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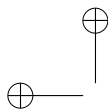
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Anais da Academia Brasileira de Ciências (2010) 82(3): 679-690  
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## Modern processes of palynomorph deposition at lakes of the northern region of the Rio de Janeiro State, Brazil

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### ABSTRACT

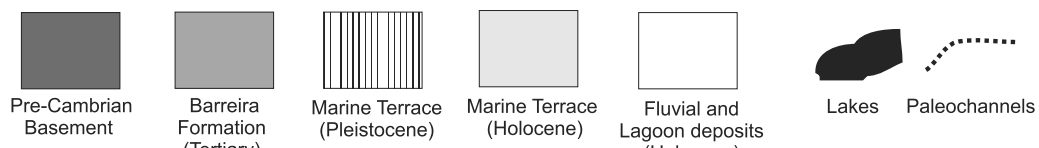
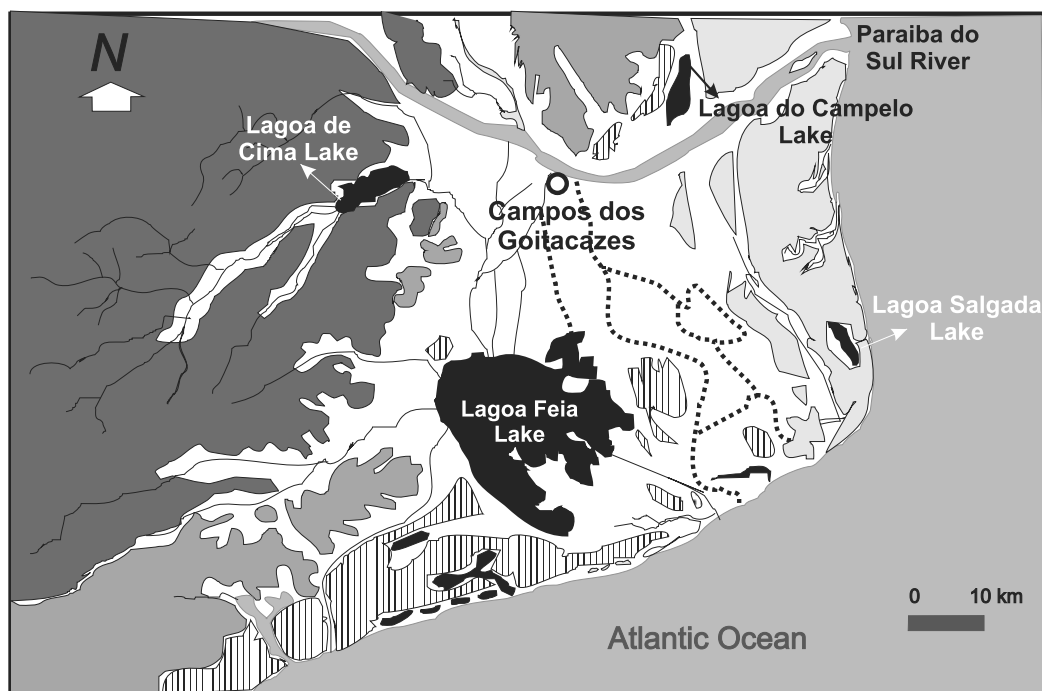
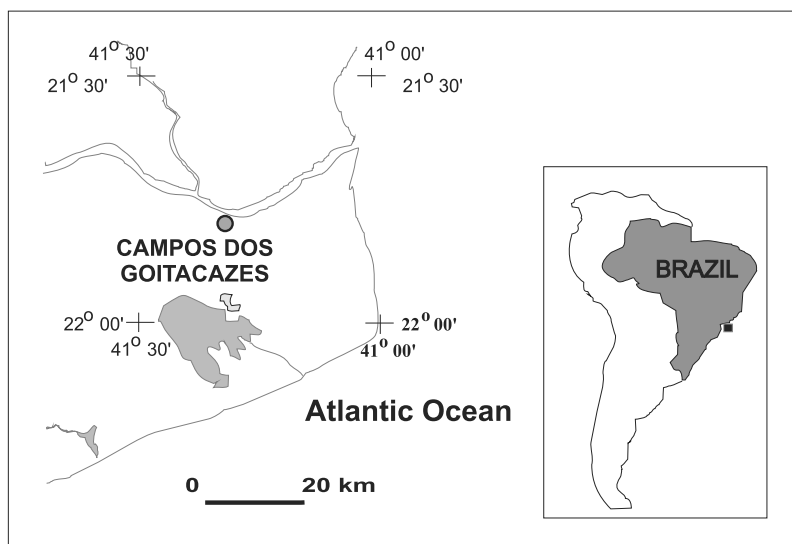
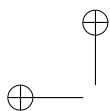
Palynological analysis of pollen, Pteridophyta spores and algae deposited in the superficial sediments at Lagoa de Cima and Lagoa do Campelo Lakes, located in the north of Rio de Janeiro state, was used to determine the spatial variation of the palynomorphs deposition. A total of 67 pollen types were identified at Lagoa de Cima, with expressive contribution of regional arboreous taxa, hydrophytes and ruderal plants of the pastureland. The depositional pattern of palynomorphs depends on the fluvial leakage, the proximity of the local sedimentation to the mouth of the Imbé and Urubu Rivers and the bathymetry of lake bottom. The highest concentrations of palynomorphs were observed in the decentralized and less deeper area, without the interference of the northeastern wind. At Lagoa do Campelo, a total of 58 pollen types were identified, among which the majority of the pollen grains came from hydrophytes, with the highest concentrations found along the northeastern shore. The southeastern shore showed high percentages of pollen and spores with degraded exine and mechanical damage, due to the transport through the lake by the currents caused by the wind, confirmed by the depositional trend of damaged palynomorphs along the same direction as the prevailing winds.

