GROWTH AND MORTALITY RATES OF HIGH-DNA AND LOW-DNA-BACTERIA IN SURFACE AND DEEP CHLOROPHYLL MAXIMUM LAYERS

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Abstract
Protozoan grazing on marine heterotrophic bacteria was measured in summer 1999 in northwestern Mediterranean coastal waters. Serial dilution experiments were performed with water of the surface and deep chlorophyll maximum layer (DCM). Measured growth and grazing rates indicate that high-DNA-bacteria being the most active component of the bacterial community in the surface layer, not only with respect to production but also as a prey for grazers. However, this tendency was not observed in the DCM, insinuating profound differences between both habitats in structure and functioning of the respective bacterial populations and microbial networks.

Key words: microbial foodwebs, dilution experiments, flow cytometry

Introduction

Heterotrophic bacteria constitute a fundamental component in marine planktonic microbial foodwebs and in dynamics of marine carbon fluxes (1). Bacterial productivity and mortality are key parameters to understand their population dynamics and therefore, the role of bacteria in biogeochemical processes and ecosystem functioning. One approach to measure bacterial net growth and mortality by bacterivory is to modify the encounter rates between predator and prey applying the dilution method (2), which manipulates the microbial community as a whole. Flow cytometrical measurements combined with nuclear staining allow to obtain indications about the DNA content of bacterial populations (3). This parameter can give information about distinct assemblages and/or their physiological status. We combined both methods in order to measure growth and grazing rates for heterotrophic bacterial populations during a cruise along the northwestern Mediterranean coast (Catalunya, Spain). Our results provide new insights into the growth dynamics of bacterial populations and how they are affected by grazing in distinct habitats of the water column.

Material and methods

During the cruise ARO-2000 (May 30 - June 9, 2000) growth and grazing rates were determined with the seawater dilution method at stations situated in the frontal slope-edge-current. Eight experiments were done with water from the surface (5m) and four experiments with water from the DCM. Water was obtained by means of a modified 30 L Niskin® bottle. Temperature and light conditions were simulated on deck with a cooling system and a blue Plexiglas incubator.

High and low-DNA-bacteria were quantified flow-cytometrically after staining with DNA stain Syto 13 (Molecular Probes). Significance of differences of calculated growth and grazing rates between high and low-DNA-bacteria from the surface and DCM was tested with the t-test (4).

Results and discussion

A freshened surface current in the frontal zone extended to about 10 m, and sometimes 20 m, depth carrying water influenced by the Rhone river. Between 5 m and DCM depth, a temperature decrease of 5 to 6° C was measured. The DCM was located between 40 and 70 m and coincided with the lowest part of the thermocline. Chlorophyll fluorescence intensities were between 3 and 22 times higher in the DCM than in the surface layer.

Concentrations of total bacteria at the beginning of the experiments ranged between 0.8 and 2.5 10^6 ml^{-1} in the surface and between 1.2 and 1.7 10^6 ml^{-1} in the DCM. In the surface layer, proportions of high-DNA-bacteria to total bacterial concentrations varied between 34 and 55%. In the DCM, the high-DNA-bacteria proportions were slightly lower (39 to 47%).

Bacterial concentrations at the end of the experiments did not differ considerably from the ones at the beginning indicating a match between growth and grazing.

Intrinsic total bacterial growth rates ranged from 0.44 to 1.64 d^{-1} in the surface and from 0.49 to 1.19 d^{-1} in the DCM. Average grazing rates on the bacterial community ranged from 0.74 to 1.29 d^{-1} in the surface and from 0.32 to 1.02 d^{-1} in the DCM. Different rates were measured for high-DNA and low-DNA-bacteria populations. In the surface, average grazing and growth rates of high-DNA-bacteria were twice as high as those of low-DNA-bacteria. In the DCM, the opposing trend was apparent: average grazing rates on high-DNA-bacteria were about a third of the rates on low-DNA-bacteria and average intrinsic growth rates were about half.

Average grazing rates on high-DNA-bacteria were nearly four times higher in the surface than in the DCM and average intrinsic growth rates were nearly three times higher. Average grazing rates on low-DNA-bacteria and their growth rates were higher in the DCM compared to the surface, however, not significantly (Fig.1).

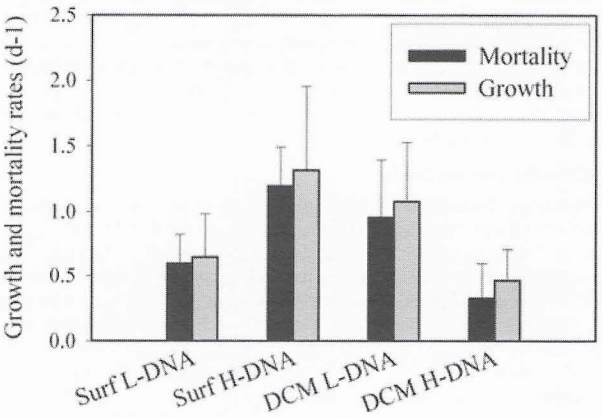

Fig. 1. Growth and mortality rates of high-DNA and low-DNA-bacteria in the surface and the DCM. Indicated are arithmetic means and one standard deviation.

A strong coupling between intrinsic growth and grazing rates was observed in both layers and in both bacterial fractions. As a result, bacterial concentrations and proportions between high-DNA and low-DNA-bacteria remained more or less the same.

Our observations provide evidence for the hypothesis that high-DNA-bacteria are the most active component of the bacterial community (5). Nevertheless this trend presented itself only in the surface layer, as in the DCM the opposing tendency was apparent. Besides the measured differences in bacterial growth and mortality rates, the properties of the different layers, coastal river-plume at the surface versus typical oceanic DCM, insinuate distinct phylogenetic affiliations of the bacterial populations and dissimilarities of the microbial foodwebs.

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