Denitrification, oxygen uptake and methanogenesis in natural and artificial tidal flats from Ago Bay, Japan: Rate measurements and regulating factors

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Ago Bay, Japan, the cradle of the modern pearl culture, has witnessed a great decline in quantity as well as quality of the pearl production in the last decade owing to the worsened environmental conditions. An environmental restoration project under Japan Science and Technology has been undertaken to study the process of eutrophication and to alleviate the worsened environment of the bay in comprehensive manner. The present work deals with variability and regulation of rates of denitrification, oxygen uptake and methanogenesis in natural and artificial tidal flats from Ago Bay.

Core sediment samples with overlying water from Tategami natural & artificial mudflats were incubated in a darkened water bath maintained at in situ temperatures in the laboratory and time series of dissolved molecular O_2, N_2 & CH_4 volume in overlying waters were simultaneously measured using a specifically designed gas chromatographic system. Experiments with nitrate and ascorbate enrichments of the overlying waters were made to elucidate their impacts on denitrification and methanogenesis, respectively. Environmental factors including, temperature, salinity, nitrogenous inorganic nutrients including NH_4^+, NO_2^- & NO_3^- in overlying waters were measured.

Denitrification rates varied ca. 15-folds and 7-folds for natural and artificial tidal flats, respectively, but did not show prominent seasonal pattern and appeared to be substrate limited as only low concentrations of NO_2^- & NO_3^- were obtained in the overlying waters. Furthermore, NO_3^- enrichment of overlying water yielded prompt stimulations of 6-10 folds. Oxygen uptake rates varied ca. 28-folds for natural and 64-folds for the artificial mud flats, with higher values for both in summer. Temperature and macrobenthos abundance appeared to be the two most dominating regulating factors. A time lag of 24-48 hours existed before methanogenesis could be observed in either of the tidal flats. Na-ascorbate enrichment of overlying water yielded only moderate increases in the methanogenesis rates, and did not reduce the time lag. Among inorganic nutrients, mostly NH_4^+ accumulated during incubations.

. The present study indicated that denitrification in both tidal flats was similar and was mostly substrate limited; oxygen uptake which was usually higher for artificial mud flats and was prominently regulated by temperature and macrobenthos abundance; and after a time lag prominent methanogenesis was evident but was not stimulated by Na-ascorbate enrichment.

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