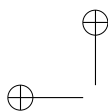
**Key words:** algae deposition, Campos dos Goytacazes municipality, palynology, pollen deposition.

### INTRODUCTION

The coastal plain of Campos dos Goytacazes municipality, northern coastal region of the Rio de Janeiro State, is an important area for palaeoenvironmental studies. This region presents several shallow lakes, which are relict bays of a large palaeolagoon system that was isolated from the sea during the Quaternary by sediments from the Paraíba do Sul River (Lagoa de Cima lake), by sand barriers or beach ridges (Lagoa Salgada lake), or by alluvial fans of the Barreiras Formation (Lagoa do

The Lagoa de Cima Lake is embedded in a Barreiras Formation (Imbé River basin) located between the Barreiras Formation and the Crystalline system, 50 km west from the coastal line and with about 30 m high. This lake have been formed by an obstruction of a palaeolagoon called Ururá Bay, and, therefore, represents the largest lake in this region. The water is fresh and presents atomite deposits at its margins. It is conditioned by the inflow of the Urubu and Imbé Rivers and presents an outlet called Ururá that flows towards the Lagoa do





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industrial activities but an intense sugar-cane agriculture, pastureland, and a small remnant fragment of the Atlantic forest bordering the lake (Soffiati Netto 1985, 1991, FEEMA 1993). The Evergreen Rainfall forest covers the high mountains of the drainage basin, especially inside the Parque Estadual do Desengano, a governmental area for the protection of the forest that is located 5 km west from the Lagoa de Cima Lake (RADAMBRASIL PROJETO 1983).

The Lagoa do Campelo Lake is located at 17 km away from the coastal line, with about 8 m high, bordering the Barreiras Formation and reaching the flattened sediments of the coastal plain, which cover the Cretaceous layers of the Campos Basin. Its drainage basin is not well limited and occupies an area of circa 98 km<sup>2</sup>. Without a tributary and an effluent, the lake receives fresh water and sediments from several swamps and bogs connected to the Paraíba do Sul River. The water of the lake was not naturally drained into the Atlantic Ocean (Tolentino et al. 1986). Nevertheless, in 1950 the extinguished National Sanitation Department (DNOS) realize did several drainage alterations in the Campos dos Goitacazes municipality in order to control the natural floods in this region. The building of a channel connecting this lake to the Paraíba do Sul River and another channel towards the sea was not good to its hydrological balance (Soffiati Netto 1985, 1991, Bidegain 2002). A small remnant of the Seasonal Semideciduous forest can be observed at 5 km southwest of the lake, and a small swampy forest fragment of “Restinga” vegetation in the northeastern margin of the lake. Pastureland, sugar-cane agriculture and subsistence plantations constitute the regional landscape of the drainage basin. The marsh vegetation next to the lake borders presents Cyperaceae, Poaceae, some additional plant taxa, and a characteristic large belt of cattail (*Typha*).

The Atlantic Forest in this region represents a mosaic of different ecosystems, as xeromorphic beach ridges, “Restinga” vegetation, Tropical Seasonal Semideciduous forest, Evergreen Rainfall forest, hygrophilous/swampy vegetation and grassland. Despite its environmental importance, the economical activities de-

Assumpção and Nascimento (2000) made a floristic analysis of a few forest remnants of the “Restinga” vegetation in Grussaí (20 km southeast of the Lagoa do Campelo Lake). The phytosociological structure is a Seasonal Semideciduous forest called “Mata de Cima do Vão”, the largest remnant fragment in this region. It is located at about 25 km north of the Lagoa do Campelo Lake, was studied by Silva and Nascimento (2000). Moreno et al. (2003) performed the floristic analysis of the arboreal stratum at 50 m high in the Imbé. Carauta and Rocha (1988) and Carauta et al. (1995) studied the vegetation composition in this region.

