphonema gracile									X	X	X	X	X		
Gomphonema parvulum											X				
Gomphonema sp	X													X	X
Luticula sp				X	X				X	X	X	X	X	X	
Melosira sp			X				X		X	X	X	X	X	X	X
Navicula sp													X		
Nitszchia sp															X
Pinullaria sp1	X									X			X		X
Pinullaria sp2						X									
Rhopalodia sp															X
Stauroneis sp				X					X						X
Surirella sp		X					X		X		X				
Synedra ulna									X		X				
Synedra sp				X	X					X			X	X	X
Tabellaria sp				X											X

Melosira spp. (13,2%) of large occurrence. These data agree partially with our data, since the results obtained from the surface samples of the sediments also indicated a deposition of 3,7 % of *Coelastrum* of the total algae counted, and this genus was not mentioned in PROAGRO's study. In our countings *Scenedesmus* reached higher percentage. As demonstrated in our results, *Scenedesmus* was the genus with the largest sedimentation ratio (count of individuals, percentage and concentration evaluations). It was also the genus that presented the highest richness of species in the samples prepared by the palynological standard method, while using the method without chemical reagents Diatomaceae presented the highest richness.

Huszar *et al*. (1987) did taxonomic studies in phytoplankton collected with a 20 ìm mesh net in the surface waters from the central point of the Lagoa de Cima, in January and September 1983 and, March and December 1986. They identified 18 taxa at specific and infra specific levels of the Chlorophyceae, this class being one of the two classes of greatest specific richness in the lake. Among the most common taxa, in all collections accomplished by these authors, the algae mentioned are *Coelastrum pulchrum*, *C. reticulatum*, *Pediastrum boryanum*, *P. duplex* and *Scenedesmus opoliensis* var. *mononensis*, among other species not being analyzed in our study. Among taxa referred by these authors, in our study were only observed *Coelastrum pulchrum*, *C. reticulatum*, *Pediastrum duplex* and *Scenedesmus quadricauda* (actually *S. westii*), among other species not observed in our study. Among species observed in our study and not referred by these authors there are *Coelastrum proboscideum*, *Scenedesmus acunae*, *S. magnus*, *S. ohauensis*, *S. pannonicus* and *S. protuberans*. *Coelastrum reticulatum* was the most representative species of this genus in our analyses and *Scenedesmus* predominated in all samples which presented algae, reaching 94,1% from the total algae counted. *Pediastrum duplex* only reached 0,8% of the total of algae.

Huszar & Esteves (1988) listed the results of the phytoplankton observed in January and September 1983 (*vide* Huszar *et al*. 1987), where the dominant taxon was *Scenedesmus opoliensis* var. *mononensis* (65%). As mentioned above, we did not observe this specie in our samples.

Huszar & Silva (1992) analyzed the density and diversity of the community of phytoplankton of Lagoa de Cima lake, using samples collected in different depths of the waters of the lake, with a 20ìm mesh net, in March and December 1986. The authors found the total of 52 *taxa*. They verified that the phytoplankton concentration fluctuated among 3,247 individuals/ml^{-1}, belonging to 35 taxa (March/1986 - sampled in 2,4 m of depth) and 5,239 individuals/ml^{-1}, belonging to 31 taxa (March/1986 - sampled in 0,1 m of depth). They did not register dominance of species, however *Scenedesmus protuberans* f. *danubianus* was mentioned as being one of the most abundant. This species was not mentioned in the paper of Huszar *et al*. (1987) that analyzed also samples collected in the same periods

of 1986. In our study, this species was observed frequently in the samples of surface sediments of the bottom of the lake; its largest spatial depositional area corresponded to sample 11 (vide Fig. 2). Other species of algae not been mentioned in Huszar *et al*. (1987) were *Pediastrum tetras*, *Scenedesmus bijugus*, *S. bijugus* var. *disciformis* and *S. denticulatus*, besides no species of *Coelastrum*.

Esteves *et al*. (1984) framed the Lagoa de Cima lake as oligotrophic with low density of algae. This fact was reviewed by Huszar & Silva (1992). They verified a great richness and high specific density in the phytoplankton and demonstrated that the Lagoa de Cima lake presented elevated specific diversity of algae in its waters, mostly at that time of rainfalls. For them the more abundant species were some Desmidiaceae and *Mougeotia* cf. d*elicata*. These algae have been observed in a very low number and only in restricted areas of sedimentation in our study, but we can agree with these authors because the richness and the high number of algae in surface sediments of the Lagoa de Cima lake are evident.

CONCLUSION

We can conclude that: 1) The genus *Scenedesmus* presented the greatest richness of species and number of counted individuals in the preparations using chemical reagents. Among the Diatomaceae the genus *Aulacoseira* presented the highest richness in the samples prepared by the method without application of chemical reagents. 2) The results of counted individuals and percentage in the preparations using chemical reagents indicated that the areas with the highest depositional rates of the algae are located near the northeast portion of the lake (samples 3, 4, 5 and 6). In this local, the configuration of the lake facilitates the accumulation of algae through a formation of a place of sedimentation. 3) The results of concentration analysis, based on the counting of the algae from the microscope slides together with the counting of the marker spore, indicated that the most central area in the lake is an excellent depositional area of Chlorococcales (samples 8, 9 and 11). 4) These algae were not observed in the central sandy sample of the lake (sample 7) and in the boundaries-sandy-samples (samples 1 and 15), probably because of the percolation processes. 5) Diatomaceae dominated in areas devoid of Chlorococcales. They were observed in large numbers all over the lake using the sediment treatment methodology without chemical reagents. This led to confirm that, for comparison of results and for a better environmental evaluation of lakes and ponds through palynological analysis of Quaternary sediments, it is necessary to use both methods for sediment preparations. 6) The algae *Coelastrum*, *Pediastrum* and *Scenedesmus*, well preserved in the sediments of the Lagoa de Cima lake, will possibly be useful in palynological facies analyses as well as they give a stratigraphic signal for the presence of freshwater.

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