Present and future estimates for Mediterranean rhodolith-bed productivity and associated carbon fluxes.

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Abstract

Marine ecosystems play a role in mitigating climate change, particularly through carbon sequestration, yet the contribution of certain habitats remains poorly understood. Among these, rhodolith beds, habitats formed by free-living coralline algae are an underexplored but potentially relevant component of the global carbon cycle. This study investigates the carbon sink/source capacity of Mediterranean rhodolith beds at different depths, focusing on their carbon fluxes, storage and resilience to marine heatwaves and overall ecological significance.

Morphological and chemical characterisations carried out via X-ray fluorescence, scanning electron microscope observations and energy-dispersive spectrometry and loss on ignition, reveal distinct species compositions and variations in Mg/Ca ratios and organic content that correlate with both depth and location. This highlights the significant variability in the mineral and chemical composition of rhodolith beds, which directly influences their carbon storage potential. Specifically, beds with higher calcification rates, such as Mar Piccolo, exhibit greater carbon storage capacity, even though with higher organic content are more vulnerable to dissolution. Mar Piccolo, the shallowest bed, was identified as a net carbon sink, underscoring the potential of rhodolith ecosystems to contribute to carbon storage. In addition, experiments assessing the physiological effects of consecutive marine heatwaves revealed species-specific responses to thermal stress. Some species exhibited resilience, while others showed reduced calcification, emphasizing the role of both acclimation and inherent traits in a species' ability to withstand temperature fluctuations. This research highlights the importance of incorporating rhodolith beds into climate change mitigation strategies and calls for further investigation into their long-term stability amidst escalating environmental stressors.