The region has a hot and humid climate with a strong seasonal influence. The rainfall pattern is related to a rainy summer with a dry season from June to September, during the winter, and with indexes around 200 mm *per* month (AW of Koeppen). The annual rainfall average is around 900-1,100 mm, and the mean annual temperature is around 22°C. The predominant wind comes from the NE (RADAMBRASIL PROJETO 1983, Tolentino et al. 1986, FEEMA 1993, Bidegain 2002).

With the aim to support the reconstruction of the temporal dynamics of the vegetation during the last 7,000 years, palynological studies of surface sediment samples were performed for elucidation of the environmental dynamics that have influenced the sedimentation of the palynomorphs inside the Lagoa de Cima and Lagoa do Campelo Lakes. In both situations, the anthropogenic influence was intense and changed almost the whole vegetation cover in the region, which is causing an accelerating lowering of the water level of the two lakes and eutrophization.

#### MATERIALS AND METHODS

Fifteen surface samples were collected with a Ponar dredger in the top five centimeters of the Lagoa do Campelo Lake sediments, in a transect of 500 m steps from the lake to the opposite side, in the NE/SW direction, with the same direction of the dominant wind:

sample 1: 21°45'23" S – 41°29'11" W;

sample 2: 21°45'34" S – 41°29'35" W.



sample 6: 21°46'03" S – 41°30'28" W;  
sample 7: 21°46'45" S – 41°30'42" W;  
sample 8: 21°46'19" S – 41°30'59" W;  
sample 9: 21°46'27" S – 41°31'14" W;  
sample 10: 21°46'37" S – 41°31'28" W;  
sample 11: 21°46'45" S – 41°31'44" W;  
sample 12: 21°46'54" S – 41°31'59" W;  
sample 13: 21°47'02" S – 41°32'12" W;  
sample 14: 21°47'11" S – 41°32'25" W;  
sample 15: 21°47'16" S – 41°32'34" W.

Sample 1 was located about 500 m shoreline in the NE margin of the lake and related to the 0 m of the transect line. Samples 6, 7 and 8 were obtained in the deeper portion (circa 3.4 m deep), near the center of the lake. Sample 15 was collected near a sand bank at the SW margin, between the mouths of the Imbé and Urubu Rivers (Fig. 2).

Four surface samples were collected with a hand dredger in the top five centimeters of the Lagoa do Campelo Lake sediments, in a transect of 500 m steps from one to the opposite side, in the NE/SW direction, the same direction of the dominant wind:

sample 1: 21°38'25" S – 41°10'59" W;  
sample 2: 21°38'35" S – 41°11'10" W;  
sample 3: 21°38'49" S – 41°11'22" W;  
sample 4: 21°38'52" S – 41°11'30" W.

Sample 1 was located about 10 m shoreline in the NE margin of the lake and related to the 0 m of the transect line. This station was about 0.5 m deep and next to the cattail belt. Sample 2 (1.0 m deep) was collected near the center of the lake. Sample 3 was obtained in the deeper portion of the lake (1.5 m deep), near a sand bank covered with Cyperaceae. Sample 4 (1.0 m deep) was located near the cattail belt in the SW margin of the lake (Fig. 3).

Two grammes of each surface sample were processed using the standard methodology (Ybert et al. 1992). The investigation was established upon the data obtained from palynological analyses of sediments, considering the palynomorphs as pollen grains, spores of Pteridophyta and Bryophyta, zygospores and coenobia

introduced *Lycopodium clavatum* L. spores. Pollen percentages were calculated on the base of the total pollen sum, excluding Bryophyta and Pteridophyta spores, Algae and the pollen grains of hydrophyte plants (Cyperaceae, *Eichornia*, Nymphaeaceae, Onagraceae, *Sagittaria*, Scrophulariaceae, Typhaceae and *Utricularia*). The concentration of palynomorphs was plotted considering the number of marker spores per gram of sediment (Stockmarr 1971). The statistical treatment was carried out using TILIA software (Grimm 1987). Pollen grains and spore fotomicrographs with morphological descriptions were presented formerly in Luz and Barth (2000, 2002) and algae in Luz et al. (2002). Palynomorphs were grouped in diagrams according to its habitus (tree, tree/shrub, shrub, shrub/herb, herb and of variable habitus). No chemical products were used for the observation of Bacillariophyceae algae.

## RESULTS

At Lagoa de Cima Lake a total of 575 pollen grains was counted, 67 pollen types were identified in all surface samples analyzed. Samples 1 and 7 presented no pollen grains. The highest concentration was 80,667 pollen grains/g (sample 3), corresponding to the north-east boundary of the lake, and the lowest (samples 8, 10 and 12) was found near its center/southwest portion (Fig. 4).

The highest percentage and concentration values of herbaceous pollen types were found in sample 3 (46,383 pollen grains/g), decreasing towards to the southwest margin. *Borreria*, Cyperaceae, Typhaceae and Poaceae were dominant, while Araceae, Begoniaceae, *Cabomba*, *Dioclea*, *Eichhornia* and *Polygonum* represented less than 10%.

