EGU23-14893, updated on 21 Feb 2024
https://doi.org/10.5194/egusphere-egu23-14893
EGU General Assembly 2023

DOM accumulation in oligotrophic surface waters: new insights from the Mediterranean Sea

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Dissolved Organic Matter (DOM), the largest pools of reduced carbon on Earth, represents the major source of energy for micro-heterotrophs, starting the microbial loop. In the open ocean, most of the autochthonous DOM is labile and is therefore respired within days, but a small fraction, called recalcitrant, persists for years to millennia. There are large oligotrophic areas in the oceans, such as the North Atlantic subtropical gyre and the Mediterranean Sea, where the decoupling between production and consumption of DOM leads to its accumulation with implications for the microbial loop.

The main goal of this study is to investigate the putative functioning of the microbial loop all across the Mediterranean Sea following the main path of the Atlantic water entering through the Gibraltar Strait. Dissolved Organic Carbon (DOC) concentration and fluorescence of chromophoric DOM were measured together with heterotrophic prokaryotes, nanoflagellates and virus abundance by flow cytometry. Samples were collected during the MSM72 oceanographic cruise carried out in March-April 2018. Results show that in the western Mediterranean Sea the heterotrophic prokaryotes are relatively abundant and DOM is efficiently removed, suggesting an active transfer of carbon to the higher trophic levels. In contrast, in the eastern Mediterranean Sea DOM accumulates, prokaryote abundance is low and low nucleic acid prokaryotes dominates, suggesting a malfunctioning of the microbial loop leading to a less efficient carbon transfer to the food web. Following the core of the Atlantic Water flowing eastward, as the nutricline deepens, an ecological succession in the phytoplankton communities (from picoeukaryotes to cyanobacteria) is observed, together with a depletion of the fluorescent components in the DOM pool, reflecting changes in the DOM quality.

Different hypotheses can be formulated to explain these observations: the microbial communities could be limited by nutrient availability, by an enhanced top-down pressure by grazers or viruses or by the quality of DOM that could be recalcitrant due to abiotic processes such as photobleaching or to the progressive use of its labile fraction by micro-heterotrophs.

With the upcoming increase in water column stratification, a change in the quality of DOM due to the combined effect of abiotic (e.g., photobleaching) and biotic (e.g., change in the phytoplankton community) is expected with consequences for the functioning of the microbial loop. The questions about the malfunctioning of the microbial loop and its implications in a global change scenario have puzzled the scientists for years and the Mediterranean Sea is a well-suited natural laboratory to answer them.