Rate Processes for Seaweed-Based Dissolved Inorganic Carbon Uptake and Dissolved Organic Carbon Release under Controlled Hydrodynamic Conditions

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Résumé

Seaweeds offer promise for ocean-based carbon dioxide removal (CDR) and seawater de-acidification. Hydrodynamic flow around the seaweed tissue couples dissolved inorganic carbon (DIC) uptake to subsequent photosynthetic carbon assimilation. The export of recalcitrant dissolved organic carbon (DOC) species from photosynthetic biomass could serve as a carbon sink for deep ocean carbon sequestration. This study advanced fundamental understanding of these rate processes under controlled hydrodynamic conditions. In the present model system, clonal cultures of the widely-distributed red seaweed Gracilaria vermiculophylla were immobilized on vertical panels within an instrumented, enclosed raceway recirculation system. The highly-branched thalli tissue proliferated on the mesh support and ultimately formed a contiguous rectangular seaweed mat of branched, entangled thalli. The DIC uptake rate was estimated from gas phase CO2 and pH dynamic measurements at bulk flow velocities incident to the seaweed mat ranging from 10 to 50 cm/sec. The specific CO2 uptake rate was not affected by bulk flow velocity, because velocity distribution measurements revealed that fluid through the seaweed mat was limited to 10-15 cm/sec. Under active growth, DOC release from the seaweed bed was not observed. However, step reductions of salinity (hyposaline stress) or pH (eg through increased pCO2) stimulated DOC release, although real-time carbon balance measurements showed that DOC release was small relative to DIC uptake. This is the first study to characterize the fundamental rate processes driving CO2 uptake and DOC release by seaweeds under controlled hydrodynamic conditions, and has implications for future assessment of seaweed-based ocean CDR in natural and engineered systems.

Mots-Clés: carbon, carbon dioxide, deacidification, sequestration

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