Enhancing the environmental and economical sustainability of aquaculture through integration of sponges – an assessment of current knowledge

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1. Fish farming - from solution to pollution

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Aquaculture is outpacing food production from capture fisheries and expected to play a major role in future economies. At the same time, it exerts pressure to adjacent marine habitats mainly via the release of organic load and other substances.

2. Sponges as promising candidates for integrated aquaculture

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Among bioremediation candidates to mitigate organic pollution, sponges emerge as prominent due to specific traits including:

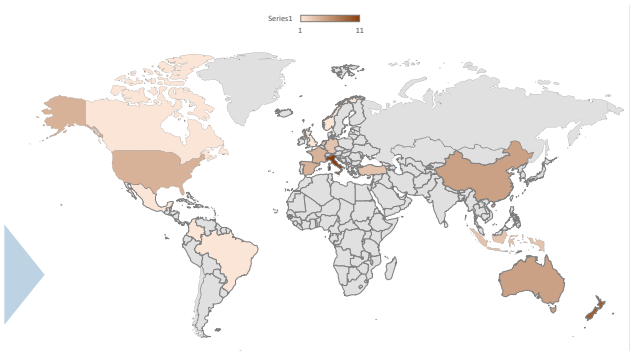
(a) water filtration at a high ratio relative to their body volume
(b) retention efficiency of minute organic particles, including nanoplankton and picoplankton
(c) capacity to feed on dissolved organic matter

3. Review of current knowledge - methodological approach

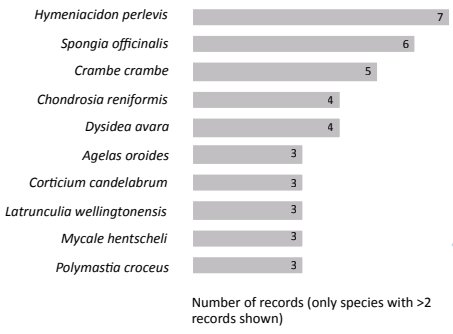
We conducted an exhaustive review of literature resources published over a 20-year timespan investigating sponges' potential for cultivation or capacity for bioremediation and biomonitoring. A total of 66 records were retrieved and information on candidate species, scope, methods employed, and outcomes was inventoried and summarised.

4. Research effort

Effort towards the experimental cultivation of sponges for bioremediation and bioproduction is taking place at a global scale, with Italy, New Zealand, Australia, and USA being the most active countries.

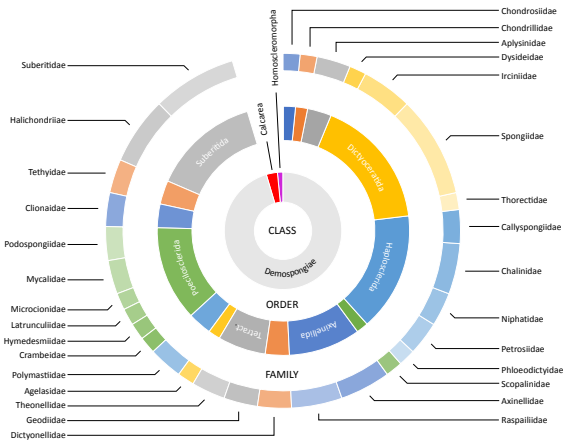


5. Identity of candidate sponge taxa



So far, 64 sponge species have been investigated for cultivation and bioremediation. Most frequently studied is *Hymeniacidon perlevis,* owing to a shallow niche and easy manipulation. The common bath sponge *Spongia officinalis* is also commonly studied, since its biomass is still valuable as a resource. *Crambe crambe* is rich in bioactive compounds, *Dysidea avara* produces the pharmaceutical Avarol, and *Chondrosia reniformis* is rich in collagen, valued in cosmetics.

Studied species are almost exclusively demosponges (belonging to the Class Demospongiae). Only one homoscleromorph and two calcarea were encountered among the studied records. Among the most investigated groups is the dictyoceratids, which include the bath sponges (Family: Spongiidae).

