The Remedia Life Integrated Multi-Trophic Aquaculture system: successful years of sponge mariculture

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INTRODUCTION

The polyculture of fish with other organisms at different levels of the trophic web (Integrated Multi-Trophic Aquaculture, IMTA) is an eco-friendly alternative that has received increasing attention and promises considerable economic potential. Among the co-cultured organisms Porifera, or sponges, show high efficiency in removing organic particles between 0.1–50 µm [1-4], which positively affect the quality of the surrounding water. The present study was undertaken to assess the survival and the effect of rearing method on it and the growth rate of five different sponge species within the Remedia Life IMTA system (Fig. 1A).

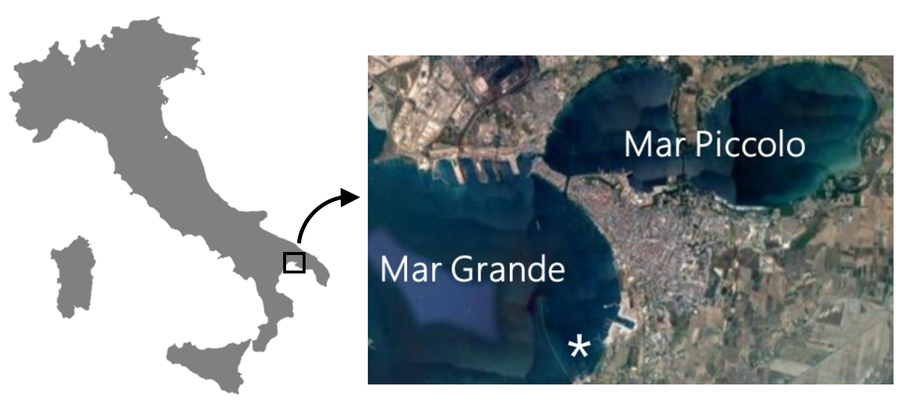

Fig 1. (A) Geographic location of the mariculture plant; (B) Remedia Life IMTA system photo and scheme; (C) the five sponge species reared in the system.

MATERIALS AND METHODS

The Remedia Life IMTA system, ongoing in the "Maricoltura del Mar Grande" aquaculture plant (Fig. 1A), consists of fish cages producing *Dicentrarchus labrax* and *Sparus aurata*, to which an innovative set of bioremediator organisms such as sponges, polychaetes, bivalves and macroalgae have been associated [5] (Fig. 1B). Among sponges five species were reared in: *Aplysina aerophoba*, *Geodia cydonium*, *Hymeniacidon perlevis*, *Ircinia variabilis* and *Sarcotragus spinosulus* (Fig. 1C). Sponge monthly monitoring was performed to evaluate the rearing performance in terms of **survival** ((N_{final} / $N_{initial}$) x 100) and **growth** ([V_{month} / $V_{initial}$] x 100) rates.

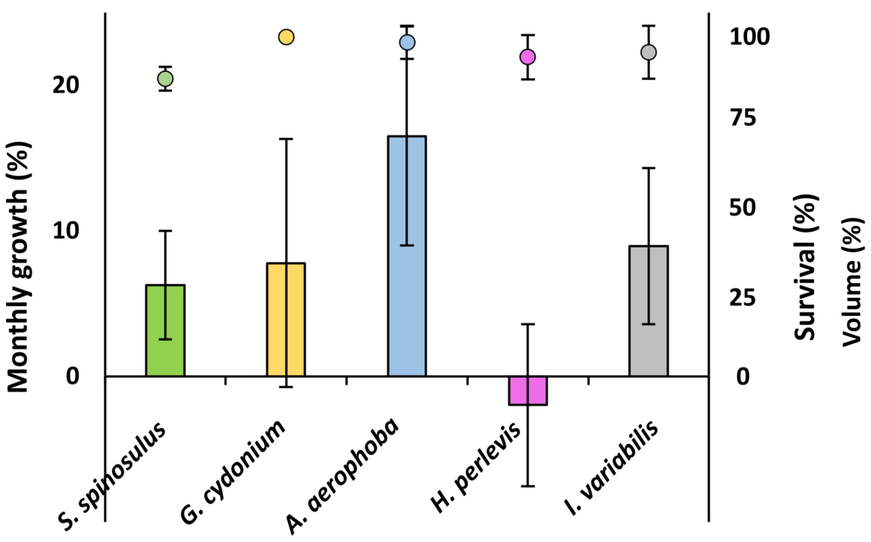

Fig 2. Rearing performance of selected species in terms of monthly growth rate (columns) and survival (dots) (± SE).

