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Effects of *in situ* shading on the photophysiology of *Zostera marina* and *Cymodocea nodosa*

Silva, J.[1*], Barrote, I.[2], Albano, S.[1], Costa, M.[1], Neves, P.[1], Graça, G.[1], Sharon, Y.[3], Beer, S.[3] and Santos, R.[2]

[1] CCMar-Centro de Ciências do Mar, 8005-139 Faro, Portugal
[2] CDCTPV, Universidade do Algarve, 8005-139 Faro, Portugal
[3] Tel Aviv University, Tel Aviv 60078, Israel
[*] Corresponding Author: jmsilva@ualg.pt

Abstract

The effects of light reduction were investigated in natural stands of the seagrasses *Zostera marina* and *Cymodocea nodosa* in Ria Formosa coastal lagoon, southern Portugal. Four shading plots and a control were set in each of two neighbouring meadows (2-3 m depth), each dominated by one species. The experiment lasted for 3 weeks, at the end of which the response of plant photosynthesis to light was determined via oxygen electrode measurements. Tissue samples were also analysed for photosynthetic pigment, soluble protein, soluble sugar and malondialdehyde contents. All plants presented a shade-adapted profile, mostly revealed by their biochemical composition. In both species the chlorophyll *a*/chlorophyll *b* ratio decreased sharply whereas the total chlorophyll/total carotenoids and the total chlorophyll/soluble protein ratios increased. Soluble protein content was reduced more noticeably in *Z. marina*. Soluble sugars dropped almost 40% in *Z. marina* leaves and roots, a more pronounced effect than the one observed in *C. nodosa*. Overall, *Z. marina* revealed to be more sensitive than *C. nodosa* to reductions in incident irradiance, suggesting that it will be more sensitive to human-induced disturbances that result in an increase of water turbidity.

Keywords: Photosynthesis, light reduction, disturbance, stress response

Vulnerability of eelgrass (*Zostera marina L*) seedlings to physical disturbance from macroalgal drift, bioturbation and sediment resuspension

Valdemarsen, T.[1*], Canal-Vergés[1], P. and Flindt, M.R.[1]

[1] Institute of Biology, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark
[*] Corresponding Author: valdemarsen@biology.sdu.dk

Abstract

Eelgrass coverage in Odense Fjord (Denmark) has declined by 90% from 1983 to present due to eutrophication and associated pressures. During the past 10-15 years nutrient loading was reduced and water clarity has increased, but the state of low eelgrass coverage is maintained despite these improvements. We hypothesized that survival of eelgrass seedlings and expansion through reproductive dispersal was negatively impacted by naturally occurring physical disturbance from drifting macroalgae, *Arenicola marina* sediment reworking and current driven sediment resuspension. The hypothesis was tested by field observations during the summer of 2009 and 2010, where mortality of unprotected and physically protected seedlings was followed through time. Results from 2009 show that the density of unprotected seedlings decreased rapidly from 1.40 ± 0.04 to 0.25 ± 0.10 m^{-2} during the first month of observations and no seedlings survived past August. This corresponded to an average seedling mortality of 1.5% d^{-1}, which was >3 times higher than for protected seedlings (0.4% d^{-1}), which indicated that physical disturbance contributed to high seedling mortality. Most seedlings where lost during periods of intense macroalgal drift (up to 250 g m^{-2} d^{-1} wet algal material) and a significant correlation ($p = 0.02$) between macroalgal drift and seedling mortality suggested that ~40% of seedlings were lost due to the physical disturbance of drifting algae. In contrast no correlations were found between *A. marina* reworking or resuspension and seedling mortality, despite mobility of up to 400 cm^3 sediment m^{-2} d^{-1} by these mechanisms. Preliminary results from 2010 confirmed the detrimental effect of macroalgal drift for sedlings, but suggest that other processes might be lead to seedling loss early in the season. When given the observed intensity of macroalgae drift, we speculate that macroalgal drift severely hampers eelgrass expansion in certain parts of Odense Fjord.