©2015. Japan Geoscience Union. All Rights Reserved.

BBG21-01 Room:304 Time:May 27 09:00-09:20

The role of coral mucus in the material cycle in reef ecosystems

NAKAJIMA, Ryota[1*]

[1]Department of Marine Biodiversity Research, JAMSTEC

It is well known that corals release transparent and mucoid organic matter (coral mucus) to the ambient seawater. This mucus release is important for various physiological functions of corals such as defense against stress, particle trap and cellular metabolic regulation. Coral mucus is mainly composed of carbohydrates, proteins and lipids, of which most are dissolved organic matter and thus utilized by heterotrophic bacteria and incorporated into the microbial loop. A fraction of the mucus, with its high molecular weight and sticky properties, captures large amounts of particulate organic matter in the seawater, forming large organic aggregates which are efficiently assimilated into higher trophic levels. Thus, coral mucus is incorporated into reef organisms in a variety of processes and functions as an important organic energy source in reef systems. This paper reviews some types of mucus forms, chemical composition and production rates of mucus, and the contribution of mucus to material recycling and heterotrophs from biogeochemical and ecological perspectives and the possible loss of reef biogeochemical processes and functions by ecosystem degradation due to global climate change and anthropogenic impact.

Keywords: Scleractinian corals, mucus, zooxanthellae, bacterial degradation, particle trap, trophic structure

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

BBG21-02 Room:304 Time:May 27 09:20-09:35

Reef environmental changes under anthropogenic influences: sediment cores beneath the reclaimed areas of Naha City

FUJITA, Kazuhiko[1*] ; HONGO, Chuki[1] ; KAWASAKI, Yuko[1] ; MINEI, Shogo[1] ; SASAKI, Toru[1]

[1]Fac. Sci. Univ. Ryukyus

Coral reef ecosystems are now being threatened by global environmental changes and human impacts. However, it is still argued that when and how increasing human populations historically affect coral reef ecosystems. This is because limited studies have been conducted on long-term environmental and ecological changes in coral reefs. In this study, we examined the geochemistry and micropaleontology of sediment cores drilled from the reclaimed areas of Naha City (Okinawa Prefecture, Japan), where pristine coral reefs had been reclaimed. 10-m deep cores with a recovery of >90% were obtained from six sites in coastal reclaimed areas of Naha City. In order to determine the timing and impacts of anthropogenic influences (e.g., terrigenous inputs and human activity), major elements ratio (e.g,, SiO2/CaO) was measured by EDX (XRF), and mineral compositions (quartz/carbonates) were determined by XRD. To reveal long-term reef environmental changes, grain-size compositions, and the taxonomic composition and abundance of foraminiferal assemblages were analyzed. Results showed that Holocene sediments with several meters in thickness cover the Pleistocene limestone (the Ryukyu Group), and are overlain by landfill sediments and soils. The Holocene cores consist mainly of bioclastic carbonate sand and mud with *in situ* corals and coral gravels, and increasingly contain terrigenous siliciclasts in the upper part of cores. Radiocarbon ages of fossil *in situ* corals and molluscs indicate that coral reefs developed at least 7-6 ka in offshore areas, and at ca. 5-4 ka in inshore areas, and that some cores may record historical changes in terrigenous sediment inputs into coral reef environments, starting from periods of Gusuku and Ryukyu Kingdom.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

BBG21-03 Room:304 Time:May 27 09:35-09:50

Linkage between the declines in Porites coral skeletal growth and a land improvement project on Ishigaki Island, Japan.

SOWA, Kohki[1*] ; WATANABE, Tsuyoshi[2] ; YAMANO, Hiroya[3] ; HAYASHI, Seiji[3]

[1]Department of Chemistry, Faculty of Science, Toho University, [2]Faculty of Science, Hokkaido University, [3]National Institute for Environmental Studies

Recent anthropogenic pollution has adversely impacted the physiology of reef-building corals. However, insufficient empirical data on the relationship between coral skeletal growth (calcification rate and skeletal density) and the degree of anthropogenic pollution are available. We conducted an analysis of *Porites* coral growth (N = 6) in the Shiraho Reef at the mouth of the Todoroki River on Ishigaki Island, Japan, over the 52 years from 1958 to 2009. Declines in calcification and skeletal density with no obvious sign of growth cessation or disease occurred in the 1970s-1980s, which coincided with the start of the public land improvement project on Ishigaki Island. The median calcification and skeletal density values were lower after the 1970s-1980s than those before the 1970s-1980s, and these differences were correlated with the degree and type of land use and development. Thus, the nutrient/sediment loads from the Todoroki River, which were related to the degree and type of land use and development, resulted in decreased calcification and skeletal density in the coral. The coral growth after the 1970s-1980s was not related to thermal stress. After the 1970s-1980s, the relationship between coral growth and environmental factors changed, which suggested that the coral physiological responses observed in the 1970s-1980s were related to the land improvement project.

