

船舶観測による広域サンゴモニタリングと生死判別 Regional Coral Monitoring and Viability by Boat-based Observation

篠野 雅彦^{1*}, 田村 兼吉¹, 桐谷 伸夫¹, 今里 元信¹, 山野 博哉², 小熊 宏之²

Masahiko Sasano^{1*}, Kenkichi Tamura¹, Nobuo Kiriya¹, Motonobu Imasato¹, Hiroya Yamano², Hiroyuki Oguma²

¹ 海上技術安全研究所, ² 国立環境研究所

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

地球規模の気候変動や熱帯地域の土地開発等により、世界規模で造礁サンゴの衰退が懸念されている。このため、サンゴ分布の現状をあきらかにするために、サンゴ生息海域における広範囲で高効率のサンゴモニタリング法が求められている。本研究では、潜水調査等ではカバーすることの難しい、100m以上の観測ラインのサンゴモニタリングを、小型船舶から高効率で実施することのできる、新しいモニタリング手法の開発を行った。この手法は、造礁サンゴに特有の蛍光たんぱく質の特性を利用したものであり、小型船舶から海底に向かって紫外線(UV)パルスレーザーを照射し、海底で生じる蛍光を、小型船舶上のゲートICCDカメラで撮影する、船舶搭載イメージング蛍光ライダー観測法である。パルスレーザーの射出時間は10ナノ秒以下と短く、ゲートICCDカメラの露光時間も100ナノ秒程度の短時間に抑えることができるため、日中でも太陽背景光の影響を抑制し、UVパルスレーザー励起によるサンゴの弱い蛍光イメージのみをとらえることが可能である。生きた造礁サンゴの多くは蛍光たんぱく質を有し、UV励起に対して青色から緑色の蛍光を示すのに対して、造礁サンゴが死ぬと蛍光たんぱく質が分解されるため、死んだサンゴ骨格、またはサンゴ骨格の表面に藻類が付着した状態となり、青色から緑色の蛍光を示さなくなる。このため、本観測法では、撮影画像中の対象物の形状を確認することで、サンゴの有無を判別することが可能であり、そのサンゴが蛍光を示しているかどうかを確認することで、サンゴの生死判別が可能である。このようなサンゴ観測を、DGPSによる船舶位置観測、SONARによる水深観測、ビデオ撮影による海底映像等と同時に記録することにより、小型船舶の航跡に沿って長距離の観測ラインを確保することが可能である。このサンゴ観測法により、沖縄県八重山郡竹富島周辺海域でグラスボートを用いて、サンゴの生死判別も含めて1km以上の観測ラインのサンゴ分布観測に成功した。

キーワード: サンゴ, 蛍光, モニタリング, レーザー, ライダー

Keywords: coral, fluorescence, monitoring, laser, lidar

化石サンゴから復元した北西太平洋における過去 6000 年間の台風履歴 Fossil corals record 6000 year history of typhoon activity in the Northwest Pacific

本郷 宙軌^{1*}
Chuki Hongo^{1*}

¹ 琉球大学理学部物質地球科学科

¹Department 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.

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キーワード: 台風, 化石サンゴ, 喜界島, ENSO
Keywords: typhoon, fossil coral, Kikai Island, ENSO

海洋酸性化がサンゴ群集の多様性および生産性に及ぼす影響 Ocean acidification impacts on coral biodiversity and productivity

栗原 晴子^{1*}

Haruko Kurihara^{1*}

¹ 琉球大学

¹University 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 pCO₂ 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 pCO₂ conditions (380 ~2,300 ppm). These CO₂ 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 CO₂. 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 pCO₂ 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.

