



# The Secret Lives of Sponges: Understanding ancient animals at their own pace

SJSU

Moss Landing Marine Laboratories & San Jose State University

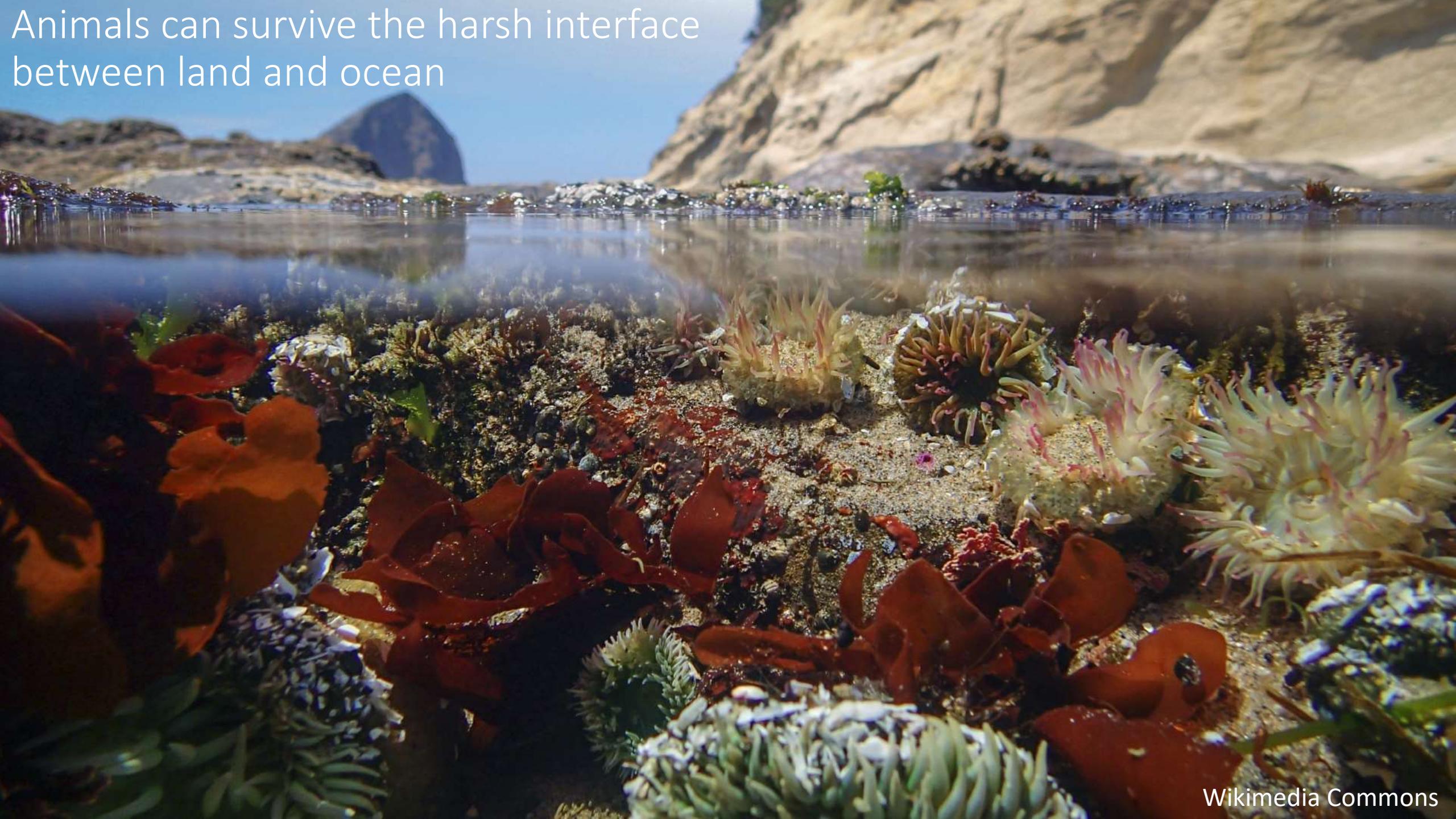
Amanda Kahn





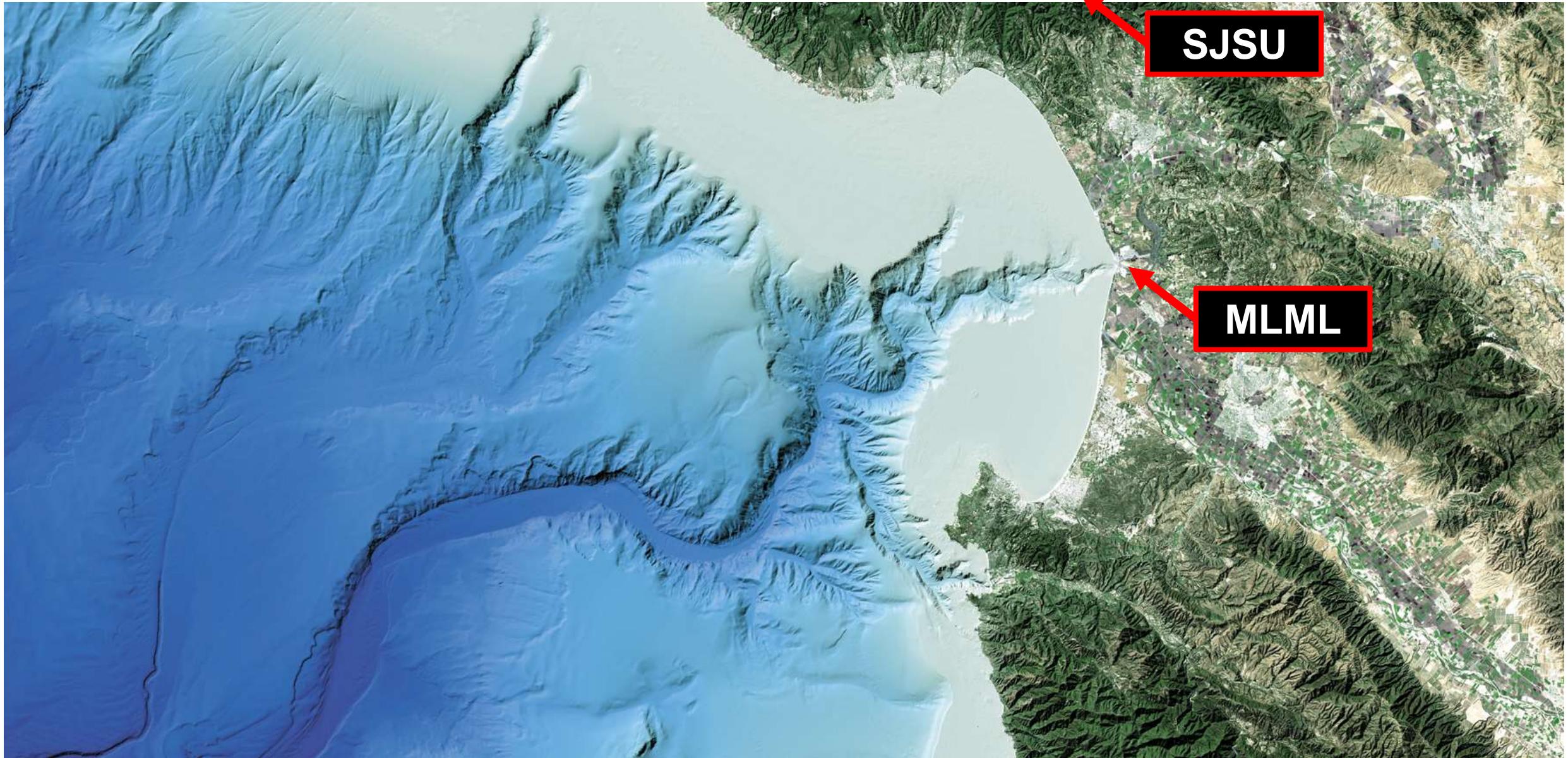


Animals can survive the harsh interface  
