Physiological steady state of phytoplankton in the field? An example based on pigment profile of Emiliania huxleyi (Haptophyta) during a light shift

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ABSTRACT: A calcifying strain of *Emiliania huxleyi* was used to study the photoacclimation process during a shift from low (LL) to high (HL) photon flux density (PFD) under nutrient-replete and pH- and [CO_2]-controlled continuous cultures. Physiological steady states were obtained after culturing the alga in each PFD for more than a month, and pigment profiles and cell volume changes were monitored for 25 d after the light shift. Fucoxanthin was the major carotenoid in LL, while under HL this role was assumed by 19'hexanoyloxyfucoxanthin (19Hex). The photoprotective pigments diadinoxanthin and diatoxanthin (Dd+Dt), normalized to chlorophyll *a* (Chl *a*), increased with increasing PFD, while Chl *a* content per cell and Chl *c*s and fucoxanthin, normalized to Chl *a*, decreased with increasing PFD. The sum of all carotenoids normalized to Chl *a* and the 19Hex+Fuco : Chl *c* ratio were remarkably constant from LL to HL conditions. The results confirm that the total amount of carotenoids was synthesized/catabolized in tandem with Chl *a* to a genetically predefined level independent of PFD. When normalized to a per cell basis, Chl *a* content reached the long-term HL steady state after 17-20 d, while Chl *c*, Fuco, and Dd+Dt, normalized to Chl *a*, reached the long-term HL steady state after 5-7 d. Growth rate adjustment was completed within 3 d after the transition to HL. When Chl *a* was normalized to cellular volume, the transition to a fully acclimated HL state was complete within 3 d. The results highlight the need for the critical evaluation of the normalization "currency" (i.e., cell number, volume, Chl *a*) to which mass is expressed during the photoacclimation process and suggest that natural phytoplankton populations are unlikely to ever be in true physiological steady state.