Seasonal Variation of Self-purification Activity in the Eutrophic Bottom Environments and its Stimulation by Using an Optical Fiber

Fukami, Kimio., Ruangdej, Uscharee., Patel, Arun B.., Oka, Shuhei.
Laboratory of Aquatic Environmental Science (LAQUES), Kochi University, Nankoku, Japan

The excessive loading of organic nutrients from intensive fish farms has caused the serious eutrophication of bottom water environments in enclosed coastal areas. The heterotrophic bacteria are one of the most efficient self-purification agents in the ecosystem. However, the activity is affected by several environmental factors. This study aims to elucidate the seasonal variation of heterotrophic activity in the eutrophic bottom environment, to clarify most important causative environmental factors fluctuating activity, and then to propose the effective design for stimulating the self-purification ability.

Intact sediment core samples were collected in a eutrophic aquaculture field and incubated in situ temperature. Seasonal changes in regeneration rates of inorganic nitrogen (DIN) and phosphorus (DIP) released from sediment to overlying water, and dissolved oxygen (DO) consumption rates were determined. For the samples collected in oxygen-deficient summer seasons, irradiance was supplied through an optical fiber to the bottom environments for stimulating the photosynthetic activity, and changes in DO concentration were measured.

Releasing rates of DIN and DIP from sediment to overlying water were highest in October to November, ranging 2.3-2.6 and 0.13-0.15 mmol m^{-2} d^{-1}, respectively. The DO consumption rates showed maximal values of 2.3-3.4 mmol m^{-2} d^{-1} in this season, too. Nutrient releasing and DO consumption rates, however, were remarkably low in summer and winter seasons. These results suggest that heterotrophic activities in the bottom environments were suppressed by DO concentration in summer and by water temperature in winter, and that it was in the maximum in autumn when both DO and temperature were not limiting.

For stimulating heterotrophic activity in the oxygen-depleted summer stratified season, we introduced irradiance into the bottom environments, measured changes in DO concentration, and then compared with dark control systems. Results showed the significant net oxygen production under irradiance of 7 or 15 μE m^{-2} s^{-1}. These results obtained in the present study indicate that introduction of natural irradiance through an optical fiber is a promising scenario to accelerate the self-purification activity by producing and supplying DO into the anoxic bottom environments in summer.