Keywords: coral calcification, coral skeletal density, land improvement project

©2015. Japan Geoscience Union. All Rights Reserved.

BBG21-04 Room:304 Time:May 27 09:50-10:05

Local Ocean Acidification Caused by Mariculture Activities in Coastal Areas of Bolinao, Northwestern Philippine

WATANABE, Atsushi[1*] ; MIYAJIMA, Toshihiro[2] ; KURIHARA, Haruko[3] ; MCGLONE, Maria lourdes s.d.[4] ; HERRERA, Eugene[5] ; NADAOKA, Kazuo[1]

[1]Tokyo Institute of Technology, [2]AORI, University of Tokyo, [3]Faculty of Science, University of the Ryukyus, [4]Marine Science Institute, University of the Philippines-Diliman, [5]College of Engineering, University of the Philippines-Diliman, Philippines

Ocean acidification (OA) due to anthropogenic CO_2 emissions is a dominant driver of long-term changes in carbonate chemistry such as pH and pCO_2 in the open ocean. However in coastal areas, local and regional drivers interact with the anthropogenic CO_2 emissions and cause complex changes in seawater pH. High productivity in coastal ecosystems itself changes pH. Due to increase in coastal populations, increasing utilization of coastal areas for mariculture activities can be anticipated and the degradation of environment due to such activities are of concern. However, the relationship between such degradation and local OA has not been well documented so far. Here we examined possible impacts of extensive mariculture activities and ecosystem productivity in Bolinao, Northwestern Philippine, on seawater pH and other carbonate parameters.

We conducted temporal, 24-hr measurements of pH, pCO_2, etc. at the aquaculture and reef sites in Bolinao in March 2011 (dry season) and September 2011 (wet season). The aquaculture site is located in the narrow channel where hundreds of mariculture structures can be found. The reef site is located in the shallow Seagrass meadow which faces the open ocean. We also conducted spatial measurements of pH, pCO_2 , etc. around the same sites in September 2012 (wet season) and March 2013 (dry season). To see the longer trend, we deployed pH loggers at aquaculture and reef sites in the surface from March 7 to May 21, 2014 (at the aquaculture site until May 4 because of the sensor breakage) in the dry season and from September 28 to December 6, 2014 in the wet season. In Bolinao area, salinity during dry season is kept at 33 PSU or so and does not differ so much from the open ocean, while salinity during wet season decreases to 20 PSU or lower in all areas in the surface.

The snapshot measurements showed that at the reef site pH (pCO_2) was increased (decreased) significantly compared to the offshore values both in dry and wet seasons, whereas at the aquaculture site pH (pCO_2) was unchanged or decreased (increased) depending on the time. The long-term pH data also showed that the aquaculture site had lower pH compared to the offshore level, sometimes reaching as low as 7.5, while the reef site had higher pH sometimes reaching above 8.5 in the daytime. The daily pH variations at the aquaculture site was typically 0.2-0.3 unit, while those at the reef site was 0.5 or more. From these results, we conclude that the aquaculture site exhibits pronounced OA due to local influence from the mariculture activities, and the reef site has buffers against OA mainly caused by high primary productivity of seagrasses in the area.

Keywords: Ocean acidification, pH, Mariculture, Seagrass meadow

©2015. Japan Geoscience Union. All Rights Reserved.

BBG21-05 Room:304 Time:May 27 10:05-10:20

Reef-scale modeling system for evaluating and predicting coral responses to future environmental changes

NAKAMURA, Takashi[1*] ; NADAOKA, Kazuo[1] ; WATANABE, Atsushi[1] ; YAMAMOTO, Takahiro[1]

