

ISOTOPIC COMPOSITION OF NITROGEN IN SUSPENDED PARTICULATE MATTER OF THE ALBORAN SEA

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Abstract

The ¹⁵N content of the particulate organic nitrogen (PON) suspended in the water column was determined during 4 seasonal surveys carried out in the northwest sector of the Alboran Sea (Mediterranean Sea). On average, the particulate matter in the mixed layer (ML) was enriched in ¹⁵N by about 1.5‰ in fall and spring with respect to summer and winter. In spite of this seasonal cycle, ¹⁵N relative content of PON in ML was correlated negatively with nitrate concentration suggesting that the mass-dependent isotopic fractionation associated to nitrate uptake by the phytoplankton was the main factor controlling the ¹⁵N signature of PON.

Keywords: Alboran Sea, Carbon, Nutrients, Primary Production

Introduction

The ¹⁵N:¹⁴N ratio (usually expressed in per mil notation, $\delta^{15}\text{N}$) of the algal material is determined by the isotopic composition of the source nitrogen used by the phytoplankton (NO_3^- , NH_4^+ and N_2) and the fractionation associated to the assimilation processes (¹⁴N is preferentially taken up by the phytoplankton). The isotopic fractionation during NO_3^- uptake results in ¹⁵N depletion in the algal-N with respect to the source- NO_3^- . The cyanobacterial N_2 fixation also lowers the $\delta^{15}\text{N}$ of the algal material because of the lower $\delta^{15}\text{N}$ of the atmospheric N_2 (0‰). The reduced forms of N resulting of organic matter and their consumption deals with decrease of the $\delta^{15}\text{N}$ of the phytoplankton. In the study area, differences in f-ratio have been documented through the seasonal cycle [1]. The objective of this work is to research which process could be more important in determining the signature of ¹⁵N in the algal material of the study zone.

Materials and Methods

Hydrological data and seawater samples were collected in 6 stations located at the Alboran Sea, Western Mediterranean Sea, during four cruises performed in July-2003, October-2003, February-2004 and May-2004. Samples of seawater were collected at 6 fixed depths within the upper 100 m layer, in order to measure nutrients and chlorophyll a. Content of organic nitrogen (PON) and carbon (POC) and nitrogen stable isotope natural abundance in the organic matter lower than 0.2 mm were also measured by using a FlashEA1112 (ThermoFinnigan) elemental analyzer connected to a Deltaplus (ThermoFinnigan) continuous flow isotope-ratio mass spectrometer. The isotopic abundances in the samples were normalized by the isotopic abundance in the standard (atmospheric N_2) and expressed in per mil notation ($\delta^{15}\text{N}$).

Results

Most of the profiles of POC and PON showed a maximum located within the upper 20-30 m layer. Contrastingly, the POC and PON maximums were situated in the surface during spring. In this upper layer, the spatial variability of POC and PON was remarkable, particularly in summer when the variation ranges for POC and PON were 300-50 and 50-10 $\mu\text{g L}^{-1}$, respectively. The organic matter concentration tended to decrease below ML until to reach the lowest value at 75-100 m depth. POC and PON concentrations averaged for ML were significantly higher in summer and spring than in fall and winter. The relative abundance of ¹⁵N in the particulate matter collected throughout the study period ranged from -0.1‰ to 13‰. In most of profiles, $\delta^{15}\text{N}$ decreased just below the surface until to attain a minimum roughly coinciding with the lower limit of ML (Figure 1). Below this minimum, ¹⁵N increased usually reaching the higher values at 75-100 m depth. The variation range of $\delta^{15}\text{N}$ in ML was -0.1‰ to 6.5‰, with these low values being obtained in summer. On average, the particulate matter in this layer was enriched in ¹⁵N by about 1.5‰ in fall and spring with respect to summer and winter. The variability of $\delta^{15}\text{N}$ in ML was substantial during each survey, which was probably linked to the hydrological variability. In spite of that, $\delta^{15}\text{N}$ averaged for ML was negatively correlated with the nitrate concentration.

Discussion

The negative relationship between $\delta^{15}\text{N}$ of PON in the surface samples and nitrate concentration indicates that isotopic fractionation during N-uptake plays a major role in determining the $\delta^{15}\text{N}$ signature. The isotopic fractionation could also explain the vertical pattern of $\delta^{15}\text{N}$ of PON commonly observed in our study area, with values of $\delta^{15}\text{N}$ lowest at the base of the euphotic layer where NO_3^- is the highest, rising toward surface with decreasing NO_3^- . The lower values of $\delta^{15}\text{N}$ of PON were obtained in winter. Note that our data precludes the possibility of significant N_2 fixation. $\delta^{15}\text{N}$ values from -2‰ to 0‰ have been described for N_2 -fixer cyanobacteria. Most of the $\delta^{15}\text{N}$ values obtained in our study are above 2‰ and all the samples in which $\delta^{15}\text{N}$ was below this threshold were collected at stations where the NO_3^- concentration was relatively high (which inhibits the N_2 fixation).

Acknowledgements: This work has been funded by the Spanish Ministry of Science and Innovation (Projects NITROALBORAN CTM2006-00426 and TROFOALBORAN CTM2009-07776, co-funded from EU)

References

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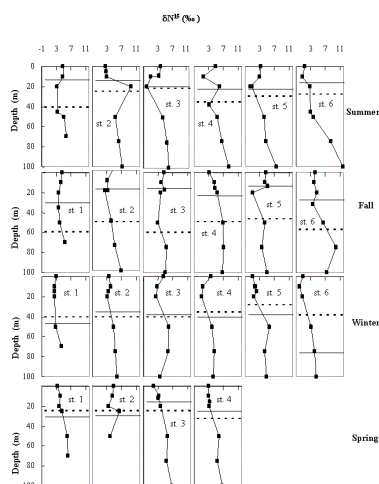


Fig. 1. Profiles of ¹⁵N:¹⁴N content of the organic matter at the sampling stations during the four seasonal surveys