DYNAMICS OF A HAB DEVELOPED AFTER AN EPISODIC RAINFALL EVENT IN A COASTAL AREA

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Abstract

The mechanism of HAB formation and evolution in relationship to anthropogenic nutrient loading remains poorly understood despite their increasing occurrence in coastal waters around the globe. In the present study, the causes and mechanisms of the development of a HAB of the potential ASP toxin producer *Pseudonitzschia calliantha* and the confirmed PSP toxin producer *Alexandrium minutum* was studied. The event occurred in the Gulf of Kalloni in the Aegean Sea after a major rainfall event in winter. The spatial and temporal dynamics of the two HAB species were analyzed and associated to physicochemical parameters, supporting the view that a cause and effect relationship seems to exist between the HAB event and anthropogenic activities in the watershed. The indirect negative impacts of these activities on fisheries and local economy are also discussed.

Keywords : Toxic Blooms, Coastal Waters, Aegean Sea.

Nutrient inputs from terrestrial runoff have been strongly associated to the development of phytoplankton blooms as well as harmful algal blooms (HABs) in coastal waters [1]. Recurrent HAB events in the coastal zone can have serious impacts on public health and local economy. The need for meticulous monitoring of productive coastal areas is necessary in order to understand the causes and mechanisms of different HAB species development and distribution.

The Gulf of Kalloni is a semi-enclosed, highly productive, shallow water body, located at the south-western part of Lesvos Island (Greece) in the Aegean, with a surface area of 110 km^2. Fish and bivalves (mussels, scallops and clams) are being harvested and exported at the national and international market. According to the EU legislation, water and shellfish quality are being monitored on a regular basis since 2001 [2]. Agricultural activity in the watershed includes olive tree, cereal and vegetable cultivation. The main contributor of nitrogen salts is runoff from the agricultural land (59%), while for phosphorous salts are domestic sewage (59%), fertilizers (19%) and residual wastes of olive press industries (19%) [3].

In order to investigate the effect of terrestrial runoff from the surrounding watershed on the phytoplankton community composition and dynamics, a network of eight stations (5-12) was set up along a gradient formed by the river plume of Tsiknias, the most important freshwater input of the area. Two of them (stations 5 and 7) along with two control stations (1 & 2) in the open sea were sampled on a monthly basis from August 2004 to July 2005, in order to collect baseline information, whereas additional samples were collected from the gradient stations (5 to 12) during the rainfall period. Physical parameters, Chl α and nutrients were measured at 1 and 5 m depths. Phytoplankton species were identified, counted and measured following the Utermöhl method [4]. Phytoplankton biovolume was also calculated.

During February, a period of fertilizer application in the watershed, a major episodic rainfall event caused maximal river discharge in the gulf. At the same time nutrient (NO_3, NO_2, SiO_2, PO_4) concentrations were significantly higher than the usual background concentrations (ANOVA, $P<0.05$) (Fig. 1). Throughout the gulf area, the input of freshwater formed a surface layer of lower density, characterized by significantly higher nutrient concentrations and lower salinity and temperature than the bottom layer ($P<0.05$). This abrupt nutrient loading and the resulting stratification stimulated the development of a bloom of the potentially toxic diatom *P. calliantha* (max cell number of $10.6x10^6$cells l^{-1}) as well as the toxic dinoflagellate *A. minutum* (max cell number of $1.5x10^5$cells l^{-1}). The spatial distribution of *A. minutum* seemed to be related to the nutrient concentrations, since densities of this species were significantly higher in the surface layer ($P<0.05$) and close to the river mouth. However, the distribution of *P. calliantha* was more homogeneous. Both cell densities and nutrient concentrations were scarce at the outer part of the gulf. Nutrients as well as phytoplankton cell number retreated to background concentrations almost two weeks after the episodic event.

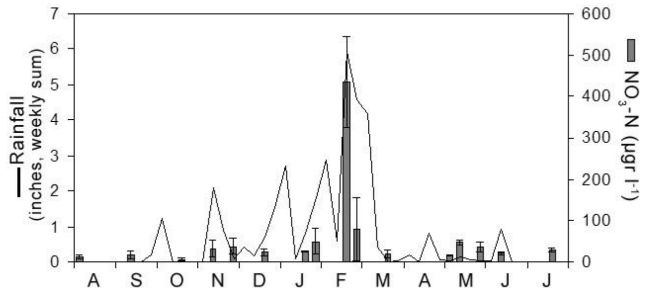

Fig. 1. Annual cycle of rainfall height and average nitrate concentrations along the river plume (stations 5-8).

The present study confirms earlier observations on the presence of the toxic dinoflagellate *Alexandrium minutum* [5] and the potentially toxic diatom *Pseudonitzschia calliantha* [6] in coastal areas with high nutrient loading. The mechanism of this recurrent bloom is attributed mainly to strong rainfall events occurring in winter (January or February), a period of fertilizer application in the watershed. The understanding of the mechanism of bloom formation not only supports the establishment of cause and effect relationships between HABs and anthropogenic activities in the coastal zone, but can additionally act as an early warning system protecting public health and local economies based on fisheries.

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