In-situ, high-frequency assessment of phytoplankton functional groups and their ecology in diverse marine areas

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Abstract

Challenges ahead in phytoplankton ecology lie increasingly within the small scales, spatially and temporally, and how the diverse components of the community adapt to biotic and abiotic constraints. Despite advances made possible with new instrumentation, still little is known about the distribution of phytoplankton assemblages at the meso/submesoscale and at the diel scale. The work presented here aims at investigating phytoplankton functional groups at those scales, with a focus on their distribution and traits through time and space in different areas, and on the role of environmental factors in shaping these distribution patterns. For this purpose, a pulse-shape flow cytometer was used *in-situ* at high-frequency, either on-board vessels or at fixed sites, to sample ocean-to-coast gradients, and coastal areas. Besides estimating concentrations of the different functional groups, a relationship derived from cell scatter helped estimating the biomass represented by each of them, and their average cellular biomass. The total biomass of phytoplankton and the individual biomass of optically-defined groups varied significantly in relation to water masses and their properties. A refined trait-based approach was applied to qualify phytoplankton functional groups from optical features, and the diel variability of these optical features was explored. Traits were significantly correlated with several abiotic factors, mainly temperature and salinity. Multivariate ordination techniques were applied to cope with the amount of data handled and revealed patterns in phytoplankton distribution, significantly tied to hydrological features down to the submesoscale. A Cytometric Diversity Index was calculated per sample and appeared tied to water mass properties, which determined the abundance of each phytoplankton size-classes. Picophytoplankton was found to be most abundant in every location (Eastern North Atlantic, Western Mediterranean Sea, North Adriatic) and drove total phytoplankton abundance (*e.g.* accounting for 94.2 ± 4% in the Atlantic), while total biomass was driven by nanoeukaryotes (87 ± 6%) and occasionally by microeukaryotes (0% to 58%) and was tied both to environmental conditions and hydrological features.