



Carbon dioxide-limitation of benthic primary production in northern lakes

Mohammed Hamdan
Sweden (mohammed.hamdan@umu.se)

Carbon dioxide-limitation of benthic primary production in northern lakes.

Mohammed Hamdan¹, Jan Karlsson¹, Par Byström¹, Erin R. Hotchkiss², Mohammed Al-Haidarey³, and Jenny Ask¹.

¹Department of Ecology and Environmental Science, Umeå University, 90187, Umeå, Sweden.

²Department of Biological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061, USA.

³Department of Ecology, Kufa University, 70023, Al-Najaf, Iraq.

Correspondence M.H. (email: mohammed.hamdan@umu.se)

Abstract

Unlike light and nutrients, carbon dioxide (CO₂) as a potential limiting factor for aquatic primary production is still largely understudied. In this study, we tested the CO₂ limitation of benthic gross primary production (GPP) in northern lakes under different levels of light availability. Surface sediment cores (with associated benthic microalgae) were collected from 1-1.5m depth in Lake Ljusvattentjärn, northern Sweden. The sediments were gently transferred to transparent incubation chambers and either used as a control or treated with dissolved inorganic (DIC) or organic (DOC) carbon. The chambers were incubated in situ at four epilimnion depths to generate different light levels but keeping temperature constant (n = 3 for each treatment and light level). Daily benthic GPP was calculated from continuous oxygen measurements during the incubation period. The DIC addition increased the CO₂ concentration from $42.3 \pm 4.9 \mu\text{M}$ to $56.9 \pm 6.4 \mu\text{M}$ whereas the DOC treatment addition was assumed to increase the CO₂ concentration by stimulating ecosystem respiration over the incubation. The increased CO₂ stimulated benthic GPP at the highest light levels in both DIC and DOC treatments, resulting in a positive relationship between benthic GPP and CO₂. The treatments had no effect on benthic GPP at the lowest light levels. Hence, this study suggests that benthic GPP can be CO₂-limited in northern lakes when the light is not limiting. Furthermore, it can be assumed that a low to moderate input of organic matter has a positive effect on benthic GPP (due to mineralization of DOC to CO₂), in contrast to negative effects on benthic GPP attributed to light limitation at higher levels of terrestrial organic matter.