Fast Detection of Nutrient Limitation in Macroalgae and Seagrass with Nutrient-Induced Fluorescence

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Abstract

Background: Rapid determination of which nutrients limit the primary production of macroalgae and seagrasses is vital for understanding the impacts of eutrophication on marine and freshwater ecosystems. However, current methods to assess nutrient limitation are often cumbersome and time consuming. For phytoplankton, a rapid method has been described based on short-term changes in chlorophyll fluorescence upon nutrient addition, also known as Nutrient-Induced Fluorescence Transients (NIFTs). Thus far, though, the NIFT technique was not well suited for macroalgae and seagrasses.

Methodology & Principal Findings: We developed a new experimental setup so that the NIFT technique can be used to assess nutrient limitation of benthic macroalgae and seagrasses. We first tested the applicability of the technique on sea lettuce (Ulva lactuca) cultured in the laboratory on nutrient-enriched medium without either nitrogen or phosphorus. Addition of the limiting nutrient resulted in a characteristic change in the fluorescence signal, whereas addition of nonlimiting nutrients did not yield a response. Next, we applied the NIFT technique to field samples of the encrusting fan-leaf alga Lobophora variegata, one of the key algal species often involved in the degradation of coral reef ecosystems. The results pointed at co-limitation of L. variegata by phosphorus and nitrogen, although it responded more strongly to phosphate than to nitrate and ammonium addition. For turtle grass (Thalassia testudinum) we found the opposite result, with a stronger NIFT response to nitrate and ammonium than to phosphate.

Conclusions & Significance: Our extension of the NIFT technique offers an easy and fast method (30–60 min per sample) to determine nutrient limitation of macroalgae and seagrasses. We successfully applied this technique to macroalgae on coral reef ecosystems and to seagrass in a tropical inner bay, and foresee wider application to other aquatic plants, and to other marine and freshwater ecosystems.

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