Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

BBG22-P01 Room:Convention Hall Time:May 23 18:15-19:30

Biodiversity of upper mesophotic coral community in Okinawa.

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Mesophotic coral ecosystems (MCEs) are usually found at depth ranging from 30 to over 100 m depth. Mesophotic coral communities are often composed of both eurybathic tolerant species and species adapted to specific condition of the mesophotic zone. The taxonomic composition of such communities is still poorly known, yet important to conduct accurate paleoenvironmental interpretations of fossil reef deposits, especially in studies aiming to reconstruct past sea-level changes. Moreover, from a biological perspective, the Deep Reef Refugia Hypothesis (DRRH) states that mesophotic coral ecosystems, due to their more stable environmental conditions, may act as refugia for shallow water species to survive extreme climatic events and re-colonise shallower reefs in the future.

Recent global environmental changes affected seriously shallow coral reefs around Okinawa. The combination of major bleaching events and several typhoons lead to changes in coral communities with some species apparently extinct from several locations. Around Sesoko Island in the northern part of Okinawa, several corals species disappeared since 1999 and were not recorded since then (van Woesik et al. 2011). *Seriatopora hystrix* was one of those species.

During the recent survey of a mesophotic coral ecosystem located between Sesoko Island and Motobu Peninsula, high coral diversity and dense communities were found between 35 and 55 m depth including abundant populations of *S. hystrix* between 39 and 47 m. In order to estimate the coral biodiversity as well as the relationships between shallow and mesophotic corals, several genetic markers, both nuclear and mitochondrial, were sequenced for the samples collected. Symbiotic dinoflagellates were also identified. Here we will present the results of the molecular analyses showing the important coral diversity in this location. Our results also show intraspecific diversity within the population of *S. hystrix*. The genotypes of those deep populations correspond to genotypes previously observed from shallower reefs as well as to new genotypes. Such results suggest an absence of vertical structuring in Okinawan *S. hystrix* populations and support the (DRRH). In the future, and if shallow environmental conditions become suitable again for this species, deep populations of *S. hystrix* might be of critical importance for the re-colonisation of shallow coral reefs.

Reference: van Woesik R, Sakai K, Ganase A, Loya Y (2011) Revisiting the winners and the losers a decade after coral bleaching. Mar Ecol Prog Ser 434: 67-76

This research was supported by the Sasakawa Scientific Research Grant from the Japan Science Society (24-748) to FS and a Mitsubishi Grant to SH.

Keywords: Mesophotic, Deep Reef Refugia Hypothesis, Seriatopora

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BBG22-P02 Room:Convention Hall Time:May 23 18:15-19:30

Use of the isotope ratio of dissolved inorganic carbon for investigating the carbon cycle of coral reef ecosystems

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The isotopic composition of dissolved inorganic carbon ($d^{13}C_{DIC}$) has been determined for reef waters collected at subtropical coral reefs of Ishigaki Island, western North Pacific. Short-term (6 - 24 h) observation has been conducted several times at several different communities in summer (September) and winter (January). $d^{13}C_{DIC}$ varied between -0.2 and +3.2 per mil (vs. VPDB). Temporal pattern of $d^{13}C_{DIC}$ was significantly different between winter and summer, with the diurnal variation being much larger in summer. Both the concentration of DIC (c_{DIC}) and the alkalinity (A_T) decreased while the $d^{13}C_{DIC}$ increased during daytime due to active uptake by photosynthesis and calcification of reef primary producers. The opposite temporal pattern was observed at night. The gradient of the c_{DIC}-$d^{13}C_{DIC}$ regression line was almost same for different coral communities and seagrass beds. However, the gradient of the A_T-$d^{13}C_{DIC}$ regression line was somewhat larger for seagrass beds and *Heliopora*-dominated communities than for branching coral-dominated communities, possibly reflecting difference in the isotope fractionation by photosynthetic uptake of DIC. The $d^{13}C_{DIC}$ at a given c_{DIC} or A_T was constantly lower for the seagrass beds than the coral communities, which could be ascribed to the addition of groundwater DIC to the seawater of nearshore seagrass beds. The overall results suggested that, by carefully correcting for the difference in the isotope fractionation during uptake processes and incorporating into an appropriate numerical model, the c_{DIC}-A_T-$d^{13}C_{DIC}$ systematics can be used for simultaneous quantitative evaluation of the magnitudes of photosynthesis, calcification, respiration, and input of exogenous DIC such as groundwater DIC at coral reefs.

