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Phytoplankton Associations of a Coastal Lagoon in South of Brazil

L. C. Torgan† V. D. Pillar ‡ and L. F. Niencheski ∞

† Fundação Zoobotânica do Rio Grande do Sul. CEP 90690-000, Porto Alegre. torgan@cpovo.net

‡ Departamento de Ecologia - Universidade Federal do Rio Grande do Sul. CEP 91540-000, Porto Alegre. vpillar@ecologia.ufrgs.br

∞Laboratório de Hidroquímica Fundação Universidade de Rio Grande CEP 96201-900, Rio Grande dqmhidro@superfurg.br

ABSTRACT

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The phytoplankton associations were investigated in the Patos lagoon, a subtropical, large, shallow, polimitic system during an annual cycle, in order to use it as a tool to provide information about the spatial-temporal variations pattern of this ecosystem. The study was based on surface water sampling collected monthly on the main N-S axis of the lagoon, from December 1987 to November 1988. Phytoplankton associations were composed mainly of *Aulacoseira*, *Cyclotella*, *Chaetoceros* and *Skeletonema* (Bacillariophyceae), *Aphanocapsa*, *Cyanodictyon* and *Planktolyngbya* (Cyanophyceae), *Rhodomonas* (Cryptophyceae) and *Psephonema* (Chlorophyceae) species. The distribution pattern of phytoplankton associations indicated that from December to March, north, middle and south areas were characterized by freshwater, brackish and brackish-marine associations respectively, meanwhile, from April to October a freshwater association was not evident, only returning in November. The analysis revealed high spatial and temporal variability in the distribution of the phytoplankton associations in the Patos lagoon during an annual cycle, which was related mainly to variation in salinity of the water in this ecosystem.

ADDITIONAL INDEX WORDS: *Algae, pattern, spatio-temporal variation*

INTRODUCTION

The concept of association applies to any group of species which occur together and that have similar reactions to properties of the environment. Therefore, the associations can be used as a tool to provide valuable information about the organization and the spatial and temporal variation of ecological units in ecosystems (FAGER and MCGOWAN, 1963; LEGENDRE and LEGENDRE, 1978). Some marine and freshwater phytoplankton associations were defined by Hutchinson (1967), SMAYDA (1980), REYNOLDS (1980, 1997), and SOMMER (1986), but phytoplankton associations in subtropical water are still poorly known. The Patos lagoon is a subtropical, shallow (medium depth 6.0 to 8.0 m) polimitic, mesotrophic to eutrophic system. The phytoplankton was previously studied in taxonomic and ecological aspects (ODEBRECHT *et al.,* 1988; TORGAN *et al.,* 1995, 1998) without regard to species associations. In this paper we aim at identifying phytoplankton associations and using them to reveal the spatio-temporal variation in environmental conditions during an annual cycle in the Patos lagoon.

METHODS

The Patos lagoon is in the coastal plain located between 30 23 and 32 07S, 50 41W and 52 12W, in the southern coast of Brazil. Seawater enters the southernmost section of the lagoon through a single narrow channel and the tidal range is low (45 cm). The hydrology is strongly influenced by inflow of the continental water and the action of the winds (MÖLLER JUNIOR *et al.,* 2001). Surface water was collected monthly at eight stations (3, 5, 7, 9, 11, 12, 14 and 16) located on the main N-S axis of the lagoon, from December 1987 to November 1988. The algae (cells, colonies, filaments) were quantified according to Utermöhl's method (1958). Cluster analysis of the most abundant species (49 spp.) in 104 sampling units was performed based on Ward's method (ORLÓCI, 1967), with data logarithmic-transformed according to ALLEN and KOONCE (1973). Cluster analysis of the sampling units were also performed based on physical and chemical conditions of the water (salinity, phosphate, nitrate, pH).