between land and ocean

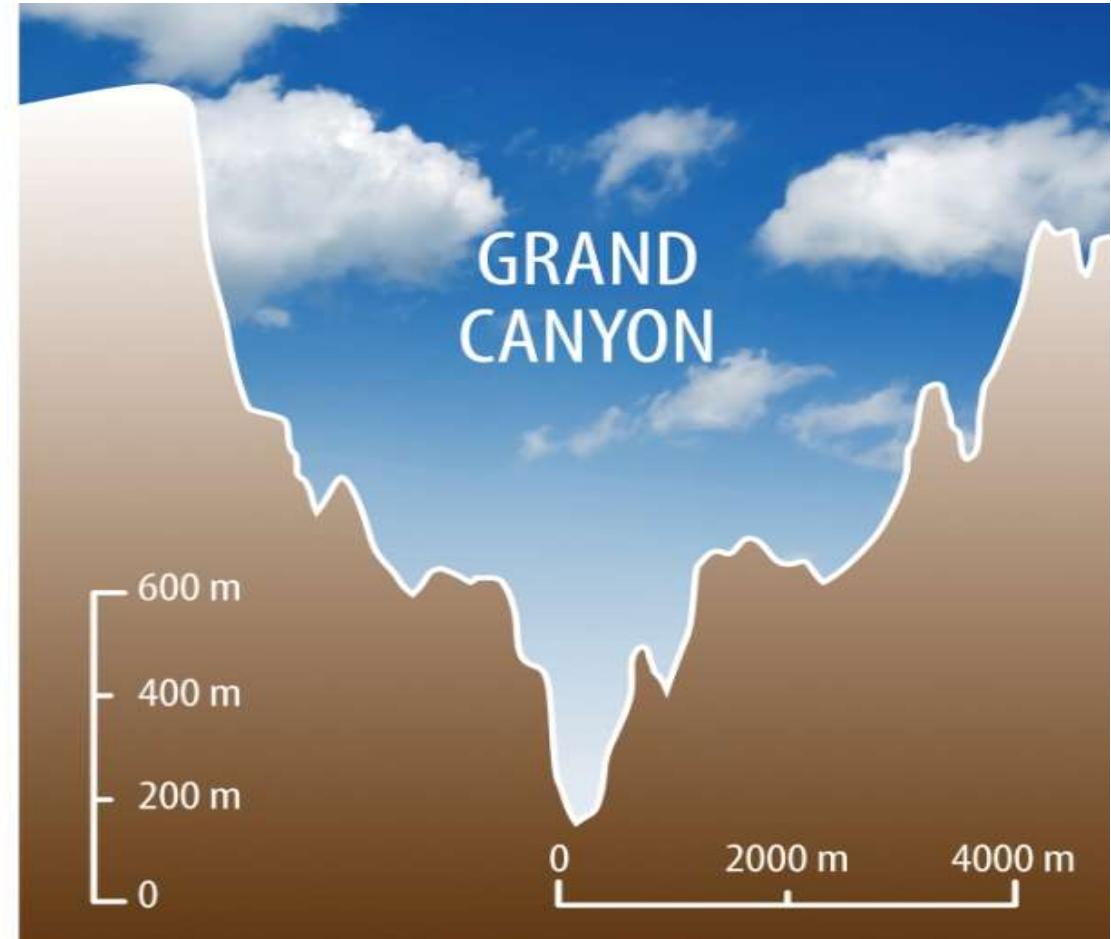
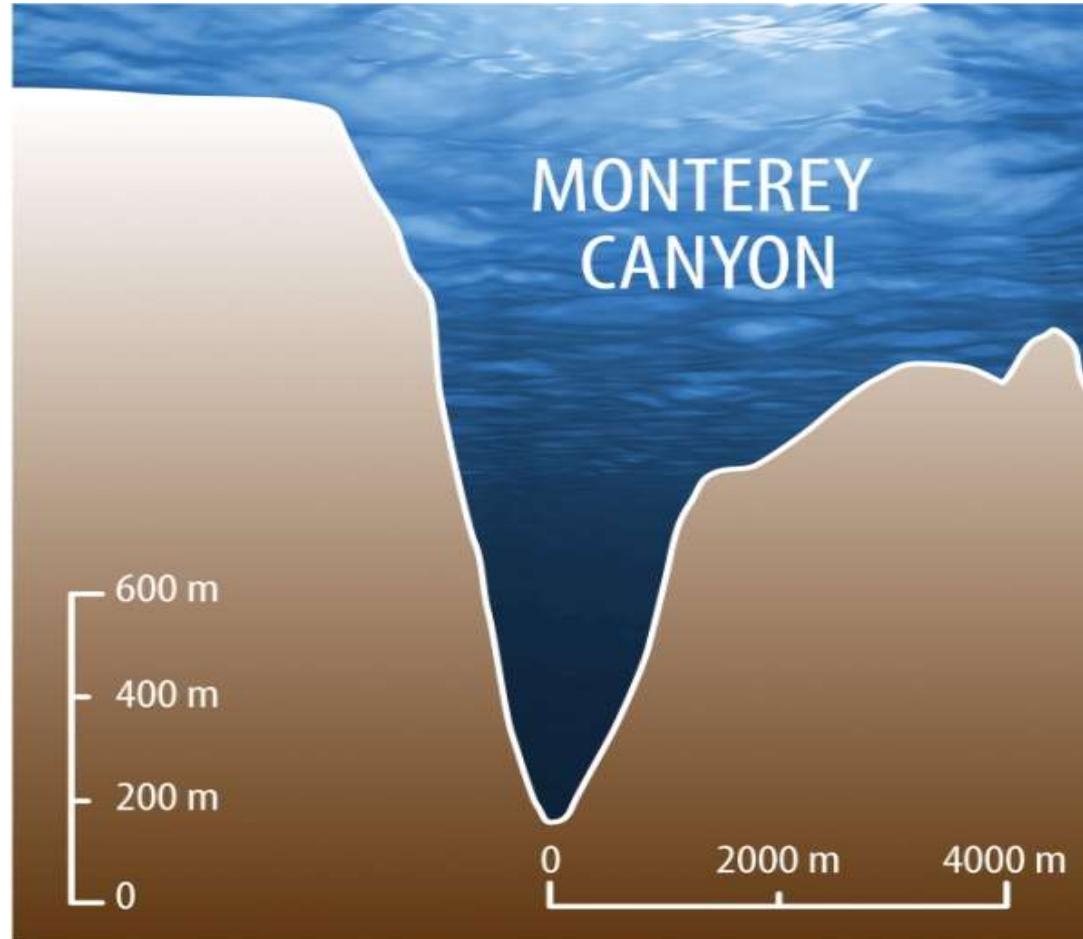


**And thrive in dense forests beneath the waves**

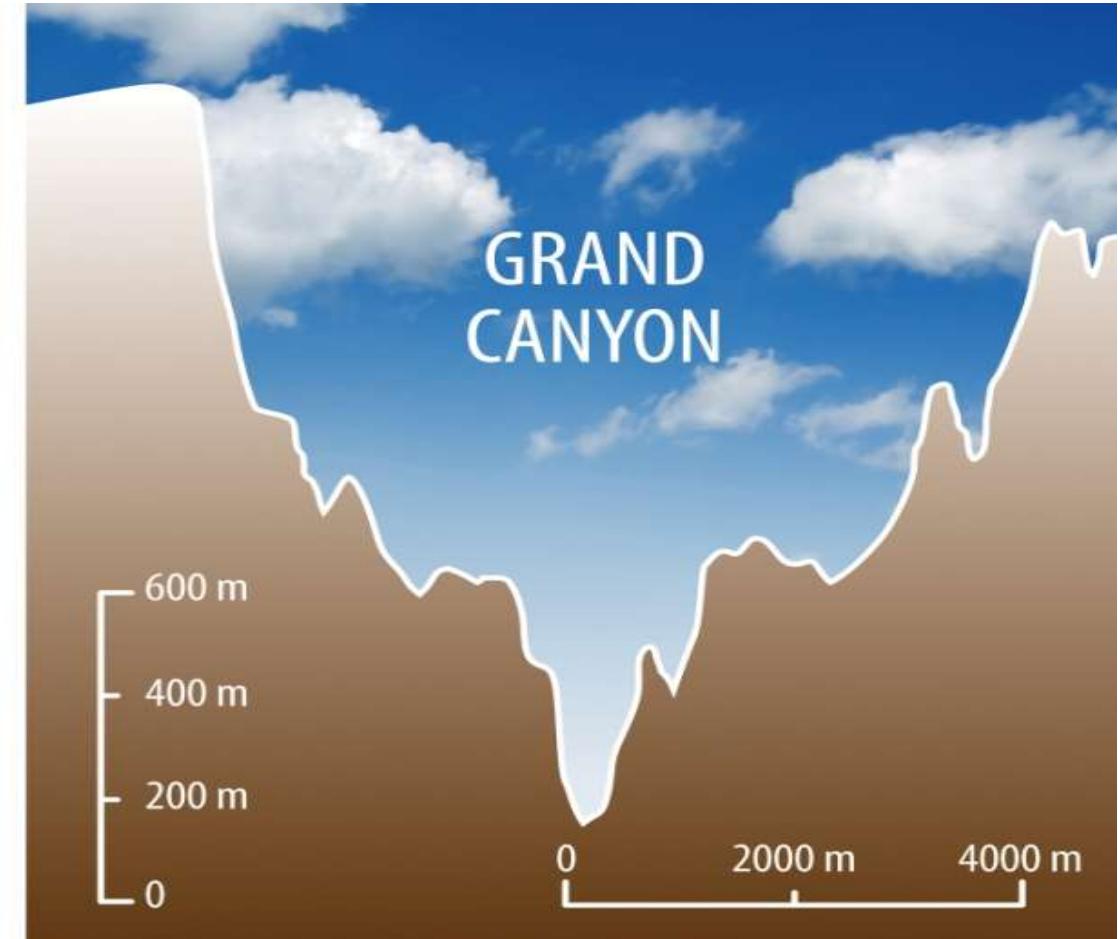
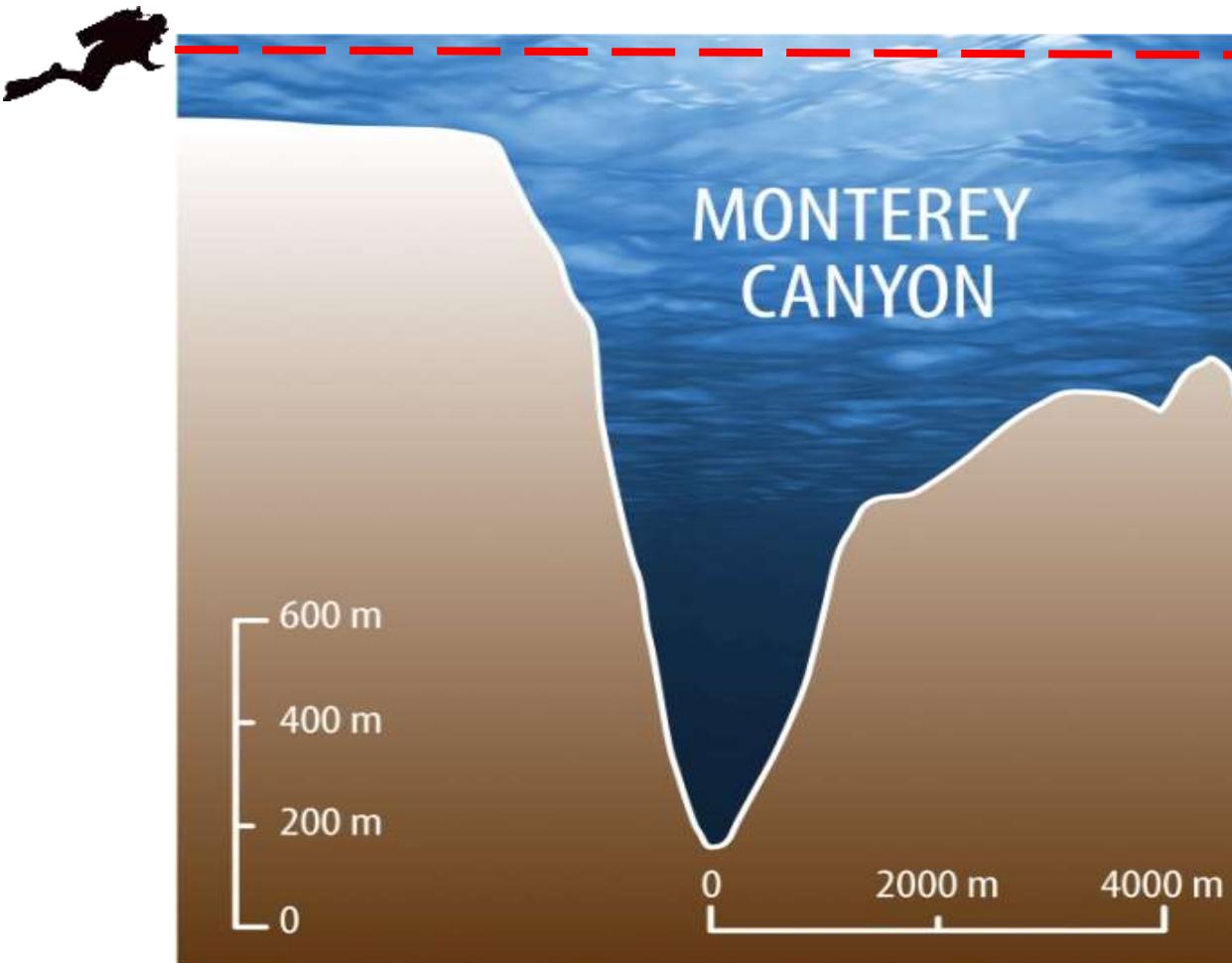
# Monterey Bay's dramatic coastline extends underwater



