國 立 臺 灣 海 洋 大 學
海洋環境與生態研究所 專題討論

中文題目：暖化和底棲群聚調適對珊瑚礁碳酸鹽沉積物代謝和溶解作用的影響

英文題目：The effect of warming and benthic community acclimation on coral reef carbonate sediment metabolism and dissolution

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中文摘要

全球暖化伴隨而來的海表升溫將改變可滲透性珊瑚礁碳酸鹽沉積物中的總初級生產力（GPP）、呼吸作用（R）和淨碳酸鈣（$CaCO_3$）溶解率。根據前人進行短時間尺度（< 24 小時）的海水暖化模擬實驗，發現暖化會使珊瑚礁沉積物的 GPP / R 比率下降和 $CaCO_3$ 溶出量增加。海水暖化在長時間尺度(> 24 小時)下可能使底棲群聚為適應而做出改變，進而改變珊瑚礁 $CaCO_3$ 沉積物代謝和溶解作用，然而尚未有研究對此影響進行探討。因此本研究使用 600 L 的水槽進行為期 15 天實驗，檢測海水暖化對法屬波利尼西亞 Mo'orea 島滲透性珊瑚礁 $CaCO_3$ 沉積物中的 GPP、R 和 $CaCO_3$ 溶解的影響。本研究發現當海水暖化（+2.8°C）時，$CaCO_3$ 沉積物的 R(+58%)比 GPP（+19％）要增加得多，因此導致 GPP / R 下降（-23％），進而使淨 $CaCO_3$ 溶解增加（+ 126％）；這些因暖化導致的代謝改變程度與日俱增，直到約 8 天後達到穩定，顯示 24 小時的實驗可能低估了暖化對在較長時間尺度下的影響。有趣的是，實驗組(暖化處理)相對於控制組白天（+ 163％）的 $CaCO_3$ 溶解增加比在夜間（+ 89％）更為顯著，這表示暖化不僅有助於增強 $CaCO_3$ 溶解作用，可能也減少生物鈣化或無機沉澱作用。這些數據也同時表明在這個時間尺度上，光合作用及其相關的無機碳與生物性的 $CaCO_3$ 沉澱作用，並無法抵消暖化造成的沉積物異營和 $CaCO_3$ 溶解作用的增加。

Abstract

Global warming (and the consequent increase in sea surface temperature) is expected to modify rates of gross primary production (GPP), respiration (R), and net calcium carbonate ($CaCO_3$) dissolution in permeable coral reef carbonate sediments. Previous simulations of seawater warming on coral reef sediments found a decline in the GPP/R ratio and an associated increase in $CaCO_3$ dissolution but were only conducted over a short timescale (<24 h). To date, no studies have examined the prolonged (>24 h) effect of seawater warming on coral reef $CaCO_3$ sediment metabolism and dissolution, which may allow the benthic community to acclimatise. This study used 600-L flume aquaria to examine the effect of seawater warming on GPP, R, and $CaCO_3$ dissolution in the permeable coral reef $CaCO_3$ sediments of Mo'orea, French

Polynesia, over a period of 15 d. On average, when exposed to warmed seawater (+ 2.8 °C), R in the CaCO3 sediments was enhanced (+ 58%) to a greater extent than GPP (+19%), resulting in a decline in GPP/R (- 23%) and an associated increase in net $CaCO_3$ dissolution (+ 126%). The magnitude of these warming-mediated metabolic changes increased each day until reaching a plateau after about 8 d, indicating that 24-h experiments may be underestimating the effect of warming over longer timescales. Interestingly, the increase in dissolution relative to control treatments was more striking during the day (+ 163%) than at night (+ 89%), suggesting that warming acted to both enhance geochemical dissolution and reduce biogenic calcification or inorganic precipitation. Together, these data indicate that, over the timescale observed here, photosynthesis and associated inorganic and biogenic $CaCO_3$ precipitation do not exhibit the ability to counterbalance the warming-mediated increase in sediment heterotrophy and $CaCO_3$ dissolution.

參考資料

Lantz CA, Schulz KG, Eyre BD (2019) The effect of warming and benthic community acclimation on coral reef carbonate sediment metabolism and dissolution. Coral Reefs 38:149–163