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

BBG22-01 Room:102B Time:May 23 16:15-16:30

Regional Coral Monitoring and Viability by Boat-based Observation

Masahiko Sasano[1*], Kenkichi Tamura[1], Nobuo Kiriya[1], Motonobu Imasato[1], Hiroya Yamano[2], Hiroyuki Oguma[2]

[1]National Maritime Research Institute, [2]National Institute for Environmental Studies

There are concerns about coral decline all over the world due to global climate changes or tropical land developments, etc. To establish the current status of coral distribution, a large-area, high-efficiency coral monitoring method is required. In this study, a new coral monitoring technique is developed based on a boat observation. It can cover the survey line of more than 100 m length easily, which is difficult by the diving investigation. This technique is applied by properties of fluorescent proteins innate in hermatypic corals. It is called a boat-based fluorescent imaging LIDAR (LIght Detection And Ranging) technique, which shoot UV (Ultra Violet) pulsed laser from the boat to the seafloor, and take a frame by a gated ICCD camera in synchronization with laser. It makes possible to get only a weak coral fluorescent image by UV excitation and suppressed the sunlight background effect, since the pulse width of the laser is only less than 10 ns, and the exposure time of the gated ICCD camera is only around 100 ns. Most of live hermatypic corals have fluorescent proteins, and they show blue to green fluorescence by UV excitation. In contrast, after death of the hermatypic corals, fluorescent proteins are degraded, and algae attached dead coral skeleton wouldn’t show blue to green fluorescent light. Therefore, in this observation technique, existence of corals can be judged by the image, and the viability of corals can be judged by the contrast of fluorescent image. This coral observation technique can ensure the long survey line along with the boat track, by simultaneous observation with DGPS position observation, SONAR depth observation and video observation, etc. We have succeeded in observing coral distribution including viability determination along with more than 1 km boat track of a glass-bottom-boat in Taketomi-island, Okinawa, Japan.

Keywords: coral, fluorescence, monitoring, laser, lidar

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

BBG22-02 Room:102B Time:May 23 16:30-16:45

Fossil corals record 6000 year history of typhoon activity in the Northwest Pacific

Chuki Hongo[1*]

[1]Department of Physics and Earth Sciences, University of the Ryukyus

Prediction of future typhoon activity is important for determining their role in ecological disturbance and economic loss. Recent increase in sea surface temperatures (SSTs) caused by anthropogenic impacts has led to an increase in intense typhoons. However, instrumental records of typhoon are too short and unreliable to reveal trends in the typhoon activity. Understanding long-term variability of past typhoons is important for assessing whether changes in the variability are induced ongoing increase in SSTs. Fossil tabular corals preserved in raised reef coast offer new indicator to understand the variability of past typhoon intense. This study presents a record of typhoon activity in the Northwest Pacific over the past 6000 years based on fossil tabular corals (*Acropora digitifera*) from Kikai Island in the Ryukyu Islands that are characterized by the variability of size related to typhoon intense. The record indicates that the frequency of typhoon has varied on millennial scales over this period; it weakened during the mid Holocene climatic optimum and it strengthened over the past 2000 years. The variability of typhoon intense was correlated with the strength of El Nino-Southern Oscillation (ENSO) during the past 6000 years. This data suggests that it is important to understand the variability of ENSO and locations of genesis of typhoon for prediction of the change in typhoon activity near future. Therefore, the information implies that recent increases in SSTs are probably not the important drivers of typhoon activity.

This research was supported by JSPS KAKENHI Grant Number 24-4044 and JSPS Research Fellowships for Young Scientists (24-4044).

Keywords: typhoon, fossil coral, Kikai Island, ENSO

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

BBG22-03 Room:102B Time:May 23 16:45-17:00

Ocean acidification impacts on coral biodiversity and productivity

Haruko Kurihara[1*]

[1]University of the Ryukyus

Introduction

Threatening of coral reefs by the climate change induced ocean acidification is now one of the biggest issues in the ocean ecosystem. Ocean acidification decreases the calcium carbonate saturation station, which result in the decrease of calcification rate of many calcifiers (Gattuso 1998, Kleypas 2004). Otherwise, the increase of seawater pCO_2 is predicted to increase the photosynthesis rate of phytoplankton and algae. Additionally, the seawater pH change will potentially affect the acid-base balance of marine organisms and impact their metabolic activity. In this study we focused on corals, and we experimentally evaluate the effects of ocean acidification on their physiology (calcification / photosynthesis / respiration). By integrating the future climate changing models and present results, we will discuss the potential impacts of ocean acidification on the coral biodiversity and productivity.

