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Deadline: 31st May 2026

GUTPOWER1: the gut microbiota's potential in organismal resilience to environmental change

Claudia Pogoreutz and Suzanne Mills are searching for a suitable candidate for a 3-year PhD studentship to be based at CRIOBE between Perpignan, France and Moorea, French Polynesia.

Project: Gut microbiota, the entirety of microorganisms living in the digestive tract, not only allow the digestion of specific materials, but may also affect a suite of organismal traits via the gut microbiota–brain axis. The gut microbiota and their metabolites interact with the brain and influence metabolism, immunity, health and cognition through several pathways linked to inflammation, endocrine disruption (including glucocorticoid concentrations), neuronal injury and oxidative stress. The gut microbiome also modulates resistance to pathogens as well as circadian rhythms and hence in general contributes to host fitness. The gut microbiota may also be especially important in mediating acclimation to environmental stressors by facilitating rapid phenotypic plastic responses in multiple organismal traits to match current environmental conditions while all the time upstream of the stress response. This PhD uses the orange-fin anemonefish, *Amphiprion maohiensis*, in Moorea, French Polynesia, to investigate how gut microbiota influences resilience to environmental stressors.

Methods: Organismal adaptive capacity to environmental stressors will be assessed through rapid phenotypic plasticity of many traits such as metabolic physiology, escape performance, swimming ability and endocrine stress responses, glucocorticoid (GC) release. GCs mediate metabolic, physiological, cognitive and behavioral changes, including reduced immune and reproductive functions, changes in behavior, neural plasticity and cognition, and prepares the body for subsequent disturbances. At a molecular level, resilience can also be measured through endophenotypes, including changes in the transcriptome, metabolome, and microbiome.

Advances in sequencing allow us to explore genomic mechanisms driving phenotypic plasticity to disturbances without the need for microbial culturing, the success of which is very limited from marine hosts and environments. Integrated-omic analyses of gut microbiota have revealed metabolic, immune, and stress response changes due to warming. Functional insights will be gained through shotgun metagenomics, which sequences total microbial DNA, including uncultured species, for a reconstruction of bacterial and fungal communities and their metabolic functions to elucidate both microbial communities and host responses. Metagenome data will be integrated with metatranscriptomics (measuring functional gene expression) to capture functional variations and link changes in microbial metabolism/activity to ecological processes. This integrative approach makes it possible to detect and identify molecular features linked to stimulus-physiological response relationships, invisible with traditional biomarkers, hence paving the way for the techniques we will use in this PhD project.

Aims: We will harness these powerful techniques by combining them with in situ manipulative experiments to investigate how gut microbiota influences resilience to environmental stressors. This project will first characterize the diversity and function of a healthy gut microbiota in young fish and identify changes in gut microbiota diversity with age. The PhD candidate will then describe changes to the gut microbiota in response to light pollution. Finally, the PhD candidate will determine the mediatory role of the gut microbiota in shaping phenotypic resilience to an environmental stressor and pinpoint specific bacterial and fungal lineages, or gene expression in microbiota that correlate with resilience.

Desired skills: We are looking for a candidate with laboratory and computational skills in (meta)transcriptomic analyses (total RNA isolation; reference-guided approach; and at least one coding language, such as R or python), shotgun metagenomics (de novo assembly and binning; taxonomic and functional profiling; gene- vs. genome-centric approaches), in metabolic physiology, endocrine stress responses, and cognitive behaviour. Ideally, candidates would have experience with two or more of the above -omics. Field work experience in remote locations along with experience with scuba diving (CAH) and a boat driving licenses is a significant asset. French language skills are not mandatory, but an advantage.