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Studies on interstitial biological indicators (amphipods and isopods) in sandy beaches of Okinawa Island

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Abstract

Title

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沖縄島の砂浜における間隙性の生物指標（端脚類および等脚目）に関する研究

In this study, we focused on amphipods and isopods as bioindicators in assessing human impacts (artificial or disturbed beaches) of coastlines along Okinawa-jima Island, Japan. Amphipods and isopods were selected as potential bioindicators due to their long life cycles, mobility and stable communities, as well as their previous use in other regions of the world. Additionally, amphipods and isopods, and their communities, are important due to their role as basal components of the food chain.

In Chapter 2, as subtropical Okinawa Island is known for its high marine biodiversity but yet relatively little work has been performed on examining the impacts of coastal development on its marine ecosystems, we examined three sandy disturbed beaches (including two artificial beaches) on three different sides of the island (artificial Ginowan Tropical Beach on the west coast, artificial Azama San-san Beach on the east coast, public Odo John Man Beach on the south coast). We investigated if differences existed in the environment and interstitial crustacean biota between paired disturbed and natural beaches. We conducted seasonal surveys at three paired locations (artificial/disturbed and natural beaches at each location, to collect and record the diversity of interstitial crustacean (isopods and amphipods) taxa. As well, environmental parameters including sand grain size, water temperature, and seawater quality (salinity, dissolved oxygen content, particulate organic matter, turbidity, conductivity, pH, phosphate, nitrite, nitrate, ammonium levels) were obtained from each site during each survey. The results showed that while water nutrients, sand composition, and water quality were very similar between paired disturbed and natural beaches, disturbed beaches had significantly less biodiversity. These results show that despite no obvious effects from water nutrients or quality, disturbed and artificial beaches influence the interstitial crustacean biodiversity/community in the classic manner of a disturbance.

In Chapter 3, we again investigated the impacts of coastal development by examining six different beaches to understand the threshold for disturbed and undisturbed beaches in comparison with the previous chapter. Additionally, for amphipod identification we conducted phylogenetic analyses with the 18S ribosomal DNA marker to generate DNA barcode baseline data for future identification, and conducted an ABGD test to separate specimens into putative operational taxonomic units (OTUs). Based on our obtained results, the comparatively pristine site showed higher diversity than disturbed sites. Interestingly, in this survey time no isopods were observed. For amphipod specimens, individuals in Chapter 3 were identified based on morphology as belonging to six different family groups, while in Chapter 2, 196 individuals were identified from 12 family groups. In the ABGD (Automatic Barcode Gap Discovery) analyses, the family Dogielinotidae with 11 individuals was grouped into two OTUs ($n=10$, 1 member each). On the other hand, the 20 specimens' sequences of Ampithoidae were split into 10 different OTUs. The remaining three individuals (one each from familie; Talitridae, Amphilochidae, Podoceridae) grouped separately in the ABGD analyses, indicating three OTUs.

In Chapter 4, isopods were collected from six sandy beaches as in Chapter 2 around subtropical Okinawa-jima Island, spanning four seasons. Seasonal patterns of isopods were examined via comparison of the numbers of Sphaeromatidae (Crustacea: Isopoda) from these four seasons. The highest and lowest numbers of Sphaeromatidae were observed in spring 2015 and winter 2016, respectively. These results are very similar to other studies from other parts of the world that also have seen isopod numbers peak in spring, although it should be noted these previous studies were not in the subtropics. These results are important for researchers as a reminder to take into seasonal variation into account when performing or comparing environmental assessments across different seasons, particularly as isopods and other small crustaceans are often used as bioindicators in environmental assessments. For future similar surveys around Okinawa, timing in spring is therefore recommended.

Overall, this thesis showed that artificial and disturbed beaches around Okinawa Island act in the manner of a classic disturbance on amphipod and isopod communities. With continuing development of the coastline of Okinawa Island, more consideration into the impacts of such plans may be needed to help conserve the unique diversity of the region. We discuss in Chapter 5 on the need to check other environmental factors such as wind and associated coastal erosion (slope of the seabed) that have been shown to cause decreases in interstitial biota. Finally, the ecology and biology of amphipods and isopods need more research to help improve the efficiency as bioindicators.