Methods

Three branching coral species from the family Acroporidae (*Acropora digitifera*, *A. tenuis* and *Montipora digitata*), and one encrusting coral species from the family Siderastreidae (*Psammacora contigua*) were collected from the patchy reefs in Okinawa island. All these species are highly common in the indo-pacific coral reefs. Several nubbins or mass of corals were taken from different colonies (5˜10) and cultured for about one month under 3 different seawater pCO_2 conditions (380 ˜2,300 ppm). These CO_2 conditions were selected according to the IPCC2007 models. All cultures were conducted under natural light conditions and flow through system. The seawater chemistry (pH, total alkalinity, salinity, temperature) was measured every day. Buoyant wet-weight was measure every week, and the physiology (calcification / photosynthesis / respiration) was measured at the end of culture using total alkalinity (TA) and total inorganic carbon (DIC) measurement technique.

Results and discussion

The sensitivity of corals to the ocean acidification was highly diverse among species. While *Montipora digitata* showed the highest decrease on calcification rate, *Psammacora contigua* show less sensitivity and *A. digitifera* was completely insensitive to high CO_2. Additionally, light and dark calcification rate were differently affected between species, and we suggest that dark calcification is possibly one of the keys that dominate the sensitivity of corals to the ocean acidification.

Photosynthesis rate of most corals was not affected by ocean acidification. Otherwise, the respiration rate of both *A. tenuis* and *P. contigua* increase with seawater pCO_2 rise. Since the metabolic activity of corals highly influence the seawater carbonate chemistry, these physiological impact induced by the ocean acidification is suggested to feed back on the reef water carbonate chemistry and may change the coral reef carbon cycle. Additionally, the species-specific response of corals to the ocean acidification is suggested to change the coral community structure and may result in the decrease of coral reef biodiversity.

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

BBG22-04 Room:102B Time:May 23 17:00-17:15

The stable isotope composition of reef-dwelling foraminifers subjected to varied pCO_2 seawater

Mana Hikami[1*], Toyoho Ishimura[2], Kazuhiko Fujita[3], Atsushi Suzuki[4], Yukihiro Nojiri[5], Kazuhiko Sakai[6], Hodaka Kawahata[1]

[1]Atmosphere and Ocean Research Institute, The University of Tokyo, [2]Department of Chemistry and Material Engineering, Ibaraki National College of Technology, [3]Department of Physics and Earth Sciences, University of the Ryukyus, [4]Geological Survey of Japan, AIST, [5]Center for Global Environmental Research, NIST, [6]Tropical Biosphere Research Center Sesoko Station, University of the Ryukyu