RESULTS

From the cluster analysis of the sampling units based on species associations three groups (**l, m, n**) were derived (Fig. 1). Group **l** was divided into subgroups **a** and **b**. The **a** subgroup included the north sampling stations (3 and 5) in different months of the year. This subgroup was distinguished from the others by the presence of *Aulacoseira ambigua*, *A. granulata*, *A. granulata* var. *angustissima* and *A. nyassensis* (Bacillariophyceae). The **b** subgroup included the north and middle sampling stations (3, 5, 7) from April to November 1988 and was characterized by the presence of *Aphanocapsa nubilum, Planktolyngbya limnetica* (Cyanophyceae), *Psephonema aenigmaticum* (Chlorophyceae) and *A. granulata*. Group **m** was divided into subgroups **c** and **d**. Subgroup **c** included the north, middle and south stations (5-14) in December 1987, the north and middle stations (5-12) in January, the north and middle stations (5-9) in February and the middle stations (7-9) in March. These stations were grouped by the abundance of *A. granulata* and *C. striata*. Subgroup **d** included the middle and south stations (9-16) in November and it was distinguished from the others by the presence of *A. nubilum* and *Cyanodictyon imperfectum* (Cyanophyceae). Group **n** was divided into subgroups **e**, **f** and **g**. Subgroup **e** included the middle and south stations (9-16) in June and October, only the south stations (14 and 16) in December 1987 and January 1988, the middle stations (11 and 12) in February and March and the middle and south stations (11-16) in April, July and August. In these stations the abundance of Bacillariophyceae (*Skeletonema costatum* and *S. subsalsum*) was evidenced. The subgroup **f** included the south stations (14 and 16) in February and March and the middle and south stations (7-16) from April to November, and this subgroup was characterized by the presence of *Rhodomonas minuta* var. *nanoplanctonica* (Cryptophyceae). The subgroup **g** included the middle stations (9 and 12) in April and May and it was distinguished from the others by the abundance of the diatoms *S. subsalsum* and *Chaetoceros subtilis.*

Tree groups (**A**, **B** and **C**) were derived (Fig. 2) from the cluster analysis of the sampling units based on physical and chemical variables. Group **A** included the south area from April

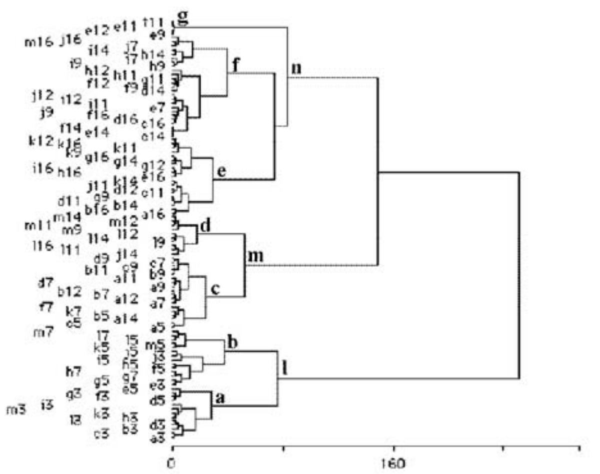

Figure 1.Cluster analysis (Ward´s method) of the sampling units in the Patos lagoon based on the most abundant species.

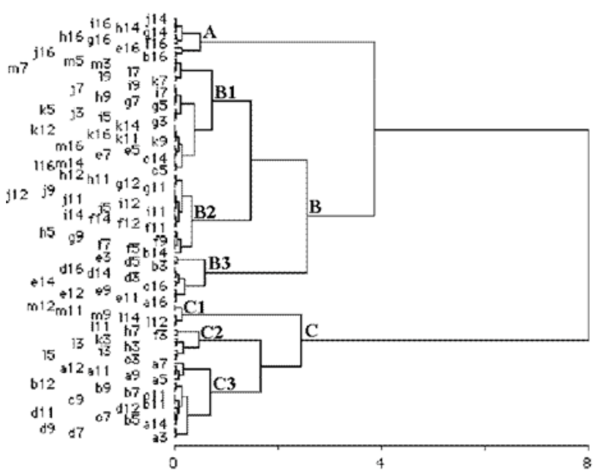

Figure 2. Cluster analysis (Ward´s method) of the sampling units based on physical and chemical variables.