Keywords: coral, seagrass, carbon isotope, DIC, isotope fractionation, groundwater

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BBG22-P03 Room:Convention Hall Time:May 23 18:15-19:30

Climate change influences on coral growth tested by a culture experiment of temperate species

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Recently, it has been reported that rising temperature of sea surface by global warming causes quick poleward range shift and/or expansion of some coral species around Japan. This is probably because the influences from not only rising temperature by global warming but also ocean acidification. The ocean acidification has been decreasing pH and Omega (saturation state of $CaCO_3$) in seawater, which would cause negative impact on calcification in coral skeleton composed of $CaCO_3$ (aragonite). However, the influences of climate changes on ”expanded” corals and corals, which are distributed in northern limited, have not yet been tested in detail. In this study, we focus on the corals distributed in the temperature zone and conducted culture experiment on these corals in order to reveal the impacts of global warming and ocean acidification on coral growth.

To evaluate coral growth by enhanced global warming and ocean acidification followed by continuous CO_2 emission, two culture experiments, ”Temperature experiments with large Omega gradient” and ”Temperature experiments with normal Omega gradient”, both of which have 5 temperature settings, were conducted. ”Temperature experiments with large Omega gradient” had Omega of 3.1 - 1.8, which were from high to low temperature, as a result of adjusting partial pressure of carbon dioxide (pCO_2) to achieve constant pCO_2 concentration throughout all temperature settings. In contrast, ”Temperature experiments with normal Omega gradient” had Omega of 2.4 - 2.1, which were little change with temperature because of no addition of CO_2 in all temperature settings.

The results of both two culture experiments showed that all coral species were bleached and died at 13 deg C treatment, suggesting that low temperature of seawater during the winter season could be a limited factor of northern distribution of temperate corals. On the other hand, suppression of coral growth according with the decreasing of carbonate saturation state indicated that ocean acidification effect could also be negative influence on calcification of corals. Recent modeling study provided a prediction in which the distribution of temperate coral around Japan might be limited by ongoing ocean acidification rather than increasing seawater temperature. Our experimental study suggests that the growth rate of temperate corals are potentially affected by decreasing Omega and that expansion of temperate corals towards the north accompanying with global warming would be suppressed by ocean acidification in the near future.

Keywords: coral, global warming, ocean acidification

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BBG22-P04 Room:Convention Hall Time:May 23 18:15-19:30

Supratidal beach sediment cores as recorders of long-term environmental and ecological changes in coral-reef ecosystems

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Coral reef ecosystems have been degraded worldwide. Modeling and culturing studies have been conducted to predict future outcomes of coral reef ecosystems. However, few studies conducted long-term (10-100 years scale) environmental changes and associated ecological changes in coral reef ecosystems, data on which would provide insight into long-term effects of global environmental changes and anthropogenic impacts on coral reef ecosystems. Here we focused on supratidal sediment cores as potential recorders of long-term (10-100 year scale) environmental and ecological changes in coral reef ecosystems. Approximately two-meter sediment cores were taken from supratidal zones of Sesoko Beach (Sesoko Island, Okinawa) and Yakomo Beach (Okinoerabu Island, Kagoshima). Sedimentary structure, grain size composition, bioclastic composition, and radiocarbon ages of bioclasts (coral/mollusk/foraminifer) were examined. Based on sedimentary features and grain-size variations, cores were divided into three parts (lower, middle and upper units), each of which indicates intertidal, storm, and aeolian deposits, respectively. Radiocarbon ages of coral fragments suggest that the two-meter cores were deposited in recent times (after 1950 yr AD). Bioclastic compositions indicate no ecological changes since the deposition of these cores. The shell morphology and weight of Baculogypsina (symbiont-bearing hyaline foraminifers) indicate that the modern tests grew larger and heavier than fossil tests (ca. 1300 yr AD), which are possibly due to biological consequences of ocean acidification and global warming.