Research Project

Cellular and Molecular Biology of Coral-Dinoflagellates Endosymbiosis

Principal Investigators

Chii-Shiarng Chen(principal investigator)、Hsing-Hui Li、Li-Hsueh Wang、Chiahsin Lin

Subprojects

1.Cellular and molecular biology of coral-dinoflagellate endosymbiosis (Chii-Shiarng Chen)
2.The regulatory mechanism of cell cycle propagation during coral and Symbiodinium association (Li-Hsueh Wang)
3.Characterization of the specific molecules involved in Cnidaria-dinoflagellate endosymbiosis (Hsing-Hui Li)
4.Development of cryopreservation techniques for reproductive cells and genetic materials of corals for future conservation efforts (Chia-Hsin Lin)

Research Overview

Endosymbiosis in cnidaria-dinoflagellate association plays a critical role in regulating productivity of corals and related marine ecosystems. Endosymbiosis is an obligatory and mutualistic association occurring at cellular level, where a cell (the “symbiont”, usually plant cells or bacteria) resides inside another cell of other species (the “host cell”, usually animal or plant cells). Environmental changes, including temperature, photo-irradiation and pollution, have devastating effects on the coral-dinoflagellate endosymbiosis and result in the expulsion of symbiont from the host cells which caused coral bleaching. This eventually leads to the death of corals and destruction of marine ecological systems. As a consequence, the urgency and interest to understand how the endosymbiosis is regulated in coral-dinoflagellate association have also resulted in intensive investigations during past decades.

Cellular endosymbiosis with Symbiodinium spp. (the symbiont) in corals (the host) is thought to be initiated by a three-step process: (i) the recognition between the host gastrodermal cell and the symbiont, then (ii) the host gastrodermal cell phagocytoses the symbiont and finally (iii) the association between the host cell and its included symbiont matures to establish an obligatory and mutualistic interaction. However, the detailed mechanisms of each step remain unclear notwithstanding decades of research. This slowness in research progress is attributed to the lack of working models that can be examined at the cellular, molecular and organism levels for both the host cell and its included symbiont. With the availability of advanced biological and biophysical technologies, plus well developed facilities and experience in coral culture, we propose to investigate several objectives to learn how the endosymbiosis are regulated during endosymbiosis establishment.

Research Project

Coral Reef Species Breeding and Aquaculture

Principal Investigators

Ming-Yih Leu(principal investigator)、Yu-Min Ju、Kwee Siong TEW、Chiao-Chuan Han

Subprojects

1.Natural spawning and larviculture of coral reef fish (Ming-Yih Leu)

2.The effects of increase nitrogen in coral reef fish larviculture (Kwee Siong Tew)

3.Propagation of the stream fish and shrimp exhibited in the aquarium (Chiao-Chian Han)

4.Genetic diversity of the cultured fish species in the aquarium (Yu-Min Ju)

Research Overview

The long-term goals of this research are to develop aquaculture techniques for raising reef fish and amphidromous fish and shrimp in captivity to increase our understanding of their ecological requirements, to preserve rare and endangered species, and to reduce harvesting pressure on natural populations. By controlling the concentration and ratio of different nutrients in the seawater, we intend to enhance the production of desirable size of phytoplankton, which in turn will produce desirable size of zooplankton that will enhance the survivor of newly-hatched reef fish. The impact of water quality on the survival of the larvae will be monitored. Water samples collected will be analyzed immediately for temperature, salinity, pH, dissolved oxygen, nutrients (as nitrite, nitrate and phosphate), ammonium and turbidity. We expect to provide basic information about water quality and nutrient concentration in the cultivation, and also establish the database of the cultivation condition. There are numerous critical processes in early life history where deficiencies could represent a limiting factor in captive rearing. These include spawning in captivity, embryo development, and the transition from endogenous to exogenous feeding. Recent research activities have resolved some of the problems related to egg quality, proper embryo development, and hatching by developing suitable diets and technologies. A major problem remained is the optimization of feeding schedules and environmental conditions for successful larval rearing. The study will determine appropriate larval rearing techniques in captivity for the reef and amphidromous fish and shrimp. In addition, coral reef fish are collected from the wild and exhibited in aquaria worldwide. Some of the fish spawn in captivity; however the eggs are usually neglected. Therefore, in this study, we applied an inorganic fertilization method commonly used in freshwater fish culture in raising these coral reef fish larvae, and compare it to the traditional rotifer-fed culturing method. The results demonstrated that the inorganic fertilization approach can be successfully adapted for coral reef fish culture in an aquarium to achieve sustainable exhibits.

Research Project

Integration of Ecological Conservation and Education of Coral Reefs

Principal Investigators

Tung-Yung Fan(principal investigator)

Subprojects

1. Coral reef monitoring, coral cultivation and marine talent cultivation (Tung-Yung Fan)

Research Overview

Since 2011, we have carried out the monitoring of the spatial and temporal changes of the benthic community structure in the coral reefs of Western Hungchun Peninsula, as well as constructed the ecological model with combining data of the benthic community structure, water quality and sediment. It is effective to understand the latest development of coral reefs near the National Museum of Marine Biology and Aquarium. Results shown the coral abundance is increasing from 2011 to June 2016. However, mass coral bleaching, typhoon and runoff occurred after July 2016, and caused negative impacts on coral reefs. It is worth to continue the monitoring to accumulate long-term ecological data and update the ecological model analysis to timely understand the ecological changes, update the content of environmental education, and propose effective management means based on scientific findings.