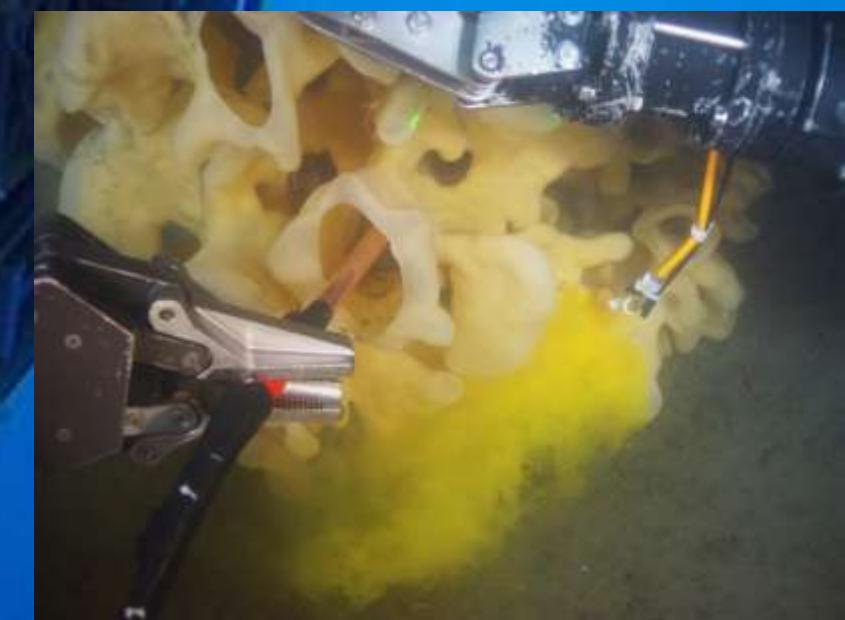
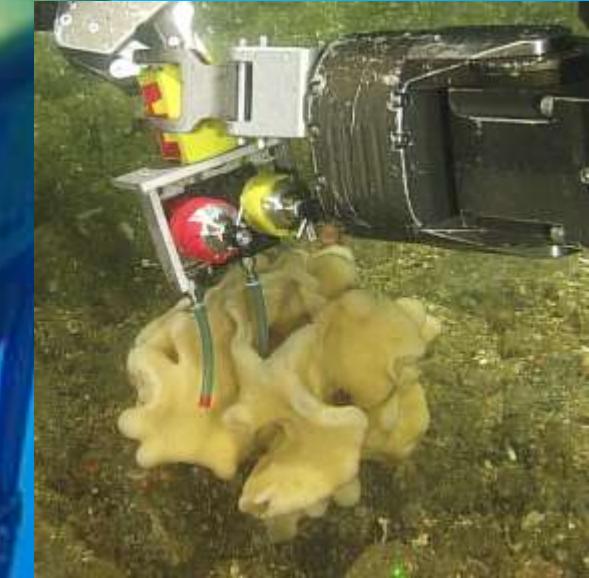
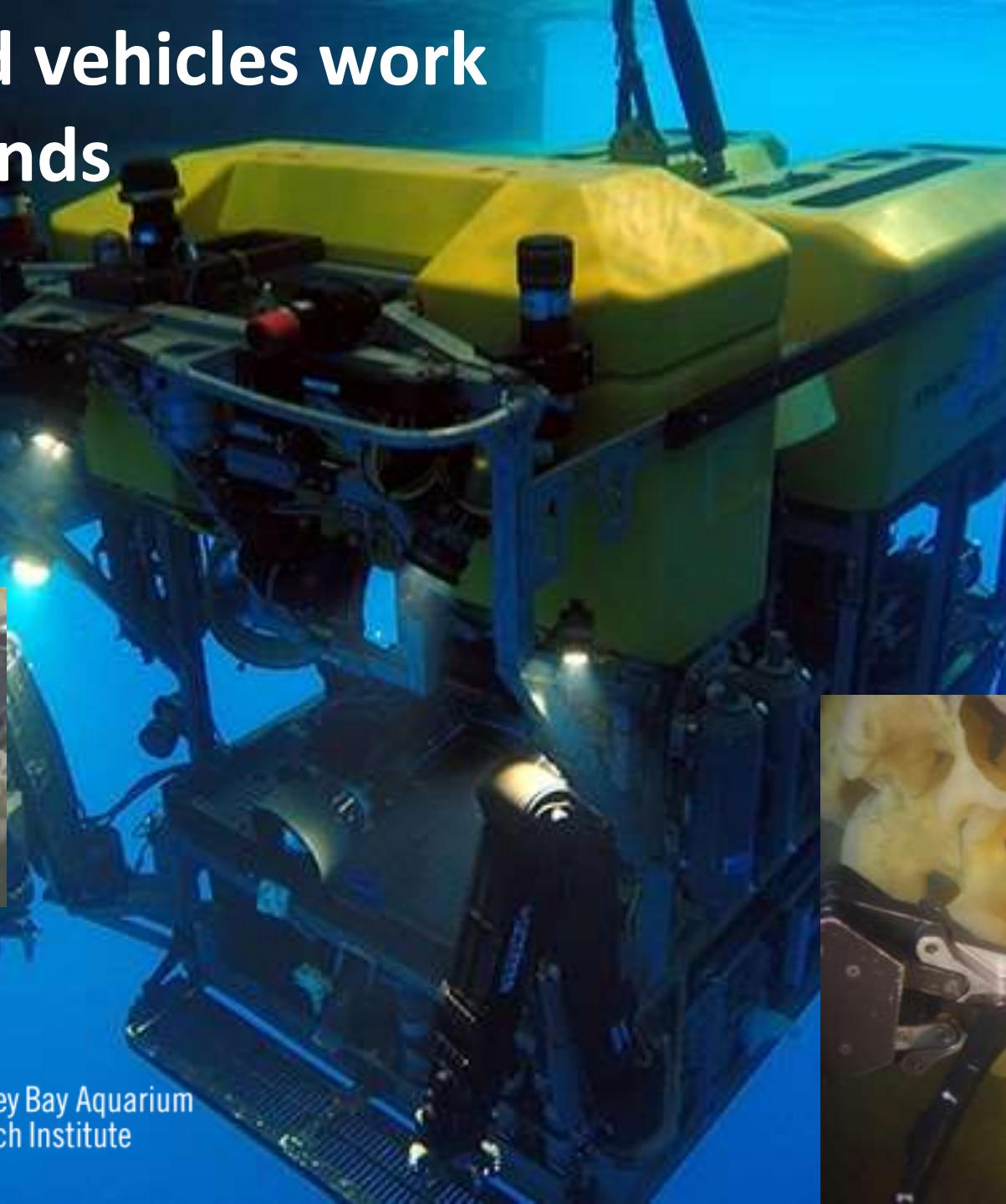
# Monterey Bay's dramatic coastline extends underwater



# Access to the deep ocean is easy here...but need technology



# Remotely operated vehicles work as our eyes and hands underwater





# The deep sea is tough to live in

## Food limitation drives evolution

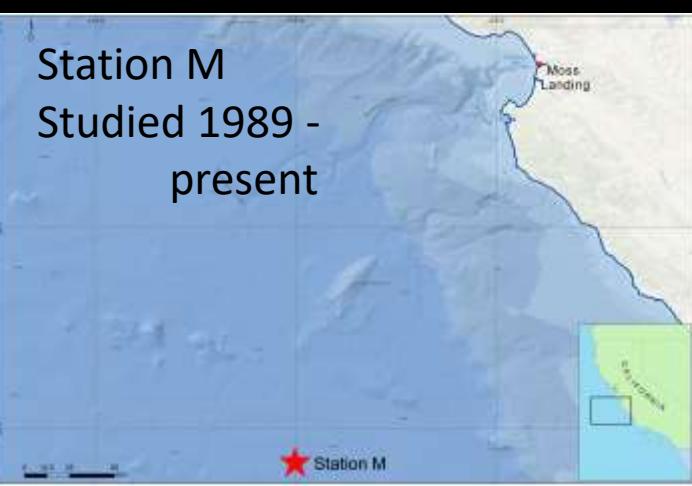
Cold water  
Total darkness  
Little oxygen  
VERY little food



# Most of the deep sea looks like this: the abyssal plain



5 months of time on the seafloor. Every photo = 1 hour

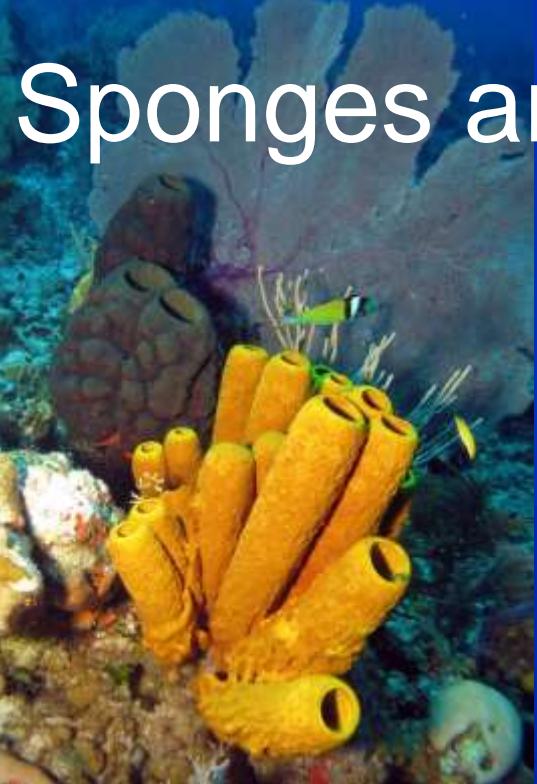


4,000 meters depth. Courtesy: K. Smith



What do you think of when you think of a sponge?

