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PHD PROGRAM IN MARINE SCIENCE, TECHNOLOGY AND MANAGEMENT

Cristina Fernández González
University of Vigo
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Orientation: Ocean Observation and Global Change
Specialization Area: Ocean Observation
Research Area: 1.4 Biological Oceanography

PhD project: Interactive effects of cell size, temperature and nutrient supply on resource allocation, metabolic rates and growth of marine phytoplankton.

Supervisors: Emilio Marañón Sainz

Summary: Phytoplankton are photosynthetic unicellular organisms that belong to 8 different phyla and span more than 9 orders of magnitude in cell volume. Through photosynthesis they control the carbon fluxes in the ocean where they are exposed to multiple and simultaneous environmental changes that can alter the metabolic activity of individual organisms with community and ecosystem implications. Temperature and nutrient supply are two major environmental drivers that control phytoplankton ecophysiology whereas cell size is a key functional trait that profoundly influences phytoplankton growth and community structure in the ocean. Based on metabolic theory of ecology and the ecological stoichiometry, this Thesis investigates the combined role of cell size, temperature and nutrient availability as determinants of phytoplankton physiology and ecology at different levels of biological organization. The results obtained show that the unimodal relationship between phytoplankton cell size and maximum growth rate persists irrespective of temperature and of the metric employed to quantify standing stocks. Growth rates calculated with chlorophyll *a* concentration, *in vivo* fluorescence or cellular abundance tend to overestimate the growth rate calculated with biomass. Temperature and nutrient supply are shown to interactively control resource allocation, photosynthetic strategy and metabolism of the cyanobacterium *Synechococcus*. A pattern observed as well in natural phytoplankton assemblages across the Atlantic Ocean. Furthermore, the stimulating effect of increasing temperature upon the metabolic rates of *Synechococcus* sp. takes place only under nutrient-replete conditions. In four microcosms experiments in the tropical and subtropical Atlantic, we found that the phytoplankton biomass consistently increased in response to nutrient addition, whereas changes in temperature had a smaller effect. The largest increase was measured in the least oligotrophic and warmest site, where we also found the highest cellular chlorophyll *a* content, an effect synergistically enhanced under combined warming and nutrient-enriched conditions. These results demonstrate the need to address the complexity of marine ecosystems by accounting for the interaction of several factors together and across multiple levels of biological organization.