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学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Variation in community structure of seagrass macrofauna across multiple spatial scales
（多重空間スケールに沿った海草藻場マクロファウナの群集構造の変異）

This dissertation examines the role of multiple environmental factors to the diversity and abundance of macrofauna in seagrass beds. This thesis is motivated by two research questions: (1) How biological communities are structured in seagrass ecosystems? (2) How biological communities in seagrass beds are structured from fine to large spatial scales? To examine these questions, this dissertation offers one main hypothesis: the structure of population and community dynamics of macrofauna in seagrass beds is influenced by local and regional factors. This thesis has three specific goals: (1) At a fine scale, to clarify the role of spatial structure of seagrass beds affecting the macrofauna, (2) At a local scale, to elucidate the impacts of human-induced disturbances to macrofauna, and (3) At broad spatial scale, to understand patterns of community structures confronted by broad-scale environmental factors. The most important contribution of this thesis is that it advances our understanding on small to broad-scale community patterns, and on how to predict patterns necessary for management strategies of seagrass beds habitat in response to small and large-scale disturbances.

I conducted three independent studies on different locations in Asia to test the main hypothesis, as well as to addressed the following three hypotheses specific for each study: (1) variation in seagrass macrofaunal structures is influenced by seagrass taxonomic identity which has different morphology across taxa; (2) impact of organic pollution to seagrass beds mediates changes/alterations in associated macrofauna; and (3) variation in climate and oceanographic current system has an important role in determining seagrass macrofaunal community across broad spatial scale. Sediment coring (depth of 10 cm, diameter range: 15-20 cm) was employed in all of the studies

First, I investigated the role of different seagrass species to macrofauna in multispecific seagrass beds of southern Philippines to clarify whether seagrass spatial structure has influence to associated benthic animals (Chapter 2). Three target seagrass species included are most common and abundant in the tropics: *Enhalus acoroides, Thalassia hemprichii*, and *Cymodocea rotundata*. I did not find a variation in macrofaunal diversity and abundance between the three vegetation types dominated by those seagrass species despite the striking difference in seagrass shoot density and biomass. This suggests that seagrass taxonomic identity is not a good

determinant of taxon diversity and abundance of macrofaunal assemblages. Nonetheless, I also observed the significant influence of aboveground biomass to epifauna, implying that seagrasses function as a whole bed and not as an individual species. Hence, conservation efforts should focus more on protecting as many intact seagrass beds as possible.

Secondly, I clarified the impact of nutrient pollution to benthic animals in seagrass beds lying along a pollution gradient in Bolinao, northwestern Philippines to elucidate how human-induced disturbance controls local variation in macrofaunal structures (Chapter 3). Results revealed that species diversity (in terms of total number of species per site) and abundance decreased and increased, respectively, towards the polluted sites. This reflects a non-linear response of sediment fauna with increasing organic enrichment as a possible result of varying life strategies. The community composition was dominated by a polychaete, *Capitella capitata* and a bivalve *Gafrarium pectinatum*, resulting to dramatic changed in composition among sites. More importantly, the species heterogeneity (beta diversity, species turnover) was reduced, which is expected to suppressed biodiversity and ecosystem functioning. Knowledge on species heterogeneity should be incorporated into environmental impact assessment and management of coastal ecosystems facing organic pollution issues.

Finally, I examined the broad-scale patterns of the diversity and abundance of macrofauna in six seagrass beds of Japan, ranging from 24 to 43°N (Chapter 4). Results revealed that species richness (and ES50) and abundance at core level, increased with latitude. Variation in species composition was found among sites, but did not directly conform to patterns of broad-scale factors like oceanographic current system and climatic condition. I suspect that there were other factors more important in driving such ecological patterns. The community similarity decayed faster compared to other previous reports on rocky intertidal, indicating that the different environmental condition among sites was important. Overall, the findings suggest the seagrass macrofauna can still vary spatially and that regional factors are still important. Knowledge on this aspect advances our understanding on how to manage seagrass beds confronted with local and regional disturbances.

The main findings of this dissertation illustrate how responses of macrofauna in seagrass beds vary across multiple environmental factors that change at different spatial scales. Results from this fine to broad scale studies are complementary; integration of the findings show that the influence of different environmental factors is more complex than previously assumed. Hence, the findings of this thesis support the prediction that macrofauna in seagrass beds are controlled by local and regional processes/variables. The results, implications for managers, and future research are discussed in this dissertation.