



Effects of $p\text{CO}_2$ on the fertilization and development of the sea urchin *Stronglyocentrotus nudus*

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We examined the effects of $p\text{CO}_2$ on the fertilization success rate and development of the sea urchin *Stronglyocentrotus nudus*, one of abundant and common organisms found in Korean coastal waters. We exposed sperms of *S. nudus* to seawater of different $p\text{CO}_2$ levels ranging from 380 ppmv to 6000 ppmv, and found that the fertilization rate of the sea urchin was lowered drastically even at $p\text{CO}_2$ level of about 500 ppmv, which we could reach as early as 2050s. When the egg of *S. nudus* was exposed to seawater of high $p\text{CO}_2$, the fertilization success rate did not change, and we could conclude that the sperm is responsible for this unprecedented low fertilization success rate. This low rate, however, was not due to the motility of the sperms since the motility was rather insensitive to $p\text{CO}_2$ within the range of our investigation.

We further examined the effect of CO_2 on the development using eggs fertilized under 380 ppmv. The eggs were divided into three groups. The first group was exposed to CO_2 treated water until plutes stage, and the second one was exposed during hatching stage (from fertilization to hatching) and then returned to the water with the water treated at 380 ppm. The third group was exposed to CO_2 treated sea water after hatching. Under 550 ppmv the development rate was not affected by $p\text{CO}_2$. At 750 ppmv the development rate was decreased, but the one exposed during the hatching stage was influenced less. As $p\text{CO}_2$ becomes higher, the development rate becomes lower, but the one exposed during the hatching stage was affected less. This result shows that $p\text{CO}_2$ has stronger effect on the fertilization stage than during development stage.