FUNCTIONAL DIVERSITY AND PHOTORESPONSES OF PHYTOPLANKTON COMMUNITY IN THE NORTH-WESTERN MEDITERRANEAN SEA DURING THE SPRING BLOOM 2003

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Abstract
The spring bloom evolution was investigated in 2003 in the North-Western Mediterranean Sea, using HPLC pigment analysis on fractionated samples (<3 mm and >3 μm) and flow cytometry. The physical and biological properties of the water mass were followed using a Lagrangian approach during 3 cruises of one week each. The onset of thermal stratification induced vertical group segregation, with cyanobacteria and prymnesiophytes at surface and green algae and diatoms at depth. The diatoms dominated larger phytoplankton during the initial phases, while also pico-sized diatoms were abundant during the peak phase of the bloom. Pigment cell content of picophytoplankton was estimated and lied in the range of values observed for another oligotrophic site of the Mediterranean Sea.
Keywords : Phytoplankton, Pigments, Blooms, Physiology.

The North-Western Mediterranean Sea is characterized by a recurrent, intense phytoplankton spring bloom, lasting more than two months and clearly visible by ocean color remote sensing. This area is characterized by a high variability in the hydrodynamics at micro- and meso-scale that is determining such elevated biological production.

During the spring 2003, two sampling cruises took place, with the aim of investigating phytoplankton dynamics as related to mesoscale physical structures. During the cruises, three Lagrangian experiments were conducted in the area interested by the algal bloom, two in March (between the 6 and 25, LExp-1 and 2) and the third one in April (18-24, LExp-3) 2003. These experiments, lasting one week each, were performed at different moments of the bloom succession and allowed to investigate phytoplankton dynamics at different time scales, from circadian to weekly. Also the vertical variability during the bloom was investigated. Light and hydrological profiles were also performed at high time frequency during the experiments and discrete samples were taken from two to five times per day at 5 depths (ranged between 2 to 70 meters) for HPLC pigment analysis on fractionated samples (<3 μm and >3 μm) and flow cytometry. The combination of size-fractionated pigment analysis and flow cytometry allowed to deeply investigate the acclimation status of this small cell size community to the environment, and to estimate their cellular pigment content. At the same time, on-board incubations on filter-fractionated samples taken at 10 meters depth were realized, in order to estimate the kinetics of photophysiological responses of the phytoplankton community (e.g. Brunet et al., 2003). The water column was mixed and no change of water mass physical properties was detected, except in April when an increase in temperature in the first 25 m marked the onset of thermal stratification.

Chla biomass ranged between 1 and 5 μg chla l^{-1} and the contribution of picoplankton was between 20 and 70 %, lowest during the LExp-2 and the highest during the LExp-3 (April), and generally dominated by green algae. The peak of the bloom was attained during the LExp-2 (late March). Diatoms dominated in the larger fraction, but were also abundant in the smaller, contrasting with what observed initially, when they contributed only to the larger phytoplankton. As related to the increasing stratification, biological segregation was visible within the picoplankton, with cyanophytes in the upper layer and picoeukaryotes at depth. In the nano- and micro-plankton (>3μm), Prymnesiophytes thrived at surface and diatoms at depth.

This distribution was probably due to the decrease in nutrient concentrations in the surface layer as well coupled with the increase in light and decrease in mixing. The increase in irradiance induced a significant higher photoprotection in the surface layer as marked by the increased diatoxanthin/chla ratio as well as by the de-epoxidation state of phytoplankton (DES, ratio the two components of the photoprotective xanthophyll cycle, diatoxanthin and diadinoxanthin). These indicators showed higher values in the larger size class than in the picophytoplankton, probably due to higher content of pigment per cell. The weak vertical gradient of cell chlorophyll fluorescence of *Synechococcus* observed by flow cytometry indicated low photoacclimation process along the water column, in relation with the beginning of the stratification during LExp-3. Also picoeukaryotes showed no clear signal of photoacclimation, probably due to species or group replacement, as confirmed by the large pigment diversity found in the smaller size fraction. Estimations of chla per cell of picoeukaryote ranged between 40 and 120 fg chla $cell^{-1}$, while the zeaxanthin content of *Synechococcus* cells was of 0.80 fg $cell^{-1}$, both being in the range of values estimated by Brunet et al. (2006) in the Strait of Sicily.

References

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