Enhancement of carotenoid biosynthesis and antioxidant responses in microalgae by light modulation

Arianna Smerilli

Doctor of Philosophy in Life and Biomolecular Science

Director of Studies

Dr Christophe Brunet

Stazione Zoologica Anton Dohrn

Naples, Italy

External Supervisor

Prof Alexander Ruban

Queen Mary University

London, UK

September 2017

The Open University

ABSTRACT

The ecological success of diatoms is mostly attributed to their ability to adjust biological performances to the variable environmental conditions they experience in the water column. While the efficient photoacclimative and photoprotective mechanisms in diatoms are already reported, the involvement of the antioxidant network in lowering or repairing light stress or damage is poorly understood.

My thesis consists of the concomitant investigation of the photoprotective and antioxidant network functioning in the coastal diatom *Skeletonema marinoi*, and during an experiment at sea in the Gulf of Naples. The aims of my work are to explore the antioxidant network in diatoms to better understand its activation in coping with light variation, and the functional link between antioxidant molecules synthesis/activity and photoprotection.

Results showed the spectral light dependent activity of antioxidant enzymes such as ascorbate peroxidase, catalase, and superoxide dismutase. They act in complementarity of the antioxidant molecules synthesis. A high concentration of ascorbic acid, phenolics compounds and among them flavonoids were found in diatoms. These molecules respond to light variations in terms of spectral composition, photon flux density, daily light dose, light shape distribution and photoperiod duration. Also, in a natural microalgal community, these molecules were found at high concentration following a dynamics that relied on light, nutrient stress and photosynthetic regulation.

The photoprotective xanthophyll cycle, involving the pigments diatoxanthin and diadinoxanthin, is activated by light and modulated in concordance with antioxidant molecules synthesis. Indeed, under different light climates, a link between these two defense processes was found. I also show that the xanthophyll cycle pigments have a high antioxidant activity. This feature explains why they increase together with antioxidant molecules during cell senescence. More generally, the physiological state of the cells modulates the antioxidant and photoprotective network in diatoms.