Effects of ocean acidification on growth and spinous skeletal composition of the sea urchin (*Mesocentrotus nudus, Strongylocentrotus intermedius*)

*Riki Miyai[1], Tsuyoshi Kuroda[1], Daisuke Muraoka[2], Hideki Takami[2], Atsushi Suzuki[3], Yukihiro Nojiri[4], Mayuri Inoue[1]

1. Graduate School of National Science and Technology, Okayama University, 2. Tohoku National Fisheries Research Institute, 3. National Institute of Advanced Industrial Science and Technology, 4. Hirosaki University

Since the Industrial Revolution, ocean acidification has advanced owing to the dissolution of anthropogenic carbon dioxide (CO_2) released into the atmosphere into sea water, and there are concerns about the impact on many marine ecosystems. Particularly, for organisms forming calcium carbonate ($CaCO_3$) shells and skeletons, since carbonate ion concentration decreases during the ocean acidification, it is predicted that skeleton formation becomes difficult and adverse effect will be exerted. However, many creatures have not been evaluated for their impact. Therefore, in this study, we investigated the influence of acidification based on the change of the chemical composition and structure of the spines of *Mesocentrotus nudus* and *Strongylocentrotus intermedius* in which calcite is the main component of spines and shells.
In this study, the sea urchins were raised under the following five carbon dioxide partial pressures (pCO_2, μatm): (i) 2000, (ii) 1000, (iii) 700, (iv) 350 (controlled setting) and (v) 250. The settings of pCO_2 from (i) to (iii) were adjusted by addition of CO_2 and condition of (v) was adjusted chemically. Five to seven sea urchins were placed in individual bottles in each setting and were raised for more than 6 months for *M.nudus* and *S. intermedius*, respectively. The shell length and the weight was measured monthly. The chemical components (Mg, Sr and Ca) in the spines were measured with an inductivity coupled plasma optical emission spectrometry (ICP –OES). Also, the surface and cross-sectional structure of the spines was observed using a scanning electron microscope (SEM).
As the result of culture experiments, the shell length and body weight of both species decreased with increasing pCO_2. In addition, the Mg/Ca ratios of the spines were relatively higher at higher pCO_2 settings. The mean Mg/Ca ratio of *M. nudus* was about 1.4 times higher than that of *S. intermedius*. As solubility increases for calcite with increasing of Mg content, it is suggested that the spines of *M. nudus* are more likely to dissolve or making calcification less likely to occur in the future ocean acidification. On the other hand, the Sr/Ca ratio was not clearly related to the pCO_2 condition. Although, in general, the sea urchin spine has a stereomorphic structure with countless holes and such structure was found in the spines reared under controlled setting, the hole filled probably by calcite in the stereomorphic structure was observed in the spines reared under higher pCO_2 settings. Therefore, intense ocean acidification would affect negative impacts on growth of spines of sea urchins.

Keywords: sea urchin, trace element, ocean acidification

