Major shift in bacterioplankton utilization of enantiomeric amino acids between surface waters and the ocean's interior

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Limnol. Oceanogr., 48(2), 2003, 755-763 | DOI: 10.4319/lo.2003.48.2.0755

ABSTRACT: The peptidoglycan layer of the bacterioplankton cell wall contains four major amino acids (alanine, Ala; serine, Ser; aspartic acid, Asp; and glutamic acid, Glu) in a characteristic enantiomeric ratio (D/L ratio). It is assumed that bacterioplankton are the only biological source of significance for these four specific D-amino acid species in the ocean. The concentrations of these dissolved total enantiomeric amino acids were measured throughout the water column of the Faroe Shetland Channel (North Atlantic). Concurrently, the uptake of D- versus L-Asp and of L-leucine (as a measure of bacterial production) by bacterioplankton was determined. The D/L ratios of the dissolved total Ala, Asp, Glu, and Ser did not exhibit any particular trend with depth, averaging 0.49 for Ala, 0.42 for Asp, 0.15 for Glu, and 0.09 for Ser. The ratio of D-/L-Asp uptake by bacteria, however, increased from surface (D-/LAsp uptake ratio of ~0.03) to deeper layers reaching a D-/L-Asp uptake ratio of close to 1 at 1,000 m depth, indicating that mesopelagic bacteria utilize D-Asp almost as efficiently as L-Asp. Subsequent laboratory experiments with surface-water bacterioplankton assemblages incubated in nutrient-amended artificial seawater confirmed that bacterioplankton, in the absence of other utilizable organic carbon, efficiently utilize D-amino acids. In these laboratory experiments, the D-/L-Asp uptake ratio increased within 8 d to values similar to those obtained for mesopelagic bacteria. Furthermore, the presence of flagellates stimulated the uptake of D-Asp probably via enhanced release of D-amino acids during bacterivory. Thus, our results indicate that dissolved D-amino acids might be an important substrate for mesopelagic bacterioplankton. The efficient uptake of D-amino acids in the deeper layers of the ocean might indicate that mesopelagic bacterioplankton are utilizing bacterial cell wall-derived organic matter efficiently.