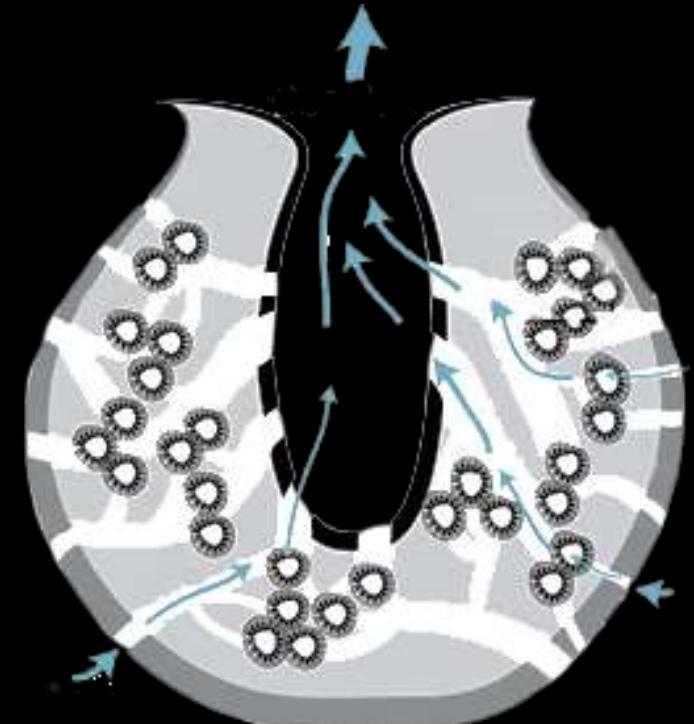
# Sponges are animals



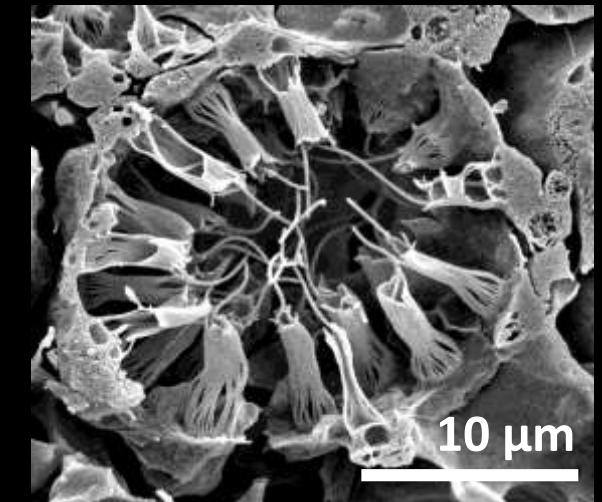
# Sponges are efficient filter feeders



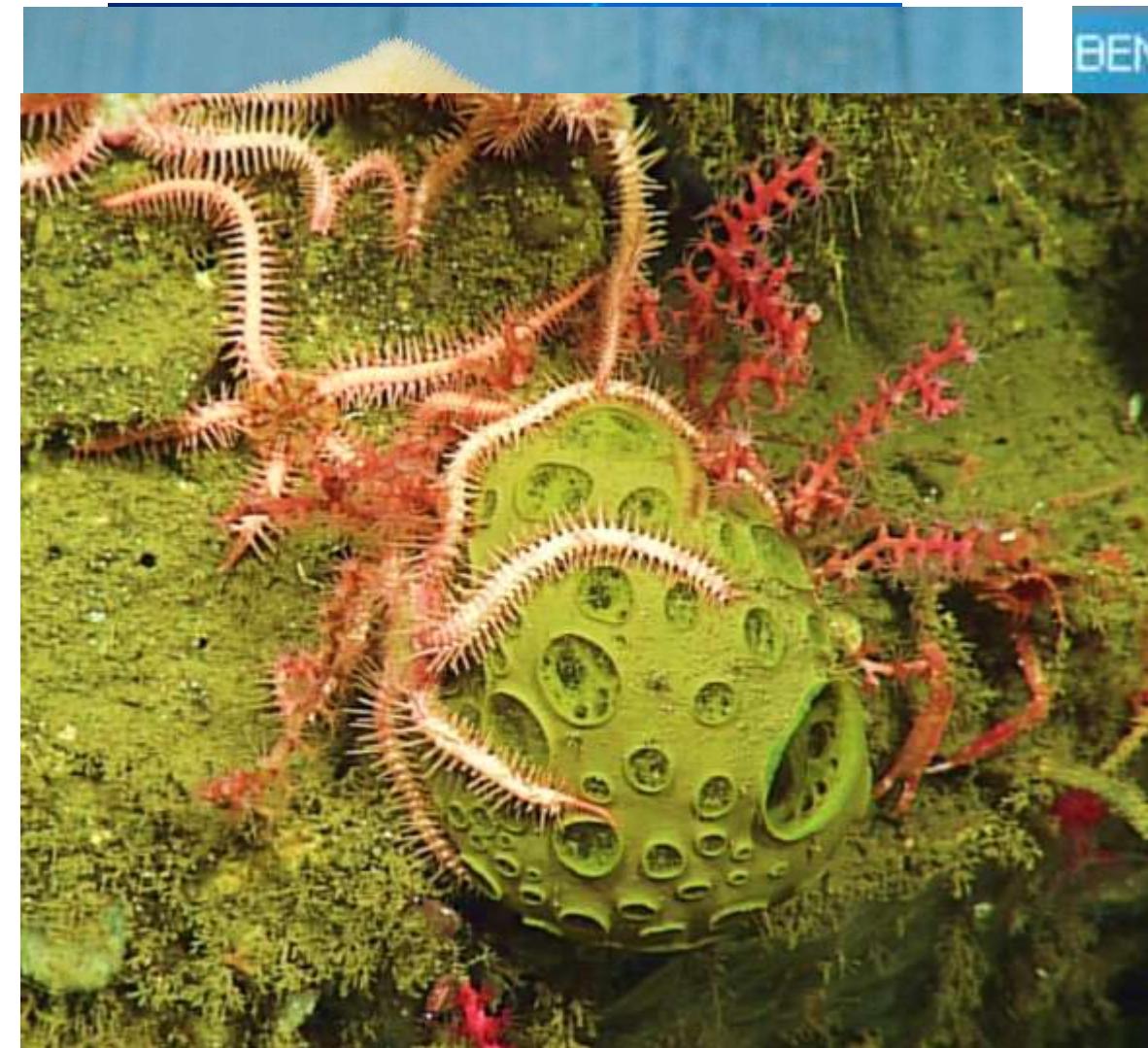
Mark Shelley Sea Studios Foundation



Ludeman et al (2017)



# Humans have interacted with sponges for thousands of years



BENGT BO  
n KALY



4



Image cr

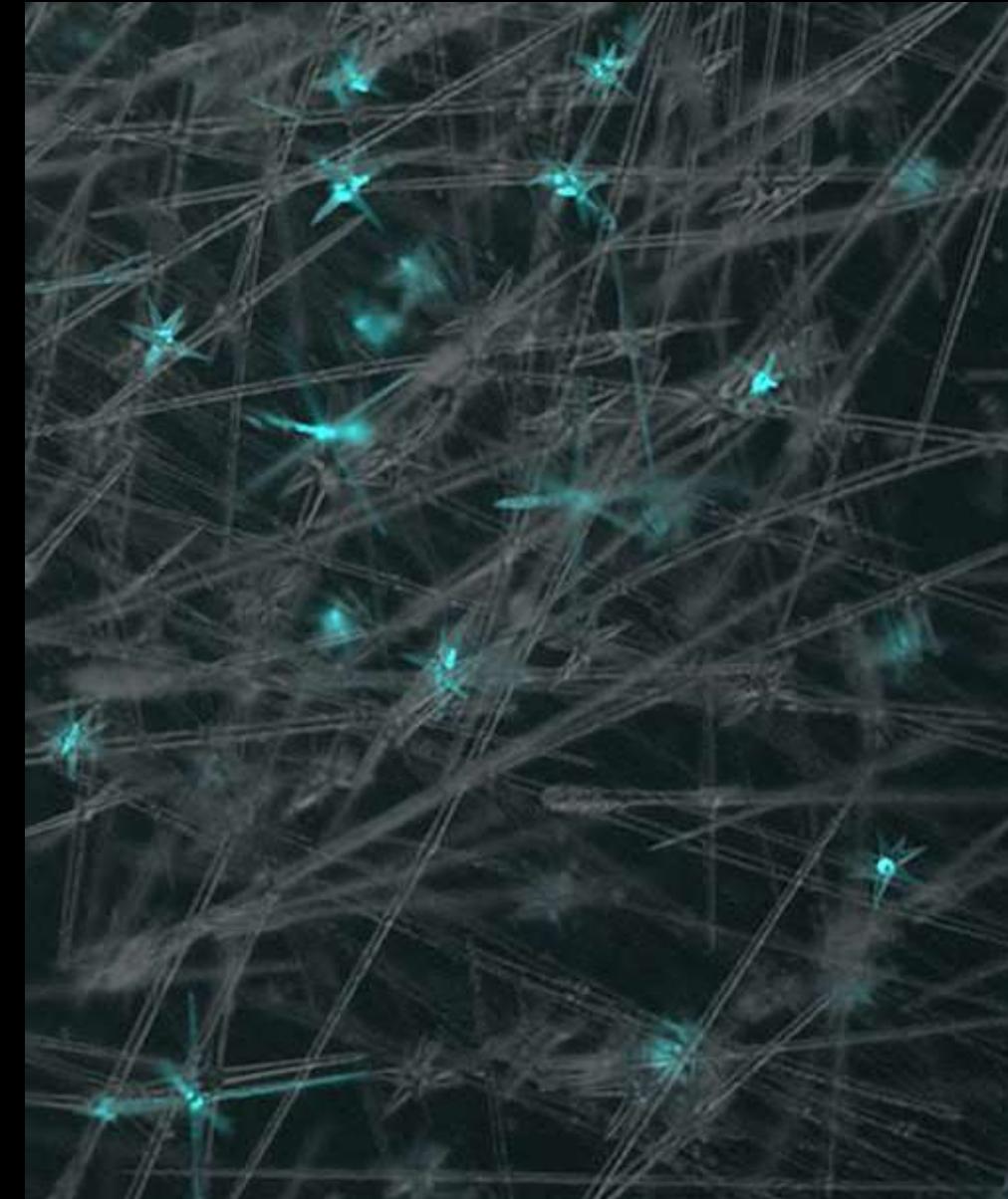
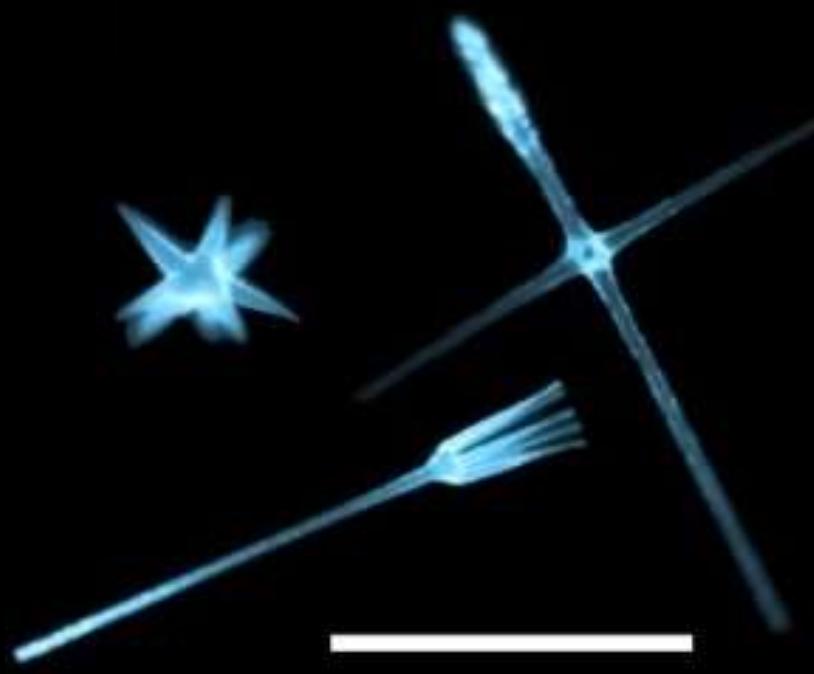
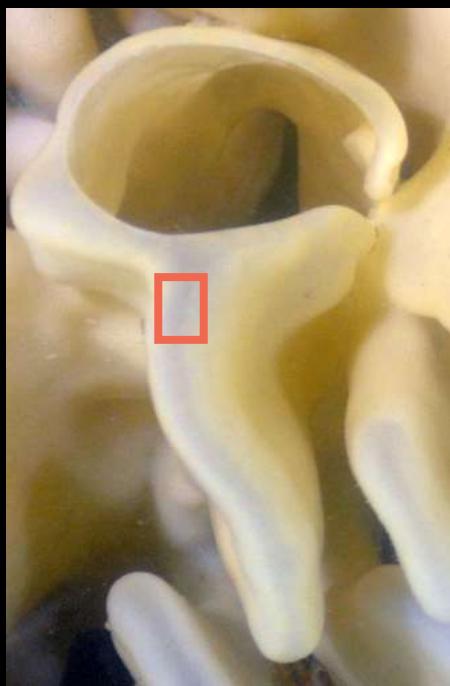


ide

# Hexactinellids make their skeletons out of glass



80-90% of the weight  
of a hexactinellid  
sponge is glass!



