Study on Progress of Ocean Acidification and Its Effect on Structure and Function of Microbial Community

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[Abstract]

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We have developed and improved a high-precision pH meter that uses a high-performance compact spectrophotometric system with optical fiber connection. This system has been introduced to the research vessels of Japan Meteorological Agency to develop their routine pH measurements in the western North Pacific as a part of internationally-coordinated ocean CO_2 and acidification monitoring program.

We evaluated the trend of ocean acidification in surface layer of extensive regions of the subtropical North Pacific using the synthesized data of partial pressure of CO_2 for the past 40 years when no precise data of pH was available. The results exhibited significant trends of acidification (the decrease in pH of –0.01 to –0.02 per decade) over subtropical North Pacific. The estimation of pH decreasing rate for the future 50 years suggests an acceleration of the acidification, depending on the scenario of future anthropogenic CO_2 emission. These results should be very useful for a realistic numerical simulation of the ocean acidification and for the assessment of influence on marine organisms and ecosystems.

Hydrographic data including ocean carbon and relevant chemical parameters in the Pacific Ocean were collected and merged to a scientifically quality-controlled database in order to evaluate the progress of ocean acidification. After primitive check, the secondary quality control procedures were performed to find significant biases and to estimate a recommended adjustment to each cruise and any significant adjustments larger than the threshold of parameters were scrutinized. The pH derived from dissolved inorganic carbon and total alkalinity of adjusted dataset PACIFICA decreases along the isopycnal at the western North Pacific region from 1990 to 2009.

Natural coastal microbial population was incubated in the large culture tank (400L) under different pH conditions, which were controlled by the bubbling of the air with 400, 800 and 1200 ppm CO_2. The responses of phytoplankton growth against the ocean acidification were variable. The most critical effect was observed for Haptophycean

alga, *Chrysochromulina* sp.; substantial decrease in the biomass was found in 800 and 1200 ppm vessels. The contribution of small phytoplankton less than 6μm was higher in acidified condition, but lower contribution for large group more than 6μm. These changes imply that the ocean acidification changes the biogeochemical cycle of bioelements in the ocean.

We examined how oceanic acidification will affect the growth, photosynthesis and calcification of coccolithophorid *Emiliania huxleyi* and found that *E. huxleyi* cells possessed a buffering ability to reduce acidification effects when photosynthesis was actively driven. When air containing 400, 800 and 1200 ppm CO_2 was bubbled into the culture, pH was automatically set at nearly 8.2, 7.7 and 7.2. Under such conditions where total DIC were almost same among various CO_2 concentrations, the growth, photosynthesis and calcification of *E. huxleyi* also remained nearly constant without any serious damage by acidification.