Porifera: Services and Disservices

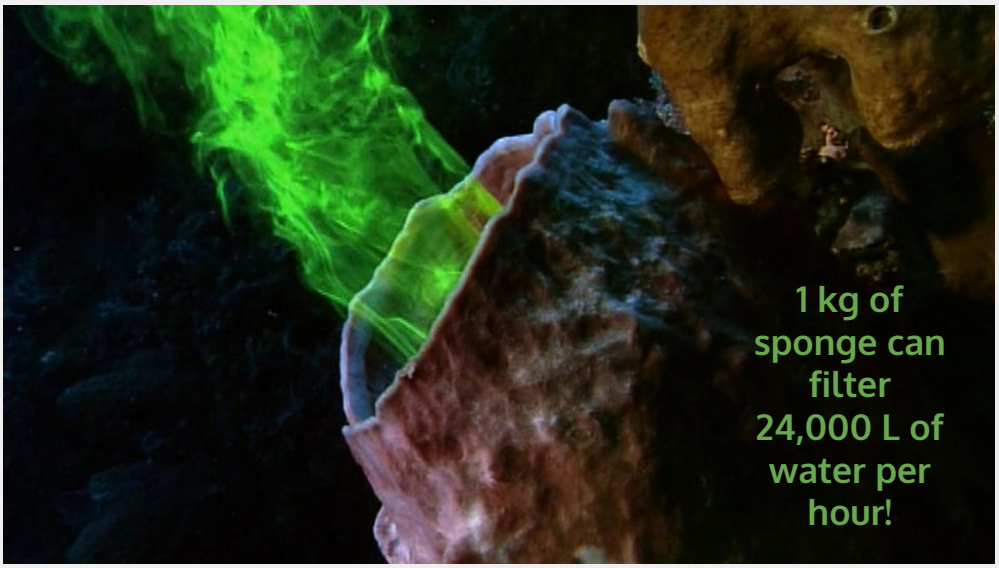
Invertebrate Biology

Kaylyn Flanigan

NOAA Okeanos Explorer Program, 2010

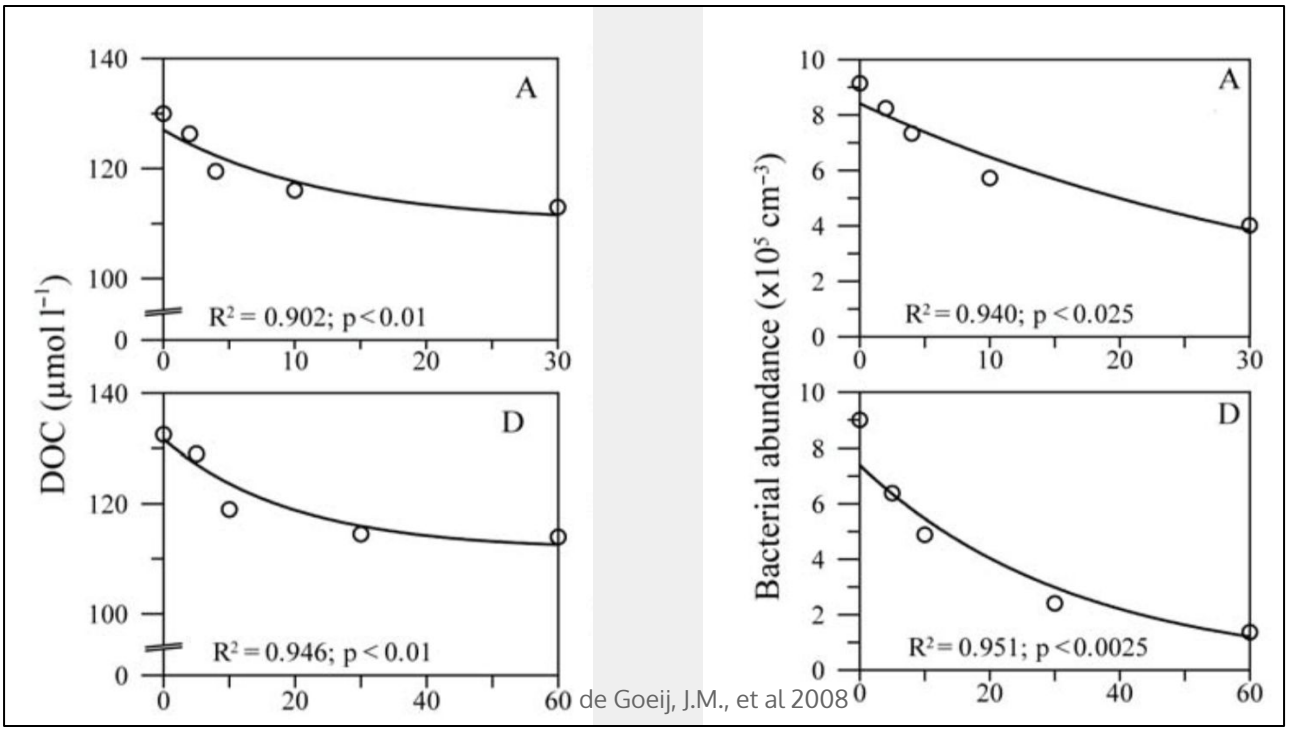
When presented with an organism similar to this, I was at a loss in identifying it. Using the anatomical labels of one of Professor McCluney's diagrams, I searched for invertebrates with rhizoids. Through internet research, I found an article from the Monterey Bay Aquarium Research Institute (MBARI), I identified the organism as belonging to phylum porifera - or sea sponges.