I use technology  
to study deep  
sea sponges



**What effect do deep sponges  
have on their environment?**

**How do they do it?**



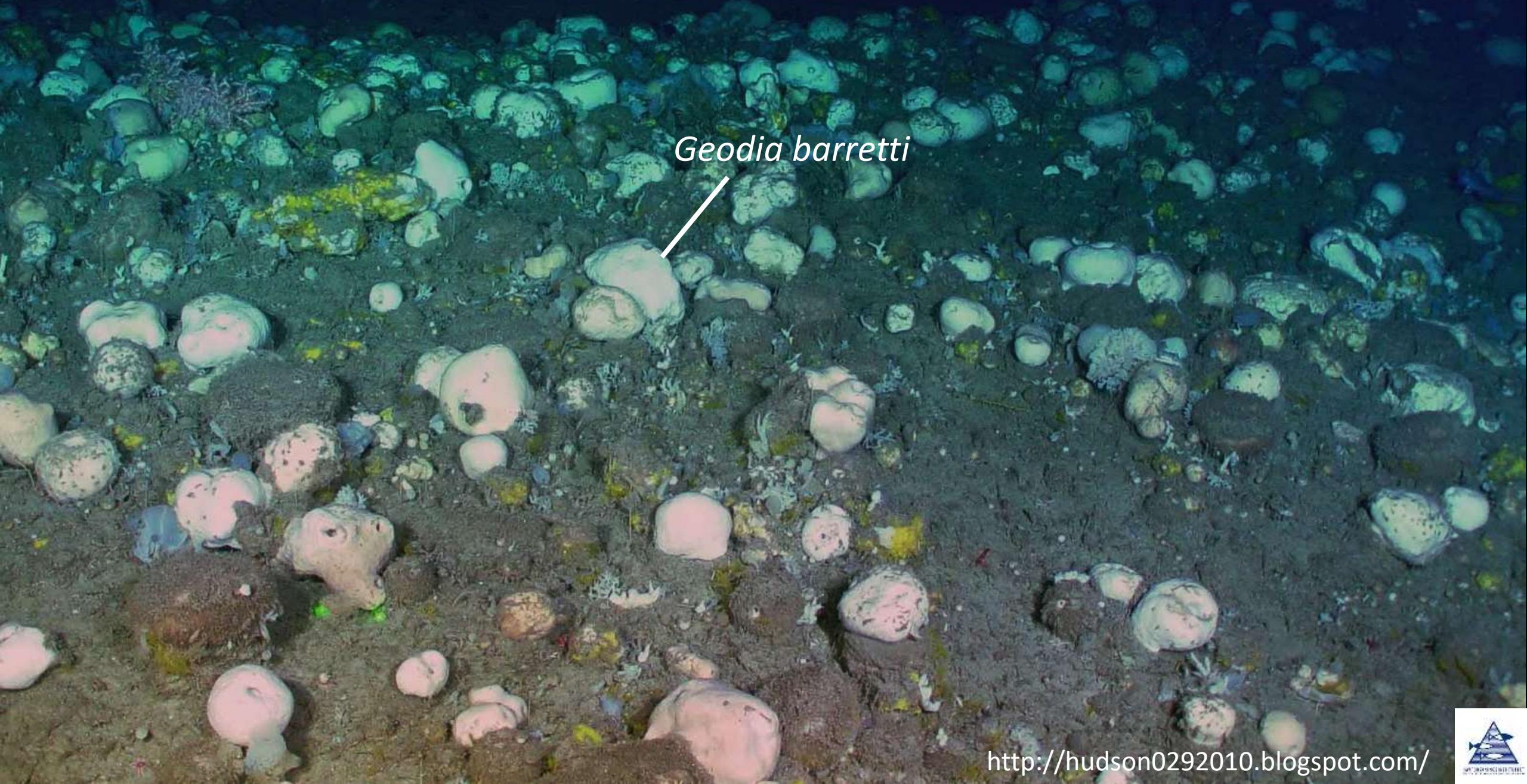
*Farrea occa*

*Aphrocallistes  
vastus*

*Heterochone  
calyx*

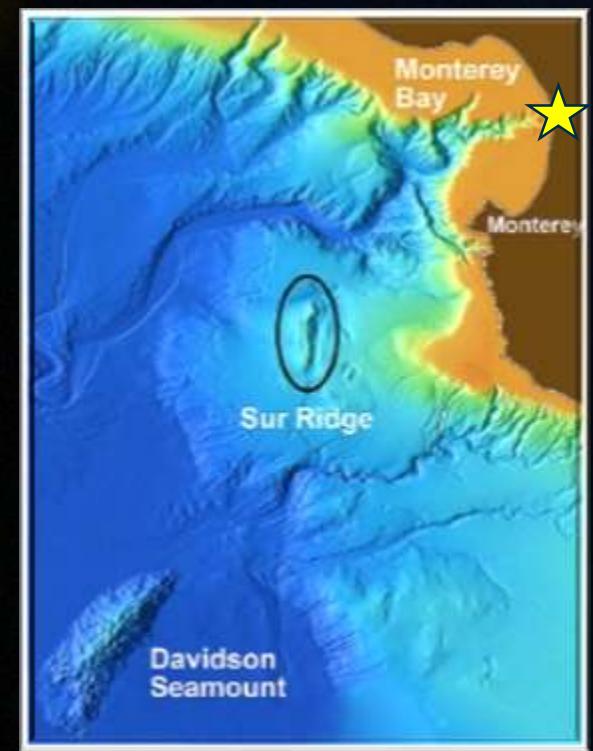


# North Atlantic ostur beds



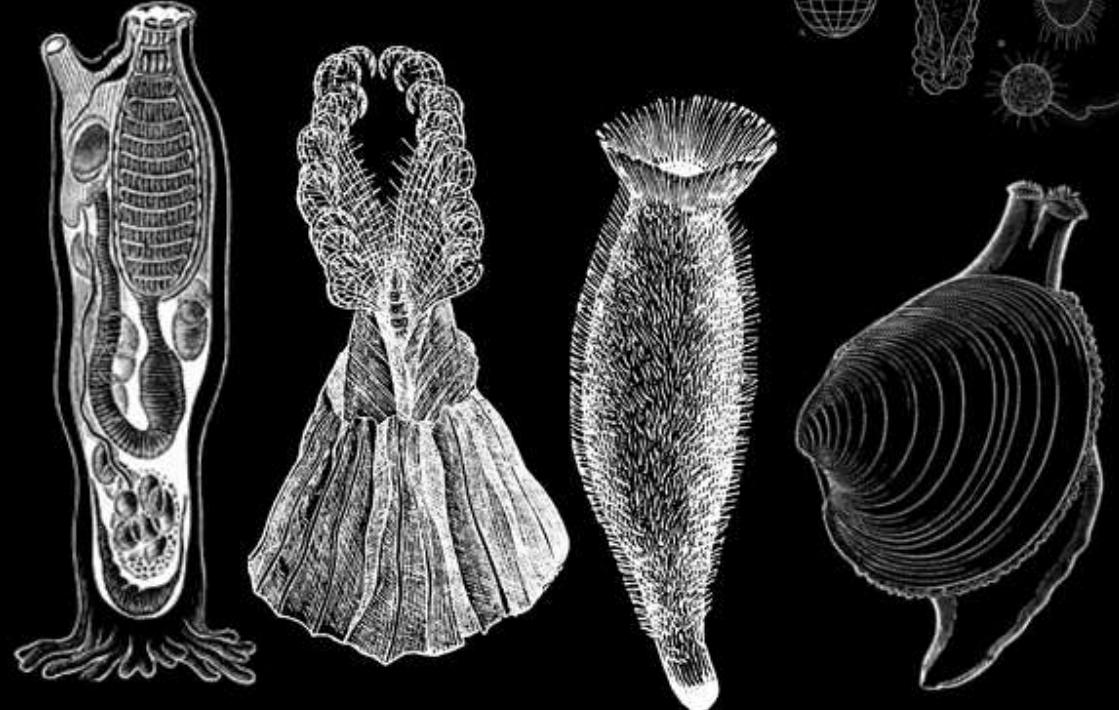
*Geodia barretti*

# Sur Ridge (California coast)

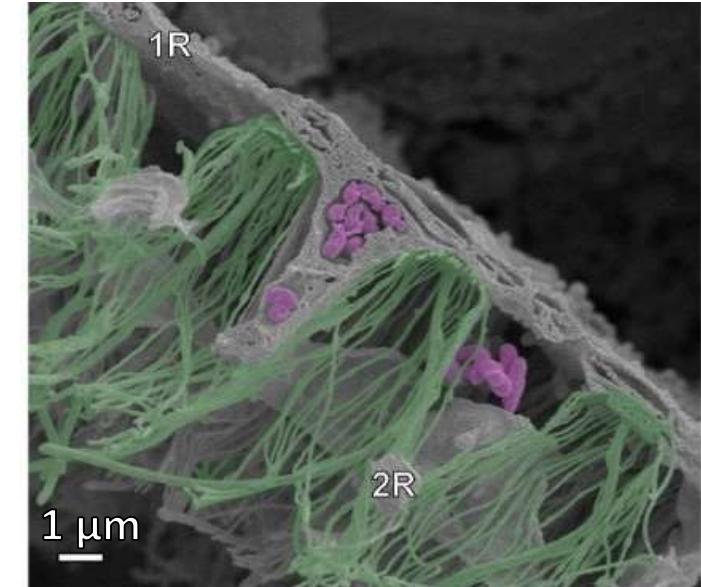
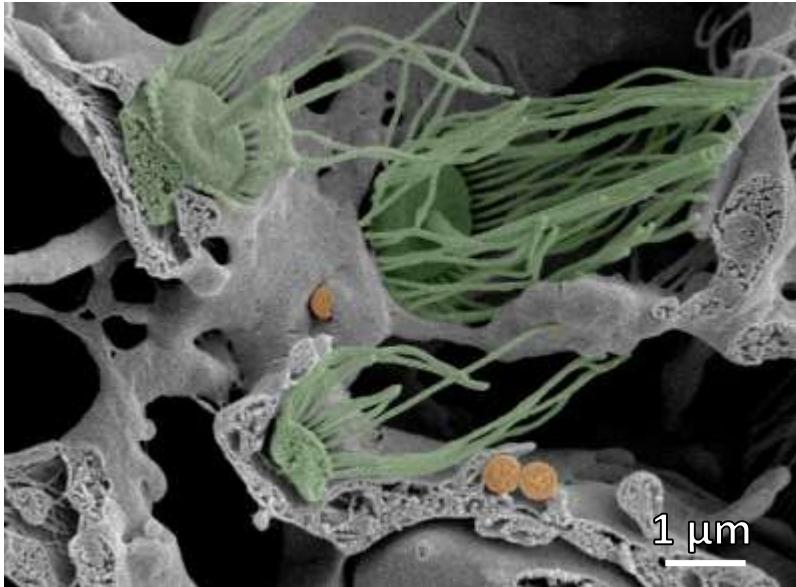




