REANALYSIS OF THE OXIDATIVE STRESS PARADIGM OF CORAL BLEACHING: THE EFFECTS OF NITRIC OXIDE

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Review

Chapter 1: Roles of oxidants in coral bleaching

Summary

Coral bleaching occurs when zooxanthellae (symbiotic algae) are expelled from the host, photosynthetic pigments are lost, or the coral gastrodermal cells are sloughed off with the zooxanthellae inside. Although bleaching events have been increasing in frequency and severity, significant variation is seen between and within conspecific corals, calling the generality of proposed bleaching mechanisms into question. Increasing evidence suggests that high light regimes, and/or elevated temperature lead to the production of reactive oxygen species (ROS), such as hydrogen peroxide (H_2O_2), hydroxyl radicals (OH) and superoxide (O_2^-). Increasing temperatures speed up the electron transport rate of the algal chloroplast, as well as of the mitochondria within both the host and symbiont, also increasing the generation of superoxide. If the amount of ROS formed is greater than the anti-oxidant capacity within the holobiont, the partnership will become oxidatively stressed. Oxidants also include reactive nitrogen species (RNS), including nitric oxide, (NO), and peroxynitrite, (ONOO). NO is an intra- and inter-cellular gaseous signaling molecule, with the ability to move freely across membranes, and promote a wide variety of physiological actions in plants and animals. NO's diverse array of reactions include direct bonding with oxidants ($NO+O_2=ONOO-$), and the alteration of protein and enzymatic function by reacting with cysteine residues (S-nitrosylation), tyrosine residues (nitration) or transition metal containing proteins (heme groups). Laboratory and field measurements suggest that under elevated temperatures NO production increases within zooxanthellae, and is visualized in host cells containing symbionts. Also, the addition of exogenous NO has the ability to promote bleaching. Given the ubiquitous nature of oxidants, and the huge number of potential NO interactions, there is much to be learned about the molecular basis governing the maintenance and breakdown of coral-algal symbioses.

Keywords: reactive oxygen species, reactive nitrogen species, superoxide, nitric oxide, hydrogen peroxide, coral bleaching, coral-algal symbiosis