Using the Red Sea upside-down jellyfish *Cassiopea* as a model to study cnidarian-Symbiodiniaceae symbiosis

Shiou-Han Hung*[1], Octavio R. Salazar[1] and Manuel Aranda[1]

[1]Red Sea Research Center, King Abdullah University of Science and Technology, Saudi Arabia.

Abstract

Tropical coral reefs are considered one of the most diverse and productive ecosystems on the planet. Corals heavily rely on the symbiotic relationships with photosynthetic dinoflagellates of the Symbiodiniaceae family, receiving photosynthates in exchange for inorganic nutrients. The breakdown of this symbiosis leads to coral bleaching, resulting in major coral reef losses.

Despite the fact that the environmental stressors causing coral bleaching are well known, the cellular and molecular mechanisms underlying this endosymbiosis are not well understood. The upside-down jellyfish *Cassiopea*, similarly to corals, has a mutualistic relationship with Symbiodiniaceae. However, unlike corals, this upside-down jellyfish has a closed sexual reproductive cycle, can be easily maintained in laboratory conditions, and has a short generation time. The use of *Cassiopea* as a model organism to investigate symbiosis with Symbiodiniaceae, would provide us with a better understanding of Cnidarian symbiosis and would bring us a step closer to the development of a cnidarian symbiosis model. *Cassiopea* polyps can stay aposymbiotic and propagate if fed regularly. To understand the molecular mechanisms behind this symbiosis, gene expression profiles between aposymbiotic and symbiotic *Cassiopea* polyps were compared, revealing genes and pathways putatively involved in symbiosis. We identified 1,227 differentially expressed genes out of 63,340 transcripts, of which 560 were upregulated and 667 were downregulated in symbiotic polyps. GO enrichment analysis indicated that processes linked to lipids, sterols, cholesterol, and membrane transport were upregulated in symbiotic *Cassiopea* polyps. We also compared GO enriched terms between *Cassiopea* and *Aiptasia* upon symbiosis, revealing shared enrichment in processes related to steroid hormone receptor activity and sterol homeostasis. Sterols are essential cell components that cnidarian hosts cannot synthesize and rely on their symbionts or in prey consumption for their acquisition. Symbiodiniaceae can produce and transfer a variety of sterols to the host including dinosterol, cholesterol, and gorgosterol, among others. Our results show that two genes annotated as NPC intracellular cholesterol transporter 2 were also increased during symbiosis, suggesting that sterol transport via Symbiodiniaceae may potentially play an essential function in *Cassiopea*.

Keywords: *Cassiopea*, Symbiodiniaceae, symbiosis, bleaching, transcriptomics

***Corresponding author. Email: shiou-han.hung@kaust.edu.sa**