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Impact of aerosol inputs on oceanic ecosystem functioning: role of heterotrophic bacteria

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Aerosols are now recognised as a significant source of mineral nutrients to the oligotrophic ocean. The positive impact of this atmospheric input on autotrophic production has received a great scientific interest given its potential to generate new production and to increase C export. However, for significant C export to occur, the dust-derived nutrient input to the surface layer must escape heterotrophic bacteria uptake and subsequent C transfer through the microbial loop. Thus, it is crucial to understand the impact of dust pulses on heterotrophic bacterial activity in order to achieve an accurate comprehension of the connections between dust and ocean carbon cycling.

We have recently conducted several studies aiming to assess the bacterial response to dust pulses in an oligotrophic region, the western Mediterranean Sea. Three approaches have been followed: (1) an *in situ* study of a Saharan dust event, (2) dust additions to the bacterial natural assemblage in microcosms, and (3) dust additions to the whole natural assemblage in large mesocosms.

(1) During the stratification period of 2006, characterized by a nutrient depleted mixed layer isolated from the depth and P-limited phytoplankton and bacterioplankton communities, a Saharan dust event (2.6 g m^{-2}) delivered 75 μmol m^{-2} of phosphate. When diluted in the surface layer, this input could have theoretically increased phosphate concentration in 10 nmol L^{-1}, enough to relieve P-limitation of heterotrophic bacteria. Saharan dust induced a 1.5-fold increase in bacterial abundance and a 2-fold increase in bacterial respiration whereas no increase in phytoplankton biomass was

observed. (2) Microcosm dust additions (equivalent to fluxes of 5 and 20 g m^{-2}) to the bacterial natural assemblage performed in the same year and region also stimulated bacterial abundance (between 2- and 4-fold increases) and respiration (between 1.5- and 3-fold increases). Pooling the *in situ* and experimental data, linear relationships were obtained between dust concentration and bacterial abundance ($r^2 = 0.86$; $p < 0.01$) and respiration ($r^2 = 0.89$; $p < 0.001$). The dust-induced bacterial bloom resulted in a C mineralization of 0.5 g m^{-2}, which may represent up to 70% of bioavailable DOC annually exported to the depth in the Mediterranean. (3) Finally, a realistic dust addition (equivalent to a flux of dust of 7 g m^{-2}) in large mesocosms, performed within the pilot phase of the DUNE project in a pristine and oligotrophic coastal site, also resulted in an increase in bacterial abundance (1.7-fold) in the fertilized mesocosm relative to control conditions.

All these results demonstrate that heterotrophic bacteria may play a much larger role in the connections between dust and oceanic ecosystem functioning than previously recognized and highlight the need for a more accurate understanding of how dust pulses may affect biogeochemical cycles at the ocean-atmosphere interface.