Sponges as emerging by-product of Integrated MultiTrophic Aquaculture (IMTA): an overview in the light of Remedia Life IMTA system

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INTRODUCTION

Coastal fish farming plants can have a significant environmental impact causing an overall increase in organic matter and bacterial load. In this sense, Integrated MultiTrophic Aquaculture (IMTA), the practice that combines the cultivation of fed aquaculture species with other organisms, represents an eco-friendly alternative which allows water quality improvement, promises high economic return and social suitability. Among extractive organisms, filter-feeders and particularly Porifera seem the most promising due to their environmental and economic potential.

BIOREMEDIATION

Marine sponges' energy source is obtained by highly efficient filtration of organic particles between 0.1-50 µm, such as dissolved and particulate organic matter, heterotrophic bacteria and eukaryotes, phytoplankton and even viruses, so that their mere growth leads to bioremediation of the surrounding environment (Fig. 1). Similarly, they are constantly exposed to contamination of the water column, which makes them target organisms as bioremediators or bioindicators due to their (and their microsymbionts') ability to accumulate metallic and organic pollutants.

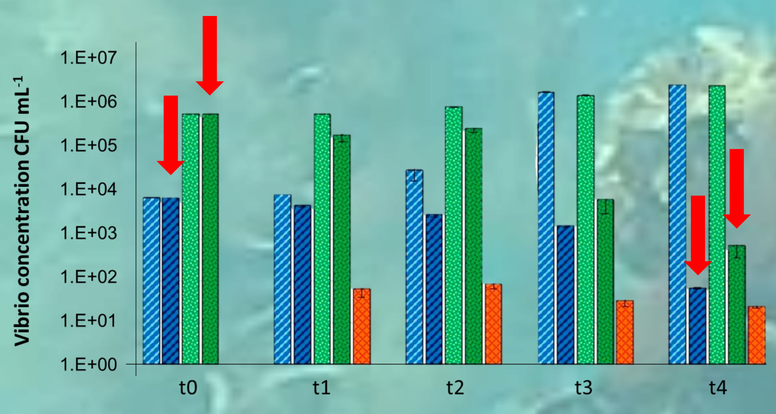


Fig 1. Significant bacterial load decrease in presence of *Sarcotragus spinosulus* (red arrows) [1].

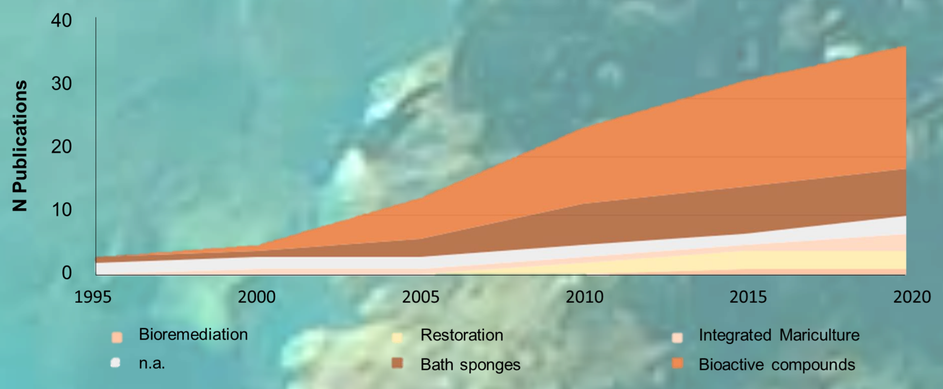
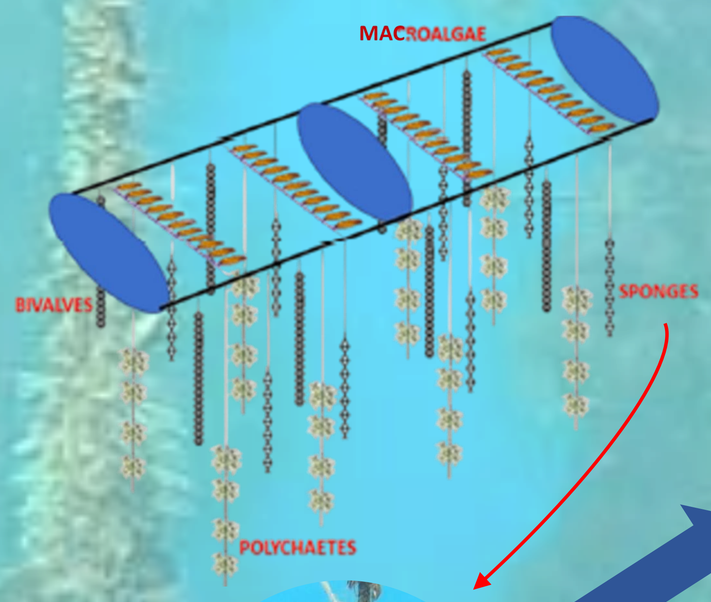