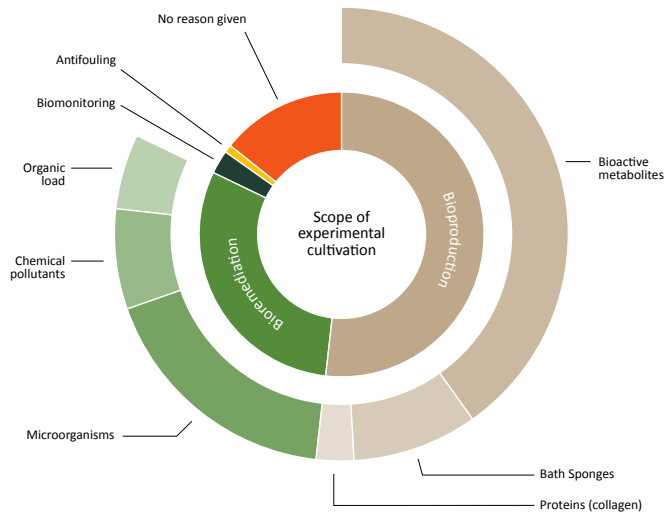


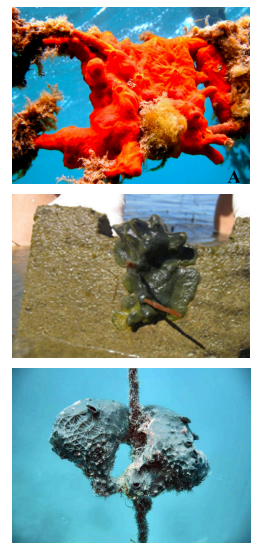
7. Scope of experimental sponge cultivation

The majority of research effort on sponge cultivation aims to the production of biomass (53% of the total records). This biomass can be utilised towards the production of bioactive secondary metabolites and proteins (i.e. collagen), or bath sponges.

A substantial part of current research focuses on bioremediation (29%of the total records), as regards to the uptake of microorganisms (bacteria or eucaryotes), chemical pollutants (e.g. PAHs, PCBs), or organic load (POM & DOM).

Only 3 studies examine the use of sponges as biomonitors (mainly due to bioaccumulation of trace metals), and 1 for antifouling in scallop aquaculture.





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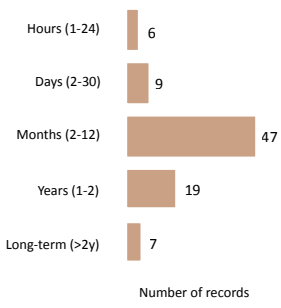
8. Methods employed in experimental sponge cultivation

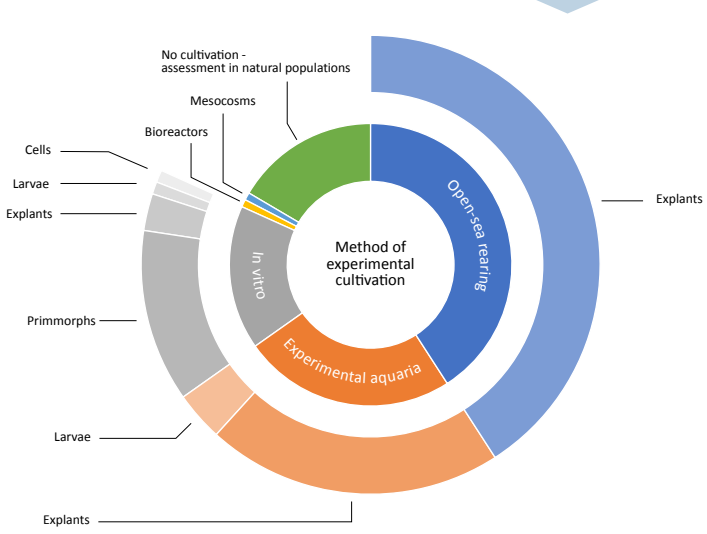
The majority of research effort on sponge cultivation employs mariculture in coastal systems using sponge explants (41%of the total records). In this approach, rearing parameters (survival and growth rates) are usually examined, sometimes coupled with environmental data.

Significant effort has also been invested on rearing in laboratory aquaria and tanks (24% of the total records). The latter effort mainly regards the conduction of controlled uptake experiments. In few instances (4 studies), experiments involve rearing of sponge larvae.

In vitro experiments (17% of the total records) regard mainly the cultivation of primmorphs (i.e. aggregates of previously dissociated sponge cells), as well as larvae and cell cultures.



Duration of experimental sponge culture varies from several hours (for experiments *in vitro*) to more than two years (open-sea rearing).



9. Outlook

Integration of sponge culture with fish farms can induce added value to aquaculture through production of bioactive substances with pharmaceutical or industrial potential. Hence, it emerges as a promising outlook, expected to support sustainable bioremediation through profitability and thus satisfy the global demand for blue growth in the following years.

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