to September 1988 and was characterized by high pH (>7.5), high salinity (> 6.35), and phosphate and nitrate concentrations ranging from 0.30 to 1.43mM. L^{-1} and 0.44 to 4.60mM. L^{-1} respectively. Group **B**, that was divided into subgroups B1 and B2, included the north, middle and south areas during different months of the year and presented a wide range of pH (5.7 - 7.6), salinity (0 - 11.58), nitrate (0.20- 66.70mM. L^{-1}) and phosphate (0.03-1.31mM. L^{-1}) values. Group **C**, that was divided into three subgroups C1, C2 and C3, included mainly north and middle areas during some months of the year and it was characterized by acidic to basic pH (5.8- 7.9), low salinity (<1.04) and high nitrate (>10.07 mM. L^{-1}) and phosphate (> 0.44 mM. L^{-1}) concentrations.

The analysis indicated the correspondence of group **l** to the north area, group **m** to north and middle areas and group **n** to middle and south areas. Figure 3 shows the spatial and temporal variability of these groups in the different areas of the Patos lagoon.

DISCUSSION

The Patos lagoon is a typical lagoon with the longer axis lying parallel to the shore line and with only a narrow linking channel to the sea. This ecosystem comprises a large area influenced by freshwater input, a smaller portion dominated by water from the Atlantic ocean and an intermediate zone of brackish water. ACCORDING to KNOPPERS (1994) the aquatic primary production in the mesotrophic to eutrophic chocked lagoons, with depths exceeding ca. two meters and light limitation at the bottom, is commonly phytoplankton based. Indeed, phytoplankton is the dominant plant community in the north and middle areas of the Patos lagoon. Therefore, in the estuarine zone, the macrophyte *Ruppia maritima* and its epiphytic community associated can also contribute to primary production (CAFRUNI *et al*., 1978; FERREIRA and SEELIGER, 1985).

Because of the relatively small size of the entrance/outlet channel in relation to the water volume, longitudinal salinity gradients in the lagoon are more stable in contrast to the situation in estuaries (BARNES, 1974). The salinity may vary seasonally, especially in areas subject to wet and dry periods of the year when the controller factors responsible for this gradient are the volume of freshwater input and the volume evaporated from the surface (BARNES, 1980). The salinity can also vary due to wind action, which, besides preventing the development of water vertical stratification, can also promote the intrusion of coastal water into the lagoon. This event was observed in the Patos lagoon from February to October 1988 and it was associated to a dry weather period that decreased freshwater discharge of the Guaiba lake into the lagoon.

The inflow and outflow of the continental and coastal waters in the system was clearly indicated by the distribution of the phytoplankton associations. Group **l** (subgroups **a**, **b**) was formed by diatoms, cyanobacteria and chorophyte freshwater species that showed a gradual spatial distribution down to the middle area of the lagoon. Group **n** (subgroups **e**, **f**, **g**) was formed by marine and brackish species of diatoms and cryptophyte that were gradually brought into the middle area of the lagoon during the intrusion of the coastal waters. Group **m** (subgroups **c**, **d)**, that was formed by freshwater species of diatoms and cyanobacteria, had a drastic reduction in its occurrence from April to October, reappearing only in November.

The species composition of a given phytoplankton community is a function of various environmental factors including salinity, turbidity, nutrients, turbulence and depth (DAY *et al.,* 1989). Based on the salinity tolerance of the abundant species in the Patos lagoon, the salinity was probably the main selective factor for the composition of phytoplankton associations. The wide range variation of salinity (0 - 30.67) in time and space allowed segregated occurrence of freshwater, brackish and marine associations in this ecosystem.