Fig 3. Temporal change in *in-situ* marine sponge cultivation interests [3].

Remedia Life IMTA System scheme



A. aerophoba reared in Remedia Life IMTA system

RESTORATION

Combining production for human consumption with restorative aspects is a recent and arising approach. IMTA plants combine bioremediation with biodiversity increase (Fig. 4B). In the case of sponges, the biomass obtained can be valorized for transplantation or restocking of threatened or vulnerable species up to benthic habitat restoration.

BIOACTIVE COMPOUNDS

Since the extraction of the first marine drug from a marine sponge in 1951, the number of the discoveries of these compounds has only increased exceeding 200 per year (Fig. 2). They have a wide range of applications: from anti-tumor, antiviral and antimicrobial in human medicine up to antimicrobial and antifouling activities in the aquaculture industry or biomaterial production.

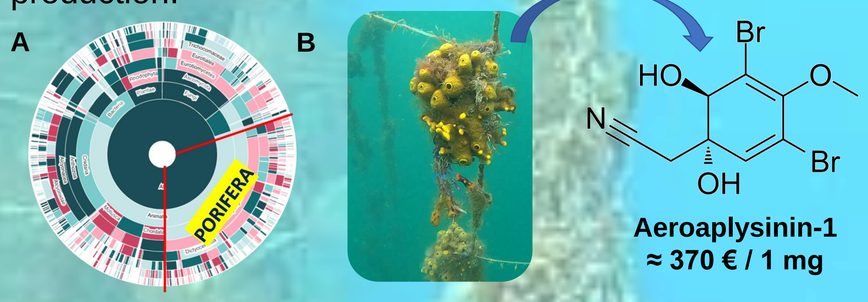


Fig 2. (A) Number of bioactive compounds of sponge origin [2]; (B) an example of a compound isolated from *Aplysina aerophoba* and its market price.

COSMETICS AND AQUARIOLOGY

The commonly known "bath sponges" have been collected for hundreds of years and still today some countries maintain this economic sector, although main commercial interests have changed (Fig. 3); besides, sponges as ornamental species, food or shelter in recreational aquaria imply another economic potential (Fig. 4A).

Fig 4. (A) *Axinella* spp. sponges in a marine aquarium; (B) high biodiversity asociated to *Sarcotragus spinosulus* reared in Remedia Life IMTA.

CONCLUSIONS

The production of biomass from non-edible species in IMTAs such as marine sponges with important profitable applications promotes a blue circular economy. In this sense, Remedia Life IMTA system represents an eco-friendly sponge biomass supply not only for economic interests such as green extraction of bioactive molecules and aquariology (ornamental species, food or shelter for fishes) but also for environmental welfare as bioremediators or restoration purposes that increase ecosystem biodiversity.

[1] Trani, R., Corriero, G., de Pinto, M. C., Mercurio, M., Pazzani, C., Pierri, C., Scrascia, M., Longo, C. 2021. Filtering Activity and Nutrient Release by the Keratose Sponge Sarcotragus Spinosulus Schmidt, 1862 (Porifera, Demospongiae) at the Laboratory Scale. J. Mar. Sci. Eng., 9(2), 178.
[2] CMNPD - Comprehensive Marine Natural Products Database.
[3] Bierwirth, J., Mantas, T. P., Villechanoux, J., & Cerrano, C. 2022. Restoration of Marine Sponges—What Can We Learn from over a Century of Experimental Cultivation? Water, 14, 1055.