Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)


BBG21-P01 Room:Convention Hall Time:May 27 18:15-19:30

# Diversity index of coral distributions and its relation to physical variables in Amitori Bay, Iriomote Island, Japan.

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The relationship between coral distributions and physical variables was investigated in Amitori Bay, Iriomote Island, Japan. Amitori Bay is located in the northwest region of Iriomote Island, Japan. Broad areas of coral have developed in the bay, and their life forms, coverages, sizes, and species vary depending on their locations. In addition, Amitori Bay has no access roads, and the bay perimeter is uninhabited. Thus, this small bay, with its variety of environments and lack of human impact, is considered to be one of the most suitable areas for studying the relationship between coral distribution and physical variables.

Field observations were conducted to obtain data on coral distributions, sea temperature, sea salinity, wind speed, and river flow rate [Shimokawa et al., 2014]. Ocean and wave model numerical simulations and soil particle tracking analysis were conducted to obtain the spatial and temporal distributions of wave height and the numbers of soil particles with the observed physical data. Our results showed that the life forms and sizes of corals significantly varied depending on their locations in the bay, because the physical variables differed significantly among these locations.

From the results of the above observations and simulations, we calculated diversity index of coral distributions and its relation to physical variables. The diversity index, DI [Shannon, 1948; MacArthur and MacArthur, 1961, Clark & Warwick, 2001, McCune and Grace, 2002] is defined as

$DI=-\sum ci \log_2 ci$,

where ci is the ratio of i-th type coverage to total coverage. DI is a quantitative measure for the degree in which a dataset includes different types and is related closely to entropy concept in Thermodynamics. The value of DI increases when both the number of types and the evenness increase. For a given number of types, the value of DI is maximized when all types are equally abundant.

The results show that Averages of diversity index of the coral types at the mouth and inner parts of the bay are lower than average of the whole region, but average of diversity index at the intermediate part of the bay with the intermediate physical disturbances is higher than it. This seems to support the intermediate disturbance hypothesis demonstrated by Connell [1978] which states species diversity in local area is maximized when environmental disturbances is neither too weak not too strong.

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Keywords: Coral, Diveristy index, Wave height, Soil particle, Intermediate disturbance hypothesis

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# Variation in the oxygen isotope ratio of dissolved orthophosphate induced by uptake process by hermatypic corals

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The oxygen isotope ratio ($\delta^{18}$O) of dissolved orthophosphate ($PO_4^{3-}$) has been recognized as a promising tool to evaluate the contributions of both external sources and internal recycling of phosphorus (P) to the P budget in natural aquatic ecosystems. However, coexistence of many biological processes that can significantly alter the phosphate $\delta^{18}$O ($\delta^{18}O_p$) in a given system often complicates quantitative interpretation of this parameter. To use the information of $\delta^{18}O_p$ effectively in biogeochemical researches, we have to know both the magnitudes of oxygen isotope effect and the reaction kinetics of major biological processes that take part in the P cycle of the concerned ecosystem. In this study, we conducted a model incubation experiment using natural hermatypic corals to evaluate the influence of uptake process of $PO_4^{3-}$ by corals on the $\delta^{18}O_p$. Live coral samples (*Porites cylindrica*, *Heliopora coerulea*, *Acropora digitifera*) were collected from coral reefs around Ishigaki Island (Okinawa) and Bolinao (northern Luzon), acclimatized in incubation aquaria for a few days, and then incubated for 3 to 5 days under natural light conditions with elevated concentrations of $NO_3^-$ and $PO_4^{3-}$. Subsamples of seawater were regularly collected and analyzed for the concentration and the $\delta^{18}$O of $PO_4^{3-}$. $PO_4^{3-}$ was usually taken up by corals linearly with incubation time, and the uptake rate apparently depended on temperature. Difference in the uptake rate between coral species was not significant. The $\delta^{18}O_p$ was initially approx. 3 ‰ lower than the equilibrium value with regard to oxygen-isotope exchange with ambient seawater. In a few cases, the $\delta^{18}O_p$ remained unchanged during the incubation even though uptake proceeded. In the other cases, however, the $\delta^{18}O_p$ gradually increased with time, and in some cases became even higher than the equilibrium value at the end of incubation. This observation suggests that kinetic isotope fractionation rather than simple equilibration operated during the uptake of $PO_4^{3-}$ by corals and influenced the $\delta^{18}O_p$. The magnitude of isotope effect associated with uptake seemed to depend on coral species, being the largest with *A. digitifera* and the smallest with *H. coerulea*. In natural environments where the concentration of $PO_4^{3-}$ is much lower than the incubation conditions we used, $PO_4^{3-}$ is presumably turned over much faster and the $\delta^{18}O_p$ is easily altered by corals and other major primary producers. This fact may limit the advantage of the $\delta^{18}O_p$ as an indicator of external $PO_4^{3-}$ sources.

Keywords: Phosphate, Isotope effect, Stable isotopes of oxygen, Hermatypic coral, Coastal marine ecosystem

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# Holocene sea-level record from a drilled core at land reclamation on reef crest in Okinawa Island

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Holocene sea level records provide the opportunity to understand reef formation history, mangrove development, and settlement by ancient people. Especially, the mid-Holocene sea-level record is important to accurate forecast coastal response to sea-level change in the near future because the amplitude of sea-level rise is similar to that of future sea-level rise. However, the magnitude and timing of Holocene sea-level records display great variability, inflecting ice sheet uploading and the redistribution of water masses in the global ocean, and glacio-isostatic and hydro-isostatic effects. Therefore, the local sea-level record is fundamental to a geological evidence for understanding the above topics. In the present study, we analyzed a drilled core and five radiocarbon ages at land reclamation on reef crest in Okinawa Island, Ryukyu Islands. Analyses of corals (*Isopora* sp. and *Goniastrea reriformis*) enable the reconstruction of a sea-level curve because these species are distributed in a shallow water depth. The Holocene sea-level curve reconstructed based on the drill core data reveals a sea-level rise until ca. 7000 cal. years BP. A mid-Holocene highstand occurred at 6760 cal. years BP, at a level of 2.7 m above the present mean sea level. The reconstructed mid-Holocene highstand is characterized by one of highest and oldest records in the Ryukyu Islands. The finding reflects the hydro-isostatic effect in response to size and volume of islands because Okinawa Island is the biggest island in the Ryukyu Islands.