The dominant arboreal/shrub vegetation pollen types were *Cecropia*, *Celtis*, Euphorbiaceae, Melastomataceae, Moraceae, *Myrcia*, *Piper*, *Trema* and several Asteraceae, Fabaceae and Myrtaceae, which presented the highest percentage and concentration values in samples 3, 5 and 11. *Alchornea*, Arecaceae, *Bombax*, *Casearia*, *Cedrela*, *Ceiba*, *Clethra*, *Copaifera*, *Didymopanax*, *Ervotheca*, *Eucalyptus*, *Ficus*, *Ilex*, Meliaceae, *Phora-*



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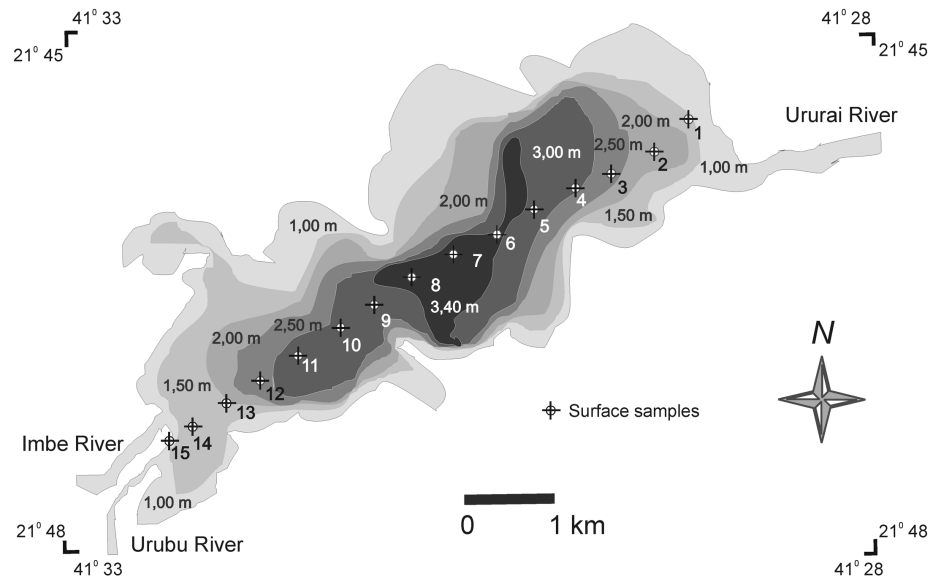
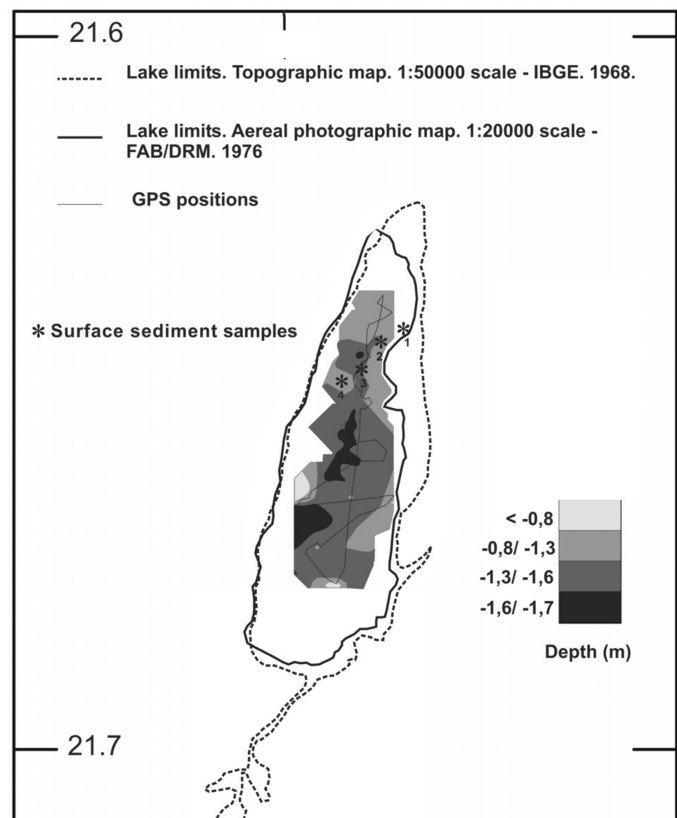


Fig. 2 – Bathymetric map of the Lagoa de Cima Lake with the localization of the surface sediment samples.





The fern spores reached a total of 155 spores counted in all samples analyzed, and represented less than 10% of the total of the palynomorphs. No spores were detected in samples 1 and 7. Its highest percentage and concentration occurred in samples 12, 13, 14 and 15, in the southwest boundary of the Lagoa de Cima Lake.

