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Influence of Structural Colour in Molecular Mechanism of Photosynthetic Light Harvesting in Chondrus Crispus

Ariel García Fleitas[a,b], Samim Sardar[b], Cosimo D´Andrea[a,b], Margot Minju[c], Juliet Broadie[c], Guglielmo Lanzani[a,b]

[a]*Politecnico di Milano, Piazza Leonardo da Vinci, 32, 20133, Milano, Italy*
[b]*Instituto Italiano di Tecnologia, Center for Nano Science and Technology, Via Pascoli, 70/3, 20133, Milano, Italy*
[c]*Natural History Museum Cromwell Road London SW7 5BD*
ariel.garcia@iit.it

Chondrus Crispus, red macroalgae, exhibits photonic structures in the isomorphic state gametophyte and are absent in the tetrasporophyte state of its lifecycle.[1] This structural coloration (SC) produced a maximum reflectivity of around 400 nm protecting the algae against the more energetic light of the solar spectrum at sea level. Furthermore, the external antenna in this organism is composed of phycobilisomes (PB), three kinds of proteins with a very efficient energy transfer chain.[2] Here, we have investigated the influence of SC in the molecular mechanism of photosynthesis in Chondrus crispus using time-resolved photoluminescence (TRPL) studies. We found that the lifetime of the pigments PE, PC and APC increases with increase in excitation intensity and the increment saturates toward the higher intensities. This observation can be attributed to the intensity dependent photoprotection mechanism present in Chondrus crispus. In case of Chl, the fluorescence lifetime increases slightly with the increase of the intensity which can be explained in terms of the probability of finding the RC closed and unable to accept the energy. Thus the Chl is not being quenched by the special pair and consequently, increase in fluorescence lifetime of Chl is observed. In order to compare the intensity dependent lifetime of the pigments in tetrasporophyte and gametophyte, the excitation intensity at 400 nm needs to be normalized by taking into account of the fact that SC in gametophyte reflects in the same region. The similarity of the traces after intensity normalization considering the SC, confirm the role of SC in gametophyte in attenuating the photon flux reaching the photosynthetic organisms. We have further investigated the excitation energy transfer processes in detail on gametophyte upon excitation at 400 nm, 480 nm and 585 nm. These results show that a light management mechanism is present in the external antenna of the red algae associated with longer dynamics where the pigments have a higher probability of decay instead of transferring to the next one. Therefore, it can be inferred that the SC on gametophyte tip helps in reducing the number of photons absorbed directly by the Chl and favouring the EET through the external antenna.

OR9

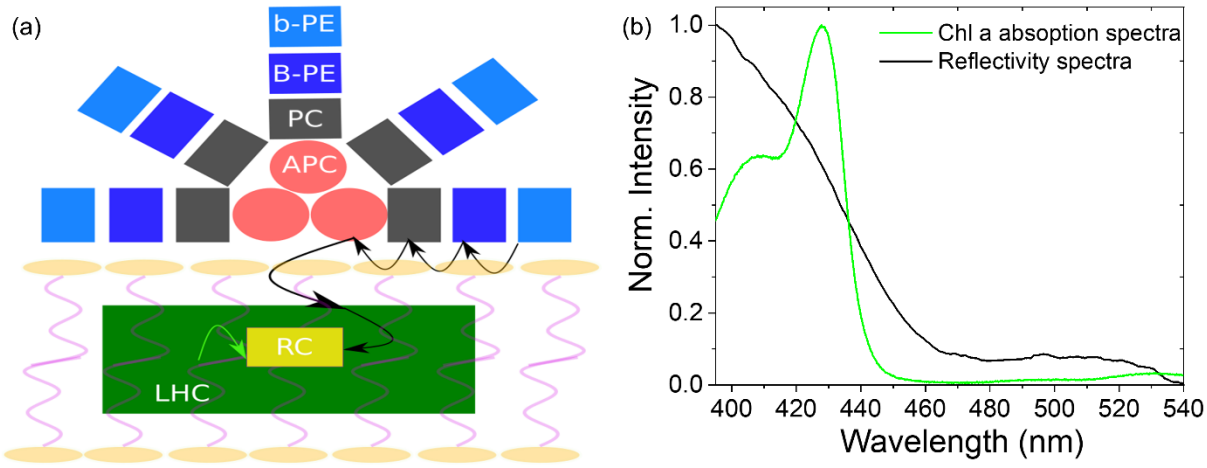

Figure 1: a) Schematic representation of the antenna systems and principal energy transfer pathways in Chondrus Crispus, b) overlap of the Chl absorption spectrum and the reflectivity spectra of Chondrus Crispus in presence of structural coloration.

References

1. Chandler, C. J., Wilts, B. D., Brodie, J. & Vignolini, S. Structural Color in Marine Algae. *Adv. Opt. Mater.* **5**, (2017).

2. Xie, M. *et al.* Difference in light use strategy in red alga between Griffithsia pacifica and Porphyridium purpureum. *Sci. Rep.* **11**, (2021).