Service of phylum porifera: Filtering Water



(Batista et. al 2013)

Shape of Life - Vimeo



Studied three sponge species: *Halisarca caerulea, Mycale microsigmatosa and Merlia normani* along the coast of Curacao, Netherlands Antilles.

The sponge assimilates some of the DOC it filters into its own structure

- *Halisarca caerulea*, *Mycale microsigmatosa* and *Merlia normani* were shown to decrease dissolved organic carbon (particulate organic matter - usually from dead or decaying organisms - DOC is consumed by some smaller organisms and filter feeders)

- The graphs on the left (figure 1) demonstrate this draw-down of DOC

Bacterial Abundance

Bacterial abundance significantly decreased when encrusting sponges were present. In their absence (with just coral or just ambient water) bacterial abundance did not decrease, which suggests that these encrusting sponges are in fact cycling bacteria within the water column.

- The same three species in the DOC research were tested for their ability to decrease bacterial abundance

- The graphs show that, by filtering water through cells, sponges are able to decrease bacteria within the water column

de Goeij, J.M., et al. “Major bulk dissolved organic carbon (DOC) removal by encrusting coral reef cavity sponges.” *Marine Ecology and Progress Series*, vol. 357:

Service of phylum porifera: Medicine

Sven Zea, Sweetings Bay, Bahamas *Ircinia sp.*

Antibacterial, antiviral, antifungal, anti-inflammatory, and immunosuppressive qualities

Sponges produce secondary metabolites (chemicals that are not necessary for their survival). Typically these metabolites are used as allomones to deter predators (the allomone actually alters the predators behavior). When humans harvest them, these chemicals can be used for medicinal purposes.

What they provide: antibacterial, antiviral, antifungal, anti-prion, antimalarial, anti-inflammatory and immune or neuro-suppressive characteristics

Mioso, R., et. al, 2017. "Cytotoxic Compounds Derived from Marine Sponges. A Review." ***Molecules.*** **2017.**

Service of phylum porifera: Medicine

Sven Zea, Sweetings Bay, Bahamas *Ircinia sp.*

- Sponges produce secondary metabolites (chemicals not necessary for survival)
  - These are called allomones
  - They are used by the sponge to alter predator behavior
    - Hopefully, deterring the predator