Next to the inflows of Imbé and Urubu Rivers, in the southern portion of the lake (samples 15, 14, 13, 12, 11 and 10), high percentages of pollen and spores with degraded and corroded exines were observed.

Algae reached a total of 4,182. Its highest concentration reached circa 800,000 individuals/g in sample 11, and the lowest (less than 1,000 individuals/g) in sample 14. Samples 1, 7 and 15 showed no Chlorococcales. *Scenedesmus* (*S. acunae*, *S. communis*, *S. magnus*, *S. ohauensis*, *S. pannonicus* and *S. protuberans*) was the dominant genus among the identified algae, followed by *Coelastrum* (*C. proboscideum*, *C. pulchrum* and *C. reticulatum*) and *Pediastrum duplex* var. *subgranulatum*. *Mougeotia* occurred only in sample 10. Bacillariophyceae were observed in all samples, mainly *Aulacoseira granulata*, *A. granulata* var. *angustissima*, *A. italica*, *Ciclotella meneghiniana*, *Luticula* sp. and *Melosira* sp.

At Lagoa do Campelo Lake a total of 919 pollen grains were counted, and 57 pollen types were identified in all surface samples analyzed. The highest pollen grains concentration was 212,106 grains/g (sample 1), corresponding to the northeastern boundary of the lake (Fig. 6). Pollen grains concentration decreased towards the southwest margin (sample 4), although showing the highest number of pollen types (36 pollen types).

Pollen grains of the herbaceous vegetation comprised more than 50% in each sample. Cyperaceae, Typhaceae and Poaceae were the dominant herbaceous pollen types, presenting more than 90% of all pollen grains (Fig. 5). The highest percentage and pollen grains concentration of cattail (*Typha*) was obtained in sample 1 (29,182 pollen grains/g), and the highest pollen grains concentration of Cyperaceae was seen in sample 3 (34,071 pollen grains/g). The percentage of Poaceae remained relatively constant (about 35% in most of the

pollen grains/g). Other herbaceous pollen types represented less than 10% (Alismataceae, Araceae, *Borreria*, Dioscoreaceae and *Polygonum*).

Pollen grains of the trees, trees/shrub and shrub vegetation occurred at less than 11% in each sample (Fig. 5). They showed the highest percentage and concentration in sample 1 and the highest number of pollen types (12 pollen types) in sample 4. *Alchornea*, *Areaceae*, *Celtis*, *Cecropia*, *Clethra*, *Lecythidaceae*, *Myrtaceae*, *Piper* and *Trema* were the most important arboreal/shrub pollen types. *Casearia*, *Castanea*, *Cupania*, *Dorstenia*, *Gochnatia*, *Loranthaceae*, *Meliaceae*, *Myrcia*, *Myrsinaceae*, *Myrsine*, *Sapindaceae*, *Sapotaceae*, *Sloanea*, *Trichilia*, *Virola* and *Weinmannia* occurred in very low percentages.

The fern spores reached a total of 159, representing less than 11.9% of the palynomorphs in each sample. The highest percentage and concentration occurred in sample 2 (36,300 spores/g).

Most of pollen and spores observed in the surface sediments presented significant exine damages, mainly in samples 3 and 4.

The highest algae (Chlorococcales) concentration reached 77,582 individuals/g in sample 1, and the lowest (1,887 individuals/g) in sample 4. *Pediastrum tetras* (Ehrenberg) Ralfs was the dominant species, and its highest percentage occurred in sample 1. *Spirogyra* and *Mougeotia* were dominant in sample 4. *Mougeotia* presented the highest percentages in sample 2 (14%) and 4 (24%). *Spirogyra* did not occur in sample 1. Bacillariophyceae was not observed.

#### DISCUSSION

The extant vegetation and spatial dynamics of the recent deposition of palynomorphs in the surface sediments of the lakes was considered.

The dominant assemblage of pollen types in the Lagoa de Cima Lake agrees with the floristic studies performed by Carauta et al. (1992), Carauta and Rocha (1988) and Rizzini et al. (1997). Nevertheless, the results obtained about the forest composition in the Imbé River basin are partially in agreement with Moreno et

Figure 1 displays 15 bar charts showing the pollen grain concentrations (grains/gram) for 15 different plant taxa across 15 samples. The taxa are: Trees, Trees and shrubs, Herbs, Shrubs, Herbs and shrubs, Indermittates, Variable habits, and Total concentration. The y-axis for each chart ranges from 0 to 5000 grains/gram. The x-axis for each chart is labeled with sample numbers 1 through 15. The total concentration chart shows the sum of all pollen grains for each sample.