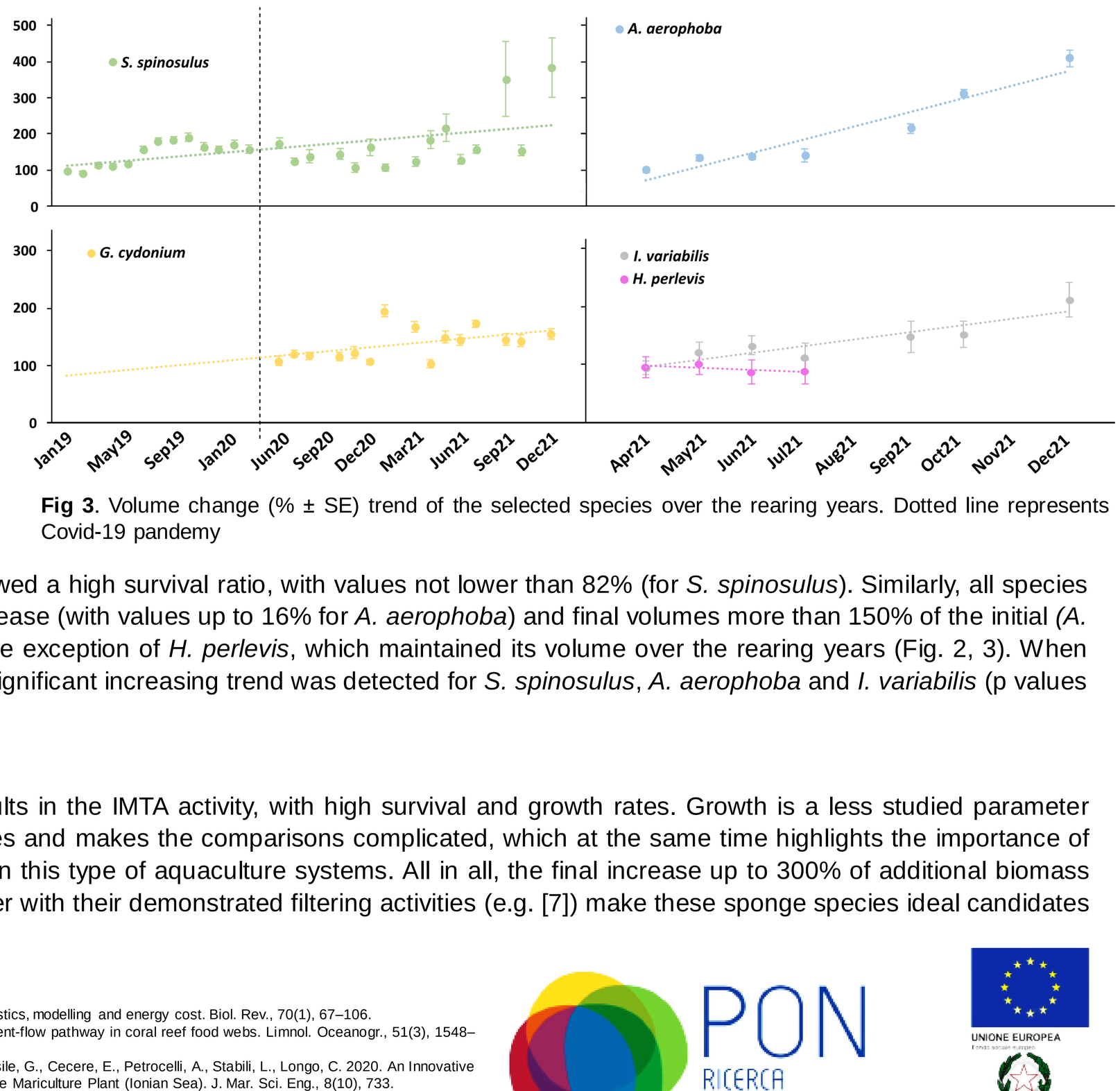

Fig 3. Volume change (% ± SE) trend of the selected species over the rearing years. Dotted line represents Covid-19 pandemy

RESULTS

All sponge species during the first year of rearing showed a high survival ratio, with values not lower than 82% (for *S. spinosulus*). Similarly, all species showed values of more than 6% monthly biomass increase (with values up to 16% for *A. aerophoba*) and final volumes more than 150% of the initial *(A. aerophoba* and *S. spinosulus* reaching 400%), with the exception of *H. perlevis*, which maintained its volume over the rearing years (Fig. 2, 3). When statistically analysed (Mann-Kendall trend test [6]), a significant increasing trend was detected for *S. spinosulus*, *A. aerophoba* and *I. variabilis* (p values < 0.01) (Fig. 3).

DISCUSSION AND CONCLUSIONS

Overall, all tested sponge species promise great results in the IMTA activity, with high survival and growth rates. Growth is a less studied parameter among in situ cultured sponges of the selected species and makes the comparisons complicated, which at the same time highlights the importance of the present research in order to improve productivity in this type of aquaculture systems. All in all, the final increase up to 300% of additional biomass and high growth rates for some reared species together with their demonstrated filtering activities (e.g. [7]) make these sponge species ideal candidates for co-culturing in IMTA systems.

[1] Simpson, T.L. 1984. The Cell Biology of Sponges; Springer: New York, NY, USA.
[2] Larsen, P.S., Riisgård, H.U. 1994. The sponge pump. J. Theor. Biol., 168(1), 53–63.
[3] Riisgård, H., Larsen, P. 1995. Filter-feeding in marine macro-invertebrates: Pump characteristics, modelling and energy cost. Biol. Rev., 70(1), 67–106.
[4] Hadas, E., Marie, D., Shpigel, M., Ilan, M. 2006. Virus predation by sponges is a new nutrient-flow pathway in coral reef food webs. Limnol. Oceanogr., 51(3), 1548–1550.
[5] Giangrande, A., Pierri, C., Arduini, D., Borghese, J., Licciano, M., Trani, R., Corriero, G., Basile, G., Cecere, E., Petrocelli, A., Stabili, L., Longo, C. 2020. An Innovative IMTA System: Polychaetes, Sponges and Macroalgae Co-Cultured in a Southern Italian In-Shore Mariculture Plant (Ionian Sea). J. Mar. Sci. Eng., 8(10), 733.
[6] Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Wiley, NY.
[7] 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.