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Depth-specific fluctuations of gene expression and protein abundance modulate the photophysiology in the seagrass *Posidonia oceanica*

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Here we present the results of a multiple organizational level analysis conceived to identify acclimative/adaptive strategies exhibited by the seagrass *Posidonia oceanica* to the daily fluctuations in the light environment, at contrasting depths. We assessed changes in photophysiological parameters, leaf respiration, pigments, and protein and mRNA expression levels. The results show that the diel oscillations of *P. oceanica* photophysiological and respiratory responses were related to transcripts and proteins expression of the genes involved in those processes and that there was a response asynchrony between shallow and deep plants probably caused by the strong differences in the light environment. The photochemical pathway of energy use was more effective in shallow plants due to higher light availability, but these plants needed more investment in photoprotection and photorepair, requiring higher translation and protein synthesis than deep plants. The genetic differentiation between deep and shallow stands suggests the existence of locally adapted genotypes to contrasting light environments. The depth-specific diel rhythms of photosynthetic and respiratory processes, from molecular to physiological levels, must be considered in the management and conservation of these key coastal ecosystems.

Seagrasses are marine angiosperms that have evolved to complete their whole life cycle submerged. They represent one of the most productive components of benthic coastal ecosystems, and in addition to being exposed to daily fluctuations in irradiance have adapted to large spatial (i.e. bathymetric) variations in both irradiance and spectral quality. In the Mediterranean Sea, the endemic seagrass *Posidonia oceanica* colonizes extensive portions of sea bottom along most of the coastline[1]. The extensive meadows formed by this species are among the most valuable marine ecosystems, fulfilling important ecosystem services from carbon sequestration to coastal protection and maintenance of fisheries[2–4]. Meadow can spread from the surface down to 45 meters depth, where distinct ramets (but possibly the same genets[5,6]) are exposed to a wide range of light conditions and different photoperiods, imposing specific adaptive responses. Such extensive *P. oceanica* meadows offer a valuable opportunity to explore how depth affects light responses and diel rhythms in seagrasses.

The amplitude of physiological changes of the species associated with depth-related variations in light is similar to the one shown by the congeneric *P. sinuosa*[7] and can be considered low in relation to other seagrasses[8,9]. These changes include modifications in the plants' photosynthetic and respiratory rates and in the ability of leaves to harvest light (e.g. refs 10,11) and involve long-lasting adjustments of key metabolic processes including carbon metabolism, stress defense and proteolysis. As a response to low-light conditions, regulatory changes of important

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