The ecophysiology and production ecology of the kelp *Ecklonia radiata* (C.Agardh) J.Agardh, at West Island, South Australia

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Abstract

Ecklonia radiata (C.Agardh) J.Agardh is an important component of the macroalgal flora in temperate regions of the southern hemisphere. This work has focused on the ecophysiology of *E. radiata* and has quantified the carbon contribution of this species to further elucidate *E. radiata*'s ecological role in the nearshore marine environment.

The photosynthesis-irradiance response of *E. radiata* was investigated *in situ* throughout the year and across the depth profile. A clear seasonal change in photokinetic parameters was detected and provided strong evidence of a seasonal acclimation response. During winter an increase in the efficiency of light utilisation at low irradiance (α) was accompanied by a decrease in both the irradiance required for sub-saturation of photosynthesis (*Ik*) and that required for photosynthetic compensation (*Ic*). Photosynthetic capacity (*Pm*) also increased during the winter and autumn months and respiratory requirements (*Rd*) decreased.

Changes in photokinetic parameters across the depth profile were less pronounced and a significant decline in productivity occurred at deeper depths. The acclimation state of *E. radiata* did, however, alter across the depth profile. When deeper plants were exposed to the shallow irradiance environment they displayed characteristics of photodamage and chronic photoinhibition. The photoprotective and/or photosynthetic capacity of these plants improved after two weeks at shallow depths but the acclimation response was not completed by that time. The time scale for changes in the pigment suite appears to be longer than two weeks.

The ecological advantage of the seasonal acclimation response was demonstrated by the finding that productivity rates at any one depth remained similar throughout the year. Rates of net daily productivity were maintained at a depth of 3 m at ~ 1300 $\mu molO_2\ g^{-1}dwt\ d^{-1}$ (0.016 $gC\ g^{-1}dwt\ d^{-1}$) and at ~ 400 $\mu molO_2\ g^{-1}dwt\ d^{-1}$ (0.005 $gC\ g^{-1}dwt\ d^{-1}$) at a depth of 10 m.

By contrast, the growth rate of *E. radiata* is highly seasonal, with low rates of growth occurring in autumn (0.002 $gdwt\ g^{-1}dwt\ d^{-1}$ at both 3 and 10 m) and summer (0.007 and 0.004 $gdwt\ g^{-1}dwt\ d^{-1}$ at 3 and 10 m respectively) and higher rates in spring (0.016 and 0.007 $gdwt\ g^{-1}dwt\ d^{-1}$) and winter (0.015 and 0.008 $gdwt\ g^{-1}dwt\ d^{-1}$).

When the results of this study are placed in context with previous work, a schema of the carbon flow through an *E. radiata* forest can be constructed. The rates of biomass accumulation represented only a small proportion of the amount of carbon assimilated annually. At 3 m the gross annual production was 7561 $gC\ m^{-2}\ y^{-1}$, of which 863 $gC\ m^{-2}\ y^{-1}$ was incorporated into biomass, 2091 $gC\ m^{-2}\ y^{-1}$ respired, 216 $gC\ m^{-2}\ y^{-1}$ utilised for reproduction and 4391 $gC\ m^{-2}\ y^{-1}$ was exuded. The equivalent amounts for 10 m were 1904 $gC\ m^{-2}\ y^{-1}$ gross production, 307 $gC\ m^{-2}\ y^{-1}$ incorporated into biomass, 983 $gC\ m^{-2}\ y^{-1}$ respired, 77 $gC\ m^{-2}\ y^{-1}$ incorporated into reproductive tissue and 537 $gC\ m^{-2}\ y^{-1}$ exuded.