High-frequency automated imaging to capture phytoplankton morpho-functional traits

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Abstract

Phytoplankton diversity is a main descriptor of the ecological status of marine ecosystems. Its assessment is fundamental in monitoring programs aimed at understanding how marine systems respond to environmental changes. Traditionally, plankton diversity is assessed through cell counting in microscopy, but this is time-consuming and requires broad taxonomic expertise. High-throughput methods such as DNA metabarcoding and imaging flow cytometry are gradually integrating microscopy routine analysis for a rapid characterization of plankton communities.

All these methods are implemented at the Long-Term Ecological Research site in the Gulf of Naples, where SZN staff studies plankton diversity and dynamics (LTER-MC and NEREA Observatory). Environmental data gathering and modelling concur to integrate the collected biodiversity data into a spatiotemporal framework. Since recently, an Imaging FlowCytoBot (IFCB) has been implemented, enabling automated imaging, and identification and processing of thousands of images from live plankton. The main aim of the proposed PhD project is to apply a trait-based approach, exploiting the IFCB's images to measure morpho-functional traits (size, shape, chain-forms), and to compare results with environmental factors, cell counts and metabarcode data. Lab experiments on cultured strains have uncovered remarkable morphological responses of phytoplankton organisms to environmental conditions. Do these occur likewise in situ? This question can be pursued interdisciplinary at SZN because the LTERs provide the contextual data needed to enable comparison with results of the trait-based analyses.

The classification of the IFCB images using trait-based criteria represents an original way of gathering ecological relevant data on plankton community. Occurrence patterns of different morpho-functional groups, as well as changes in morpho-functional traits in response to changing environmental pressures will contribute to our understanding of costs, benefits, and evolutionary constraints of these traits. Results enable predicting effects of climate change on the structure and functioning of the phytoplankton.

The project will deliver elements towards development of standards for phytoplankton diversity assessment, including morpho-functional groups as indicators of environmental status. Results will integrate classical and molecular assessments of plankton diversity, thus contributing to the design of more effective marine observatories. The IFCB is also a marvellous tool for outreach activities, showing the diversity and beauty of planktonic organisms. Last but not least, the project will deliver a young expert in phytoplankton diversity who has acquired all the practical and state-of-the-art skills to pursue a successful research career.