EFFECT OF DENSE WATERS ON THE DIVERSITY AND METABOLISM OF PLANKTONIC BACTERIA IN THE SOUTHERN ADRIATIC SEA

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Abstract

During winter, the northern Adriatic Sea is subjected to cold outbreaks, resulting in generation of cold and dense waters which sink and eventually move southward. This water mass contributes to ventilate deep waters in the Eastern Mediterranean Sea, and can potentially influence prokaryotic diversity and metabolism at large spatial scales. We collected water samples of dense bottom currents in the Southern Adriatic Sea in March 2012, and measured bacterioplankton diversity (using fingerprinting techniques and 16S rDNA pyrosequencing) and key functional variables of microbial metabolism (heterotrophic C production, respiration and degradation rates). Our results indicate that bacterial diversity and metabolism are influenced by the dense water passage, and this has important consequences for the ecosystem functioning of the entire area.

Keywords: South Adriatic Sea, Bacteria, Biodiversity, Deep waters

Planktonic microbes are key players in the fluxes of matter and energy in the sea [1], yet their diversity, distribution and functional response to episodic events (such as dense water inputs) are poorly known. Heterotrophic bacteria process about half of the net primary production and play a dominant role in the microbial carbon pump, by altering and transforming labile organic matter into refractory forms that persist in the ocean [2]. An uncoupling between prokaryotic-mediated production and degradation processes can have important consequences on the functioning, carbon sequestration and the ecological efficiency of marine ecosystems [3], especially in the warm Mediterranean Sea [4].

During the winter, the northern Adriatic Sea is typically subjected to intense cooling associated with dry and cold north-easternly (the Bora wind). The resulting water mass (Northern Adriatic Dense Water, NAdDW), cold and dense, sinks and flows southward [5], typically reaching the proximity of Bari in the early spring. NAdDW eventually mixes with other Adriatic water masses to form the Adriatic Deep Water (ADW), which contributes significantly to the ventilation of deep water in the whole Eastern Mediterranean [6]. This episodic event has the potential to influence prokaryotic diversity and metabolism at large spatial scales, with unpredictable effects which deserve in-depth investigations.

In spring 2012, we collected seawater samples along three transects in the Southern Adriatic Sea during the outflow of dense water generated after a severe cold spell occurred in early February 2012. Several stations were clearly sampling the veins of the dense water, with potential density anomaly as high as 29.7 Kg/m$^3$ and temperature as low as 10.5°C (Figure 1).

Fig. 1. Isochines of temperature along one of the sampled transects. Dots indicate the sampling depths and location.

We measured bacterial diversity and key functional variables of prokaryotic metabolism, including prokaryotic heterotrophic carbon production rates (using the 3H-leucine incorporation method), potential respiration rates (via the Electron Transport System assay) and organic matter degradation activities (aminopeptidase, β-glucosidase and alkaline phosphatase). Biodiversity was assessed by a combination of molecular fingerprinting (Automated Ribosomal Intergenic Spacer Analysis, ARISA) and 16S rDNA tag pyrosequencing. In sub-surficial layers, the specific water masses were identified basing on their distinct temperature-salinity characteristics and the oxygen content. The analysis of bottom waters indicated that NAdDW samples, when compared with LIW samples collected at similar depths, were characterized by higher abundance of prokaryotes, higher respiration and organic matter degradation rates, while the carbon production rates were apparently unaffected by the dense water passage. Significant differences in the community composition of deep bacterial assemblages were observed between NAdDW and the other water masses. Our results indicate that diversity and metabolism of bacterioplankton are influenced by the dense water passage, suggesting that this episodic event may have large-scale consequences for the ecosystem functioning and the biogeochemical cycles in the Southern Adriatic Sea.

References