Marine Biodiversity and Ecosystems

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Identifying Key Parameters of Coral Reefs' Resilience to Sustain Their Resources under Climate Change and Anthropogenic Disturbances: Case of Kenting National Park (KNP), Taiwan

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Interdisciplinary Research Building
跨領域科技研究大樓1樓演講廳

Host: Dr. Chaolun Allen Chen 陳昭倫研究員

Doctoral Dissertation Defense Presentation

~Attendee must wear mask~

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Abstract

Climate change and increasing anthropogenic pressures have profoundly transformed coral reef ecosystems. Reefs' resilience capacities have been imperiled and their short-term persistence is doubtful. Therefore, there is an urgent need to develop a resilient system, which can face environmental changes. We developed a transdisciplinary approach using ecosystem modeling to identify key parameters which could leverage reef degradation in the Kenting National Park (KNP), Southern Taiwan. This location is the shelter of an extraordinary reef biodiversity but despite the implementation of Marine Protected Areas (MPAs), coral reefs have been severely degraded under increasing natural and anthropogenic disturbances. First, benthic and fish data from over 100 sampling locations from 2012 to 2015 were combined to document the initial condition of the reef ecosystem. Then, in 2015-2017, additional surveys were performed to assess impacts of typhoons and bleaching events. Communities' conditions and responses were related to environmental conditions as well as anthropogenic activities. These results were combined to inform an ecosystem model encompassing 869.75 km2 of land and ocean. Environmental and ecological surveys (Chapter 2) showed that repeated storms in the KNP kept thermal stress low, preventing extensive bleaching, and mitigating the impacts of the 2015-2017 El Niño event. However, typhoons induced local shifts from coral to macro-algae dominated states.

Synchronous storms and heatwaves could influence local reef persistence and decrease the structural complexity and the diversity of KNP's reefs. The structural complexity loss in KNP is highlighting the urge to understand relationships between species composition, structural complexity and resilience capacities of coral reefs. To fulfill this goal, we developed a fine-scale depth dataset approach (Chapter 3). We could distinguish the relative contribution of structural complexity provided by the inhabiting organisms (micro-rugosity) and, the geological features (macro-rugosity). The relationships between rugosity patterns and reef functional groups were identified, highlighting conservation priorities of specific taxonomic groups, along with sites with higher recovery potential. Finally, combining data from Chapters 2 and 3 with historical datasets, we built an ecological model based on the interactions between 21 reef-associated functional groups, together with natural and anthropogenic changes occurring within KNP (Chapter 4). The ecological processes reproduced by our model highlighted water quality as a major driver of loss of reef resilience. We then tested 5 management scenarios based on the identified relationships between the ecosystem dynamics and the local disturbances. Results of this PhD are offering a handful set of tools for scientists and managers to improve our understanding of reef resilience and sustainably manage their resources.