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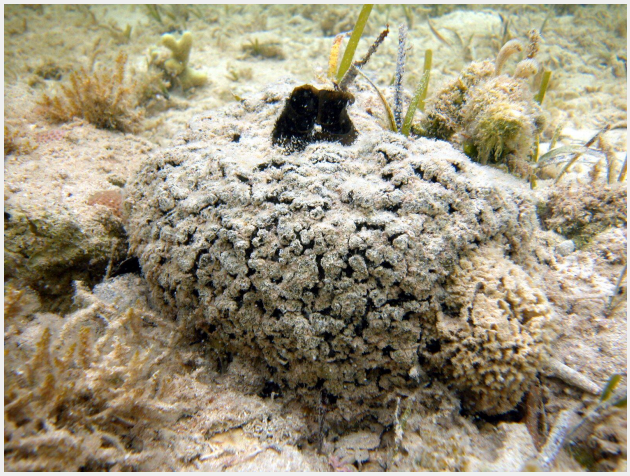

Tectitethya crypta

Sven Zea, Little San Salvador, Bahamas

- AZT
- Antiviral
- Anti-Leukemia

(Pomponi, National Museum of Natural History)

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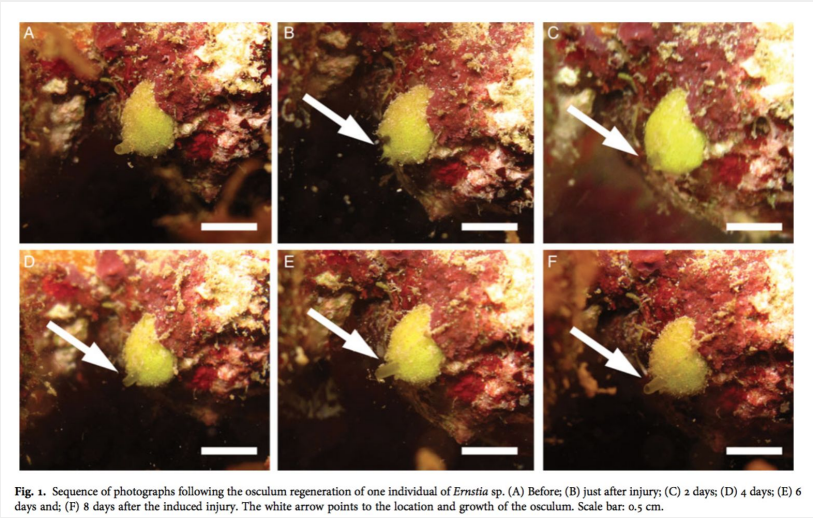

Fig. 1. Sequence of photographs following the osculum regeneration of one individual of *Ernstia* sp. (A) Before; (B) just after injury; (C) 2 days; (D) 4 days; (E) 6 days and; (F) 8 days after the induced injury. The white arrow points to the location and growth of the osculum. Scale bar: 0.5 cm.

Padua, A. and Klautau, M. 2016

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Regenerative medicine.

While Padua and Klautau (2016) found that, in sponges, regeneration depends on morphology and body polarity, Wang, Schröder, and Müller (2014) believe that the enzymatic processes that occur during regeneration in sponges, including biosilicate and biocalcite, could be manipulated to grow bone in humans.

Padua, A. and Klautau, M. "Regeneration in calcareous sponges (Porifera)." *Journal of the Marine Biological Association of the United Kingdom,* (96)2: 553-558. 2016.

Wang, X., Schröder, HC., and Müller, W. "Enzyme-based biosilicate and biocalcite: biomaterials for the future of regenerative medicine." *Trends in Biotechnology*, (32)9. 2014.

