Interactions between anthropogenic dissolved organic carbon and marine microorganisms

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Thousands of semi-volatile hydrophobic organic pollutants reach open oceans through atmospheric deposition and oceanic currents causing a chronic and ubiquitous pollution by anthropogenic dissolved organic carbon (ADOC). Microorganisms play a major role in the breakdown and mineralization of some ADOC compounds, allowing, at least, their partial elimination from seawater. Even though thousands of organic pollutants have been reported in seawater, large fractions of ADOC remain uncharacterized as part of the chromatographically unresolved complex mixtures (UCM). It is unknown most of the genes used to degrade ADOC compounds, neither under which conditions degradation occurs in the oceans. We performed field experiments in different oceans (Svalbard, Arctic and South Shetlands, Antarctica, Atlantic, Pacific and Indian Oceans, and NW Mediterranean). We challenged marine microbial communities from these contrasted environments with ADOC amounts obtained from the hydrophobic dissolved organic matter in seawater at oceanic relevant concentrations and analyzed the gene expression profiles through metatranscriptomics and other physiological approaches. Additional experiments were performed with specific families of pollutants such as organophosphate ester flame retardants and polycyclic aromatic hydrocarbons (PAHs). We taxonomically identified the main degraders and the main metabolisms involved in the responses to cope with ADOC, including the nutritive and the toxicological effects. In order to know if biodegradation is actually relevant in oceans at global scale, in addition to exposure field experiments, we performed an assessment of the large data set on hydrocarbons generated during the Malaspina expedition. These observations showed the relevance of microbial degradation depleting the bio available dissolved aromatic and aliphatic hydrocarbons. In agreement, degradation genes for hydrocarbons were found to be ubiquitous in the ocean. Our different approaches show that microorganisms are key players driving the fate of ADOC and simultaneously, ADOC substantially influence the functionality and structure of marine microbial communities.