[1]Tokyo Institute of Technology

Coral reefs exhibit significant spatiotemporal variations in temperature, CO_2 system parameters (dissolved inorganic carbon, total alkalinity, pH, $CaCO_3$ saturation state, etc.), flow field, etc. Therefore it is difficult to regard any coral incubation experiments as those simulating actual environmental conditions, because many experiments are conducted under steady or gradually changing environmental conditions. Reconstruction of reef environments by numerical hydrodynamic simulations is getting close to practical use level with the developments in computer simulation technology (e.g., Watanabe et al. 2013). Development of a sophisticated coral-response model coupled with a reef-scale hydrodynamic model is an effective approach for evaluating and predicting reef responses to the changes in various environmental conditions. For this purpose, we recently developed a coral polyp model (Nakamura et al. 2013), which can well reconstruct the coral responses to ocean acidification, flow conditions and others. We then incorporated it into a reef-scale model based on a 3D hydrodynamic model (ROMS) following the Carbonate System Dynamics (CSD) model (Watanabe et al. 2013). The developed model system was applied to the Shiraho fringing reef, Ishigaki Island, Japan, and it was confirmed that the model system well reconstructed the spatiotemporal variations of the reef environmental parameters. According to IPCC (2013), pCO_2 will reach at ca. 935 μatm and sea-level will rise to ca. 0.45-0.82 cm for late 21st century if we select the RCP8.5 scenario. Therefore we analyzed four different scenarios: (1) present condition, (2) high pCO_2 (~935 μatm) condition, (3) high sea-level condition (63 cm higher than present), and (4) high pCO_2 and high sea-level condition. The simulation result of high-pCO_2 condition indicated that the coral calcification rate will decrease to ca. 75% from the present condition. When the sea-level will be 63 cm higher than the present condition, the calcification will increase to ca. 107% because both the mass exchange between the corals and their ambient sea water and that between inside and outside of the reef will be enhanced due to higher flow condition. When both pCO_2 increase and sea-level rise will occur, the calcification rate will decrease to ca. 77%. This rate is lower than the present condition but it keeps higher than the case only with high-pCO_2 effect. The results imply that comprehensive evaluation of concurrent multiple environmental effects is important for future predictions.

Keywords: coral polyp model, reef scale, numerical simulation, ocean acidification, sea-level rise

©2015. Japan Geoscience Union. All Rights Reserved.

BBG21-06 Room:304 Time:May 27 10:20-10:40

Deterioration of tropical coastal ecosystems by multiple human impacts: the effects through seascape connectivity

NAKAOKA, Masahiro[1*]

[1]Akkeshi Marine Station, Field Science Center for Northern Biosphere, Hokkaido University

Coastal ecosystems in tropical regions consist of major seascapes such as coral reefs, seagrass beds and mangrove, which occur in mosaic patterns. Diversity and connectivity of these seascapes have great effects on ecosystem functions and services of coastal area. The present paper aims to review some important effects of seascape connectivity in tropical coastal areas, based on our recent studies conducted in Okinawa, Thailand and the Philippines. I also preview how climate changes and other types of human-induced threats affect coastal ecosystems via changes in connectivity among different components of seascapes, and finally consider effective conservation and adaptation strategies against degradation of coastal ecosystems.

Interrelationships among different seascape/landscape components have been most investigated on the aspects of material and nutrient flows among these habitats using biogeochemical techniques such as stable isotope analyses. For example, it has been pointed out that major carbon and nitrogen sources for organisms in seagrass beds and coral reefs often come from mangrove and/or upper basins. Furthermore, the broad-scale studies comparing several seagrass beds facing different areas of watershed revealed that biodiversity and ecosystem functions of seagrass beds are highly affected by the amount and patterns of terrestrial input from river basins.

Another important aspect of seascape connectivity has been highlighted by the studies investigating multiple habitat uses by animals in coastal areas, especially by large-sized animals such as fish, birds and mammals which are highly mobile. Fish census survey revealed that major reef fish species which are commercially important generally change their habitats ontogenetically from mangrove, seagrass beds to coral reefs. In addition, acoustic telemetry studies which continuously monitor behavior of large-sized fish showed that they migrate frequently between seagrass beds and coral reefs on a daily basis. Although these higher-level consumer contribute relatively low in terms of energy and material flows in coastal ecosystems, they sometimes changes abundance and diversity of seascape-forming organisms by strong top-down effects. Its quantitative evaluation, however, remain to be conducted in future studies.

Global climate changes and other local human-induced stresses negatively affect ecosystem functions derived by such seascape connectivity. The most serious, but less studies problems are the interacting effects of multiple stressors which operate in a synergistic way and cause nonlinear, unpredictable changes in coastal ecosystems. For example, shallow coastal seascapes such as mangrove and intertidal seagrass beds are heavily affected by the interacting effects of sea level rise and coastal development (constructions of dikes, ports, resort hotels, etc.). Similarly, sea use conversion from mangrove to shrimp ponds leads to loss of disaster prevention functions of coastal areas, which become more vulnerable to severe disturbance by typhoons intensified with climate changes.

To solve these problems on multiple, non-linear impacts of human-induced threats, it is primarily important to carry out conservation of coastal areas with healthy combination of seascape components. For example, to set a marine protected area (MPA), it becomes more effective to place one to include mangrove, seagrass beds and coral reefs in conjugation rather than separately. For the restoration of lost habitats, arrangement and interactions of different seascape components should also be taken into account. Poor restoration practices, such as planting mangroves in healthy seagrass beds, should be avoided through consultant with stakeholders and scientists.

Keywords: coastal ecosystem, seascape, ecosystem connecivity, biodiversity, climate change, human impact