國立臺灣海洋大學
海洋環境與生態研究所 專題討論

英文題目：Recombination of cell membrane components is a strategy of phytoplankton in adapting to low phosphorus environment and its possible regulatory mechanism-taking the Coccolithophore *(Emiliania huxleyi)* as an example

中文題目：細胞膜成份重組是植物性浮游生物適應低磷環境的一種生存策略—以鈣板藻 *Emiliania huxleyi* 為例

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中文摘要

海洋植物性浮游生物 (海洋植浮) 是重要的初級生產者，但其生長常受限於環境中營養鹽多寡。面對營養鹽缺乏的壓力，海洋植浮具有反應快速的適應機制。以磷 (phosphorus) 為例，海洋植浮在磷缺乏環境中，除了使用高親和力磷酸鹽運送蛋白 (high-affinity phosphate transporter) 或鹼性磷酸酶 (alkaline phosphatase) 加強吸收外界微量磷酸鹽外，近來發現使用不含磷的脂質，例如：含硫 (sulphoquinovosyldiacylglycerol, SQDG) 或含氮(betaine lipids;如: diacylglyceryl-carboxyhydroxymethylcholine, DGCC) 的脂質，去取代細胞膜中的磷脂 (phospholipids)，應是其適應磷限制環境的另一種生存策略。這樣的機制除了在模式藻種被證實外，在處於缺磷的 Sargasso Sea 的海洋植浮也發現有類似的現象 (Van Mooy *et al.,* 2009)。然而，其中的細胞生理調控機制卻仍未被釐清。Shemi 等人 (2016) 以鈣板藻 *Emiliania huxleyi* 為研究對象，透過質譜儀、螢光顯微鏡、電子顯微鏡、以及相關基因表現量分析等技術，觀察到處於磷限制環境下的*E. huxleyi*生長前期，細胞膜上部分磷脂即會被 SQDG 與 DGCC 等非磷脂質所代替。細胞膜脂質組成改變的過程非常快速並具有可逆性，即當重新添加磷於培養液中，細胞會再重新使用磷脂構成細胞膜。但若添加 Phosphoinositide 3-kinase (PI3K) 抑制劑 “wortmannin” 後，減緩了缺磷培養細胞其細胞膜磷脂被取代置換比例，暗示著 PI3K 可能參與調控這個置換的過程。除此之外，磷限制處理也會誘發細胞質中的酸性囊泡形成，暗示著 *E. huxleyi* 在缺磷環境下會經由類似細胞自噬 (autophagy) 促進細胞物質的回收再利用。這兩研究結果對海洋植浮如何適應磷限制環境在生態生理學方面的評估提供了細胞層次上的基礎。

英文摘要

Marine phytoplankton has developed diverse strategies to cope the lack of nutrients in oligotrophic oceans. Taking phosphorus as an example, except for the use of high-affinity phosphate transporter or alkaline phosphatase to enhance the uptake of external trace phosphates, the use of sulphoquinovosyldiacylglycerol (SQDG) or betaine lipids (e.g.

diacylglycerylcarboxyhydroxymethylcholine, DGCC) to replace phospholipids in cell membranes, should be another survival strategy to adapt the P-starvation environment. This alternative mechanism was not only found in the model algae but also in the Sargasso Sea (Van Mooy *et al.,* 2009). However, the regulatory mechanism of cell membrane remodeling therein has not yet been clarified. Using *Emiliania huxleyi* as the research object, Shemi *et al.* (2016) found phospholipids on the cell membrane were replaced by non-phospholipids such as SQDG and DGCC. The process of the recombination of lipid composition in the cell membrane was very rapid and reversible, that is, when phosphorus was re-added to the culture medium, the cells re-used the phospholipid to build cell membrane. However, the treatment of the Phosphoinositide 3-kinase (PI3K) inhibitor "wortmannin" decreased the replacement ratio of phospholipids in the cells under phosphorus-deficient, suggesting that PI3K may be involved in the regulation of this remodeling process. In addition, phosphorus deficient also induced the formation of acidic vesicles in the cytoplasm, implying that the autophagy-like process might be induced to promote the recovery and reuse of cellular materials. The results of these two studies provide a cellular level for the assessment of how marine phytoplankton adapts to the phosphorus-limited environments.

參考資料

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