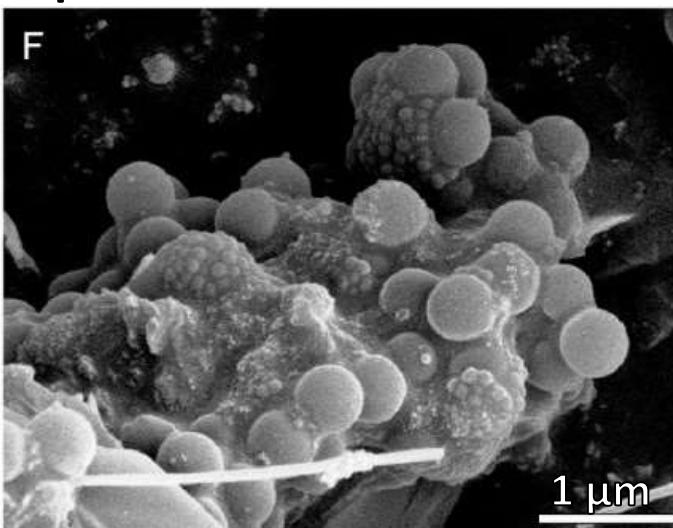
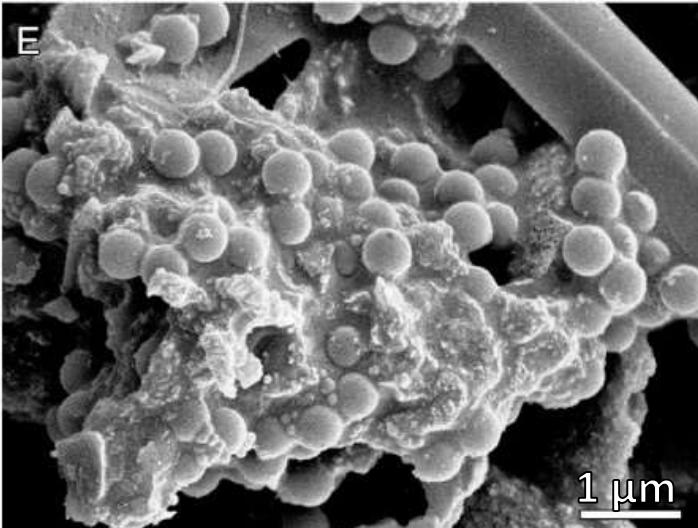
**Filter feeders are important for moving food energy from the water column to seafloor**



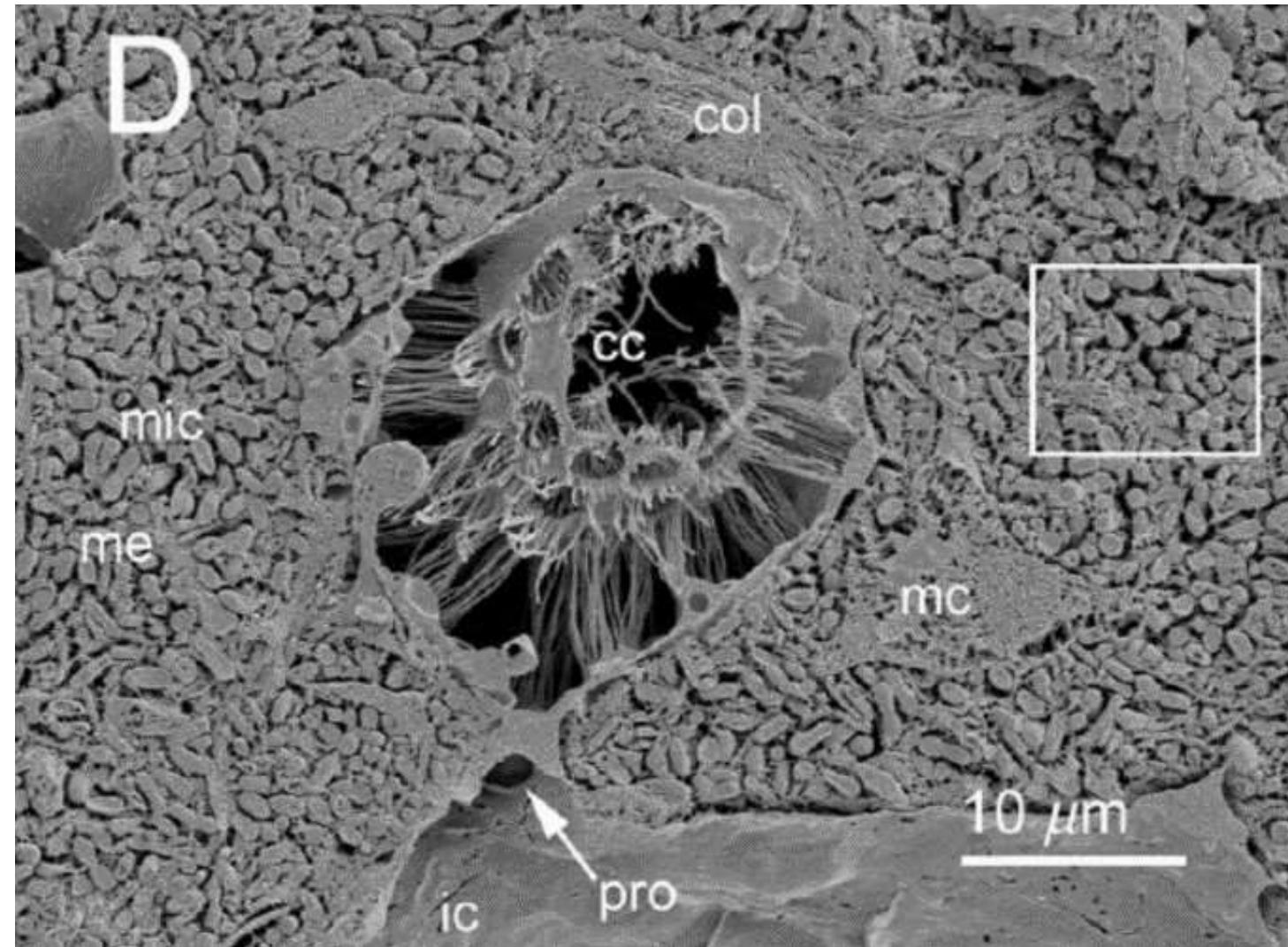
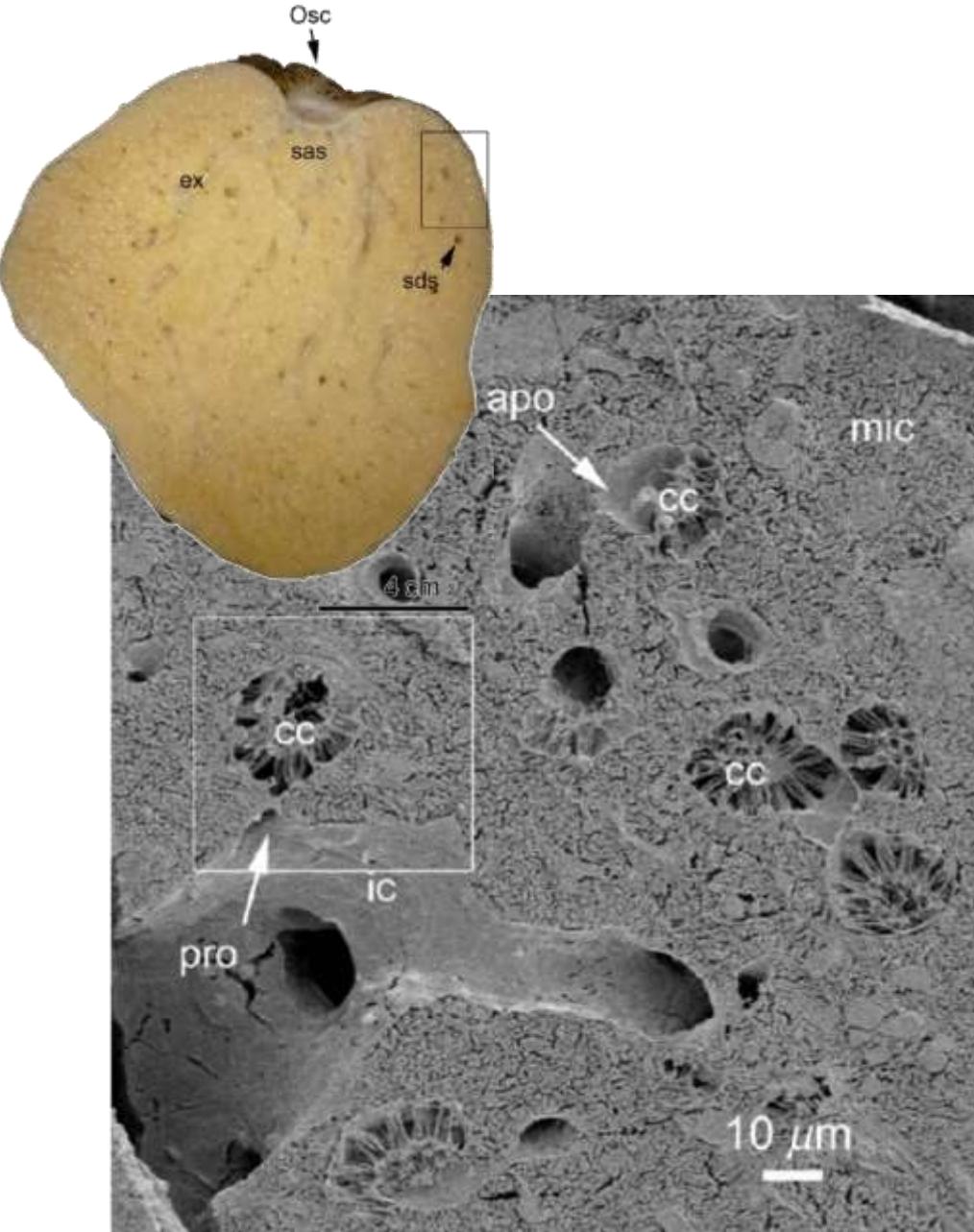
# Glass sponges eat bacteria as small as 100 nm



