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酸性化海水がサンゴの石灰化および骨格中の微量元素に及ぼす影響

Effects of acidified seawater on calcification and trace elements of coral skeleton

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1. Introduction
The rising CO_2concentration in the atmosphere is changing the carbonate chemistry of the ocean. Elevated partial pressure of CO_2(pCO_2) has caused significant decrease in surface seawater pH and carbonate ion concentration. Therefore, ocean acidification has a negative effect on calcification of marine calcifying organisms. Especially, hermatypic corals are basic animals in coral reef ecosystems, so their calcificication is a key to determine the health of reef ecosystems. Many researches have been studied on coral calcification, but the results of these studies have been differed from species, culture experiment periods and experiment conditions. In addition, the growth of the skeleton of polyp corals has been little studied.
On the other hands, the geochemical compositions preserved in the coral skeleton are used to reconstruct the past marine environments. Although trace elements of coral skeleton have been used as proxies for marine environment, such as sea surface temperature and upwelling, factors, it has been little studied on the relationship between seawater pH and trace elements of coral skeleton.
The aim of this study is to clarify the effects of acidified seawater on coral calcification and incorporation of trace elements into coral skeleton by rearing experiment with controlled environment factors.

2. Materials and Methods
Colonies of Acropora digitifera and Porites australiensis, which are the dominant species around the Ryukyu Islands, were collected at Sesoko Island, in the northern part of Okinawa, Japan. We reared polyp corals and adult coral nubbins of A. digitifera in seawater with different pCO_2settings (300, 400, 600, 800, 1000ppm), and adult coral nubbins of massive P. australiensis in seawater controlled different pH settings (7.4, 7.6, 8.0) controlled by CO_2bubbling. Calcification rate of adult coral was calculated by weighting coral nubbins following buoyant weight technique once a week during the period of experiments, while skeletal growth of polyps was evaluated by measuring the dry weight of each skeleton at the end of experiments. Photosynthesis parameters are measured both during and after experiments. The ratios of trace elements (Mg/Ca, Sr/Ca, Ba/Ca and U/Ca) in coral skeletons were analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

3. Results and Discussion
3.1 Effects of acidified seawater on coral calcification

The results of A.digitifera showed that the growth rate of adult corals had no significant correlation against pCO_2, but dry weight of polyp skeletons decreased with increase in pCO_2. In addition, photosynthesis parameters of adult coral had no significant correlation with pCO_2. Under ocean acidification predictd in the end of this century, skeletal growth of polyp corals of A. digitifera before acquring zooxanthella may be affected. Growth rate of P. australiensis typically showed a positive correlation with pH. However, growth rates were different among colonies, suggesting that their responses to acidification varied among the colonies.

3.2 Effects of acidified seawater on trace elements of coral skeleton
Trace elements of polyp skeletons of A.digitifera showed no significant correlation against pCO_2 and skeletal weight, except for Ba/Ca. Mg/Ca of adult coral of A.digitifera were significant correlation with $pCO_2$and growth rate, which corresponds to Reynaud et al. (2005). In contrast, the relationship between Sr/Ca and both $pCO_2$and growth rate was negligible. Therefore, Sr/Ca is expected to be a robust proxy for seawater temperature, as suggested previously (e.g. Beck et al., 1992). On the other hand, U/Ca of adult corals of A.digitifera and P. australiensis showed a positive correlation with pH, suggesting that U/Ca in corals may be useful as a proxy for seawater pH, although more experiments should be required.

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