Service of phylum porifera: Bioindicators

Nick Hobgood

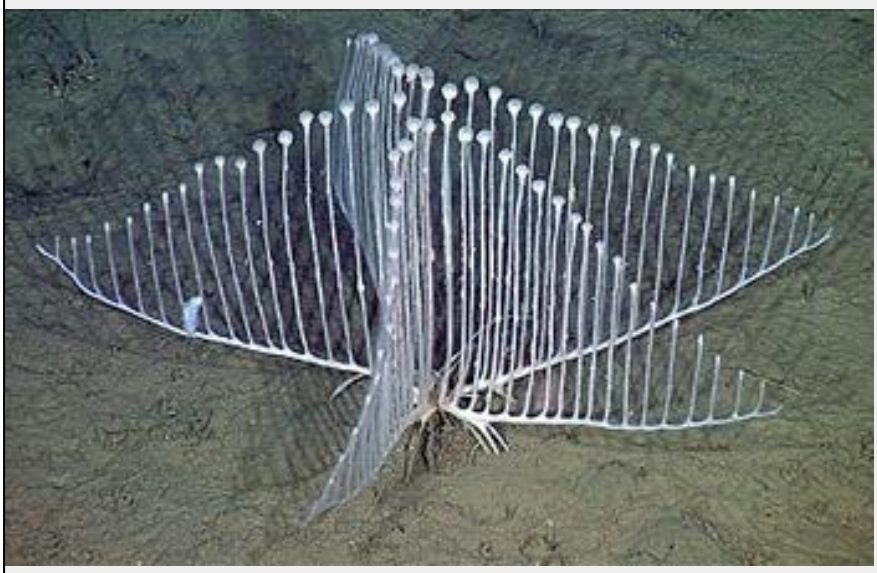
- Polycyclic aromatic hydrocarbons (PAHs)
- Metal

NOAA

Sponges are ideal bioindicators because of their location in the water column. Mussels, and other intertidal species, are not a true reflection of the contaminants in the water column. Moreover, the research that is conducted with intertidal species to measure the amount of contaminants in the water are unreliable because most of the contaminant forms a film on the top layer of the water. Sponges, due to their high rate of filtration, are more likely to absorb contaminants than their intertidal counterparts.

Batista, D., et. al. "Marine sponges as bioindicators of oil and combustion derived PAH in coastal waters." ***Marine Environmental Research*****, 92: 234-243. 2013.**

Services of *Chondrocladia lyra*



MBARI, 2012

- Filtering water
  - Although not used for eating like others within the phylum, *C. lyra* could filter bacteria, toxins, or DOC out of the water

Not much is known about the exact services and disservices of *Chondrocladia lyra*; however, if we apply the knowledge that we have from the phylum as a whole, we might be able to hypothesize about the specific services and disserivces of *Chondrocladia lyra*.

1. Filtering water - although Lonny Lundsten of MBARI noticed that species similar to *C. lyra* didn't have choanocytes used to filter feed, they may have a way to filter bacteria, toxins, and/or DOC out of the water column (Arnold, 2014).

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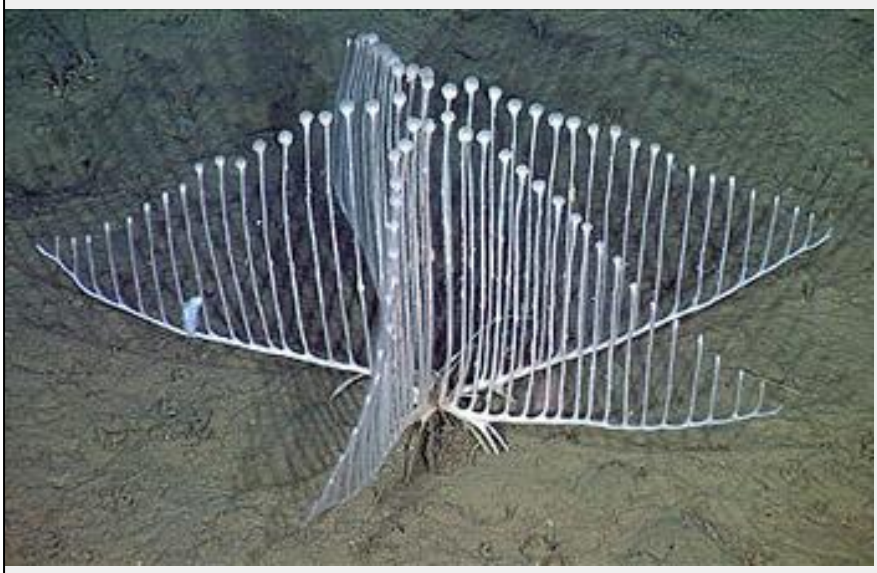