Taxon	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
Trees	100	200	2500	3500	1000	3000	0	0	4500	500	500	0	500	2000	0
Trees and shrubs	100	100	6050	2500	5618	2500	0	2500	1000	500	6050	2500	500	1500	100
Herbs	100	1000	46383	99651	86431	114631	0	60501	158811	25000	113441	40000	62921	121001	1000
Shrubs	100	500	4000	4500	1500	4000	0	2000	2500	500	2000	0	1000	1500	100
Herbs and shrubs	100	100	2000	1500	500	1000	0	1000	1000	500	1000	500	2000	1000	100
Indermittates	100	500	10083	3500	69141	3000	0	3000	4000	1000	3000	2000	3000	2500	500
Variable habits	100	500	10083	2500	7346	7005	0	2500	9075	3000	9831	2500	2000	2500	100
Total concentration	100	1000	80667	28471	31979	31842	0	15125	37056	8943	33275	10974	15004	21267	1000





Euphorbiaceae and Rubiaceae. Euphorbiaceae had larger canopy values due to the presence of a high number of individuals. Lauraceae pollen grains were not observed in our surface sediment samples, probably because their fragile exine prevents preservation, as well as very few ones of Rubiaceae and Sapotaceae. Pollen grains of Fabaceae, Euphorbiaceae, Moraceae and Myrtaceae were significant. The main pollen source was the vegetation of about 200 m around a lake and the rivers, as demonstrated by several authors (Jackson and Wong 1992, Jackson 1994, Sugita 1994, Punning and Koff 1997). The high concentration of pollen types in our samples can probably be considered a result of pollination of herbs, shrubs and trees of the hygrophilous vegetation, reflecting the local vegetation of the southwest margins of the Lagoa de Cima Lake and also of the Imbé and Urubu Rivers.

It was interesting to notice the presence of *Podocarpus* pollen grains in a sample from the southwest margin of the lake. Nowadays, this tree can be found only in the high altitudes of the Paraíba do Sul River basin (Carauta and Rocha 1988). The fluvial transport of pollen and spores supplies a better vision of the vegetation than the aerial one, as also demonstrated by Chmura et al. (1999). It includes high values of palynomorph frequency that may not be related to an anemophilous transport only. Pollen types of plants of zoophile pollination, as *Bombax* and *Cedrela*, fall down by gravity directly into the water or may come by the rivers from plants located far from the depositional site. However, the possibility of input of palynomorphs by air directly into the lake cannot be discarded, not only from the local vegetation but also from regional areas. The presence of these pollen types in the samples from the southwest margin of the lake indicates long distance dispersion, as well as a process of pollen capture by the Imbé River. These pollen types will be deposited preferentially nearby the inflow of the Imbé River into the lake.

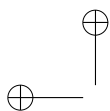
Traverse (2007) suggested that a normal depositional pattern of pollen and spores in rivers is the arrangement of pollen assemblages in decreasing concen-

centration from the inflows, following the fluvial current towards the northeast margin of the lake. Small and very small sized pollen types and spores in high concentrations were deposited in samples 6 and 5 of the transect. This observation indicates that the decrease of depth in this locality constitutes a physical barrier to the SW-NE aquatic transport of these pollen grains, as also explained by Davis (1968).

The erosion of the Lake margins by torrent waters during rainy periods, mainly the ones of the Imbé River, led to a great input of pollen and spores in the lake sediments. A high percentage of degraded pollen and spores was seen mainly in the southwest surface samples, which is the entrance area of the Imbé and Urubu Rivers. Rich organic sediments of older adjacent stratigraphic layers, and formerly exposed to the air, may also be incorporated into the sediments, resulting in a strong representation of the vegetation nearby these inflows (mostly Pteridophytae, Poaceae, Cyperaceae and *Piper*).

The deposition of Chlorococcales algae was observed only at the deeper and calm water portions of the Lagoa de Cima Lake, which are better protected from the inflow currents. Bacillariophyceae were very abundant in all the surface samples, as Huszar and Esteves (1988) and Huszar and Silva (1992) pointed out. Esteves et al. (1984) considered the Lagoa de Cima Lake as oligotrophic, with low density of algae, but Huszar and Silva (1992), noted a high specific richness of algae in it, mostly during the rainfall periods. The most abundant species belonged to Desmidiaceae and *Mougeotia* cf. *delicata*. Despite zigosporos of these algae have been observed in low frequency, we agree with Huszar and Silva (1992), regarding the high concentration values and richness of algae in our samples.

