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Assessing the role of demersal zooplankton in the food web of shallow coastal ecosystems using stable carbon and nitrogen isotopes

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学 位 論 文 要 旨

Abstract of Doctoral Thesis

専　　攻：

Course：Environment and Energy Systems

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論文題目：炭素・窒素の安定同位体を用いる沿岸浅海域生態系の食物網における底生動物プランクトンの役割の評価

Title of Thesis：Assessing the role of demersal zooplankton in the food web of shallow coastal ecosystems using stable carbon and nitrogen isotopes

論文要旨：

Abstract：

The coastal habitats exist somehow isolated from the oceanic environment. However, they keep important interactions among interconnected coastal ecosystems. Mangroves, seagrass beds, and coral reef lagoons are examples. Mangroves distribute mainly on estuarine areas, which play an important role as a trap of sediments' runoff. Toward to the sea, seagrass distributes in the subtidal area; they act as a buffer area accumulating sediments and pollutants from runoff of terrestrial zones before reaching coral habitat. Meanwhile, coral reef lagoons protect inshore habitats from the wave action. Overall, mangroves, seagrass beds, and coral reefs lagoons are important marine coastal ecosystems that sustain high biodiversity and are highly efficient at transferring organic matter from primary producers to higher trophic levels. Although, these habitats accumulate a large quantity of non-living organic matter in their sediments in the form of detritus, leaf litter, and decomposed dead organisms; there are few species of consumers can utilize this food source directly. Thus, sediment detritivores and herbivores might be important for connecting these food webs by transferring energy from primary producers to higher trophic levels. Demersal zooplankton (DZ) emerge to the water column at night with high densities in shallow coastal ecosystems (i.e. seagrass, coral reefs, soft bottoms, and kelp beds). Therefore they might play an important role in linking small particles (detritus and primary producers attached to sediments) to planktivores (fishes and other suspended feeders). This study aims to clarify the role of DZ in three shallow coastal ecosystems, using stable isotope analysis in combination with stomach content analysis.

Determination of the proportional contribution of food sources to the diet of consumers by solely the stomach contents show serious limitation because the food is

rapidly digested in comparison to the slow digestion of non-living organic matter derived from sediments. Natural stable isotope analysis is a powerful tool to determine the relationship between predators and their food sources. The stable isotope analysis in R (SIAR) isotopic mixing model based on dual stable carbon and nitrogen isotope signature was applied to calculate the proportion of food source in the diet of consumers. Stomach content analysis of fishes and invertebrates was used to find out indications of potential food sources. The combination of both methods was applied in this study. Moreover, the biomass and composition species of DZ was also studied in order to evaluate their contribution in each of the studied environments.

The experiment presented in chapter 3 was designed to find out the trophic enrichment factor between *Artemia salina* and its food source, the diatom *Nitzschia* sp. Natural stable carbon and nitrogen isotope of *Artemia salina* and its food source were measured at different stages of the life cycle of *Artemia salina* . This study demonstrated that isotopic signal of *Artemia salina* reached the equilibrium isotope value at day 25 after hatching and the trophic enrichment factor of *Artemia salina* was determined to mean (± SD) 0.0 ± 0.9 (‰) for $\Delta^{13}C$ and 1.0 ± 0.5 (‰) for $\Delta^{15}N$.

The trophic enrichment factor between zooplankton and its food sources that were determined in chapter 3 was applied to estimate the proportion of potential food sources in the diet of DZ. This study was presented in chapter 4 and conducted the reef lagoon at Bise, Okinawa, Japan, which is composed by a seagrass area and coral heads mixture with seagrass the reef lagoon. The result of stable isotope mixing model highlights the role of organic matter derived from seagrass, particularly seagrass detritus, influencing the abundance of DZ in each specific habitat. Phytoplankton and macroalgae also play an important role as a food source for DZ in the lagoon. When comparing the importance of potential food sources, it suggests that DZ prefer on main food source which depending on available sources and their migration among habitat in small spatial scales.

Finally, in Chapter 5, the role of DZ as a food source for higher trophic levels in an estuarine area was discussed, particularly with respect to the food preference and size selection of their consumers. The lowest DZ biomass was recorded in mangroves and mainly dominated by smaller organisms because their consumers in this habitat prefer large-sized prey. The $\delta^{13}C$ and $\delta^{15}N$ signatures showed that, in mangroves, DZ constituted a higher proportion of the diet of fishes than in lagoon habitats; however, DZ did not play a significant role in the diet of fishes and macroinvertebrates in the lagoon. Consistency among biomass, stomach contents, and the proportions of DZ of all size classes in the diet of mangrove fishes indicated that DZ serve as a major food source. In contrast, fishes in lagoon habitats consumed more crabs, shrimps, and mollusks than DZ. We found that role of DZ as a food source was different in the different habitats.