Experimental assessment of warming effects on vermetid reef metabolism along a complexity gradient

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FRAMEWORK

The Mediterranean basin is experiencing a rise in the frequency and intensity of heat extremes(1). Among coastal ecosystems, **intertidal communities are particularly exposed to temperature fluctuations and increasingly threatened by climate change**(2). A key intertidal habitat in the Mediterranean Sea is **the vermetid reef**, a bioconstruction formed by the coralline red alga *Neogoniolithon brassica-florida* and the gastropod *Dendropoma cristatum*(3).

These bioconstructions provide essential ecosystem services, but **the intensification of extreme thermal stress may negatively affect their metabolism and adaptative capacity** and could be among the reasons of their recent collapse in the Western Mediterranean(4).

AIM

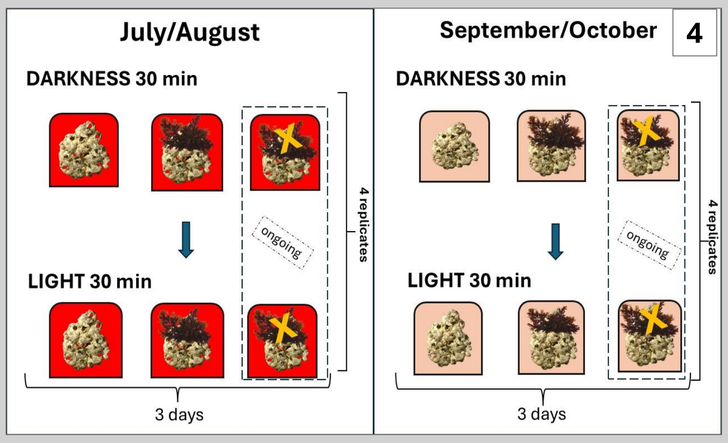
To infer how the functioning of vermetid reefs changes with temperature, we aim to conduct *in-situ* measurements of oxygen fluxes during summer and post-summer period, where thermal anomalies are present, taking into account different levels of community structure complexity. In addition, we aimed to **develop a non-destructive and effective method to measure the metabolism of intertidal communities directly in the field**, addressing the lack of field-based marine climate change studies in this habitat.

EXPERIMENTAL DESIGN AND METHODS

We considered three levels of community structure complexity:

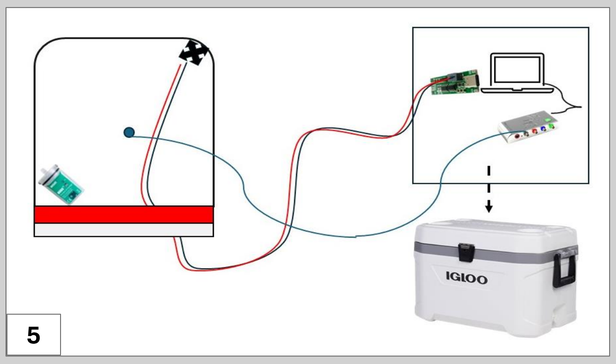
- vermetid reefs naturally devoid of macroalgae **[V]**;
- vermetid reefs naturally covered by macroalgae **[V+M]**;
- vermetid reefs from which macroalgae were experimentally removed **[V-M]**.

Oxygen consumption and production were used as proxies for community metabolism.
For each replicate (n.12 per level) respirometric measurements were carried out in the dark and in the light, every second for 30 minutes (Fig. 4).



The experiment was carried out during the summer period (T1) and will be extended into the post-summer period - September/October (ongoing), December/January (T2), and March/April (T3) - to assess the habitat's resilience ability after summer thermal fluctuations.

Oxygen fluxes were measured using fiber-optic technology with custom-designed benthic chambers specifically developed for intertidal *in-situ* measurements (Fig. 5).
Oxygen measurements were used to quantify key metabolic rates - respiration (R), net community production (NCP), and gross primary production (GPP) - of the studied habitats.



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6. Dark respiration measurements on vermetid reef experimental patches [V];

7. Light respiration measurements on vermetid reef experimental patches [V];

8. Light respiration measurements on vermetid reef covered by macroalgae patches [V+M];

9. Macroalgae biomass measurement;

10. *Dendropoma* biomass measurement;

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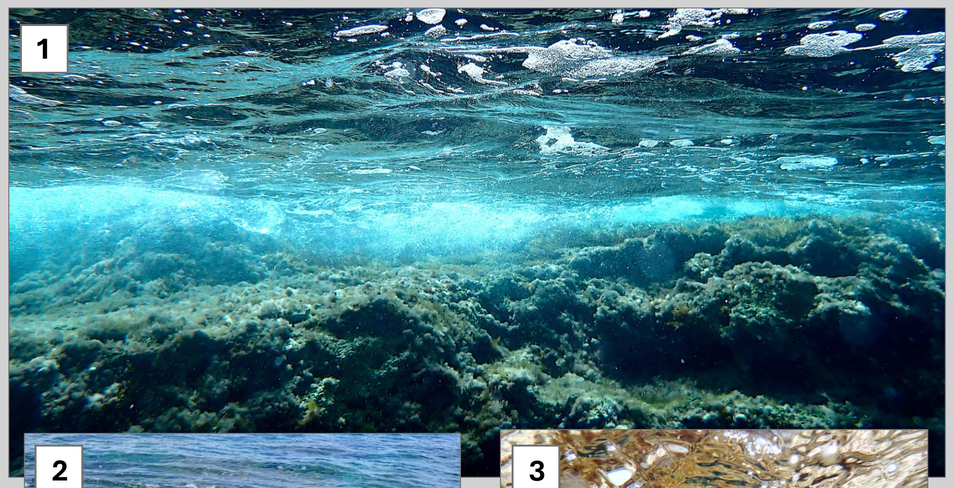