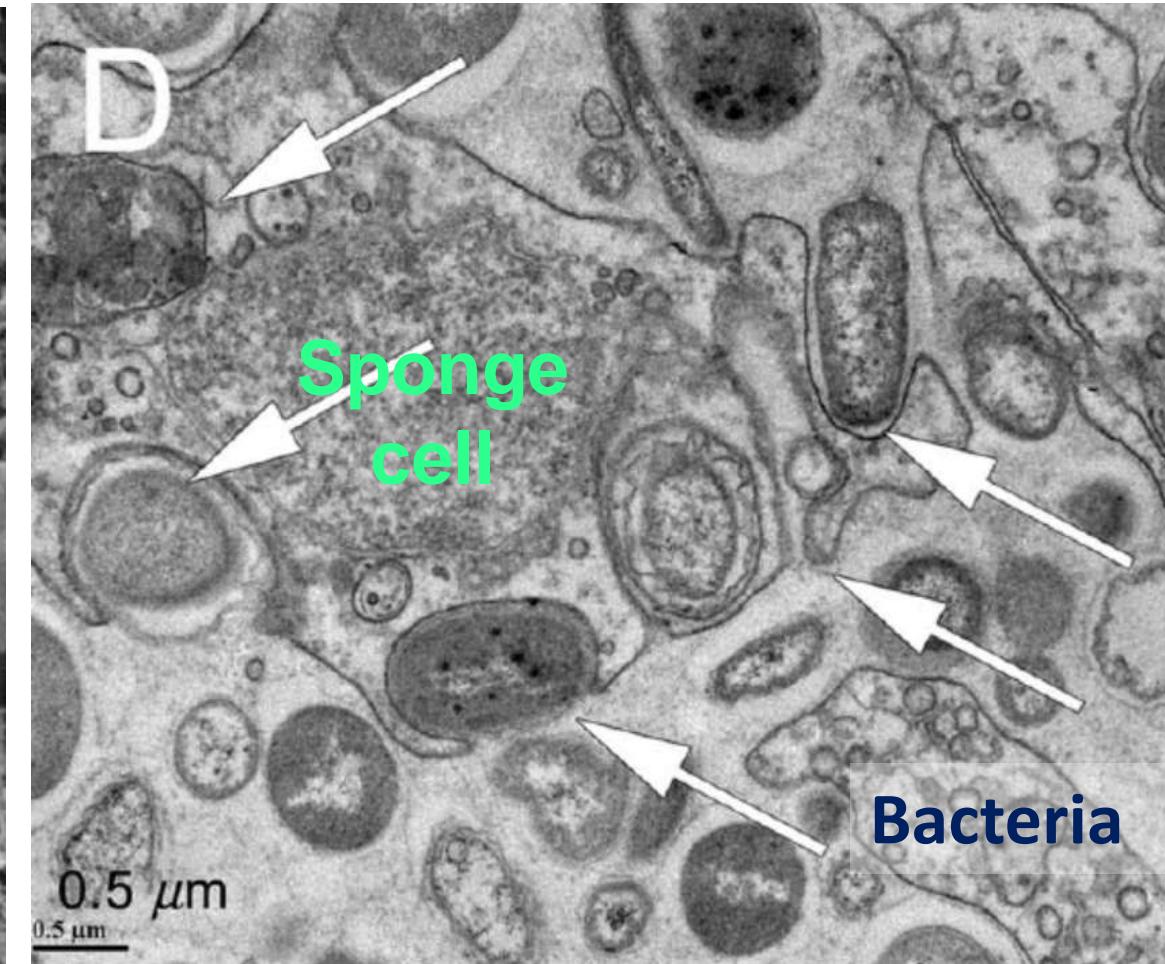
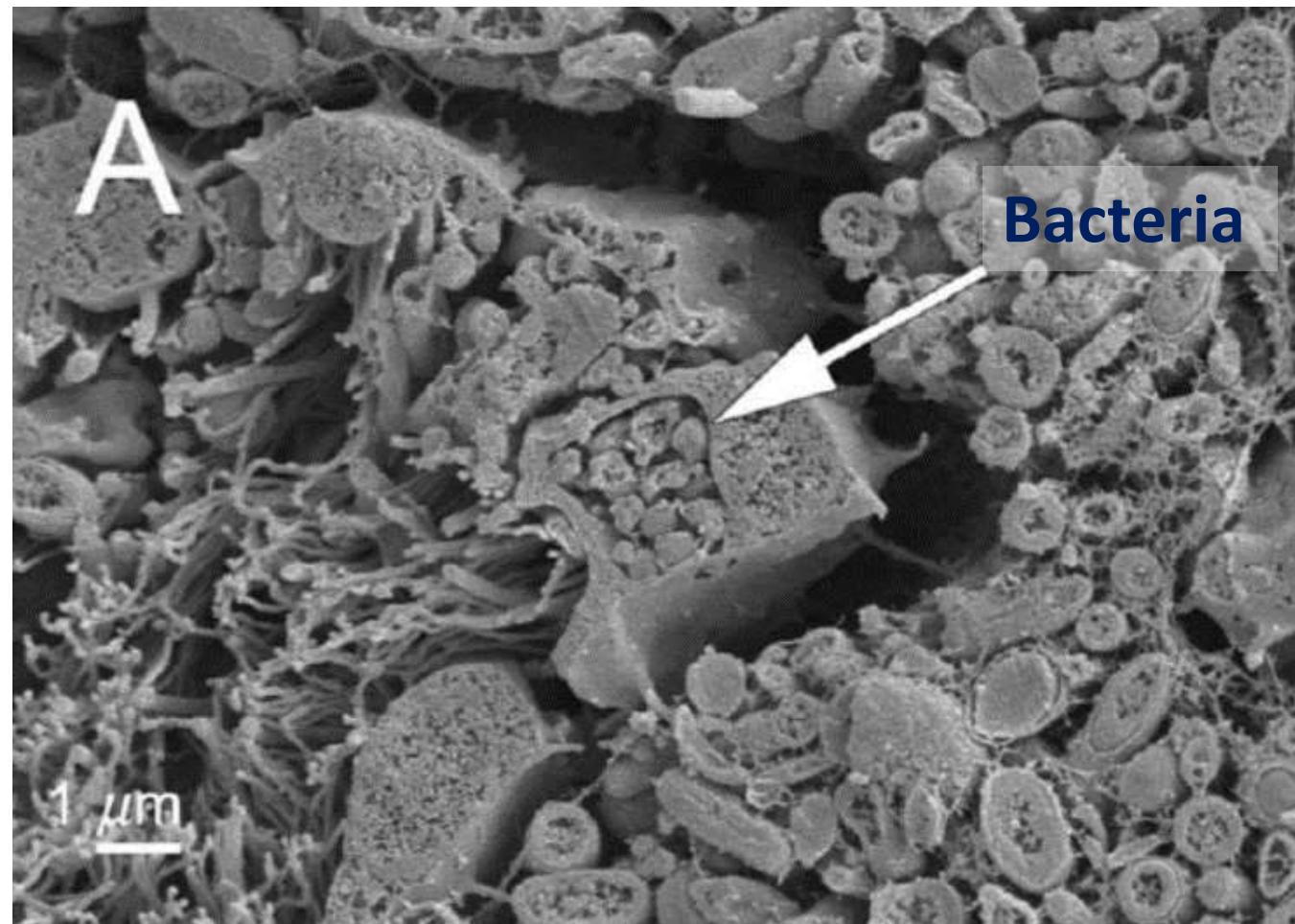
And excrete fecal pellets that can be 1,000 times larger



