

Submarine groundwater discharge-derived nutrients: A key factor in sustaining tidal flat ecosystems

JI-HEE PARK¹, HYUNG-MI CHO¹, JIHYUN PARK²,
NAHYEON KWON² AND GUEBUEM KIM²

¹Inha University

²Seoul National University

Submarine groundwater discharge (SGD) is well recognized as a significant source of nutrients in coastal oceans. However, direct evidence linking nutrient supply through SGD to biological production across trophic levels, from primary producers to consumers, remains limited. In this study, we examined the impact of SGD on a tidal flat ecosystem along the west coast of Korea, where high benthic productivity by microphytobenthos (MPB) persists despite oligotrophic seawater and the absence of river input. A significant negative correlation between nitrate (NO_3^-) concentration (fresh groundwater: $\sim 360 \mu\text{M}$; coastal seawater: $\sim 6 \mu\text{M}$) and salinity confirmed that SGD is the primary source of NO_3^- . The stable isotope values of $\delta^{15}\text{N}$ - NO_3^- and $\delta^{18}\text{O}$ - NO_3^- , along with the isotope enrichment factors ($^{15}\epsilon = 2.03\text{‰}$ and $^{18}\epsilon = 2.30\text{‰}$), suggest that SGD-derived NO_3^- is removed through biological processes (assimilation) within the coastal aquifer of the tidal flat, which aligns with in situ observations of enhanced MPB production. Furthermore, the stable isotope values of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ for two species of deposit feeders (*Batillaria cumingii* and *Macrophthalmus japonicus*) and their potential food sources (MPB and organic matter) revealed that MPB contributes significantly to their diets, accounting for $\sim 67\%$ in *B. cumingii* and $\sim 84\%$ in *M. japonicus*. These findings underscore the crucial role of SGD as a key nutrient source that enhances MPB productivity, thereby increasing food availability for deposit feeders (e.g., snails and crabs) that preferentially consume MPB in tidal flat ecosystems.