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- Medicine
  - May produce allomones used to deter predators which could be used for human medicinal research
  - May have regenerative properties

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2. Medicine - sponges tend to use two defenses to deter predators: mechanical (spicules) and chemical (toxins) defenses. If *C. lyra* produces toxins, there is a chance that those allomones can be used in medicinal research like many other marine sponge allomones.As is relevant in some marine sponge species, regeneration may be possible for *C. lyra*. It would be helpful for the organism to possess this ability in the case that one of its branches gets removed.
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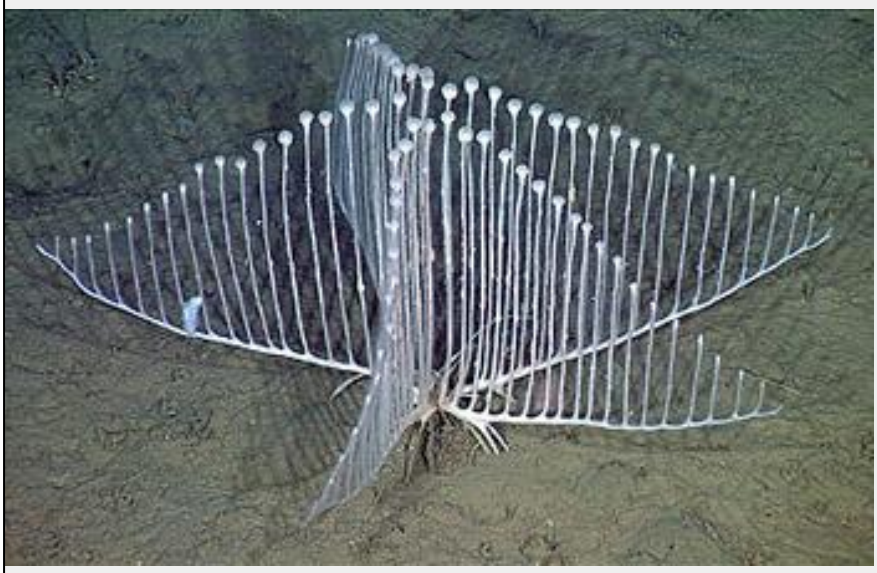

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What does coral have to do with sponges?

Toby Hudson

Disservice of porifera: Outcompeting Coral for Space

Sven Zea, Sweetings Cay, Bahamas

- Corals create a calcium carbonate skeleton ($CaCO_3$)

Suchaneck, T.H., et al. "Sponges as Important Space Competitors in Deep Caribbean Coral Reef Communities." ***West Indies Laboratory*****.**

Mueller, B., et al. "Natural Diet of Coral-Excavating Sponges Consists Mainly of Dissolved Organic Carbon (DOC)." ***PLoS ONE*** **9(2): e90152. 2014.**

Coral excavating sponges are the most abundant and destructive bioeroders on coral reefs and are strong competitors for space. They can remove as much $CaCO_3$ as a coral accretes within a year.

Reefs are important because they protect the land from power wave surges, erosion of coast lines, maintain coastal livelihoods of fishers, and maintain the tourism industry. They are also at the head of biodiversity on the planet.

Slow growing sponges are the ones that have chemical defenses. The fast growing ones are good competitors. Reefs that are off-limits to fishers have an abundance of fish that will consume the fast growing, coral-competing sponges which help the reef to thrive.

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- Corals create a calcium carbonate skeleton ($CaCO_3$)
  - Bioeroding sponges can dissolve that skeleton and outcompete corals for space on a reef
- Fishes can usually consume these sponges before they erode much coral
  - But due to overfishing, sponges have a greater advantage

(NSF, 2014)

