



Effect of light intensity on photophysiology and growth dynamics of crustose coralline algae (CCA): implications for the loss of canopy-forming algae

Eun Ju Kang · Ye Rim Kim · Hyung Woo Lee · Haryun Kim · Young Sik Kim · Ju-Hyoung Kim

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Abstract The disappearance of canopy-forming algae in coastal habitats exposes crustose coralline algae (CCA) to varying light conditions during the transition from foliose macroalgal habitats to barren ground by physical, chemical, or biological interaction. We hypothesized that the sudden increase in light intensity, resulting from the absence of canopy-forming algae, leads to photodamage in CCA related to inhibition of growth. To test this, a 4-week indoor incubation experiment was conducted under different light intensities (20-, 60-, 120-, and 250- $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$). Results revealed that CCA can acclimate to limited light environments, with the efficiency of PSII significantly reduced at higher light levels. Photoprotective mechanisms were activated under persistent

stress, leading to a reduction in encrusting area and CCA bleaching. This suggests that CCA coexist with canopy-forming algae in environments with sufficient light exposure, benefiting from the shade provided. However, if directly exposed to light due to the disappearance of canopy-forming algae, CCA faces extreme light stress and potential disappearance.

Keywords Barren ground · Canopy-forming algae · Crustose coralline algae · Light intensity · Photophysiology

Introduction

The foliose macroalgal communities in temperate coastal ecosystems provide many ecological functions, such as high primary production (Miller et al., 2009; Kim et al., 2015, 2022, 2023). However, coastal ecosystem dominated by macroalgae frequently experience dramatic phase shift driven by a variety of physical, chemical, and biological interactions (Edwards et al., 2020). A representative example of dramatic phase shift of coastal ecosystem is the extension of barren ground caused by heatwave (Arafah-Dalmou et al., 2019) or overpopulation of sea urchins (Estes et al., 1998). Keystone and foundation species in the community undergo various stressors during the phase shift, either to adapt or to disappear (Doney et al., 2012). Barren ground is an apparent phenomenon of ecological succession.

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Eun Ju Kang and Ye Rim Kim have contributed equally to this work and share first authorship.

E. Ju. Kang · Ye. R. Kim · H. W. Lee · J.-H. Kim
Department of Aquaculture and Aquatic Science, Kunsan National University, Gunsan 54150, South Korea
e-mail: juhyoung@kunsan.ac.kr

Ye. R. Kim · Y. S. Kim
Department of Marine Biology, Kunsan National University, Gunsan 54150, South Korea
e-mail: kimys@kunsan.ac.kr

H. Kim
East Sea Research Institute, Korea Institute of Ocean Science & Technology, Uljin 36315, South Korea

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