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Impact of sediment-derived organic matter on heterotrophic prokaryotes metabolism during hypoxia in Jinhae Bay

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Heterotrophic prokaryotes (HP) account for half of the community respiration rate in water columns due to their high biomass and active degradation of dissolved organic carbon (DOC). Heterotrophic organic carbon degradation serves as a primary biological oxygen sink in coastal ecosystems. The combination of stratification, reduced external oxygen inputs, and eutrophication from anthropogenic effects or river discharge results in dissolved oxygen (DO) depletion, leading to hypoxia (DO<2 mg L^{-1}). Coastal hypoxia begins in the bottom layers and is driven by high transport of organic matter into the sediment, which enhances sediment respiration and rapid depletion of DO. By-products of sediment diagenesis, such as increased supply of nutrients, labile DOC, and reduced inorganic species, can further exacerbate or prolong hypoxia by affecting microbial activity in the overlying water. However, there is a significant knowledge gap on the regulation of HP by sediment-derived organic matter and its contribution to the development of coastal hypoxia. Therefore, elucidating the interaction between HP metabolism and sediment-derived organic matter as part of benthic-pelagic coupling provides insight into the biogeochemical cycles of oxygen and carbon in coastal hypoxic basins.

Jinhae Bay (JB) is a semi-enclosed bay located on the southeastern coast of Korea, and having shallow water depth (<30 m) subject to seasonal hypoxia (May to November). In this study, we deployed an in situ benthic lander and conducted fine-scale water sampling at the oxycline in hypoxic bottom waters to understand the interaction between sediment-derived DOC and HP secondary production (HPP). We surveyed three sampling sites in June, August, and November 2024. Notably, HPP peaked for oxycline only at hypoxic bottom layer sites (33 – 102 μg C $L^{-1}d^{-1}$, avg. 69 ± 24 μg C L^{-1} d^{-1}). Excitation-emission matrix parallel factor (EEM-PARAFAC) analyses revealed that tyrosine-like fluorescent DOM ($FDOM_{Ty}$) significantly stimulated HPP in JB ($p<0.05$). Based on the benthic lander experiments, this $FDOM_{Ty}$ was likely derived from sediment. Utilizing in situ experiments on microbial metabolism and optical analyses has improved our understanding of benthic-pelagic interaction in hypoxic bottom waters.