Brooding reef corals are abundant in Nanwan Bay, Southern Taiwan. They are important reef-builders and recruits. They release larvae throughout the year and their reproductive timing could be regulated by seawater temperature or photoperiod. They are easier to be cultured under artificial environment and widely used as model organisms for biological research. We are cultivating brooding coral species to enhance their thermal tolerance. These corals are also used to develop model species for investigating how corals acclimatized to climate change.

The “Coral Reef Ambassadors” project was sponsored and initiated by the 2012 US State Department's “Museums Connect” program, which is executed by the Birch Aquarium at San Diego, California and the National Museum of Marine Biology and Aquarium, Pingtung, Taiwan. The collaboration extended to several middle and high schools as well as the Hawaii Institute of Marine Biology. This project continuously attracts motivated teachers and students to learn marine education, coral reef conservation and aquarium technology. It promotes the integrated development of research, education, conservation and industry based on coral reefs. Taiwanese teachers and students have been visited visit San Diego, California or Oahu, Hawaii every year during 2013-2016. It has become a well-known international marine talent education program

Research Project

Marine Natural Products

Principal Investigators

Ping-Jyun Sung(principal investigator)、Jimmy Kuo、Mei-Chin Lu、Jui-Hsin Su

Subprojects

1.Natural products from the marine invertebrates, secondary metabolites of marine microorganism and cultured octocorals. (Ping-Jyun Sung)

2.Bioactive natural products from octocorals and sponges and investigate the synthesis and bioactivities of related analogues. (Jui-Hsin Su)

3.Anticancer activity of marine natural products. (Mei-Chin Lu)

4.Analysis microorganism flora of the marine invertebrate and Screen bioactive marine microorganisms. (Jimmy Kuo)

Research Overview

The research of marine natural products has been conducted for over five decades. Thanks to sophisticated techniques from sample collection, extraction, purification and finally to bioactivity screening, researchers have successfully isolated more than 30,000 compounds from marine organisms, including bacteria, fungi, microalgae, seaweed, sponges and corals. The hostile nature of marine environment drove organisms to produce secondary metabolites with unique skeletons and potent biological activities. To date, the worldwide marine pharmaceutical industry includes eight approved drugs, such as the powerful antivirus drug, cytarabine, and the anticancer agent, halichondrin. Aiming to participate in this global movement, the main purpose of our project is to advance the techniques of breeding and culturing marine invertebrates and stabilize the mass production of marine natural products. Moreover, we aim to raise the public awareness of marine environmental conservation. We not only farm marine invertebrates but also study their associated microorganisms that are involved in secondary metabolite biosynthesis. Using microorganism biotransfer or the substitution of natural products and precursors for microorganisms facilitates mass production of the microorganisms. In this way, we could obtain stable yields of metabolites to increase the depth of marine natural products.

Research Project

Marine Biodiversity

Principal Investigators

Hsuan-Ching Ho (principal investigator)、Chia-wei Lin

Subprojects

1. Biodiversity of fishes in Taiwan (Hsuan-Ching Ho)
2. Diversity and Phylogeny of Crustacean in the coral reef of Indo-Pacific (Chia-Wei Lin)

Research Overview

The integrative project of Marine Biodiversity aims to expanse the specimen collection of marine organisms from Taiwan and the adjacent areas, to promote a worldwide collaboration by an effective utilization of the collection, and to engage regional and/or global coordinated studies on both genetic and species diversity. Ultimately, the potential of specimen collection and related studies at NMMBA could be upgraded and of a significantly worldwide impact.

Research Project

Environmental Sciences and Aquarium Animal Research

Principal Investigators

Te-Hao Chen(principal investigator)、Tsung-Hsien Li、Fung-Chi Ko

Subprojects

1.Ecotoxicology of the Emerging Contaminants. (Te-Hao Chen)

2.Epidemiology of Fibropapillomatosis of Endangered Sea Turtles. (Tsung-Hsien Li)

3.Marine Biogeochemical Cycle of Persistent Organic Pollutants: Microplastics Issues. (Fung-Chi Ko)

Research Overview

Emerging contaminants are a big group of compounds, including endocrine disruptors and microplastics. These contaminants are of academic and ecological importance and raise significant public concern. Therefore, research of emerging contaminants can be of great value for popular science education. Marine pollution can cause disease to marine wildlife as well as the exhibition animals in our aquarium. Wildlife diseases are an increasing concern for endangered sea turtles conservation, but their occurrence, causes, and environmental influences are often unknown. Therefore, additional studies are recommended for Taiwan sea turtle populations to improve our understanding of the diseases.

The environmental quality is also closely related to the physiological and psychological health of captive marine mammals. Therefore, the background noise and vocalizations of captive beluga are monitored to improve the environmental noise, training methods and evaluate the environmental enrichment. The stress hormones are also an indicator of physical health in captive beluga whales and could be exploited as a useful monitor of animal welfare in captive marine animals. Cytokines are fundamental for a functioning immune system, and thus potentially serve as important indicators of animal health. The probe-based qRT-PCR assay has established for accurate and reliable detection and quantification of six immunologically relevant genes (IL-2α, IL-4, IL-10, IL-12, IFN-γ and TNF-α) and two validated reference genes (PGK1 and RPL4) in beluga. This assay has the potential to identify immune system deviation from normal state, which is caused by health problems. Furthermore, knowing the immune status of captive cetaceans could help both trainers and veterinarians in implementing preventive approaches prior to disease onset.