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Chlorophyll detoxification catabolism associated with protistan phycophagy and evolution of phototrophic symbiosis

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Chlorophylls are highly phototoxic and thus potentially problematic during their biosynthesis, organization, and degradative processes [1]. We have recently reported that metabolic conversion of chlorophyll to 13^2,17^3-cyclopheophorbide enol (”cyclo-enol”) is a major detoxification mechanism for phycophagic protists (i.e., unicellular eukaryotes feeding on algae).[2] Significantly, a cyclo-enol is completely non-fluorescent and proven to be non-photosensitive in spite of their intact cyclic tetrapyrrole structure exhibiting green color in a solution. We cultured a series of phycophagic protists feeding on uniclonal algae and identified cyclo-enols as a sole major chlorophyll derivative presenting in extracts of the cultures. In addition, we demonstrated in microscopic observations of phycotrophic protists a quick disappearance of the autofluorescence of chlorophylls in the chloroplasts of ingested algae in an early stage of their digestion in phagocytosis, suggesting very rapid and nonradiative quenching of the presumable chlorophyll degradative product therein. We also infer that the cyclo-enol catabolism would be significant for the evolutions of algae that possess chloroplasts originating in secondary symbionts.

References
[1] Scheer, H. Proc. Natl. Acad. Sci. USA 2012. 109, 17311.
[2] Kashiyama, Y.; Yokoyama, A. et al. Proc. Natl. Acad. Sci. USA 2012. 109, 17328.

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