Exposure of microalgae to heavy metals: effects of growth, bioremediation strategies and identification of new methods to identify physiological damages

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Project Summary

Phytoremediation of heavy metals (HMs) is based on the employment of photosynthetic microorganisms to sequester these pollutants through adsorption and/or active transport from aquatic environments.

Microalgae could be considered as suitable candidates for metal depletion from seawater and sediments, since they are able to immobilize metals onto their cell wall, with a variety of mechanisms, including passive adsorption on cell wall polymers, and, in healthy cells, accumulation by active transport in the cytosol or inside chloroplasts, mitochondria, and vacuoles.

The project is aimed at evaluating resilience and/or detrimental effects of heavy metals on microalgae, and using these photosynthetic organisms as biosensors for HM detection. Effects of HM on algal cells and organelles will be also evaluated with: cell counts, biomass estimation, transcriptome sequencing to find additional genes involved in heavy metal uptake and detoxification. Furthermore, an innovative technique will be employed: the in-flow tomographic phase microscopy (TPM), a label-free and interferometric imaging technique able to provide a 3D rendering of biological samples and to reveal cell and chloroplast impairments in damaged microalgae.

Microalgae will be also tested to evaluate their efficiency in HM removal in depuration devices. They will be embedded in synthetic or natural substrates in order to create a prototype for in situ HM bioremediation.

Differently from the already existing depuration systems for HM removal, characterized by freshwater and/or dead cells trapped in solid or semi-solid matrixes, our intention is to develop a prototype with healthy seawater species or consortia of species. The choice of employing living microorganisms limits risks related to HM release in the environment after an initial phase of adsorption on microalgal cell walls. Besides, autochthonous algae, isolated from samples of the Gulf of Naples, will be preferred to avoid ecosystem contamination by allochthonous species.

In summary, the main purposes of the project are: 1) to assess the impact of heavy metals on cell morphology through tomographic phase microscopy; 2) to evaluate the impact of heavy metals on microalgal metabolism via RNA extraction followed by quantitative PCR of targeted genes (e. g. phytochelatin synthases); 3) to evaluate species-specific thresholds of tolerance to the most widespread heavy metals in aquatic environments; 4) to create an environmentally-sustainable device based on marine microalgae to remove metals from seawater.