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A Review Investigating the Potential Of Zooxanthellae to Be Genetically Engineered to Combat Coral Bleaching

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Abstract : Coral reefs are of the most diverse and productive ecosystems on the planet, but due to the impact of climate change, these infrastructures are dying off primarily through coral bleaching. Coral bleaching can be described as the process by which zooxanthellae (algal endosymbionts) are expelled from the gastrodermal cavity of the respective coral host, causing increased coral whitening. The general consensus is that mass coral bleaching is due to the dysfunction of photosynthetic processes in the zooxanthellae as a result of the combined action of elevated temperature and light-stress. The question then is, do zooxanthellae have the potential to play a key role in the future of coral reef restoration through genetic engineering? The aim of this study is firstly to review the different zooxanthellae taxa and their traits with respect to environmental stress, and secondly, to review the information available on the protective mechanisms present in zooxanthellae cells when experiencing temperature fluctuations, specifically concentrating on heat shock proteins and the antioxidant stress response of zooxanthellae. The eight clades (A-H) previously recognized were redefined into seven genera. Different zooxanthellae taxa exhibit different traits, such as their photosynthetic stress responses to light and temperature. Zooxanthellae have the ability to determine the amount and type of heat shock proteins (hsps) present during a heat response. The zooxanthellae can regulate both the host's respective hsps as well as their own. Hsps, generally found in genotype C3 zooxanthellae, such as Hsp70 and Hsp90, contribute to the thermal stress response of the respective coral host. Antioxidant activity found both within exposed coral tissue, and the zooxanthellae cells can prevent coral hosts from expelling their endosymbionts. The up-regulation of gene expression, which may mitigate thermal stress induction of any of the physiological aspects discussed, can ensure stable coral-zooxanthellae symbiosis in the future. It presents a viable alternative strategy to preserve reefs amidst climate change. In conclusion, despite their unusual molecular design, genetic engineering poses as a useful tool in understanding and manipulating variables and systems within zooxanthellae and therefore presents a solution that can ensure stable coral-zooxanthellae symbiosis in the future.

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