Effects of ocean acidification on growth and calcification in juvenile Japanese surf clam *Pseudocardium sachalinense*

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Many previous studies have reported that ocean acidification could give negative influences on marine calcifiers. However, the influences of ocean acidification on edible marine species, especially on cold-water species, are poorly understood. Juvenile Japanese surf clam was exposed to five levels of pCO_2 (400, 600, 800, 1,000, and 1,200 μatm) during 20 weeks and these effects on its growth and stable isotope compositions of shell were examined. The clam is important in local fisheries and inhabits on the upper subtidal sandy bottom in northern Japan.

We found non-significant effects of elevated CO_2 on weight (whole body, shell, and soft tissue), shell length, shell width, and shell height during experiments. Meanwhile, shell thickness at a region that grew during experiments thinned in a pCO_2-dependent manner. These results suggest that effect of ocean acidification on juvenile Japanese surf clam was not the shell dissolution but the inhibition of shell formation.

We studied the contribution of acidified seawater on shell calcification by stable carbon isotope composition ($\delta^{13}C$). The $\delta^{13}C$ of the shells collected from the external margin of the outer shell layer showed significant positive correlations with pH ($R = 0.56$, $p < 0.05$). The regression slope of the relationship between shell $\delta^{13}C$ and pH was roughly the same as that between $\delta^{13}C$ of dissolved inorganic carbon (DIC) of seawater and pH, and calcification of the experimental specimens might be strongly affected by acidified seawater. Thus, by measuring $\delta^{13}C$ of molluscan shell and DIC of seawater, it might be possible to estimate the contribution of acidified seawater to calcification.

The concentration of carbonate ion which is necessary for calcification decreased with increasing pCO_2. Because of the influx of acidified seawater into the extrapallial fluid, the decrease in carbonate ion in the extrapallial fluid might induce a thinner shell formation. Therefore, in acidified seawater, Japanese surf clam might have a poor pH regulation of the extrapallial fluid.

Keywords: ocean acidification, growth effect, calcification, stable carbon isotope, Japanese surf clam

