INFLUENCE OF SMALL INCREASES IN TEMPERATURE ON PLANKTONIC BACTERIAL CARBON USE IN THE BLANES BAY (COASTAL NW MEDITERRANEAN)

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Abstract
Bacterial production (BP) and respiration (BR) were measured seasonally in a Mediterranean coastal area (Blanes Bay) at two temperatures: ambient temperature (TA) and about two degrees above that temperature (T+2). Seawater samples were filtered through 0.8 µm to obtain a predator-free bacterioplankton assemblage and incubated for 48 hours at both temperatures. From production and respiration rates we derived bacterial growth efficiency (BGE). Production and respiration rates were positively affected by the increase in temperature, while BGE remained unchanged. Therefore, small increases of temperature might increase the amount of carbon passing through bacteria.

Keywords: Bacterial production. Bacterial respiration. Bacterial growth efficiency. Temperature.

Introduction

Due to human industrialization and deforestation the concentration of CO_2 has increased in the atmosphere [1], and this is expected to lead to an increase in Earth's average temperature of ~ 2.5 ºC in a century [2]. Temperature has an extremely important influence on biological processes such as bacterial production and respiration [3, 4]. As microbes are relevant actors in the transfer of carbon in aquatic ecosystems [5], there is an increasing interest in the effect of small temperature increases on microbial plankton [6]. The objective of this study is to test the effect of small increases in temperature (ca. 2ºC) on bacterial carbon use and growth efficiency in an oligotrophic coastal system (NW Mediterranean) and its implications for the planktonic carbon cycle.

Methodology

Experiments were done monthly (March-August 2003) with subsurface seawater collected from a fixed station in Blanes bay (41° 39' N, 2° 48' E), over 15 m depth and about half mile offshore. Seawater temperature was determined with a calibrated thermometer, and 25 liters were pre-filtered through 200 µm, placed on a carboy, and transported to the laboratory. The samples were then filtered through 0.8 µm (AAWP, Millipore), bacterial production rates determined by ^{3}H-Leucine uptake [8] and converted to bacterial carbon with a standard factor of 3.1 Kg C mol^{-1}. Filtered water was also distributed in 48 borosilicate glass bottles (ca. 130 ml), of which 8 were immediately fixed with Winkler reagents (t0). The remaining bottles were placed in two temperature-controlled chambers, set at ambient temperature (TA) and ~ 2 degrees above this temperature (T+2). At 24 and 48 hours we fixed the remaining 40 bottles, 10 each time for each temperature. Dissolved oxygen was determined with an automatic titrator based on potentiometric endpoint detection [7]. Respiration rates were obtained by linear regression of oxygen concentration vs. time, and were transformed to carbon units assuming a respiration quotient of 1. Bacterial carbon use is BP+BR and bacterial growth efficiency (BGE) is BP/(BP + BR) [9].

Results and discussion

Seawater temperature varied twelve degrees in Blanes bay, between 13 ºC in March and 25 ºC in August. Initial bacterial productions varied between 1.3 µg C l^{-1} d^{-1} in June and 150 µg C l^{-1} d^{-1} in July, increasing exponentially at 24 hours during the incubations and showing a clear shift-up in the T+2 samples (Fig. 1), The average increase of bacterial production ((BP_{TA} - BP_{T+2})/ BP_{TA}) was 36 (± 12) %. BP's at both temperatures were positively correlated, BP_{T+2} = 15.3 (± 20.3) + 1.1 (± 0.1) BP_{TA} (n = 18, r^2 = 0.8, p< 0.01). Respiration rates at ambient temperatures varied between 9.2 µg C l^{-1} d^{-1} in May and 102.1 µg C l^{-1} d^{-1} in March. The average increase of respiration rates at the higher temperature was 27 (± 11) %. Both respiration rates were significantly related, BR_{T+2} = 3.2 (± 2.7) + 1.1 (± 0.05) BR_{TA} (n = 18, r^2 = 0.99, p< 0.01). Finally, bacterial growth efficiencies varied between 4.7 and 95 %, , and were not influenced by the small increase in temperature, BGE_{T+2} = 4.5 (± 3.7) + 0.95 (± 0.05) BGE_{TA} (n = 18, r^2 = 0.95, p< 0.01). Adding the values up, it can be calculated that a small temperature increase could enhance bacterial carbon use by near a 60 %.

We obtained experimental data that agree with modeling studies in which small increases in temperature had a positive effect on bacterial production, respiration and carbon demand [3, 4], but no influence on BGE [9]. Therefore, small changes in temperature will have an effect on the microbial components of aquatic systems [6] significantly increasing the amount of carbon processed by bacteria.

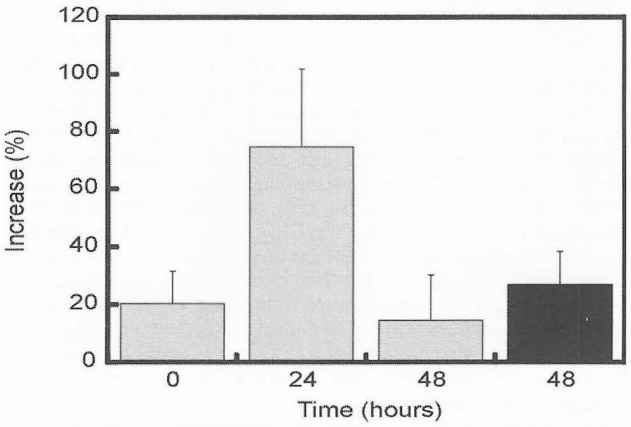

Fig. 1. Average increase in BP and BR at time 0, 24 and 48 hours (BP, gray columns) and during 48 hours (BR, black column).

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