Ocean acidification in response to rising atmospheric pCO_2 is generally expected to reduce rates of calcification by reef calcifying organisms, with potentially severe implications for coral reef ecosystems. Various studies have revealed potentially dramatic responses in a variety of calcareous organisms to the range of pCO_2 values projected to occur over this century. In our previous culture experiment with reef-dwelling foraminifers, *Amphisorus kudakajimensis* and *Calcarina gaudichaudii* at five different pCO_2 conditions seawater for four weeks, net calcification of *A. kudakajimensis* was reduced under higher pCO_2, whereas calcification of *C. gaudichaudii* generally increased with increased pCO_2. The contrasting responses are possibly due to differences in calcification mechanisms, but the factors affecting these calcification mechanisms are poorly understood. In this study, to get better understanding of the effect of ocean acidification on foraminiferal calcification, we cultured three reef-dwelling foraminifers: *Amphisorus hemprichii*, belong to imperforate species, *Baculogypsina sphaerulata* and *C. gaudichaudii*, belong to perforate species, using same experiment systems in the seawater of five different pCO_2 conditions for twelve weeks and we address the response of carbon and oxygen isotope compositions of the carbonate shells of foraminifers. Oxygen isotope value of cultured foraminiferal tests under five varied pCO_2 seawater indicated no significant correlation to pCO_2 values. The oxygen isotope values stay constant within narrower range from carbonate ion concentration. On the other hand, carbon isotope of foraminiferal tests indicated heavy trend with rising pCO_2 in all species. Alteration of carbonate chemistry result from ocean acidification may be effect strongly on carbon isotope composition relate to metabolic system. In perforate species, carbon isotopes are close to DIC value with increasing CO_2. It is possible that decreasing of metabolic CO_2 supply for the shell construction. In perforate species, both of oxygen and carbon isotope was lower than that in imperforate. For oxygen isotope variation possibility among species would be caused by their Mg-content concentration in calcite shells. The distinct difference in the level of carbon isotope values between pure calcite and perforate foraminifera might be influenced by the degree of dependency on metabolic CO_2 used for shell construction. While ˜7% of the carbon used for calcification would be derived from respiratory for the perforate species, the imperforate species would use most carbon derived from bicarbonate ion of seawater directly because carbon isotope of shell is almost same to that of pure calcite. This study suggested that oxygen and carbon isotope of foraminiferal test have the potential to reveal difference in calcification mechanism of two species.

Keywords: stable isotope, reef-dwelling foraminifera, ocean acidification

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

BBG22-05 Room:102B Time:May 23 17:15-17:30

Projected shift of coral habitats around Japan under different future CO2 emission scenarios

Yumiko Yara[1*], YAMANO, Hiroya[1], STEINACHER, Marco[2], FUJII, Masahiko[3], VOGT, Meike[4], GRUBER, Nicolas[4], YAMANAKA, Yasuhiro[3]

[1]National Institute for Environmental Studies, [2]University of Bern, [3]Faculty of Environmental Earth Science, Hokkaido University, [4]Environmental Physics Group, Institute of Biogeochemistry and Pollutant Dynamics, ETH Zurich

We estimate the effects of both global warming and ocean acidification on potential habitats for corals around Japan under different future CO2 emission scenarios (SRES A2 and B1), based on published estimates and newly developed datasets on sea surface temperatures (SSTs) and aragonite saturation states ($OMEGA_{arag}$). The difference in the future coral habitats caused by higher SSTs and lower $OMEGA_{arag}$ between the two scenarios was significant, suggesting possible conserve coral habitats under the A2 and B1 scenarios, respectively. We conclude that both reducing CO2 emissions and setting up conservation plans to reduce direct anthropogenic effects would be required to save corals in the future.

Keywords: Coral, Global warming, Ocean acidification, Climate model, CO2 emission scenario

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

BBG22-06 Room:102B Time:May 23 17:30-17:45

Temperate coral reefs and coral communities and their recent changes

Hiroya Yamano[1*], Kaoru Sugihara[1]

[1]National Institute for Environmental Studies

Latitudinal gradients of coral reef geomorphology and coral communities are observed in Japan, as it covers a wide latitudinal range, stretching from subtropical to temperate areas. While the northernmost coral reef was found in Iki Island, Nagasaki Prefecture, coring and age determination revealed existence of a coral reef at a higher latitude, Tsushima Island (Yamano et al., 2012; Geology). The coral reef was composed of faviid corals, which shows substantial difference from coral reefs in tropical and subtropical areas with acroporid corals. Recently, settlement of warm-temperate species, Acropora solitaryensis was observed in the vicinity of the coral reef. Data mining of coral occurrence from the 1930s showed poleward range expansion of not only A. solitaryensis but also tropical-subtropical species, A. muricata, A. hyacinthus and Pavona decussata (Yamano et al., 2011; GRL). The maximum speed of the range expansions was 14km/year. Warming sea surface temperatures in the last century was attributed to the expansions. Corals are some of the world’s most important species, being not only primary producers, but also habitat-forming species, and thus fundamental ecosystem modification is expected according to changes in their distribution.

Keywords: coral, poleward expansion, global warming