

# Photosynthetic responses of seven tropical seagrasses to elevated seawater temperature

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## Abstract

This study uses chlorophyll *a* fluorescence to examine the effect of environmentally relevant (1–4 h) exposures of thermal stress (35–45 °C) on seagrass photosynthetic yield in seven tropical species of seagrasses. Acute response of each tropical seagrass species to thermal stress was characterised, and the capacity of each species to tolerate and recover from thermal stress was assessed. Two fundamental characteristics of heat stress were observed. The first effect was a decrease in photosynthetic yield ( $F_v/F_m$ ) characterised by reductions in  $F$  and  $F_{m'}$ . The dramatic decline in  $F_v/F_m$  ratio, due to chronic inhibition of photosynthesis, indicates an intolerance of *Halophila ovalis*, *Zostera capricorni* and *Syringodium isoetifolium* to ecologically relevant exposures of thermal stress and structural alterations to the PhotoSystem II (PSII) reaction centres. The decline in  $F_{m'}$  represents heat-induced photoinhibition related to closure of PSII reaction centres and chloroplast dysfunction. The key finding was that *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule uninervis* and *Thalassia hemprichii* were more tolerant to thermal stress than *H. ovalis*, *Z. capricorni* and *S. isoetifolium*. After 3 days of 4 h temperature treatments ranging from 25 to 40 °C, *C. rotundata*, *C. serrulata* and *H. uninervis* demonstrated a wide tolerance to temperature with no detrimental effect on  $F_v/F_{m'}$ , qN or qP responses. These three species are restricted to subtropical and tropical waters and their tolerance to seawater temperatures up to 40 °C is likely to be an adaptive response to high temperatures commonly occurring at low tides and peak solar irradiance. The results of temperature experiments suggest that the photosynthetic condition of all seagrass species tested are likely to suffer irreparable effects from short-term or episodic changes in seawater temperatures as high as 40–45 °C. Acute stress responses of seagrasses to elevated seawater temperatures are consistent with observed reductions in above-ground biomass during a recent El Niño event. Crown Copyright © 2005 Published by Elsevier B.V. All rights reserved.

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## 1. Introduction

Shallow water tropical seagrasses are exposed to a range of environmental stresses, including high solar radiation, ultra-violet radiation, desiccation and temper-

ature fluctuations. Fluctuations in seasonal seawater temperatures in tropical habitats range from 19.8 to 41 °C (McKenzie, 1994; McKenzie and Campbell, 2004). Critical thermal stress has been reported in temperate seagrasses at temperatures exceeding 35 °C (Bulthuis, 1983; Ralph, 1998), but few studies have examined temperature responses of tropical seagrass species (Fong and Harwell, 1994; Terrados and Ros, 1995). Tropical species of seagrasses generally increase their photosynthesis at elevated temperatures (Perez and

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