DYNAMICS OF PHYTOPLANKTON COMMUNITY STRUCTURE IN AN ENCLOSED COASTAL SYSTEM INFLUENCED BY TERRESTRIAL RUNOFF

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Abstract

In situ knowledge of phytoplankton community dynamics and environmental factors remains a powerful tool for determining processes underpinning changes in species assemblages in relation to time, space, resources, and competition. This study aims at investigating changes in phytoplankton assemblages before, after and during the development of blooming in the Kalloni Gulf (Aegean Sea) under the influence of environmental parameters and particularly terrestrial runoff. Links between environmental parameters and species abundance data have been analysed using multivariate methods and biodiversity patterns. Our results indicate that assemblages thriving under nutrient loading from runoff have a different structure in comparison to natural blooms occurring in summer and in autumn.

Keywords : Biodiversity, Blooms, Coastal Waters.

The Gulf of Kalloni is a semi-enclosed shallow water body, occupying a surface area of 110 km^2. The climate of the area is typically Mediterranean. During the rainfall period (November to March) a notable amount of nutrients is carried into the gulf through leaching from the surrounding agricultural land. A six station network was sampled monthly from August 2004 to July 2005. Stations 1 and 2 were positioned in the open sea and the inlet of the gulf respectively. Stations 3, 4, and 7 were in the vicinity of three important rivers which discharge at the northern part of the gulf. Station 5 was placed in the middle of the gulf to characterize the overall condition of the gulf water mass.

Data related to physical parameters, nutrients and Chl α were collected from 1 and 5 m depths. Phytoplankton samples were quantitatively analyzed using the Utermöhl method [1] as well as using bright field (BF) in order to identify nanoplankton species at 1000x. Phytoplankton biovolume and biosurface values were also calculated according to Hillebrand et al. [2]. Multivariate analysis of species abundance data were applied using the Primer 6.0 package, and statistical comparisons with the permutational multivariate analysis of variance known as PERMANOVA [3].

We tested the effect of time (month) and space (location of stations) in a two-way multivariate analysis of variance. The effect of month (PERMANOVA F=37.07, P<0.05) was much stronger than the effect of location of stations (F=2.14, P<0.05) in the grouping of samples, since the latter was found significant only within February and July. Similar results were obtained when the test was applied on presence-absence phytoplankton data. These results suggest that the phytoplankton community of the Kalloni Gulf is well diversified over time through the formation of distinct assemblages, which are however spatially homogeneous within the gulf. Moreover, each assemblage is distinct because of differences in the relative abundance of species as well as in its species composition.

Samples from late autumn and winter months formed a wide "winter" group characterized by rather low species abundances and without any specific proliferation (Fig. 1). The phytoplankton community sampled in February was particular since it was marked by a *Pseudo-nitzschia calliantha* bloom. Spring and summer assemblages were marked by high densities of the diatom *Chaetoceros diversus* followed by *Proboscia alata f. gracillima* and *Rhizosolenia setigera.* Finally August and October phytoplankton assemblages were characterized by high abundances of small diatoms such as *Cyclotella spp.* and *Thalassionema nitzschioides f. parva*.

Total cell number during the February bloom was higher by three orders of magnitude. However, due to the small biovolume of the blooming species *P. calliantha*, the total biovolume did not differ from that of summer and September assemblages which were dominated by more voluminous cells, such as those of *Rhizosolenia* species. Although the February assemblage maintained relatively high species richness, mainly due to the contribution of dinoflagellate species, it was characterized by significantly lower evenness (J') and diversity (H') values compared to any other assemblage.

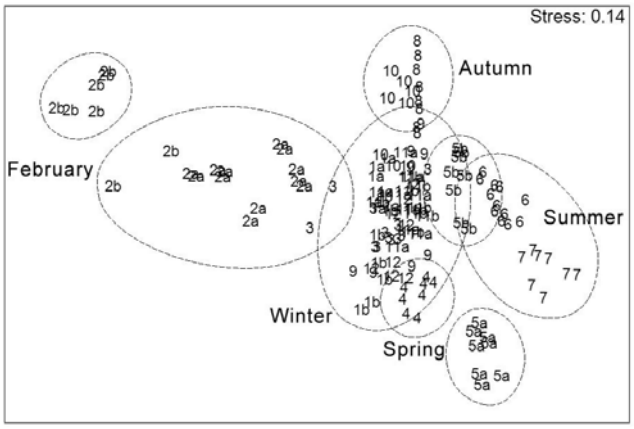

Fig. 1. Multidimensional scaling of the stations inside the gulf using the Bray-Curtis similarity index with 40% similarity contours.

The above results indicate that the winter bloom, initiated by high nutrient loading through surface runoff, presented a different phytoplankton assemblage structure than the natural blooms occurring in early summer and early autumn. The development of the early summer bloom as well as its decline was progressive evolving over a time period of more than one month. No apparent relation seemed to exist between available resources and the bloom initiation, apart from the increased light availability during summer. Conversely during the *P. calliantha* winter bloom which lasted for less than 20 days, there was a clear-cut connection between peak abundances and peak nutrient densities, and the bloom declined soon after the nutrients were exhausted. Finally, low values of biodiversity indices during the winter bloom suggest that a sudden heavy nutrient loading into the system may greatly destabilize phytoplankton community structure, however stability is rapidly regained as soon as nutrients are exhausted.

References

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