Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XL

Feeding or Fading?

Automated image analysis of white corals' behavior to unlock natural patterns, stress responses, and conservation needs

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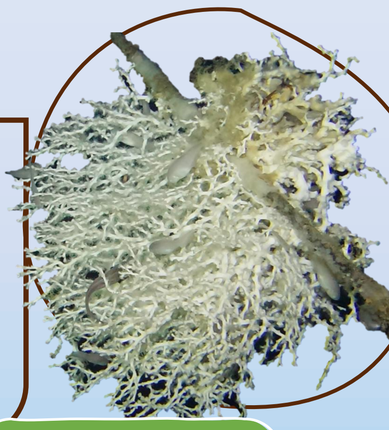
Background

Madrepora oculata, Desmophyllum pertusum, and Desmophyllum dianthus inhabit bathyal hard substrates, forming three-dimensional reefs that provide a multitude of ecosystem goods and services. Unfortunately, they are subjected to numerous threats. Fundamental aspects of these species remain poorly documented *in situ* [3]. Previous studies highlight the significance of polyps' behavior in distinguishing natural from altered states; while primarily linked to feeding, polyps' activity also affects respiration and reproduction, potentially regulated by biological clocks that confer adaptive advantages [1]. Such rhythms are well-characterized in shallow waters but remain less understood in the deep sea [2].



Research objectives

This PhD aims to bridge key knowledge gaps via two complementary perspectives:

1. **Ecology** – Role of population demographic structure in shaping coral abundance dynamics, focusing on *M. oculata* as a model species.
2. **Ecophysiology** – *In situ* characterization of *M. oculata* polyp-scale behaviors in response to environmental fluctuations to identify potential biological rhythms and adaptive mechanisms

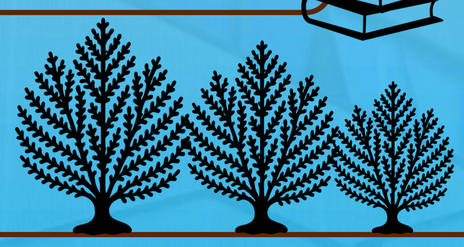
Growth rates
Reproduction
Feeding habits
Adaptability
?

M. oculata demographic structure

M. oculata biological patterns

Ecology

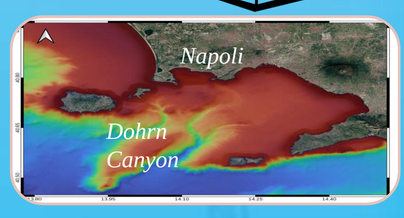
1. **Literature review** on demographic structure across different benthic invertebrate species to establish a comparative framework.



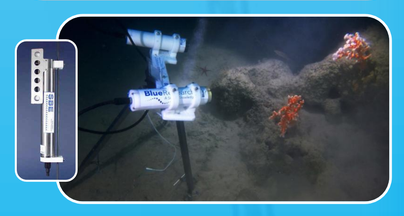
2. **Analysis of SZN archival video data** to extract demographic traits of *M. oculata*.
3. **Image dataset organization for colonies size estimation**
   - Development of a methodology to scale colony size from images
   - Classification of colonies into size classes based on morphometric criteria.
4. Evaluation of substrate type and colony morphometrics to identify spatial patterns and demographic trends in *M. oculata*.

Ecophysiology

1. **Literature review** on biological rhythms and behavioral patterns in sessile marine invertebrates.
2. **Identification of potential deployment sites** in the Dohrn Canyon based on environmental features, local morphometry, and *M. oculata* colonies' presence and distribution.



3. **Instrumentation design/purchase**
   - **Cameras' setup testing in Aquaria**



4. **Development of automated image analysis tools** for polyp-scale behavioral extraction, supported by a European micro-grant.

