

Investigating eco-physiological roles of extracellular superoxide production by *Emiliana huxleyi*

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In marine waters, ubiquitous reactive oxygen species (ROS) drive biogeochemical cycling of metals and carbon. Marine plankton, in which ROS are conventionally thought to accumulate as a result of oxidative stress, can be a dominant source of these ROS in nature. However, model plankton species generate abundant extracellular ROS even under ideal growth conditions in the absence of any obvious stressors. Thus, the eco-physiological role of extracellular ROS production remains mysterious. Here, we report the first extracellular production rates of superoxide (O_2^-) by the model phytoplankton species, *Emiliana huxleyi*, while exploring potential functions of O_2^- in growth, morphology, and photo-physiology of this cosmopolitan phototroph. O_2^- production was highest under low-stress conditions of active growth and inversely related to cell density, consistent with a signalling role. Yet removal of O_2^- through addition of the superoxide-scavenger superoxide dismutase (SOD) was beneficial for growth, biovolume, and photosynthetic health. Furthermore, quenching of extracellular O_2^- production was observed in the dark, suggesting a connection with intracellular photosynthetic processes, photoacclimation physiology, and redox homeostasis, which may explain these paradoxical dynamics. Overall, these results suggest that O_2^- production by marine phytoplankton, and coupled transformations of carbon and metals, may respond dramatically to shifting light regimes predicted to occur within warmer, more stratified oceans expected in the future.