The palynological analysis of the surface samples from Lagoa do Campelo Lake showed a strong deposition of pollen grains from hydrophyllous/swampy plants and less from “Restinga” arboreal/shrubs. Local plant species provided the dominant assemblages of herbaceous vegetation. The belt bordering vegetation of Lagoa do Campelo Lake was largely reflected by Ty-



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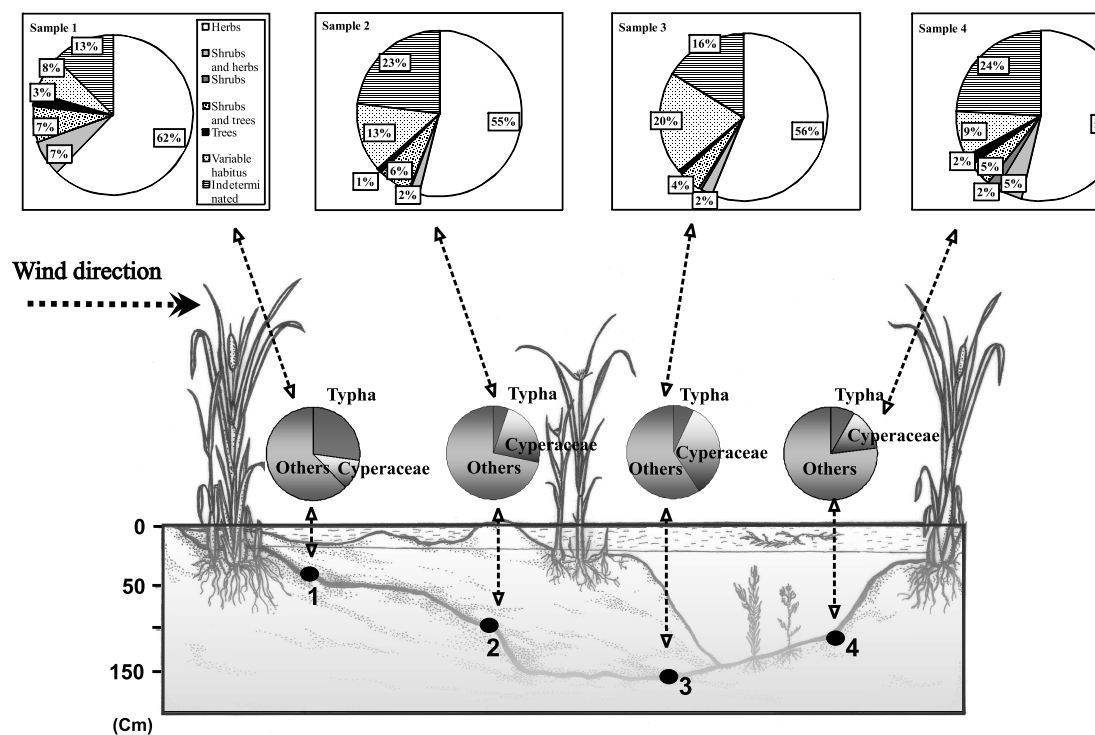
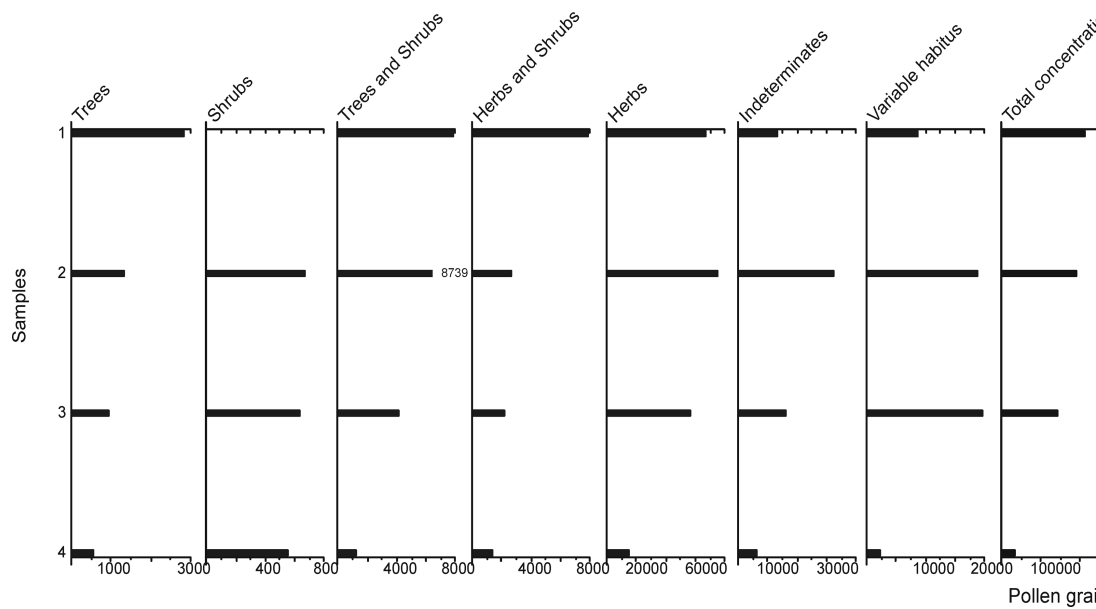


