Title: **Impact of nutrients availability on resources allocation and photosynthesis of marine dinoflagellates in view of climate changes** (SSD BIO/01)

Research project:

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This specific project is generally aimed at deciphering the molecular mechanisms regulating nutrient assimilation, photosynthesis, and the adaptations that occurred during the evolution of diverse groups of algae. In INPHOMARE, 3 research units from Università Politecnica delle Marche (UNIVPM), Università di Bologna (UNIBO), and Università di Padova (UNIPD) will cooperate to deepen our understanding of the physiological and molecular mechanisms of nutrient uptake, assimilation and resources allocation in marine microalgae.

Activity plan:

The candidate will work within the Algal Biology research group (AlgoLab) of the Department of Biological, Geological and Environmental Sciences (BiGeA), in Ravenna campus, under the supervision of Dr. Laura Pezzolesi.
The objective of this research grant is to contribute to the study of marine microalgae, in particular dinoflagellates to unravel how species-specific adaptations in resource assimilation and allocation contribute to shaping dominant phytoplankton communities as a function of environmental variations.
Photosynthetic organisms use sunlight, carbon dioxide, water, and mineral nutrients to produce biomass and molecular oxygen, also supporting the growth of heterotrophic organisms through the food web. Microalgae are responsible for about half of global C fixation and enclose an exceptionally variegated group of species, characterized by both phylogenetic and metabolic diversity, which is a precious source of biodiversity both for ecophysiological studies and biotechnological applications.
Microalgae growth and productivity are continuously challenged by perturbations in the physico-chemical parameters of their habitat, like light intensity, nutrient chemical form and concentration, and temperature. Thus, changes in microalgae distribution and abundance have been predicted also due to climate change. In marine environments, light intensity and quality, nutrients chemical form and concentration, pH and temperature show significant temporal and spatial variability with a major impact on the growth of planktonic and benthic microalgae, and consequently of all other marine organisms. Particularly in coastal ecosystems, a general increase in algal bloom frequency and intensity has been attributed to eutrophication and further increases have been predicted due to climate change. Optimal growth conditions (i.e., temperature, salinity, light) may vary among bloom-forming algal species. Intensive blooms of nontoxic microalgae often result in bottom-water hypoxia being potentially fatal to sessile macrofauna. Conversely, toxins produced by some harmful dinoflagellates may be detrimental to marine species, including fish, birds, marine mammals, and even humans.

As for nutrients, proteins are the major sink for cellular N, and also harbor the S-containing aminoacids Cys and Met. Cell N content positively affects photosynthesis, which is partly related to N signalling and N partitioning in photosynthetic enzymes, pigment biosynthesis, and the size, number, and composition of photosynthetic membranes. Similarly, S plays multiple structural and functional roles in the cell, including photosynthesis. S-containing metabolites in marine microalgal cells also include dimethylsulfoniopropionate (DMSP). DMSP contributes to about half of the natural flux of S into the atmosphere through its breakdown product dimethylsulfide (DMS). In the atmosphere, DMS oxidation creates aerosols acting as cloud condensation nuclei, which in turn increases sunlight reflection due to cloud albedo, decreasing temperature on Earth. Dinoflagellates are among the major DMSP producers in the oceans, with a concentration of up to 3.4M. Dissecting how environmental variations and occurring/forecasted climate changes affect microalgal DMSP production is of utmost relevance in the context of global warming. Further, DMSP could act as an osmolyte in algal cells, while DMS is an important infochemical involved in microbial predator–prey interactions either as an algal chemical defense or as an eat-me signal for grazers, raising questions regarding its role in trophic dynamics of dominant bloom-forming dinoflagellates.
The Candidate will focus on Nitrogen and Sulfur assimilation metabolism and on the characterization of photosynthesis, the primary energy source for photosynthetic cells, by challenging selected microalgae with nutrient limitation, and various light intensities and by mimicking temperature variations due to climate change.
The Candidate, in particular, will: i) evaluate how future global warming, together with nutrient availability, may affect the dinoflagellate bloom dynamic, with a focus on a small-size species producing high biomass and toxic benthic species; ii) study the photosynthetic response to increasing temperatures in dinoflagellates; iii) investigate the effect of temperature increase on sulfur metabolism, considering the influence on DMS and DMSP production, which can act as cloud condensation nuclei, during algal growth; iv) highlight the implications of DMS/P production in sulfur cell metabolism.

The project will consist of:

- Literature review on the N and S metabolism in microalgae with a focus on dinoflagellates and the effect of climate changes
- Cultivation of microalgal, in particular bloom-forming dinoflagellates, under different nutrient (i.e., N, S) and temperature conditions to understand how future global warming, together with nutrient availability, may affect dinoflagellate bloom dynamic
- Investigation of the effect of temperature increase on sulfur metabolism, highlighting the implications of DMS/P production in sulfur cell metabolism
- Activities of dissemination and communication related to the project
- Final report

Required Skills:
Applicants should:

- Proven experience in the field of microalgal and/or cyanobacterial cultivation
- Proven experience in microalgal or cyanobacterial strains' isolation, nutrient analysis, monoalgal culture preparation
- Proven experience in the extraction and characterization of algal biomass through spectrophotometric or chemical analyses (e.g. CHN, Ion Chromatography, GC/MS)

- Proven experience in writing scientific reports or articles
- Good knowledge of spoken and written English