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Molecular controls in the life cycles of marine centric diatoms

Traditionally phytoplankton have been looked at as an ensemble of organisms drifting in the water column and mostly regulated by light and nutrients availability. However, there is growing evidence that unicellular organisms can actively make choices based on endogenous controls, e.g., diel cycles, formation of resting stages, mating. Diatoms are photosynthetic unicellular eukaryotes responsible for 20% of the global carbon fixation and present in all aquatic habitats, often dominant in marine communities.
In centric diatoms, the same clone can self-fertilize, like in many plants. Diatom cells reduce their size at each mitotic division and only cells under a given cell size can reproduce sexually.
We know very little of the molecular mechanisms governing life cycles and size perception.
This project will address three main questions: I) what is the genetic program underlying the cell choice to divide vegetatively, progress towards an egg, or a sperm, or a dormant spore in a population of apparently identical cells? II) Which environmental triggers influence these choices and how? III) How do cells tell their size and know when they are small enough to mate?
The candidate will learn to identify and isolate diatoms, will define the environmental triggers for sexual reproduction and will characterize the sexual phase progression. They will then use single-cell transcriptomics for the definition of the genetic program underlying life cycle transitions and will apply advanced 3D microscopy to follow cell morphology changes in parallel. Finally, meta-omics data from oceanic expeditions (TREC, Nerea) will be mined for the estimation of sex events in natural environments and correlation with environmental parameters. The project foresees the use of innovative methodologies for phytoplankton research, such as scRNA-seq and expansion microscopy. Expected outcomes include the definition of gene networks and morphology changes involved in the transition towards specific cell types, of the genetic program for sex competence, and of the relative importance of endogenous signaling and external cues. Finally, the combination of lab data with *in situ* data will contribute to place single organisms' information in the context of ecosystems, allowing to generalize concepts on cell function and integrate them with mechanisms at sea.