Fig. 5 – Surface samples from the Lagoa do Campelo Lake and frequencies of Typha, Cyperaceae and other pollen grains





with Cyperaceae, which reflects the highest frequency of this pollen type in the sediment. Sample 4 showed the greatest percentual of regional pollen grains with damaged exine. The arboreal and shrub pollen types probably came from plants of a little forest fragment that is adjacent to the northeast border of the lake, comprising representatives of the “Restinga” forest (Assumpção and Nascimento 2000) and of the Seasonal Semideciduous forest (Silva and Nascimento 2001). Degraded pollen grains came from the nearby bogs and swampy areas that are frequently exposed to oxidation and microbial activity. Successive wetting and drying caused significant damages to palynomorphs and was rapid and severe (Campbell 1991, 1999). The west margin was the best depositional place of wind-pollinated arboreal pollen grains and was of less concentration of pollen grains. This pattern may be explained by the NE wind that caused turbulence of the lake’s water that spread pollen grains laterally into other areas, before and after sinking down (reworked grains). Pollen grains probably suffered constant processes of resuspension in this margin. The depositional processes of palynomorphs in the Lago do Campelo Lake are strongly influenced by the NE wind, by the bathymetry of the lake, and by the input of pollen grains and spores formerly deposited in swampy areas around the lake.

Lagoa de Cima and Lagoa do Campelo lake surface samples revealed a differentiated standard of deposition of palynomorphs, as well as surface sediments from the Lagoa Salgada Lake (Barth et al. 2001, Luz et al. 2005). This lake is also located in the northern region of Rio de Janeiro State, of at about 1,5 km from the seashore, near Cape São Tomé. It has no tributaries, lying in the coastal plain between the sand barriers (beach ridges) and the mouth of the delta of the Paraíba do Sul River, with a characteristic vegetation of the herbaceous “Restinga” nevertheless, this area has been disturbed by anthropogenic action since the eighteenth century. The palynological analysis made by Barth et al. (2001) showed a dry-open environment with high frequency of herbs, and very low representation of trees, shrubs, hydrophyllous plants (*Typha* and Cyperaceae) and Pteridophyta.

Toledo, personal communication), similar to the conditions observed in the Lagoa do Campelo Lake.

### CONCLUSIONS

Pollen grains occurring in samples obtained in the superficial sediments from a transect across the Lagoa de Cima Lake reflect the extant vegetation around the lake and along the Imbé and Urubu Rivers, with an expressive contribution of arboreal regional taxa, as well as an important contribution of hydrophyllous/swampy plant species and ruderal plants from the wide-ranging pasturelands in this region. In the Lagoa de Cima Lake, the resuspended sediments take a preferential direction of deposition caused by water currents that generate high pollen rates in less deeper and decentralized areas.

Pollen and spore preservation was sometimes bad in the superficial sediments of the Lagoa do Campelo Lake, means their exposition to the air during the partial drying of the lake and corrosion by microorganisms. The pollen spectra indicate a major performance of the local vegetation and the preferential deposition of regional pollen types at the southwest margin of the lake, reflecting the action of the NE wind.

Taking in account the obtained results, the dynamic of deposition was different in the areas of the two studied lakes. At Lagoa de Cima Lake, it reflects the response of the vegetation to the sea level, always presenting a strong grouped influence of regional and local forest, grassland and swampy vegetation. Nevertheless, the dynamic of deposition in the Lagoa do Campelo Lake is in innermost dependence of the water level of the Paraíba do Sul River. The high number of pollen types is attributed to the local plants. The results reveal new information regarding the richness, concentration and distribution of the palynomorphs in the studied lakes, representing the regional and local vegetation and assisting in the paleoecological studies in the region.

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#### RESUMO

A análise palinológica de grãos de pólen, esporos de Pteridophyta e algas depositados nos sedimentos superficiais da Lagoa de Cima e Lagoa do Campelo, norte do Rio de Janeiro, foi usada para a avaliação da variação espacial de deposição dos palinórmfos. Um total de 67 tipos polínicos foi identificado na Lagoa de Cima, com expressiva contribuição de taxons arbóreos regionais, plantas hidrófitas e ruderais de pastagens. O padrão deposicional dos palinórmfos está sujeito às vazões fluviais, à proximidade do local de sedimentação em relação à desembocadura dos rios Imbé e Urubu e à batimetria do leito da lagoa. As maiores concentrações de palinórmfos foram observadas em áreas descentralizadas e menos profundas, não interferindo a ação dos ventos NE. Já na Lagoa do Campelo foi identificado um total de 58 tipos polínicos, em sua maioria de grãos de pólen de hidrófitas, com área de maior concentração relacionada à borda nordeste. A borda sudoeste apresentou altas percentagens de pólen e esporos com a exina degradada e danos mecânicos, resultado da ação de correntes aquáticas impulsionadas pelo vento, confirmando ser a tendência deposicional dos palinórmfos danificados a mesma da direção dos ventos dominantes.

**Palavras-chave:** deposição de algas, município de Campos dos Goitacazes, palinologia, deposição polínica.

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