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Investigating cellular stress response to heat stress in the seagrass *Posidonia oceanica* in a global change scenario

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ABSTRACT

Posidonia oceanica meadows are facing global threats mainly due to episodic heat waves. In a mesocosm experiment, we aimed at disentangling the molecular response of *P. oceanica* under increasing temperature (20 °C–32 °C). The experiment was carried out in spring, when heat waves can potentially occur and plants are putatively more sensitive to heat stress, since they are deprived in carbohydrates reserves after the cold winter months. We aimed to identify the activation of different phases of the cellular stress response (CSR) reaction and the responsive genes activated or repressed in heated plants. A molecular traffic light was proposed as a response model including green (protein folding and membrane protection), yellow (ubiquitination and proteolysis) and red (DNA repair and apoptosis) categories. Additionally, we estimated phenological trait variations to complement the information obtained from the molecular proxies of stress. Despite reduced leaf growth rate, heated plants did not exhibit signs of irreversible damage, probably underlying species pre-adaptation to warm and fluctuating regimes. Gene expression analyses revealed that molecular chaperoning, DNA repair and apoptosis inhibition processes related genes were the ones that mostly responded to high thermal stress and will be target of further investigation and *in situ* proofing for assessing their use as indicators of *P. oceanica* performance under sub-lethal heat stress.

1. Introduction

Seagrasses are keystone primary producers, “ecosystem engineers” responsible for the biophysical/chemical footprint of the coastal environment (Jones et al., 1994). They host a complex network of interacting organisms, providing them with trophic resources, nursery grounds, shelter and living substrate (Duarte, 2000). Covering nearly 0.2% of the global ocean, seagrass meadows represent ecological units with high biodiversity, which supply important ecosystem services, thus deserving conservation efforts as biological and economic value (Costanza et al., 1997; Heip et al, 1998; Duarte, 2000, 2002). These extensive marine prairies take an active role in climate regulation, biogeochemical cycling, local nutrient dynamics as well as sequestration of organic matter pools into millennial carbon-rich sediments; they also contribute to seafloor stability, preventing erosion and sediment resuspension (Mateo et al., 1997; Duarte, 2000; Marbà et al., 2006; Bos et al., 2007; Macreadie et al., 2014a). Furthermore, extending from shallow waters down to more than 50 m depth, seagrass beds overwhelmingly influence local hydrodynamics, attenuating wave energy and currents, ensuring coastline stability and water clarity (Gambi et al., 1990; Duarte, 1991; Pasqualini et al., 1998). *Posidonia oceanica* meadows represent the Mediterranean hotspots of benthic primary production and biodiversity, playing pivotal roles in ecosystem functioning (Procaccini et al., 2003). *P. oceanica* is included in the Red List of marine threatened species of the Mediterranean and meadows are defined as priority natural habitats on Annex I of the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Since the early 20th century, seagrasses have been experiencing a global crisis, as highlighted by several reports of mortality events,

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