Sea sponges need oxygen, as fish and people do

30 March 2022, by Valentina Ruiz-Leotaud

Processed wool sponge. Credit: Nicola Smith

The inconspicuous sea sponges are Earth's oldest multicellular animals and have filtered the oceans for nearly 900 million years, long before the first plants appeared on land. New research appearing in the journal *Fishery Bulletin*, published by the National Oceanic and Atmospheric Administration, indicates that their growth depends on their oxygen supply in a manner similar to more complex animals such as fishes.

Researchers from the University of British Columbia and Florida International University explain that a "dimensional tension" is at play as sponges grow because they are forced to rely on the two-dimensional cross-section of their inhalant pores to supply their tridimensional growing bodies with oxygen dissolved in water.

By analyzing data from new and previous studies on sponges, and estimating their growth parameters, the researchers suggest that such respiratory stress in the central portion of spherical sponges, such as those that are commercially harvested, limits their maximum size. Past this size, sponges change from near-spherical to vase-shaped forms. The central, oxygen-poor part of near-spherical sponges is, however, rich in anaerobic microbes—those that do not require molecular oxygen to survive.

"This means that sponges have evolved in a way that allows them to nurture complex microbial communities within themselves to deal with the geometric constraints imposed on their physiology," said Dr. Daniel Pauly, lead author of the study and principal investigator of the Sea Around Us initiative at UBC's Institute for the Oceans and Fisheries.

"These microbial communities are similar to the human gut microbiome and can be equivalent to 40% of the sponge wet body weight. High densities of microbes confer multiple beneficial functions for the sponge, such as metabolic regulation," Dr. Pauly said.

The UBC researcher is the person behind the Gill Oxygen Limitation Theory, which explains the links between growth and respiration in fish and other water-breathing animals.

"Sponges originated over 800 million years ago in the Pre-Cambrian. At that time, atmospheric oxygen levels were only about 50% of what they are today. Although global oxygen stores later increased with the evolution of multicellular plants, for 500 million years sponges evolved in a world depauperate of oxygen. In the absence of tissues or organs specialized for oxygen acquisition, sponge morphology was likely strongly constrained by physiological oxygen demand," said Dr. Mark Butler, of Florida International University, a co-author of the study.

Wool sponge. Credit: Mark Butler

Understanding the growth and evolution of these ancient organisms is important because they serve important ecological functions in marine ecosystems, including in coral reefs.

Sponges are responsible for regulating the exchange of energy, mass, and nutrients between habitats through filtration and nutrient cycling; enhancing habitat complexity; altering sediment structures; contributing to underwater soundscapes and providing food for spongivorous species.

"Sponges are also important to fisheries," said Dr. Nicola Smith, another co-author of the study and a researcher at UBC's Institute for the Oceans and Fisheries. "In the Caribbean, the export of marine sponges began in the mid-1800s as they were used for personal hygiene, house and car cleaning, medical surgery, glazing pottery, and cleaning industrial machinery, among other uses. Today, international demand for commercially harvested sponges is driven primarily by the cosmetic, biomedical and aquarium trades."

Data from the Food and Agriculture Organization of the United Nations show that nearly 40,000 tons of processed sponges were exported by two dozen countries from 1950 to 2019, corresponding to 1 million tons in live weight.

"When it comes to the number of countries exploiting sponge populations and their catches, the FAO numbers are likely underestimates," Dr. Smith said. "Also, the effects of commercial fisheries on sponge communities are largely unknown, although in south Florida, management limitation of harvest to the use of artisanal techniques appears to have produced a sustainable fishery. In the past, however, many sponge fisheries have been so overexploited that they collapsed."

Following this study, the researchers will join forces with other colleagues to perform a detailed reconstruction of the catches of commercial sponges around the world.

More information: Daniel Pauly et al, Growth and related traits of the sheepswool sponge (Hippospongia lachne): practical and theoretical considerations, *Fishery Bulletin* (2022). DOI: 10.7755/FB.120.2.1 spo.nmfs.noaa.gov/sites/defaul… h-bull/1202pauly.pdf

Provided by Sea Around Us

APA citation: Sea sponges need oxygen, as fish and people do (2022, March 30) retrieved 31 March 2022 from https://phys.org/news/2022-03-sea-sponges-oxygen-fish-people.html

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