Study on Biological Effects of Acidification and Hypoxia

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[Abstract]

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Effects of ocean acidification and deoxygenation on coastal ecosystem were investigated through a synthesized assessment of rearing experiments with whole transcriptome analysis, coastal monitoring, and future projections using ecosystem models. Interactive effects of ocean acidification and deoxygenation were examined by rearing experiments with twenty-five treatments (5 x 5 levels of oxygen and pH). Among the six species investigated, Japanese whiting (*Sillago japonica*) and coastal tigriopus (*Tigriopus japonicus*) showed different tolerances for low oxygen as a function of pH, and both species showed higher oxygen thresholds for deoxygenation hazards than present levels at the pH levels that are expected for coastal regions at the end of this century. These results suggest that we need much stricter regulation of coastal oxygen levels for the protection of future coastal environments. Whole transcriptome analysis was applied to the subject of each rearing experiment. Increased expressions of genes related to glycolytic processes were observed for stressed Japanese whiting eggs, indicating that the activity of the electron transport chain was inhibited under low-oxygen conditions and hence glycolytic processes were activated to produce ATP. Temporal variations of oxygen, pH, and aragonite saturation state (Ω_{ara}) were monitored at Miyako Bay, Kashiwazaki Coast and Tokyo Bay, and annual minimum values of these parameters were compared with the threshold values of acidification and deoxygenation hazards that were obtained from the rearing experiments. It was found that oxygen and Ω_{ara} become lower than the deoxygenation threshold and acidification threshold, respectively, in the present Tokyo Bay. Future prediction made by the high-resolution marine ecosystem model newly developed for these three areas revealed that number of the days with low oxygen under the threshold values will be increase further by the end of this century, if conditions following the RCP8.5 CO_2 scenario persist. On the other hand, results of multi-parameter analysis of the monitoring data suggested us that we can diminish the extent of short-term drawdowns of oxygen and pH in coastal waters by regulating nutrient loadings from terrestrial areas. Model estimates including this process projected that the number of the days with low oxygen under the threshold values in Tokyo Bay will become even lower at the end of the 21st century compared to the present day if we can diminish nutrient loadings into the Bay to 50 % of present values.

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