

# High production of benthic algae promoted by increased available phosphate in the Obitsu River tidal flat

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Tidal flats are an environment of high biological productivity, with many benthic organisms such as crabs and bivalves. Major primary producers in tidal ecosystems are regarded as benthic algae inhabiting on the sediment surface. So far, such a eutrophic property has been attributed to organic matter and nutrients derived from the upper stream. Here, we raise a hypothesis that photosynthesis of benthic algae is promoted by available phosphate ( $\text{PO}_4^{3-}$ ) that is increased abiotically in tidal flats, which can support higher trophic level organisms. Phosphate bound to iron oxides is expected to be released accompanied with iron reduction under reductive environment, which is easily formed in sediments of tidal flats. In this study, we aimed to quantitatively show the production of benthic algae promoted by the available phosphate.

A monthly survey was conducted from June to December 2018 (except August) in a small creek beside the Obitsu River estuary in Kisarazu City, Chiba Prefecture. At two station of a downstream site (St.1) and an upper stream site (St.2) of the blind tubular creek, photosynthesis was measured by in situ light and dark chambers, and water analysis of pore water and properties of surface sediments were also determined. Phosphate concentration was measured by the molybdenum blue method, and the ammonium concentration by the indophenol blue method. The flux of phosphate and ammonium from sediments was measured from the concentration change in the chamber with time. Chl a, particle size composition and organic matter contents were measured for surface sediments.

Positive phosphate flux from the sediment surface was detected. At an upper stream site of a small creek, the dissolved oxygen flux was positive in the light condition and negative in the dark condition, showing the photosynthesis of benthic algae. The maximum photosynthesis rate ( $185 \text{ mg O}_2 \text{ m}^{-2} \text{ h}^{-1}$ ) was higher than previous reports. On the other hand, at a lower stream site, the dissolved oxygen flux was often negative not only under dark condition but under light condition. This fact implies that, despite high Chl a concentration and sufficient light onto the sediment surface, oxygen consumption due to organic decomposition surpassed photosynthesis. Organic contents were  $\text{St.1} > \text{St.2}$ . The particle size was smaller at St.1. The average N/P ratio of the pore water was 14 in St.2, whereas 4.8 at St.1, being much lower than the Redfield ratio. This remarkable low N/P ratio suggests the occurrence of abiotic phosphate production within the sediment at this site.

Results show that available phosphate is produced to promote the active primary production of benthic algae in this tidal creek. On the other hand, this creek showed a remarkable spatial difference in organic matter contents and N/P ratio.