INTERANNUAL DIFFERENCES IN PHYTOPLANKTON SEASONAL CYCLES IN SARONIKOS GULF

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The originally oligotrophic waters of the Saronikos Gulf have been locally submitted to eutrophication due to a continuous input of nutrient-rich sewage from urban and industrial origin. Hence the former seasonal phytoplankton cycle (IGNATIADES, 1969) has been affected. This study considers the effects of the effluents on both the algal abundance and distribution (chl. *a*) and on the annual cycle (FRILIGOS, 1985; PAGOU and IGNATIADES, 1988). Monthly samplings (April 1982 to March 1983 and April 1989 to March 1990) were done at 1 m depth (Niskin bottles) at two stations : S1 in an eutrophic environment (sewage from Athens) and S2 in an almost oligotrophic area. Different parameters were determined (see Table 1). A similarity matrix using the Bray-Curtis measure of similarity on log (x+1) data of the main phytoplankton groups abundance was subjected to MDS analysis (KLARKE and GREEN, 1988). Although temperature and salinity values did not differ between stations, the ranges and mean values of nutrients (Table 1) confirmed the eutrophic character of station S1 in relation to S2, for both sampling periods. The results from the chlorophyll *a* and phytoplankton cell data showed that the eutrophic environment promoted the growth of phytoplankton (Table 1) for both periods. However, differences on phytoplankton parameters values occurred mainly in the eutrophic area (S1) between the two sampling periods. During 1982-1983 exceptionally high concentrations of chlorophyll *a* and phytoplankton cells were recorded at station S1 in comparison to values either from the same station during 1989-90, or from station S2 for both years. These differences can be attributed to the lower values of nutrients (NO_3-N, PO_4-P, Table 1) recorded during 1989-90 at the eutrophic station S1, caused rather from the unstable character of this eutrophic environment, than from a better control of the effluents.

Station	Temperature (°C)	Salinity (ppt)	DO ml/(l)	NO_3-N (µg-at/l)	PO_4-P (µg-at/l)	Chl-a (µg/l)	Total cells (cells/l)
A. April 1982 - March 1983							
S_1	12.90-26.00 18.98	36.67-38.69 37.44	2.75-7.21 4.33	0.07-6.13 1.94	0.05-4.20 1.37	0.10-84.25 12.19	$2.9X10^4$-$1.9X10^7$ $3.1X10^6$
S_2	12.80-25.2 18.81	36.69-38.49 37.51	2.80-6.11 4.69	0.18-1.54 0.59	0.05-0.27 0.13	0.10-2.17 0.51	$4.0X10^3$-$2.4X10^5$ $4.5X10^4$
B. April 1989 - March 1990							
S_1	13.61-24.87 18.82	37.49-38.73 38.23	3.98-5.96 5.05	0.17-1.24 0.59	0.03-4.53 0.84	0.31-9.35 2.85	$2.2X10^4$-$7.0X10^5$ $4.0X10^5$
S_2	13.93-25.14 19.29	38.22-38.72 38.46	4.60-5.83 5.21	0.10-0.49 0.27	0.03-0.76 0.14	0.10-1.66 0.61	$8.6X10^3$-$3.0X10^6$ $8.3X10^5$

Table 1. Range and mean values of selected hydrographic and biological parameters in 1m depth of Saronikos Gulf, during the periods April 1982-March 1983 (PAGOU and IGNATIADES, 1988; PAGOU, unpublished data) and April 1989 -March 1990 (NCMR, 1991).

The annual cycles of chlorophyll *a* (Fig. 1) have been altered from the pattern previously described and maxima were recorded in summer (June), at the eutrophic station S1, during both sampling periods, whereas at station S2, maxima were recorded both during spring (March 1983, 1990) and summer (June 1983). From the above presented and discussed data, it is obvious that differences had occurred, concerning the annual cycles of phytoplankton between stations and sampling periods. Thus numerical taxonomy (MDS - stress : 0.130, Fig. 2) was used in order to assess whether these differences are significant and to test if a seasonal grouping of the phytoplankton samples exists, according to the presence and abundance of phytoplankton groups. At the similarity level of 70% two groups were distin-guished (Fig. 2): a) Group 1 consisted only from some 1982-83 samples from both stations, i.e. autumn samples (August, September, October 1982) from station S1 and various sam-ples from station S2, originating throughout the first sampling period (April, May, June, July, September, October, November, December 1982). The samples of group 1 were characterized by low abundances of µ-flagellates and "others" and intermediate of all other groups. b) Group 2 was con-structed from all the remaining samples from the first period and the samples from 1989-90. However in group 2, two well defined subgroups could be described. The first subgroup (2A) joined samples from spring to late summer, from both stations and sampling periods (S1: June, July 1982, April, June, September 1989, March 1990, S2: April, September 1989), having as dominant groups mostly dinofla-gellates and µ-flagellates. Mainly winter samples (S1: December 1989, S2: January February 1983, June, December 1989) were contributing to the formation of the second subgroup (2B) and were characterized by almost equal predominance of diatoms, dinoflagellates and coccolitho-phorides, along with relatively high abundances of µ–flagellates and "others". The conclusion that could be drawn from the above data analysis, for both sampling periods, is that discrepancies have been occurred on the seasonal cycles of phytoplankton groups in both eutrophic and oligotrophic areas, which have altered the succession pattern of phytoplankton, although in different ways for each period. This conclusion is in agreement with the hypothesis that though phytoplankton community responds to changes in the physicochemical environment, other factors such as climatological changes can also act as a "stress" factor on the ecosystem, and pollution alone cannot explain the observed differences (GREVE and PARSONS, 1977).

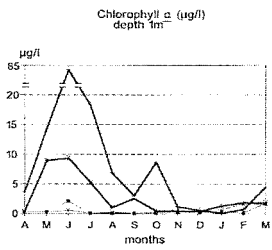

Fig. 1. Annual cycles of chl *a* (mg/l, 1 m depth)

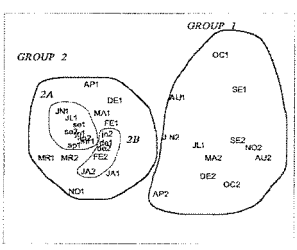

Fig. 2. MDS plot of phytoplankton samples (stress: 0.130). **Symbols:** upper case letters = months of 1982-83, lower case letters = months of 1989-90, 1 = station S1, 2 = station S2.

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