Unveiling the evolution of sulfur-containing amino acids metabolic pathways: insight from Cnidaria

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Project Summary

Marine organisms developed mechanisms to survive in a constantly changing environment, including global warning, excessive UVR, variable oxygen availability, and acidification. One of the most intriguing questions about the study of the mechanisms underpinning the adaptation of organisms to these pressures concern the role of small sulfur-containing compounds in maintaining cellular redox homeostasis and regulating life-cycle transitions. During evolution, marine invertebrates, microalgae, and cyanobacteria have developed the ability to synthesize sulfur-containing histidines. Although the biological/ecological roles of these small natural products remain mostly obscure, increasing evidence suggests that they may contribute to the evolutionary success of organisms to thrive in different environmental niches. Cnidaria represent ideal models to address this question, because they are at the stem of the metazoan lineage, display a spectacular life-cycle, and are particularly sensitive to anthropogenic factors. Although the ecology of coral reefs has been intensively studied, the molecular mechanisms underlying sulfur redox-homeostasis in basal metazoans and their involvement in the tight metabolic coupling of holobionts (cnidarian host and microbial symbionts) remain poorly understood. This project aims to integrate genome mining and chemical biology approaches in order to study the co-evolution of sulfur-containing metabolites biosynthesis. The tasks to achieve will be: *in silico* analysis of sulfur-redox metabolic networks in metazoan genomes; cloning and biochemical characterization of highly diversified enzymes in cnidarian species; atlas of sulfur-containing histidines in basal metazoans. These tasks will allow to trace the origin and diversification of these pathways, providing new insights into the molecular network responsible for sulfur redox-homeostasis from basal metazoans to vertebrates. The knowledge acquired will allow to learn more about the biology of marine organisms and development of plasticity mechanisms during evolution.

Intellectual Merit. This project aims to unravel sulfur redox-homeostasis control in basal metazoans and to understand the biological/ecological role of marine-derived sulfur-containing amino acids. The results are expected to uncover novel concepts in redox biology and biochemistry of marine organisms. The knowledge of marine molecular biodiversity may bring new evolutionary insights on life origin and inspire the development of innovative and eco-sustainable solutions to preserve the planet.

Broader Impacts. The results may improve the knowledge of evolutionary mechanisms and adaptation of organisms to environmental challenges; provide an atlas of marine biological sources for the development of new bioactive molecules (patents); have important societal implications for the sustainable use of ocean resources. All the results will be disseminated through scientific publications in peer-reviewed journals and patents.