CONCLUSION

The distribution pattern of phytoplankton associations indicated that from December to March, north, middle and south areas were characterized by freshwater, brackish and brackish-marine associations respectively, meanwhile from April to October a freshwater association was not evident, returning only in November. The analysis revealed high spatial and temporal variability in the distribution of the phytoplankton associations in the Patos lagoon during an annual cycle, which was related mainly to variation in the salinity of the water in this ecosystem.

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LITERATURE CITED

ALLEN, T. F. H. and KOONCE, J. F., 1973. Multivariate approaches to algal stratagems and tactics in systems analysis of phytoplankton. *Ecology*, 54, 1234-1246.

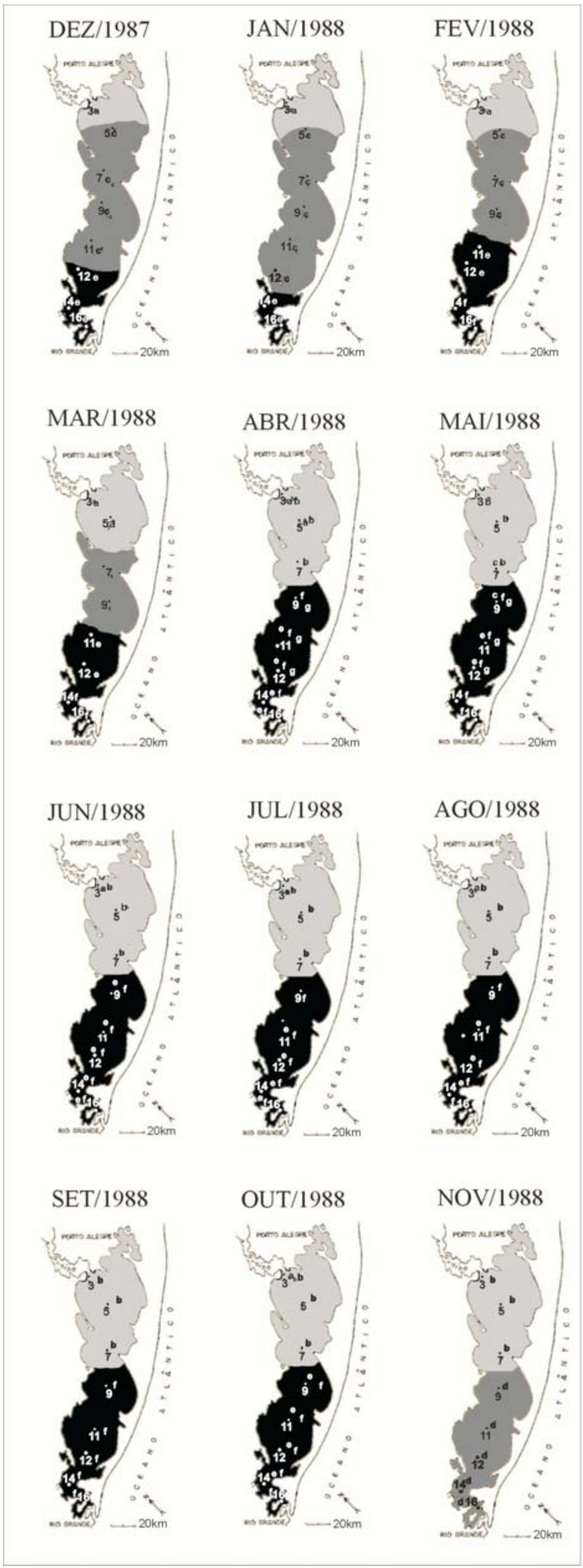

Figure 3. Spatio-temporal variation of the distribution of phytoplankton associations subgroups **a**, **b** (grey), subgroups (dark grey) and subgroups **e**, **f**, **g** (black) in the Patos lagoon from December 1987 to November 1988.