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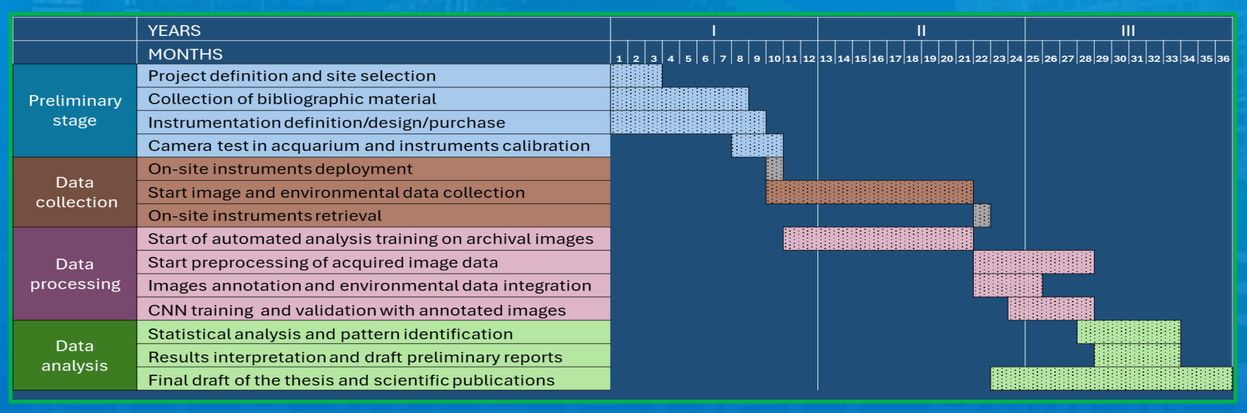
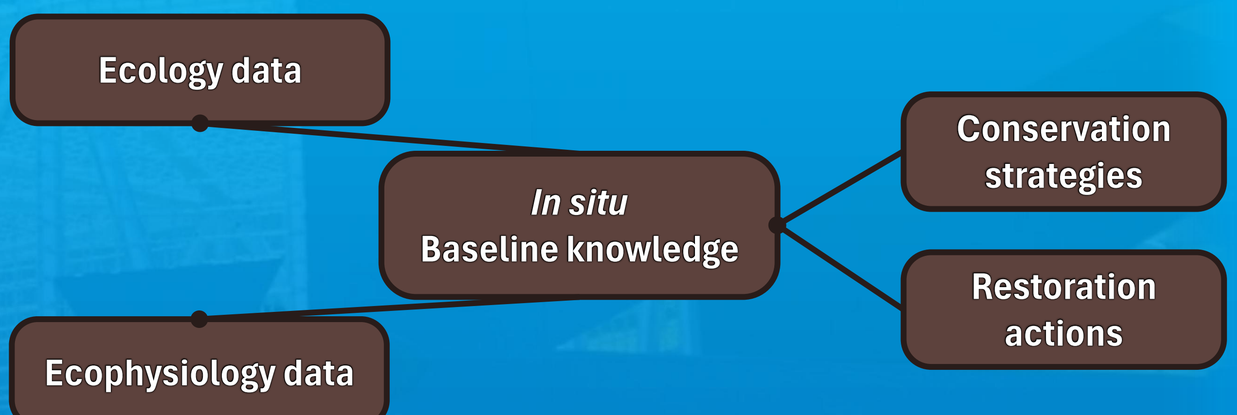
Expected Outcomes

Comprehension of white corals' behavior in their natural habitats is key to meeting practical conservation needs through targeted, site-specific strategies. New data will clarify their ecological role and provide a solid foundation for conservation and restoration efforts that protect both the corals and the ecosystems that rely on them, ensuring their survival for future generations.





References

[1] Girard, Fanny, et al. "Phenology in the deep sea: seasonal and tidal feeding rhythms in a keystone octocoral." Proceedings of the Royal Society B 289.1985 (2022): 20221033.

[2] Lopez-Vazquez, Vanesa, et al. "Video image enhancement and machine learning pipeline for underwater animal detection and classification at cabled observatories." Sensors 20.3 (2020): 726.

[3] van Kevelaer, Robin, et al. "A data science approach for multi-sensor marine observatory data monitoring cold water corals (Paragorgia arborea) in two campaigns." PloS one 18.7 (2023): e0282723.