Doctorat EPHE

Thème Général : Ecologie, évolution, Environnement

Titre proposé : Functional ecology of coral assemblages: wave energy, reef accretion and climate change

Laboratoire EPHE de formation : CRIOBE, USR 3278, Perpignan

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Description et but du sujet de recherche (une page au maximum) :

Mots clés (5 au Maximum) : a functional ecology, coral reefs, reef accretion, climate change

Coral reefs are the most diverse marine ecosystem on Earth and provide crucial ecosystem services for coastal societies. Among them, coastal protection from oceanic waves is one of the most important as it allows the persistence of human societies along the coastline. The efficiency of coral reefs in dissipating waves is directly linked to the three-dimensional structural complexity of coral reefs as well as their capacity to maintain a positive carbonate budget. However, this capacity is presently threatened at a level that has never been observed. Coral reefs recently witnessed the largest climate-induced disturbance on record due to coral bleaching.

Coral reefs are calcium carbonate structures produced by building corals. The persistence of their ability to withstand waves energy and sea level rise mainly rely on the capacity of coral assemblages to maintain a positive carbonate budget, a process that keeps the reef growing despite changing environmental conditions, erosion and dissolution. Increasing our capacity to assess and monitor these ecological processes is becoming increasingly important as the pace of global impacts (i.e. mass bleaching events, sea level rise, increased dissolution by ocean acidification) threaten coral reef biodiversity and the services they provide to humans.

In French Polynesia two projects are presently tackling this question. The first one is the IDEA AVATAR project led by the CRIOBE and the University of Berkley (USA) and whose aim is the capacity to create a digital model of the island of Moorea to ease the modeling of the ecological processes performed within the island according to climate change scenarios. The second, in collaboration with the MARUM Institute in Bremen (Germany) developed the first mathematical model of wave energy dissipation in various sites in French Polynesia (Teahupo'o in Tahiti and Tiahura, Temae and Haapiti in Moorea). Preliminary results highlight that the capacity of coral reefs to maintain high structural complexity is far more important than sea level rise in maintaining coastal protection from storms.

We aim to propose a PhD project (3 years) to quantify the metabolic processes performed by coral reef assemblages and related to the capacity of coral reefs to withstand wave energy. Our estimates will be applied to existing field data in order to map risk for coastal protection according to scenarios of climate change in 23 Pacific Islands. Using an additive framework, the PhD will evaluate the processes performed at assemblage level according to the assessment of species-specific estimates. Using extensive experiments in aquaria, we will evaluate for each coral genus present in French Polynesia (\textit{n} = 24) the calcification rate, the respiration, the growth rate, the photosynthetic activity, the skeletal density, the resistance to mechanical impact and fecundity. Calcification, respiration, growth and photosynthetic activity are processes related to the accretion capacity of coral assemblages, skeletal density and resistance to mechanical impact are related to the capacity of coral assemblages to withstand extreme climatic events (i.e. storms, cyclones) while fecundity may be considered as a proxy of the capacity of coral assemblages to insure long-term persistence trough reproduction or the recovery capacity after disturbance.

This information will be used to build a genus-specific model relating colony size and the performances of each ecological process in a Bayesian framework. These models will be then used to calculate the processes delivered at assemblage level according to information of assemblage composition estimated with photographic techniques at the CRIOBE since 2001 in Moorea.