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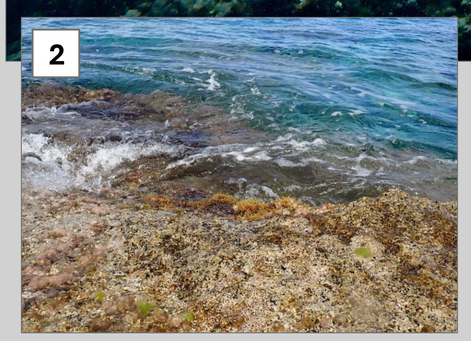

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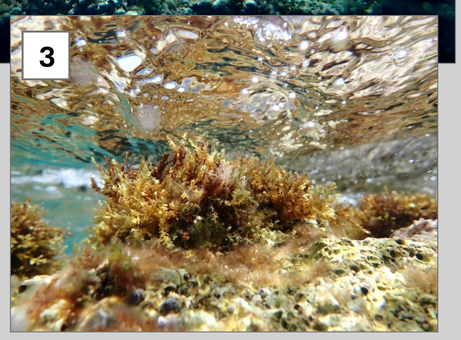

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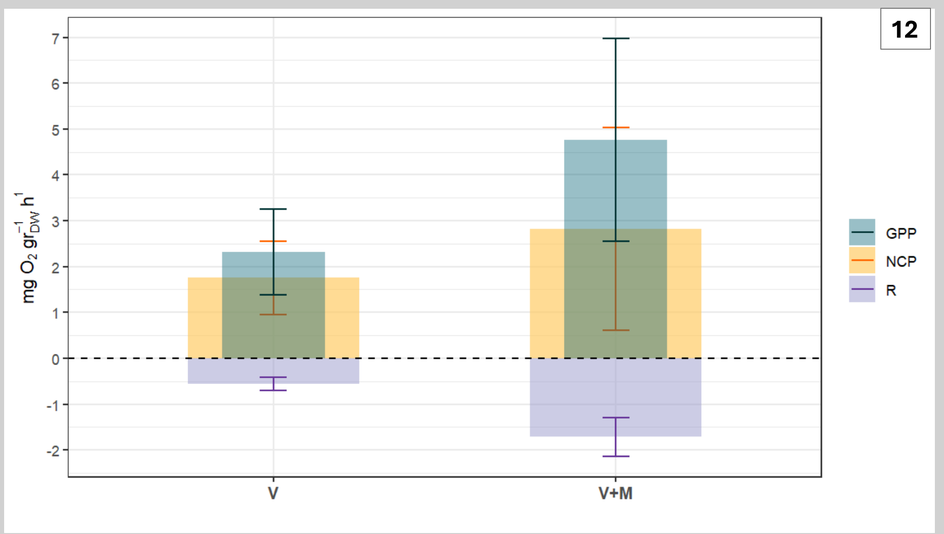
1.Submerged vermetid reef **2.**Emerged vermetid reef **3.**Submerged macroalgae on vermetid reef

PRELIMINARY RESULTS



12. Sensor readings of DO during dark and light incubations of vermetid reef patches [V] (n=3) and vermetid reef – macroalgae assemblage [V+M] (n=3). **GPP**, Gross primary production; **NCP**, Net community production; **R**, Respiration. Vertical lines represent the standard error.

FUTURE DIRECTIONS

This study represents the first attempt to quantify the metabolic rates of vermetid reef communities under natural *in situ* conditions, in order to assess the resilience of this threatened habitat to thermal anomalies.

Future developments of the project will focus on:

- Refining instrumentation and field data collection methods.
- Increasing the number of replicates, as well as finalizing and incorporating the experimental treatment [V-M].
- Comparing and analyzing data collected across a temporal temperature gradient to evaluate the habitat's resilience to warming events and to investigate how community structure influences ecosystem functioning.

REFERENCES

1.Lazoglou, G., Papadopoulos-Zachos, A., Georgiades, P. *et al.* Identification of climate change hotspots in the Mediterranean. *Sci Rep* **14**, 29817 (2024). https://doi.org/10.1038/s41598-024-80139-1

2. Sarà, G., Milanese, M., Prusina, I. *et al.* The impact of climate change on mediterranean intertidal communities: losses in coastal ecosystem integrity and services. *Reg Environ Change* **14** (Suppl 1), 5–17 (2014). https://doi.org/10.1007/s10113-012-0360-z

3. Picone, F., & Chemello, R. (2023). Seascape characterization of a Mediterranean vermetid reef: a structural complexity assessment. *Frontiers in Marine Science*, *10*(May), 1–11. https://doi.org/10.3389/fmars.2023.1134385

4.Luca Bisanti, Giulia Visconti, Gianfranco Scotti, Renato Chemello. Signals of loss: Local collapse of neglected vermetid reefs in the western Mediterranean Sea, Marine Pollution Bulletin, Volume 185, PartB,2022,114383,ISSN 0025-326X, https://doi.org/10.1016/j.marpolbul.2022.114383.