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Patterns in tropical seagrass photosynthesis in relation to light, depth and habitat

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Abstract

Seagrass meadows across north-eastern Australia, survive a range of environmental conditions in coastal bays, reefs, estuarine and deepwater habitats through adaptation of a range of structural, morphological and physiological features. The aim of this study was to investigate the influence of spatial features (habitat type, site and depth) and photon flux on the photosynthetic performance of 11 tropical seagrass species. Pulse amplitude modulated (PAM) fluorometry was used to generate rapid light curves from which measures of maximal electron transport rate (ETR_{max}), photosynthetic efficiency (α), saturating irradiance (E_k) and effective quantum yield ($\Delta F/F_{m'}$) were derived. The amount of light absorbed by leaves (absorption factor) was also determined for each population. In intertidal habitats many seagrass species exhibited typical sun-type responses with a close coupling of both ETR_{max} and E_k with photon flux. Photosynthetic performance ranged from minima in *Thalassodendron ciliatum* to maxima in *Syringodium isoetifolium*. The absence of a coupling between photosynthetic performance and photon flux in subtidal populations was most likely due to highly variable light climates and possible light attenuation, and hence the photo-biology of estuarine and deepwater seagrasses exhibited photosynthetic responses indicative of light limitation. In contrast seagrass species from shallow reef and coastal habitats for the most part exhibited light saturation characteristics. Of all the variables examined ETR_{max}, E_k and $\Delta F/F_{m'}$ were most responsive to changing light climates and provide reliable physiological indicators of real-time photosynthetic performance of tropical seagrasses under different light conditions.

Keywords: fluorescence; photosynthesis; seagrass; photon flux; PAM; tropical; habitat

1. Introduction

The north-eastern region of Australia possesses a range of marine habitats including estuaries near the entrance of rivers, coastal embayments, calcareous reefs and deepwater habitats (Carruthers et al., 2001). Seagrass meadows are a dominant structural component of these ecosystems, subject to a range of environmental conditions along gradients of photon flux associated with tidal movement, distance from riverine systems, depth gradients and seasonal turbidity events influenced by terrigenous runoff.

Light availability is often the most important factor controlling seagrass productivity, distribution and survival (Longstaff et al., 1999; Carruthers et al., 2002; Biber et al., 2005), yet other factors such as nutrient availability and physical disturbance from terrigenous runoff also influence seagrass survival. Fluctuations in seasonal turbidity and light availability due to pulsed river flow inputs and wind driven re-suspension impose strong selective pressures on seagrasses, which undergo eco-physiological acclimation to cope with changing light climates (Waycott et al., 2005). Physiological traits may vary with

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