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

ToC-ToC - SMART - To Change or not To Change: Assessing Sponge-Microbiome Acclimatization to changing environmental conditions through Reciprocal Transplantation

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Introduction

Marine sponges are ecologically important components of the benthic communities which provide habitats for a wide range of infaunal species, mediate nutrient recycling, and benthopelagic coupling. Most of these animals are filter-feeders heterotrophs with some exceptions (mixotrophic, phototrophic, or carnivorous). Despite their simplistic body plan, these organisms have been deeply studied as models of holobiont systems (complex and interdependent consortia comprising the host, its associated microbiome, and their interactions). Indeed, they host diverse, dense, and species-specific microbial communities which can comprise up to 35% of the host's biomass. The host is presumed to benefit from the microbial-mediated functions including carbon, nitrogen, sulfur, and phosphate metabolism, DOM re-cycling, vitamin synthesis, and chemical defense. It has been hypothesized that sponges may be "winners" in future global change scenarios compared with other benthic invertebrates. Nevertheless, the metabolic interactions between the microbiome members and the host remain largely unknown.

The aim of the present research is to acquire a holistic comprehension of the sponge as an holobiont system, linking hosts ecological traits with microbiome dynamics, trophic patterns, and metabolic exchanges in order to better understand the acclimatization potential of Porifera towards changing environmental conditions.

Methodology

Target species → Three sponge species commonly inhabiting Mediterranean hard bottom substrates have been selected on the basis of the feasibility for transplants and trophic strategy.

Petrosia ficiformis

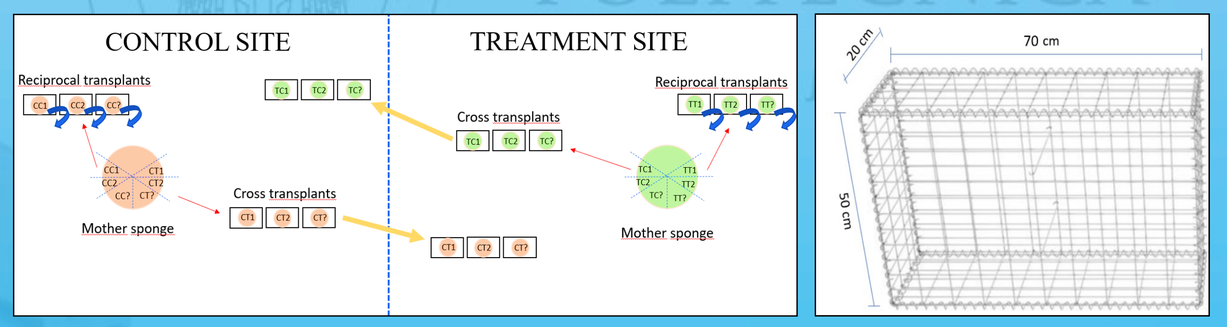
Chondrosia reniformis

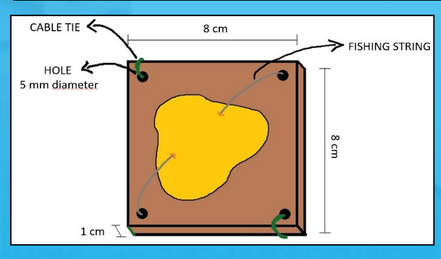
Chondrilla nucula

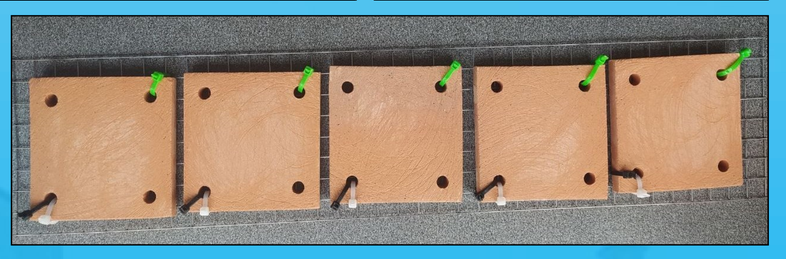
Study areas → For reciprocal and cross transplants, three sites and corresponding controls have been selected to assess acclimatization to two paired environmental conditions.

