



Unraveling seagrass resilience: A multilevel analysis of stress memory and complex response strategies in a changing Mediterranean

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Mediterranean seagrass meadows, key foundation habitats for biodiversity and blue carbon sequestration, are increasingly threatened by climate change-driven stressors, including marine heatwaves (MHWs). Understanding the mechanisms underpinning their resilience is essential to support effective conservation and restoration strategies. Within the framework of the National Biodiversity Future Center (NBFC), a three-year research program investigated the adaptive responses of seagrasses, focusing on *Posidonia oceanica* (adults and seedlings) and *Cymodocea nodosa*, through the integration of physiological and molecular approaches. Mesocosm experiments simulating ecologically relevant and dynamic environmental conditions revealed complex and context-dependent responses to multiple stressors, highlighting non-linear interactions affecting seagrass performance. A specific focus was placed on stress memory processes. Pre-exposure to stress conditions can activate regulatory mechanisms that persist over time and modulate subsequent responses to environmental stressors, as a consequence of stress memory formation. Multi-integrated approaches, including physiological, transcriptomic, and epigenetic analyses, are essential to investigate these processes. Consistently, results indicate that prior exposure to thermal stress can influence subsequent responses in *P. oceanica* seedlings, and suggest the persistence of such responses also in clonal fragments of *C. nodosa*. Overall, this work provides new insights into the mechanisms underlying seagrass resilience and contributes to the development of innovative strategies for the conservation and restoration of Mediterranean coastal ecosystems.