In Situ Photosynthetic Performance of *Ecklonia cava* Forming Macroalgal Beds

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The importance of macroalgal beds in coastal, especially in enclosed seawater areas is relevant, as they serve as nurseries for young of many fish species, as food for herbivores and detritivores, stabilizing and improve water quality, etc. *Ecklonia cava* is a characteristic species of temperate coastline, inhabiting on rocky substratum forming marine forests (kelp beds). Photosynthetic activity and the resulting biological production of this species has been traditionally estimated by oxygen evolution techniques, which normally cannot be used for the measurements using the whole adult thalli, nor for the *in situ* underwater measurements. Therefore, it has not been possible to determine photosynthetic rates under *in situ* natural conditions for *E. cava*. However, the pulse amplitude modulated (PAM) fluorometry of chlorophyll *a* has made it possible, by the underwater PAM fluorometer (Diving PAM, Walz GmbH, Germany). Photosynthesis of natural and transplanted sporophytes of *E. cava* has been studied *in situ* at the coast of Saigasaki, Wakayama and its vicinity with an underwater PAM fluorometer, together with the recording of environmental factors, such as irradiance, temperature and sedimentation. Effective quantum yield, maximal electron transport rate (ETR_{max}) (which can express light-saturated photosynthesis) and photosynthetic efficiency (□) have been studied *in situ* on sporophytes from different depths, in different seasons, and of different ages or sizes. In order to confirm the validity of such fluorescence measurements of photosynthesis for *E. cava* using Diving PAM, the photosynthetic ETRs based on fluorescence parameters were compared with rates of oxygen evolution in three different stages of the life-cycle of this species (gametophytes, ten-weeks-old sporophytes, and adult sporophytes). Photosynthesis *versus* irradiance curves have been done using both Diving PAM and differential gas-volumeter, irradiating samples with photon flux densities (PFD) ranging from 0 to 800 μmol m^{-2} s^{-1}. For the three life-cycle stages a high linear correlation ($r>0.9$) between oxygen evolution and ETR measurements was found from the lowest PFD to the highest one. These results showed that chlorophyll fluorescence measurements were suitable for estimating photosynthetic rates of *E. cava in situ*. Furthermore, this study allowed the photosynthetic characterization of the three life-cycle stages examined. Light-saturated photosynthesis was higher in gametophytes than in sporophytes, and decrease with age of the sporophyte. Photosynthetic efficiency was very similar in gametophytes and young sporophytes, and the lowest in adult sporophytes.

Compensation light point for photosynthesis was lower in gametophytes than in sporophytes, and increasing with age of sporophyte.