BARNES, R. S. K., 1974. *Estuarine Biology*. London: Edward Arnold Ltda, 77p.

BARNES, R. S. K., 1980. *Coastal Lagoons*. Cambridge: Cambridge Univerity Press. 106p.

CAFRUNI, A. M. S.; KRIEGER, J. and SEELIGER, U., 1978. Observação sobre Ruppia maritima L. no sul do Brasil. *Atlântica* (Rio Grande) 3, 85-90.

DAY, J. W. JR.; HALL, C. A. S.; KEMPT, W. M. A. and YÁ NEZ-ARANCIBIA, A., 1989. *Estuarine Ecology*. New York: Wiley & Sons, 558p.

FAGER, E. W. and MCGOWAN, J. A., 1963. Zooplankton species groups in the North Pacific. *Science*, 140 (3566), 453-60.

FERREIRA, S. and SEELIGER, U., 1985. The colonization process of algal epiphytes on Ruppia maritima L. *Botanica Marina*, 28, 245-249.

HUTCHINSON, G. E., 1967. A treatise on Limnology, Vol. II. Phytoplankton Associations. New York: Wiley & Sons, pp. 355-397.

KNOPPERS, B., 1994. Aquatic primary production in coastal lagoons *In:* Kjerfve B. (ed), *Coastal lagoon processes* London: Elsevier Science Publisher, pp. 243-286.

LEGENDRE, L. and LEGENDRE, P., 1978. Associations *In:* Sournia A. (ed), *Phytoplankton manual.* Paris: Unesco, pp. 261- 272.

MÖLLER JUNIOR, O. O.; CASTAING, P.; SALOMON, J.-C. and LAZURE, P. 2001. The influence of local and non local forcing effects on the subtidal circulation of Patos Lagoon. Estuaries, 24 (2), 275-289.

ODEBRECT, C.; MOLLER, O. O. and NIENCHESKI, L. F., 1988. Biomassa e categorias de tamanho do fitolpâncton total na lagoa dos Patos, Rio Grande do Sul, Brasil (verão, 1986). *Acta Limnologica Brasilensia*, 2, 367- 386.

ORLÓCI, L., 1967. An agglomerative method for classification of plant communities. Journal Ecology, 55(1), 193-206.

REYNOLDS, C. S., 1980. Phytoplankton assemblages and their periodicity in stratifying lake systems. Holarctic Ecol., 3, 141-159.

REYNOLDS, C. S., 1997. *Vegetation Processes in the pelagic: A model for ecosystem theory.* Excellence in Ecology. Germany: Ecology Institute, 371p.

SMAYDA, T. J., 1980. Phytoplankton species sucession. *In:* Morris I. (ed). *The physiological ecology of phytoplankton,* Oxford: Blackwell Scientific Publications, pp. 493-570.

SOMMER, U., 1986. he periodicity of phytoplankton in Lake Constance (Bodensee) in comparison to other deep lakes of central Europe. *Hydrobiologia*, 249, 59-65.

TORGAN, L. C.; GARCIA-BAPTISTA, M. and MOLLER O. O., 1995. Distribuição vertical do fitoplâncton na laguna dos Patos, Rio Grande do Sul, Brasil (verão, 1986). *Acta Limnologica Brasilensia*, 7, 67-77.

TORGAN, L. C.; TUNDISI, J. G. and NIENCHESKI, L. F. H., 1998. Seasonal variation of planktonic diatoms in Patos lagoon, southern Brazil. *In:* JOHN, J. (ed.) *Proceedings of the 15th International Diatom Symposium*. Koenigstein, Germany: Gantner Verlag, pp. 459-470.

UTERMÖHL, H., 1958. Zur Vervollkommung der quantitativen Phytoplankton-Methodik. *Mitt. int. Ver. theor. angew. Limnol.,* 9, 1-38.