BACTERIAL ACTIVITY IN THE SURFACE MICROLAYER OF THE OPEN MEDITERRANEAN SEA

Eva Sintes * and Gerhard J. Herndl

Department of Biological Oceanography, Royal Netherlands Institute of Sea Research, PO Box 59, NL-1790 AB Den Burg, The Netherlands - * esintes@nioz.nl, herndl@nioz.nl

Abstract

Diel dynamics in the activity and viability of bacterial cells were studied in the surface microlayer (SML) and the underlying water layer (UWL) of the open Mediterranean Sea, following a drifting buoy. Bacterial abundance was rather stable and only slightly higher in the SML as compared to the UWL. The cell-specific activity of bacteria was variable, however, and diel cycles of bacterial activity showed a decrease in the percentage of active cells and a slight increase in the percentage of cells with compromised cell membranes during the day, which might be related to UV-induced damage.

Keywords: Bacteria, sea surface microlayer, activity, viability

Introduction

The SML is a unique microenvironment characterized by the accumulation of dissolved and particulate inorganic and organic matter (1). Accumulation of organisms (2, 3) and enhanced enzymatic activities have been reported for these waters (4). Essentially all the information available thus far on the SML originates from studies conducted in coastal areas, lakes or ponds, but diel dynamics of the activity of organisms of the open sea SML are still lacking.

Material and Methods

To determine the diel dynamics of the microorganisms in the SML of open sea areas, we sampled the SML and the UWL waters over diel cycles, following a drifting buoy in the open Mediterranean Sea. The first sampling (29-30 Sept. 03) was characterized by a calm sea state and bright sunshine while the second diel cycle (4-5 Oct 03) was preceded by a day with wind force 7 and white caps, calming down overnight prior to sampling. We measured the abundance of bacteria by flow cytometry distinguishing high and low-DNA bacteria, CTC+ cells (highly active cells), and cells with compromised cell membranes. Bacterial production via ^{3}H-leucine uptake was measured as well, along with some basic chemical parameters (inorganic nutrients, dissolved organic carbon, DOC).

Results and Discussion

Bacterial abundance was rather stable, ranging between 2.97 and 4.29 x 10^5 cells ml^{-1} during the first sampling, and between 4.67 and 6.56 x 10^5 cells ml^{-1} during the second diel cycle, decreasing slightly around noon and being higher in the SML with one exception. The specific production of bacterial cells, calculated as the bacterial production per cell, was variable (Fig. 1), ranging from 0.20 to 5.99 fgC cell^{-1} d^{-1} with no clear diel pattern. Other factors related to the activity and viability of the microbial cells showed distinct diel dynamics. The percentage of high-DNA cells generally decreased during the day and increased over night (Fig. 2). The respiratory activity per CTC+ cell decreased around noon, while the percentage of cells with a compromised cell membrane increased concurrently.

The higher biomass of microorganisms in the SML, as found elsewhere (2, 3), was related to the higher nutrient and DOC concentrations. The decrease in bacterial activity around noon is most likely mediated by the damaging effect of UV radiation on bacteria (5) and/or photolysis of DOM (6) forming radicals.

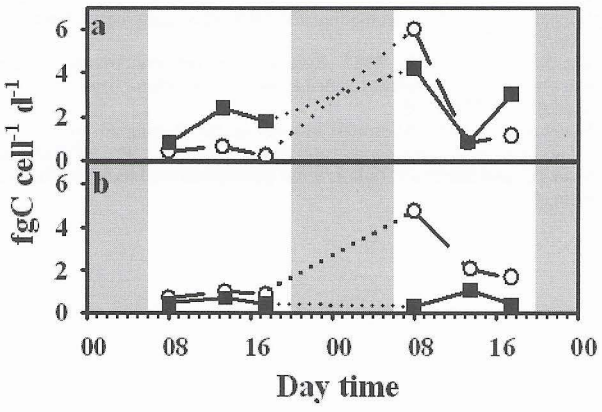

Fig. 1. Diel dynamics of the specific production of bacteria in the surface microlayer (circles) and the underlying water layer (squares) during (a) the first (29-30 Sept.) and (b) the second diel cycle (4-5 Oct.) of sampling.

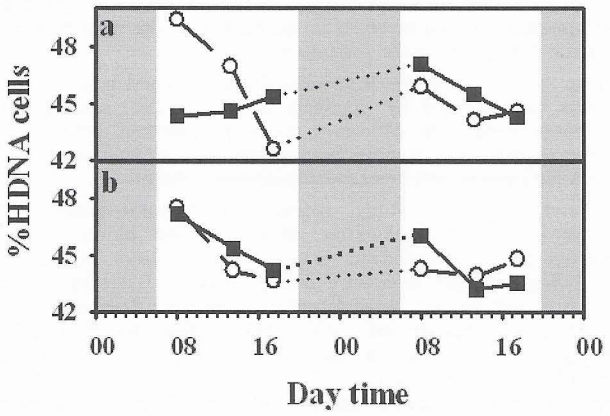

Fig. 2. Diel dynamics in the percentage of high-DNA cells. Legend as in Fig. 1.

Acknowledgements. ES was supported by a fellowship from "Sa Nostra", Illes Balears.

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