# MASTER'S THESIS

## Physiological and Molecular Responses of the Massive Coral Dipsastraea rotumana to Heat and Hypo-saline Stresses

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# Abstract

Coral reefs around the world have declined due to their exposure to global and regional stressors. However, corals of different growth forms differ in their sensitivity to stressors. Most previous studies of coral responses to stressors have used branching corals as the experimental models, while corals of massive growth form have received very little attention because they are in general considered to be more tolerant to environmental stressors. The objective of my MPhil thesis was to study the effects of high temperature and low salinity on the massive scleractinian coral *Dipsastraea rotumana* in the northern South China Sea, as these two environmental stressors have been known to cause coral bleaching in subtropical regions in recent years. The coral fragments were exposed to either high temperature or low salinity in the laboratory, then determined the physiological and molecular responses of *D. rotumana* and its endosymbiotic zooxanthellae (*Cladocopium* sp.).

When exposed to 32°C for thirty days, *D. rotumana* exhibited a 4.54% reduction in photosynthetic efficiency ($F_V/F_M$) in the first ten days, but this parameter became relatively stable in the following days. Cell density of zooxanthellae and chlorophyll *a* concentration fluctuated between $3.96 \pm 0.15 \times 10^6$ cells/cm$^2$ and $5.51 \pm 0.11 \times 10^6$ cells/cm$^2$ and between $7.47 \pm 0.21$ μg/cm$^2$ and $10.79 \pm 0.30$ μg/cm$^2$, respectively. Both values showed a similar changing trend, with the lowest point appearing on day 20. Compared to other species of scleractinian corals, *D. rotumana* displayed higher tolerance to the elevated temperature, with no apparent discoloration occurring even after 30 days of exposure. The high resistance to thermal stress might be related to an up-regulation in the expression of genes involved in immunity and cytoskeleton. In the zooxanthellae, genes that participated in the photosystems were significantly down-regulated on day10, congruent with the physiological responses.

The responses of *D. rotumana* to low salinity exposure depended on the salinity levels. Photosynthetic efficiencies in the 21 psu and 25 psu treatments were similar, and they fluctuated more when compared to the 29 psu treatment and the normal salinity control (33 psu). Zooxanthellae cell density and chlorophyll *a* concentration of corals in the 21 psu and 25 psu treatments were also lower when compared to the 29 PSU treatment and the control. Notably, these compromised physiological conditions occurred only after 20 days of exposure to the low salinity treatments, indicating the species is tolerant to this environmental stressor. At the molecular level, the hypo-saline stress mainly caused an up-regulation of genes involved in the antioxidation network and specific response of genes involved in amino acid metabolism and transport. Nevertheless, the zooxanthellae cells were less affected by the hypo-saline stress than by the thermal stress.

In conclusion, this study revealed the high-tolerance of the massive coral *D. rotumana* to high temperature and low salinity stressors. As one of the first comprehensive transcriptomic analyses of the responses of massive coral species and their algal symbionts to the two stressors, this study provides insights into the potential responses of massive scleractinian corals to future global warming and flooding events.

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