Quantifying the ecological and evolutionary responses of photosymbiotic mutualisms to warming

Supervisors

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Project description

Mutualistic symbioses shape ecosystem function, yet the mechanisms underpinning how symbioses will respond to environmental change are unresolved. Global warming has the potential to strongly modify organismal physiology, which may in turn drive changes in behaviour and ecological interactions with other species. A critical challenge is to develop integrated approaches that link the physiological processes driving mutualisms with ecological and evolutionary dynamics to predict how these key interactions will respond to warming.

In the above context, photosymbiosis - in which autotrophic microbes inhabit unicellular or multi-cellular hosts - are critical components of diverse ecosystems and have well documented sensitivities to temperature change (e.g. temperature induced bleaching in corals). Despite this, understanding of the thermal sensitivities of the metabolic processes underlying these associations, and how they shape the long-term stability of the interaction remains limited. Photosymbioses are underpinned by tightly regulated trade in respiratory and photosynthetic metabolites, and both of these processes are temperature dependent. The major advance this project will pursue is to use knowledge about the asymmetries in these metabolic processes to predict the effects of warming on the relative costs/benefits of photosymbiotic associations and therefore their ecological and evolutionary trajectories in a warmer world.

In this project the mutualism between the freshwater ciliate *Paramecium bursaria* and its autotrophic algal symbiontwill be used as a tractable experimental system to examine how photosymbiotic partners deal with the thermal physiological constraints imposed by long-term global temperature change. The project will combine metabolic theory and experimental evolution to examine the ecological and evolutionary responses of photosymbiotic mutualisms to temperature change. Combining laboratory and field based studies, the project will aim to understand: 1) the degree of host-symbiont physiological asymmetries in response to temperature; 2) the consequences of such physiological asymmetries for host-symbiont ecological dynamics; and 3) the specific role of host-symbiont co-evolution in shaping thermal adaptation.

The project will place the PhD candidate at the forefront of eukaryote microbial biodiversity science, as it will directly link metabolic and evolutionary theory to investigate the mechanisms underlying the responses of photosymbioses to warming. Further, the student will develop expertise in aquatic respirometry and fluorometry, statistical modeling, experimental design, and will benefit from the GW4+ doctoral training program.