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XXXIV CICLO DEL DOTTORATO DI RICERCA IN AMBIENTE E VITA

LIVING WITH GLOBAL CHANGES: PHYSIOLOGICAL AND MOLECULAR MECHANISMS AS THE BASIS FOR SEAGRASSES RESILIENCE IN A CHANGING WORLD

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ABSTRACT

The intensification of seawater warming and the co-occurrence of different anthropogenic stressors are threatening coastal marine habitats, including seagrasses which form a unique group of marine plants supporting diverse and productive ecosystems. However, seagrasses are declining globally and are one of the most threatened ecosystems on earth. The simultaneous presence of sea warming with local pressures can result in antagonistic, additive, or synergistic effects depending on their interactions. One of the main concerns of rapid environmental shifts is that these changes do not allow species to react swiftly enough in order to cope with and survive in the new more stressful environment. Thus, the analysis of the degree of phenotypic plasticity could reveal important insights into seagrasses' persistence. The main aim of this doctoral research was to investigate the resilience capacity of *Posidonia oceanica*, endemic of the Mediterranean Sea, to environmental changes. Plants' performances were analyzed exploring the effect of local environmental conditions in driving different plants' responses to single and multiple stressors. To this end, I previously reviewed the concept of phenotypic plasticity suggesting mesocosm experiments and reciprocal transplants as useful approaches to assess the phenotypic plasticity that allows discriminating the effect of local adaptation and acclimation in plants' responses to common stress conditions. Starting from these considerations, I performed a mesocosm experiment where plants growing in oligotrophic (Ol plants) and eutrophic (Eu plants) environments were exposed to single (nutrients and temperature increases) and multiple stressors (nutrients combined with temperature increases). Plants' performance was assessed applying an 'omic approach', exploring physiological and transcriptional responses with the focus on the dynamics of DNA methylation during the exposure to stress conditions. Physiological analysis revealed that the exposure to nutrients induced the worst effect in the leaf in both Ol and Eu plants while antagonistic effects with temperature were found in Eu plants for some parameters. Accordingly, the analysis of the whole battery of transcribed genes revealed an organ-specific response depending on the plants' origin and stress exposure. I also aimed to investigate the dynamics of DNA methylation selecting key genes and analyzing the global DNA methylation levels during the exposure to stresses in both Ol and Eu plants. DNA methylation levels changes according to the plants' origin and environmental stresses, demonstrating that DNA methylation changes dynamically with the surrounding environmental conditions contributing to the regulation of stress responses in *P. oceanica* plants. In the framework of designing appropriate restoration strategies, approaches to assisted evolution can be implemented. In

this thesis, I applied the thermo-priming treatment to *P. oceanica* seedlings through exposure to a simulated warming event. This priming process modifies the phenotypic state of an organism favouring phenotypic-plastic adjustments to future environmental stress conditions. Primed seedlings performed better during the re-occurring stress event than un-primed ones. This possibility provides important implications for restoration and conservation management. During the Ph.D. thesis, I also authored a review paper, highlighting the importance of the genetic component in seagrass restoration, where the hypotheses and the knowledge acquired during the study, were integrated for providing a conceptual framework to serve future restoration plans. The integration of studies related to local adaptation and acclimation, local environmental disturbances with the analysis of the genetic and epigenetic component, should always be considered to select the most appropriate donor site to restore degraded habitats, guaranteeing the success of the restoration plan.