キーワード: 酸性化, サンゴ, 石灰化, サンゴ礁, 気候変動

海洋酸性化によるサンゴ礁棲有孔虫殻の安定同位体比の変化

The stable isotope composition of reef-dwelling foraminifers subjected to varied pCO₂ seawater

氷上 愛^{1*}, 石村 豊穂², 藤田 和彦³, 鈴木 淳⁴, 野尻 幸宏⁵, 酒井一彦⁶, 川幡 穂高¹

Mana Hikami^{1*}, Toyoho Ishimura², Kazuhiko Fujita³, Atsushi Suzuki⁴, Yukihiko Nojiri⁵, Kazuhiko Sakai⁶, Hodaka Kawahata¹

¹ 東京大学大気海洋研究所, ² 茨城工業高等専門学校物質工学科, ³ 琉球大学理学部物質地球科学科, ⁴ 産業技術総合研究所地質情報研究部門, ⁵ 国立環境研究所地球環境研究センター, ⁶ 琉球大学熱帯生物圏研究センター瀬底研究施設

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 Ryukyus

Ocean acidification in response to rising atmospheric pCO₂ 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 pCO₂ values projected to occur over this century. In our previous culture experiment with reef-dwelling foraminifers, *Amphisorus kudakajimensis* and *Calcarina gaudichaudii* at five different pCO₂ conditions seawater for four weeks, net calcification of *A. kudakajimensis* was reduced under higher pCO₂, whereas calcification of *C. gaudichaudii* generally increased with increased pCO₂. 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 pCO₂ 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 pCO₂ seawater indicated no significant correlation to pCO₂ 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 pCO₂ 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 CO₂. It is possible that decreasing of metabolic CO₂ 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 CO₂ 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.

キーワード: 安定同位体比, サンゴ礁棲有孔虫, 海洋酸性化

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

地球温暖化に伴う水温上昇および海洋酸性化が日本近海のサンゴ分布に及ぼす影響 ~ CO2 排出シナリオの違いから ~

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

屋良 由美子^{1*}, 山野 博哉¹, スティンナッチャー マルコ², 藤井 賢彦³, ボグト マイケ⁴, グル バー ニコラス⁴, 山中 康裕³

Yumiko Yara^{1*}, YAMANO, Hiroya¹, STEINACHER, Marco², FUJII, Masahiko³, VOGT, Meike⁴, GRUBER, Nicolas⁴, YAMANAKA, Yasuhiro³

¹ 国立環境研究所, ² ベルン大学, ³ 北海道大学, ⁴ スイス連邦工科大学チューリッヒ校

¹National Institute for Environmental Studies, ²University of Bern, ³Faculty of Environmental Earth Science, Hokkaido University, ⁴Environmental 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.

キーワード: サンゴ, 地球温暖化, 海洋酸性化, 気候モデル, CO2 排出シナリオ

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

温帯のサンゴ礁・サンゴ群集と最近の変化 Temperate coral reefs and coral communities and their recent changes

山野 博哉^{1*}, 杉原 薫¹
Hiroya Yamano^{1*}, Kaoru Sugihara¹

¹ 国立環境研究所
¹ National Institute for Environmental Studies

南北に長い日本では、南から北へとサンゴ礁地形やサンゴ群集の緯度勾配に沿った変化が観察される。これまで、サンゴ礁の北限は長崎県壱岐と考えられてきたが、ボーリングと年代測定により北限が対馬であることが確認された (Yamano et al., 2012)。このサンゴ礁はククメイシ科のサンゴで形成されており、沖縄など熱帯・亜熱帯で見られるミドリイシ科主体のサンゴ礁とは形成種が全く異なっている。最近、このサンゴ礁の近傍で、暖温帯性のエンタクミドリイシの定着が確認された。日本沿岸においては、1930年代から現在にかけての数時期にサンゴの調査が行われており、その結果をデータベース化することにより、エンタクミドリイシのみならず、熱帯・亜熱帯性のスギノキミドリイシ、クシハダミドリイシ、シコロサンゴが分布北上しており、北上速度は最大で 14km/年であることが明らかとなった (Yamano et al., 2011)。日本近海では最近 100 年間に水温が 1~1.6 度程度上昇しており、その水温上昇がサンゴ分布北上の原因と考えられる。サンゴは藻類と競合関係にあり、サンゴの北上や増加は沿岸海洋生態系を変えてしまう可能性がある。

キーワード: サンゴ, 北上, 地球温暖化
Keywords: coral, poleward expansion, global warming