学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Effects of ocean current fluctuations on community dynamics in rocky intertidal habitat
（海流系変動が岩礁潮間帯ハビタットにおける群集動態に及ぼす効果）

Chapter 1

1. I reviewed previous studies that examined community dynamics. The result showed that the quantification of community dynamics has been conducted using a variety of aggregate properties (community abundance, species richness, and diversity), univariate non-aggregate properties (individual species abundances), and multivariate non-aggregate properties (species composition), and there are three main significance of the study of community dynamics: (1) to deepen our understanding of the variability of ecosystem, community, and population dynamics and its driving mechanisms, and (2) to deepen our understanding of many key ecological phenomena such as stability, succession, community assembly and synchrony, and (3) to elucidate the driving mechanisms of community dynamics.
2. I reviewed the studies on marine community dynamics. The results indicated that many previous studies analyze community dynamics after disturbance caused by experimental manipulation, while marine community dynamics after natural disturbance, in particular ocean current fluctuations, eruption, marine heatwave, ice scour, and freshwater flooding, have not been rarely examined yet. Future work should use long-term continuous community data, including periods before and after natural disturbances, to determine the effects of natural disturbances on community dynamics. Especially, influence of ocean current fluctuations on marine community dynamics is the most important topic of the research area. This is because ocean current fluctuations occur over a wide area and have a large spatial range of influence.
3. The target system was examined for assessing the effect of the ocean current fluctuations on community dynamics, and it was shown that the rocky intertidal community is one of the best model systems.

Chapter 2

1. Evaluating the ecological resilience of communities is crucial for predicting their potential to recover from various natural disturbances such as ocean current fluctuations. In contrast, community temporal invariability can be relatively easily estimated for various metrics through short-term investigations. Thus, if ecological resilience can be estimated based on community temporal invariability, this would be advantageous from a management and conservation perspective.
2. I investigated spatial variation in patterns of a long-term trajectory of community dynamics representing different aspects of four ecological resilience (stable, reversible, abrupt, or linear) and temporal variability of species richness, species composition, and community abundance, as well as their interdependence by analyzing 16-year census data from 141 rocky intertidal sessile assemblages from six regions along the Pacific coast of Japan.
3. The result shows that while the stable trajectory was the most common, there was considerable difference in trajectory of community dynamics among regions, with a faster recovery to steady-state equilibrium in low-latitude regions. Furthermore, trajectories and various metrices of temporal variabilities varied among regions, depending on the strength of ocean current fluctuations. Thus, the relationship between community temporal invariability and trajectory may be weak or absent, at least at the regional scale.
4. In regions where fluctuations in the flow patterns of the ocean current are greater, temporal variability in species richness and

species composition is greater, while temporal variability in community abundance is smaller. Temporal variability of species composition was greater near the Kuroshio Current than near the Oyashio, while temporal variability of community abundance was the opposite.

Chapter 3

1. Ocean current fluctuations are associated with the occurrence of marine heatwaves (MHWs), which are anomalously sea water temperature warm event, have increased. In recent years, the frequency and duration of MHWs. Therefore, there is an urgent need to understand the response of marine organisms to MHWs. However, there are several issues that have not yet been considered.
2. I investigated the response of rocky intertidal communities in the southeast Hokkaido to marine heat waves during 2010–2016 caused by ocean current fluctuations. I evaluated the impacts of MHWs on the abundances and species niche traits (thermal niches and vertical niches) of rocky intertidal communities (macroalgae, sessile invertebrates, herbivorous mollusks and carnivorous invertebrates) by separating the effect of environmental stochasticity.
3. I found that the carryover effects (i.e., continued increase or decrease in abundance with the number of years elapsed since the onset of the MHWs) of MHWs were detected both in the community abundance of functional groups and in the abundance of each species. Furthermore, the community abundance of macroalgae and herbivorous mollusk increased and decreased during MHWs and up to two years later, respectively. Thus, during/after MHWs, abundances of species with low thermal niches decreased and those with high thermal niches increased. The increase in abundance in warmer-water species due to MHWs is more pronounced for species with higher vertical niches, only when carryover effects were considered.
4. These results emphasize that the response of organisms to MHWs should be evaluated even when carryover effects are considered. Few signs of community abundance recovery in the functional groups by the second year after the MHWs caused by ocean current fluctuations. Focusing on thermal niches can be useful for understanding and predicting the ecological processes of responses of marine organisms to MHWs, while importance of vertical niches is still unknown.

Chapter 4

1. I summarized Chapter 1 to 3. Next, I discussed effects of ocean current fluctuations on community dynamics of marine organisms.
2. My study supported previous studies that spatiotemporal variations in ocean currents drive community dynamics. Therefore, the important role of ocean current fluctuations as a driver of marine community dynamics may be universal in marine ecosystems. However, since most of the evidences were obtained at the population level of single species or few species, assessments of the importance of ocean current fluctuations as a driver of marine community dynamics are awaited as future researches. My study also shows that analyses, using various properties, provides a comprehensive understanding of the impact of ocean current fluctuations on the community dynamics and a greater understanding of the processes and mechanisms behind that impact. It is recommended to take an approach, where multiple properties are quantified at the same time when evaluating the effects of ocean current fluctuations on community dynamics. Furthermore, my study demonstrates that long-term data over a period of 10 years is extremely useful in assessing the effects of ocean current fluctuations on community dynamics. Despite the outstanding efficacy of long-term data over 10 years to assess the effects of ocean current fluctuations on community dynamics, many previous studies have been conducted over relatively short time series.
3. In elucidating the response of community dynamics to ocean current fluctuations, the knowledge lacking in previous studies, including this study, is how species traits other than thermal niche are related to species response to ocean current fluctuations. Therefore, future studies are needed to evaluate and predict the effects of ocean current fluctuations on community dynamics, taking into account various species traits, such as nutritional (trophic) niches, dispersity, as well as thermal niche.