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Cross-Ecosystem Connectivity of Crustose Coralline Algae (CCAs) Microbiomes in Tropical Coastal Seascapes (CCA_CONNECT)

Tropical coastal ecosystems are rapidly transforming under climate change and intensifying coastal development. Mangroves, seagrasses, and coral reefs are among the most impacted habitats, yet they function as interconnected "meta-ecosystems" where hydrodynamic processes exchange organisms and carbon across spatial gradients. While blue carbon research has focused mainly on vegetated habitats, crustose coralline algae (CCA) are key but overlooked contributors. These foundational reef builders stabilize substrates, promote reef accretion, and induce larval settlement in corals and other invertebrates. Their physiology combines photosynthesis with high-Mg calcite precipitation, linking CCA directly to coastal carbon cycling. Crucially, CCA skeletons host diverse microbial communities that may regulate both carbon fluxes and key ecological interactions.

This project investigates how host identity, skeletal mineralogy, environmental gradients, and cross-ecosystem connectivity shape CCA microbiomes, carbon dynamics, and settlement functions. Embedded within the recently funded SeaStrong Horizon Europe project, research will be conducted across mangrove–seagrass–reef corridors in Belize, the Seychelles, and Fiji, encompassing gradients of strong to weak physical connectivity.

We hypothesize that CCA-associated microbiomes reflect host traits, mineralogy, and environmental context, producing characteristic signatures across ecosystem types. Spatial variation in connectivity is further expected to shape carbon fluxes and microbial community structure, with strongly connected systems exhibiting more consistent microbiome–carbon flux relationships through enhanced inter-habitat exchange. Microbiome assembly is also expected to mediate coral larval settlement cues, with highly connected corridors supporting stable settlement-promoting communities and weaker connectivity leading to more localized, variable microbiomes.

By integrating microbial ecology, algal physiology and biogeochemistry, and seascape connectivity, this project will provide the first cross-ecosystem, multi-region assessment of CCA microbiomes and their functional contributions to carbon cycling. This work advances blue carbon frameworks by explicitly incorporating calcifying algae and identifies microbiomes as mechanistic links between connectivity and ecosystem functioning. Findings will inform management strategies for preserving connectivity and microbial function to sustain resilient coastal ecosystems under global change. The PhD candidate will receive interdisciplinary training in microbial ecology, biogeochemistry, and bioinformatics, with fieldwork across tropical seascapes and access to the SeaStrong international partner network.