学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Larval dispersal patterns and their effects on population structures of two anemonefishes (*Amphiprion frenatus* and *Amphiprion perideraion*) in the Philippines
（フィリピンにおけるクマノミ属魚類の幼生分散と個体群構造に関する研究）

For most marine species, dispersal during pelagic larval stage can make a demographic link between geographically separated local populations. During this stage, pelagic larvae are subjected to various biological and physical oceanographic processes, which affect success of larval dispersal and their abundance patterns. Understanding larval dispersal and abundance patterns of marine species are thus essential for effective plans of marine conservation such as setting marine protected areas (MPAs). The aim of this study is to investigate larval dispersal patterns and responsible factors and processes for the dispersal and abundance of two anemonefishes (*Amphiprion frenatus* and *Amphiprion perideraion*) at Puerto Galera (PG) in a relatively continuous reef along Verde Island Passage (VIP) of the Philippines. I used integrating approaches of comprehensive field survey, genetic parentage analysis and larval dispersal model based on hydrodynamics.

Chapter 2 investigated the factors affecting abundance patterns of two anemonefishes. I examined the effect of the habitat patch size (anemone size), patch isolation (mean distance from other anemones), presence/absence of other anemonefish species and depth on the abundances of two anemonefishes around PG. Local abundance of *A. frenatus* was related to habitat size and the presence of other anemonefish species, whereas that of *A. perideraion* was affected by the presence of other anemonefish species and water depth. Patch isolation was not significant for either species probably because complex ocean currents may offset the isolation effect.

In Chapter 3, I developed microsatellite markers of two anemonefishes using a next-generation sequencer for genetic analysis estimating population connectivity in a following section. Totally, 15 markers were developed, and 10 makers of them worked well for both species, while three of them were specific for *A. frenatus* and two of them were specific for *A. perideraion*.

In Chapter 4, I carried out genetic parentage analysis to estimate the larval dispersals of two anemonefishes around PG situated in a continuous reef. Based on the number of self-recruits and immigrants among juveniles estimated by parentage analysis, I calculated self-recruitment rate, self-replacement and external-replacement for each species. I found that four individuals of 48 total settlers for *A. frentatus* and zero individuals of 17 total settlers for *A. peridearion* were assigned to each focal parents at PG. Self-recruitment rate and self-replacement were low, and external-replacement was high for both species compared to those at isolated habitats in patchy seascapes. These results indicate that focal population of two anemonefishes may be mainly sustained by outside populations.

Chapter 5 estimates larval dispersal patterns of two anemonefishes. I simulated the larval dispersal around PG using hydrodynamic and particle tracking models. To explore the effect of hydrodynamics and other factors on the larval dispersal and local abundance, I compared the predicted larval dispersal with observed dispersal and abundance patterns. The simulation results predicted that a majority of larvae dispersed to the outside of PG, and a small number of larvae retained inside for both species. The simulations also predicted a slightly higher number of the retained larvae for *A. frenatus* than for *A. perideraion*. These predictions were consistent with results of parentage analysis, indicating that oceanographic environments around PG can make such long-distance dispersal of larvae and local retention patterns. The results also revealed that predicted numbers of larval retention were greater than the observed numbers, implying that settlement and post-settlement processes such as conspecific and heterospecific competitions may reduce success of larval dispersal. Predicted larval supply on host habitats was not a good predictor for the observed abundance patterns, probably because unmeasured local environment factors or a large number of immigrants into PG offset the relationships.

Overall, this study revealed that larval dispersal of anemonefishes is associated with both oceanographic and biological factors, while the abundance patterns are strongly related to local environments and biological interactions. By comparing with previous studies, I considered that continuous seascape is a main factor for both population openness and high dependence of population persistence on external sources at the study site. Larval dispersal patterns around PG indicated that populations of anemonefish may be mainly sustained by external sources and they may also export the larvae to outside populations. These results suggest that designing MPA networks around VIP over broad spatial scale may be beneficial to strengthen the resilience of coral reef fish population in this region.