Topics: Rehabilitation of damaged ecosystems

Bioremediation of eutrophic bottom environments by using optical fibers and psychrophilic bacteria

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【Background and Objectives】The excessive discharge of organic nutrients from intensive fish farms (cage culture) have resulted in serious eutrophication of water column and sediment in enclosed coastal areas. The heterotrophic bacteria are one of the most efficient biological agents capable of degrading, transforming and utilizing or recycling the allochthonous organic materials within the ecosystem. Studies of annual dynamics of heterotrophic activities in the eutrophic areas have indicated that the activities in water column are constrained by lower temperature during winter, while during summer when water column get stratified, the activities in the bottom water decrease due to the dissolved oxygen (DO) depletion.

It is said that there are still surviving phytoplankters and enough amount of inorganic nutrients in the bottom water of coastal areas. However, since no light is available for the plankton, oxygen is not produced in the bottom water. On the other hand, during winter, although there is much DO in the bottom water because of well vertical mixing, temperature is too low for the bacteria to be active. When we hypothesized that addition of such specialized microorganisms as psychrophiles which are capable of maintaining high metabolic activities at lower temperature, and during the summer oxygen is supplied to the bottom environment in someway, the in situ heterotrophic activities would be enhanced and we remedy the environments of bottom waters. Objectives of the present study is to assess the effect of the addition of psychrophilic bacteria in winter, and introduction of irradiation by using optical fiber in summer, on the bioremediation of bottom environments.

【Materials and methods】 Bottom seawater and sediment samples were collected

from a eutrophic enclosed inlet, and were incubated at in situ temperature for 2 weeks in the dark or under low light intensity of 500 lux with a optical fiber. The fluctuations of DO concentration during the incubation were measured. Bottom water-sediment systems with and without inoculating a strain of psychrophilic bacteria were incubated under dark condition in 10 and 25 C, and the concentrations of ammonia released into water were measured for assessing bacterial activities.

【Results and discussion】 In the bottom water about 2 ug/l of chlorophyll a and 10 to 15 uM of dissolved inorganic nitrogen were usually contained. When the bottom waters were incubated in the dark condition, DO concentrations always decreased, while it was under light condition (500 lux), the decreasing rate of DO concentrations were usually slower than those in the dark. The DO concentrations sometimes increased when water samples were collected in the stratified seasons. These results indicate that such low light intensity as 500 lux was often over the compensation light intensity and was effective for phytoplankton on stimulating photosynthesis, resulting in the suggestion that introduction of light by using optical fiber is promising way for supplying oxygen into the oxygen-depleting bottom water environments.

A strain of a psychrophilic bacterium CA(20)14, which was isolated from the Antarctic, had the optimal growth temperature of 10 to 15 C and did not grow over 20 C. When we added this strain to the bottom water-sediment system and incubated at 10 C, the releasing rates of ammonia into water was accelerated as twice as greater than that in the system without addition of the strain. Stimulation of ammonia releasing rate, however, was not significant at 25 C.

From the results of the present study, it was indicated that low activities of bacterial communities in the bottom environments were enhanced by introducing the light with optical fiber in the stratified season, and by the addition of some psychrophilic bacteria in the low temperature season. The combination using both optical fiber and psychrophilic bacteria is promising strategies for bioremediation of the eutrophic bottom environments.
presenter: FUKAMI K.