- *Acclimatization to OA vs normal pH* – Site Grotta del Mago (Island of Ischia, Naples), average pH of ~7; control: a rocky cave outside Grotta del Mago with pH of 8.1.
- *Acclimatization to light vs dark* – Site Grotta Punta Vico (Island of Ischia, Naples), a semi-submerged rocky cave. The area near the entrance of the cave is used for illuminated exposition and the internal crevices of the cave for dark exposition transplants.
- *Acclimatization to polluted vs non-polluted areas* – Bagnoli bay (Naples), versus Schiacchetiello serving as control unpolluted site.

Sample collection and reciprocal transplantation → Large specimens of the three target sponge species (n=5–8) will be collected by scuba diving at each target site and will be divided into 7 clonal replicates. One clonal replicate will be processed immediately as initial the "wild" holobiont. The remaining 6 fragments will be distributed in 3 to be used in reciprocal transplants and 3 for cross transplants. Each sponge fragment will be fixed on individual clay tiles with fishing string, and the tiles with sponges will be fixed on a metal cages. After 2 months, one cage at each site will be collected and samples processed and preserved. Idem after 4 months with a second cage. Seawater samples (10 L) will be further collected in triplicate at each site and time point (0, 2, and 4 months).



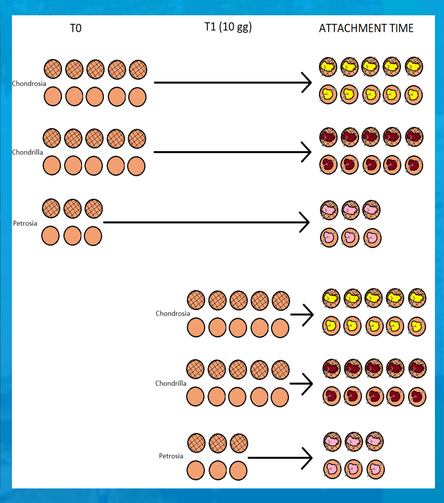




Environmental monitoring → Experimental sites are monitored for light, temperature, pH, and nutrients. Pulse-amplitude-modulated (PAM) fluorometer will be used in situ for photosynthesis and photosymbionts densities yields in sponges.

Laboratory analysis → It will be investigated the microbial diversity through high throughput sequencing and the functional and trophic profile of the holobiont by employing metatranscriptomic, metabolomic, and stable isotopic analysis (SIA).

Preliminary experiments in aquaria



Our results of preliminary experiments in aquaria:

- Clonal grafts heal rapidly showing no differences with intact individuals after few days.
- The cable ties are too invasive as attachment tool, forcing the sponges to divide instead of attaching to the substrate. The fishing line was the right compromise between the free attachment and the cable ties to secure the sponge to the substrate.
- Raw clay tile, not subjected to industrial treatments to make it waterproof, is a good substrate. Rough surface guarantees a quicker attachment.
- Biofilm has an important role in sponge attachment

Expected results

To broaden knowledge on the microbiome diversity associated with different marine sponge species in relation to diverse marine ecosystems

To shed light on the implications of microbiomes in metabolism and nutrition of the sponges

To identify phenotypic traits of holobiont acclimatization under diverse environmental scenarios

References

Botté E.S., et al. (2019). Changes in the metabolic potential of the sponge microbiome under ocean acidification. *Nature communications*, *10*:1-10.

Fan L., et al. (2012). Functional equivalence and evolutionary convergence in complex communities of microbial sponge symbionts. *Proceedings of the National Academy of Sciences*, *109*:E1878-E1887.

Glasl B., et al. (2018). Exploring the diversity-stability paradigm using sponge microbial communities. *Scientific Reports*, *8*:1-9.

Kiran G.S., et al. (2018). Marine sponge microbial association: towards disclosing unique symbiotic interactions. *Marine environmental research*, *140*:169-179.

Pita L., et al. (2018). The sponge holobiont in a changing ocean: from microbes to ecosystems. *Microbiome*, *6*:1-18.