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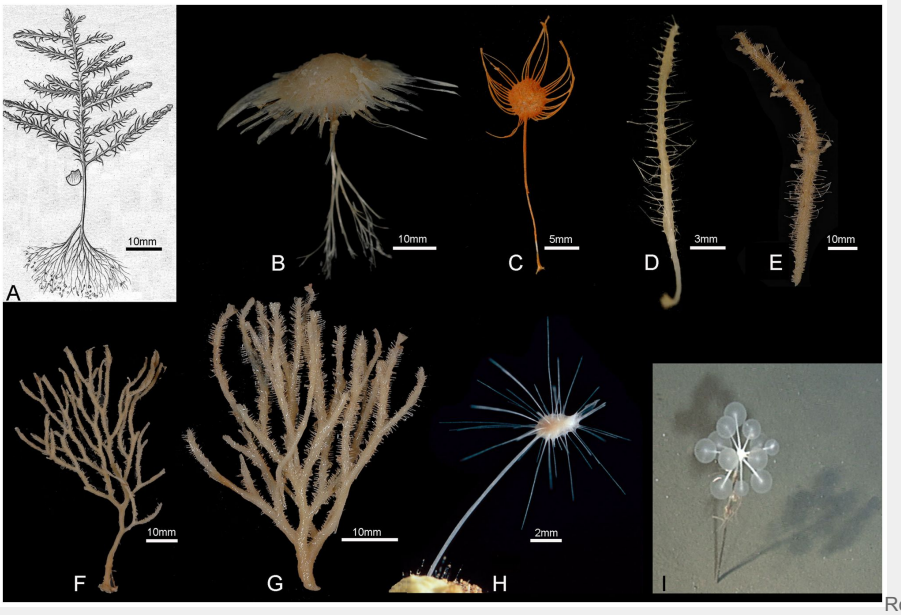

- *C. lyra* and other carnivorous sponges could also be outcompeting some deep-sea organisms

Rob W. M. Van Soest

Deep sea sponges are not likely to outcompete organisms for space since there is so much of that deep in the sea. However, its unique eating habits could alter food webs with the increase of population size and monopolization of resources.

By outcompeting other deep-sea organisms, *C. lyra* could be altering the food webs. If *C. lyra* is consuming all of the crustaceans in the deep-sea, other organisms that would also consume the crustaceans would go without, unable to be preyed upon by some species within the upper water column. This could drastically alter the abundance of necessary food web interactions.

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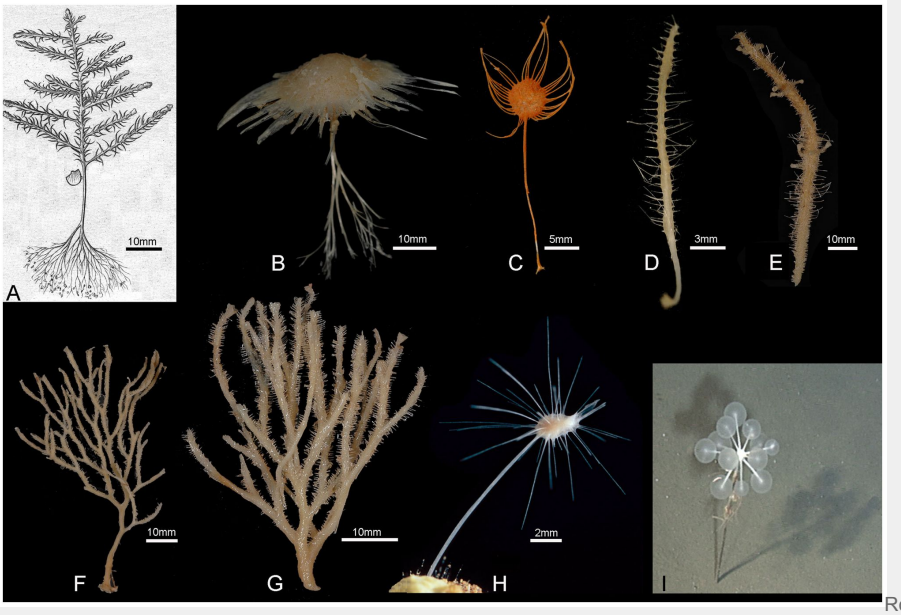

- *C. lyra* and other carnivorous sponges could also be outcompeting some deep-sea organisms
  - They could be monopolizing the planktonic food sources, making it difficult for other organisms to survive

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