# The tissue of *Geodia barretti* is full of bacteria

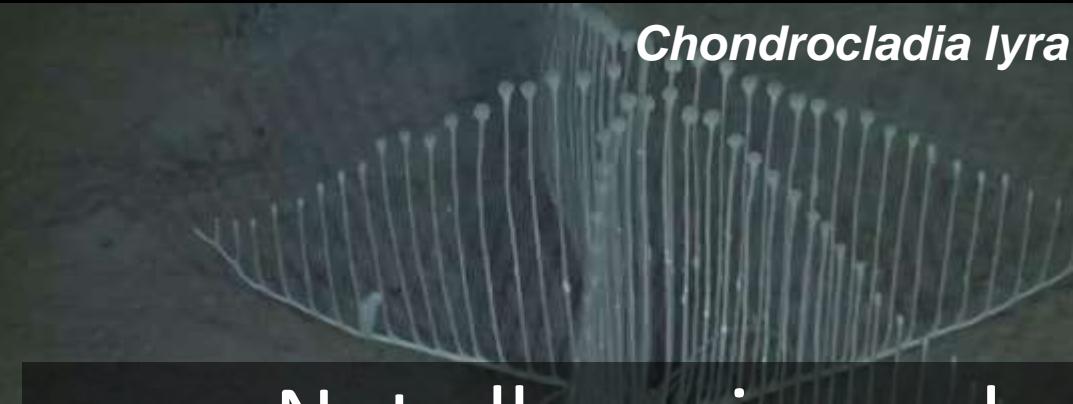


# As a result, *Geodia barretti* feeds differently

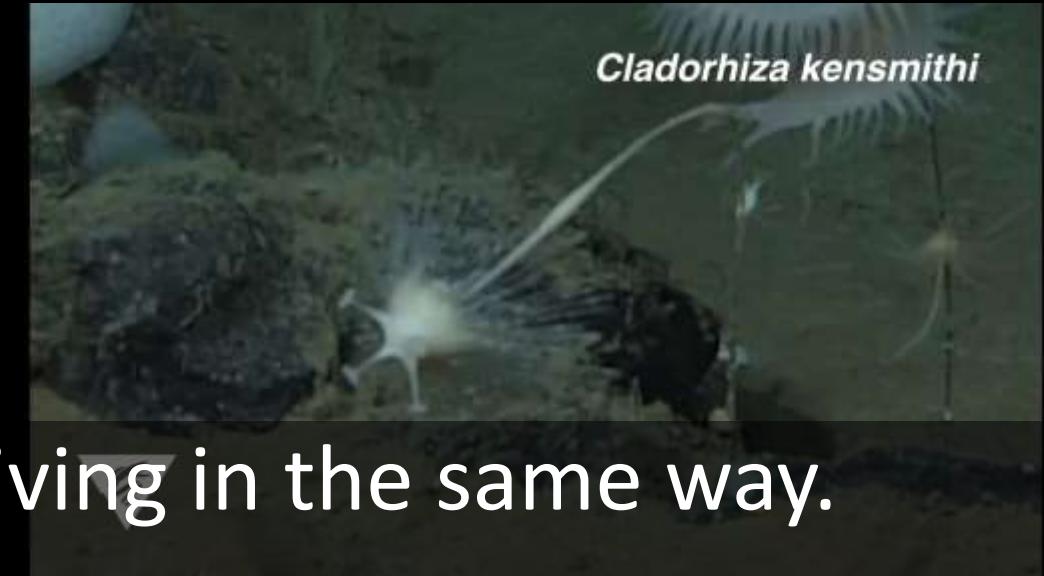


# Some deep-sea sponges have even turned from filter feeders to carnivores

*Chondrocladia lyra*



*Cladorhiza kensmithi*



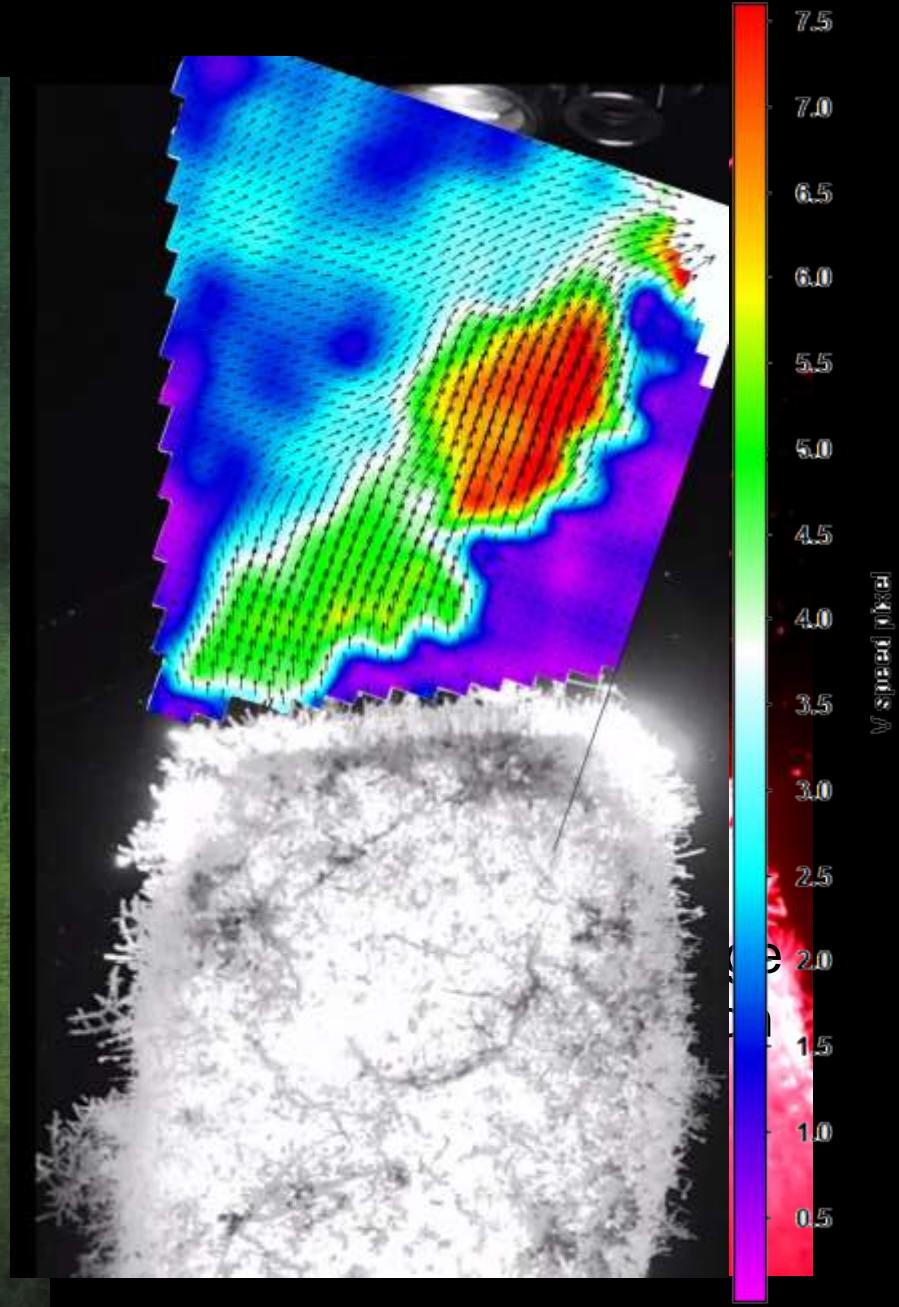
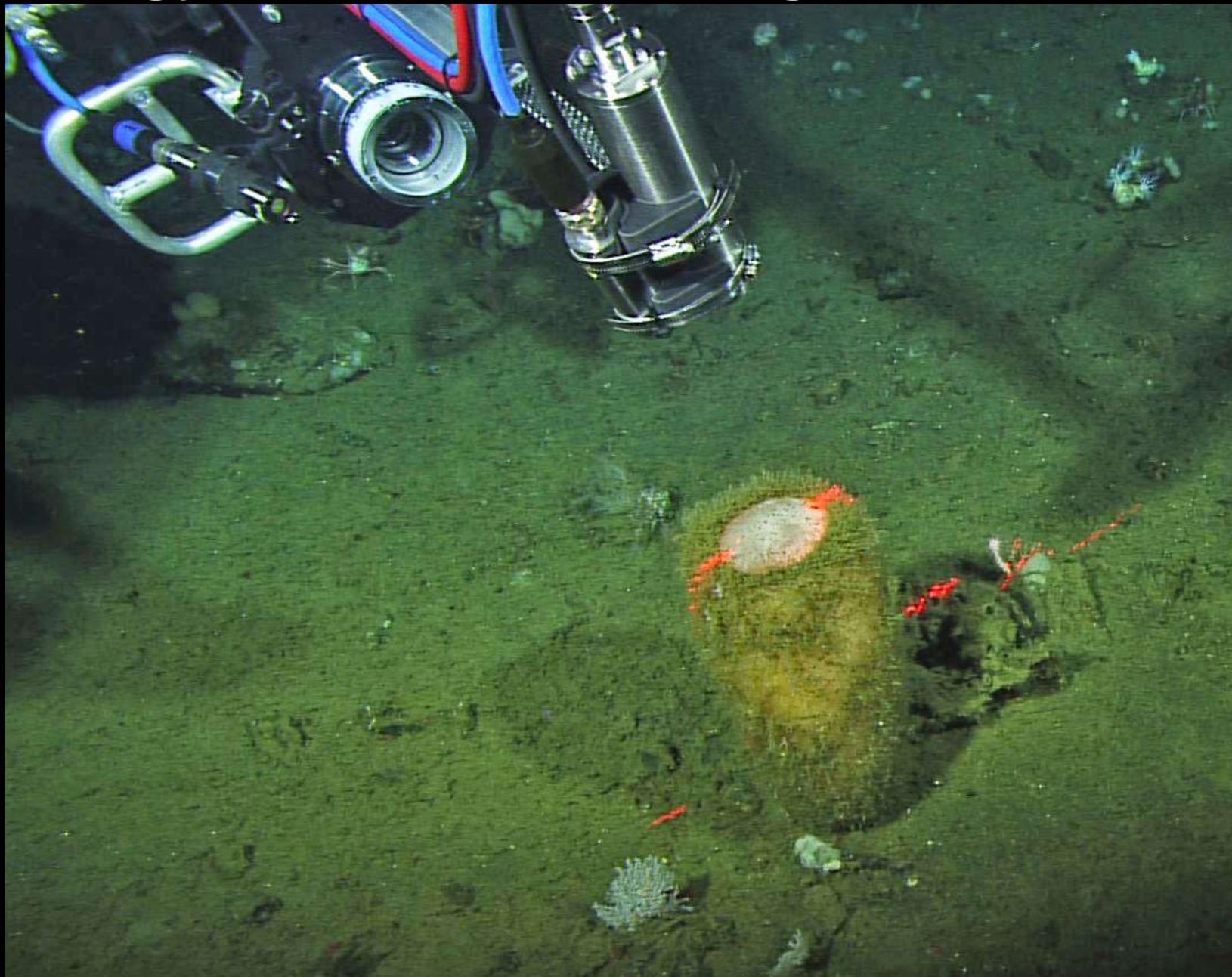
Not all species make their living in the same way.

They have adaptations to survive where there is little food.

*Asbestopluma monticola*

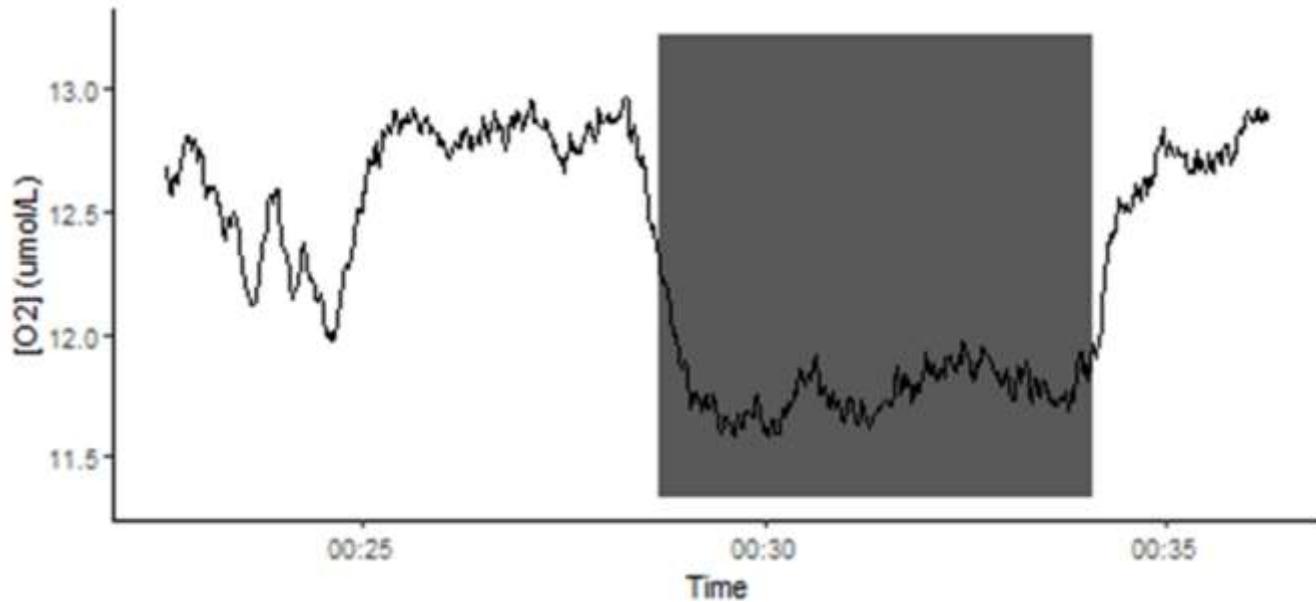


# Energy balance of a sponge



DeepPIV, particle imaging velocimetry

# Energy balance of a sponge



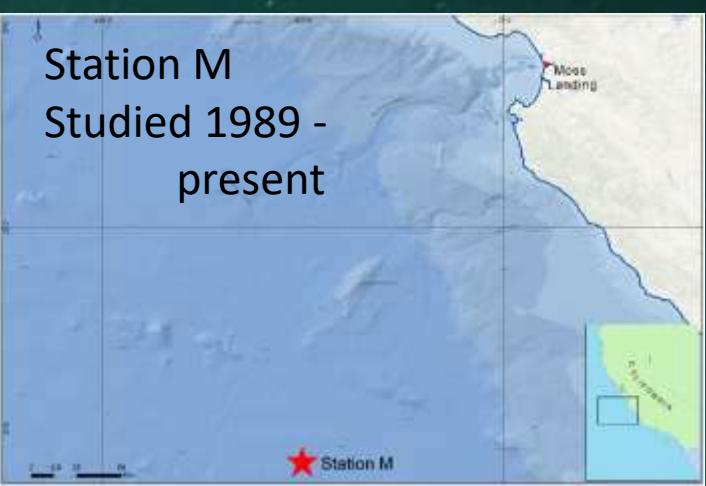
# **What effect do deep sponges have on their environment?**

**Oases in food-poor habitats**

**How do they do it?**

**By finding novel ways to catch food  
or with a low-cost lifestyle**

# Sponges live at their own pace



5 months of time on the seafloor. Every photo = 1 hour

4,000 meters depth. Courtesy: K. Smith



# Sometimes discovery happens completely by accident

1.5x speed

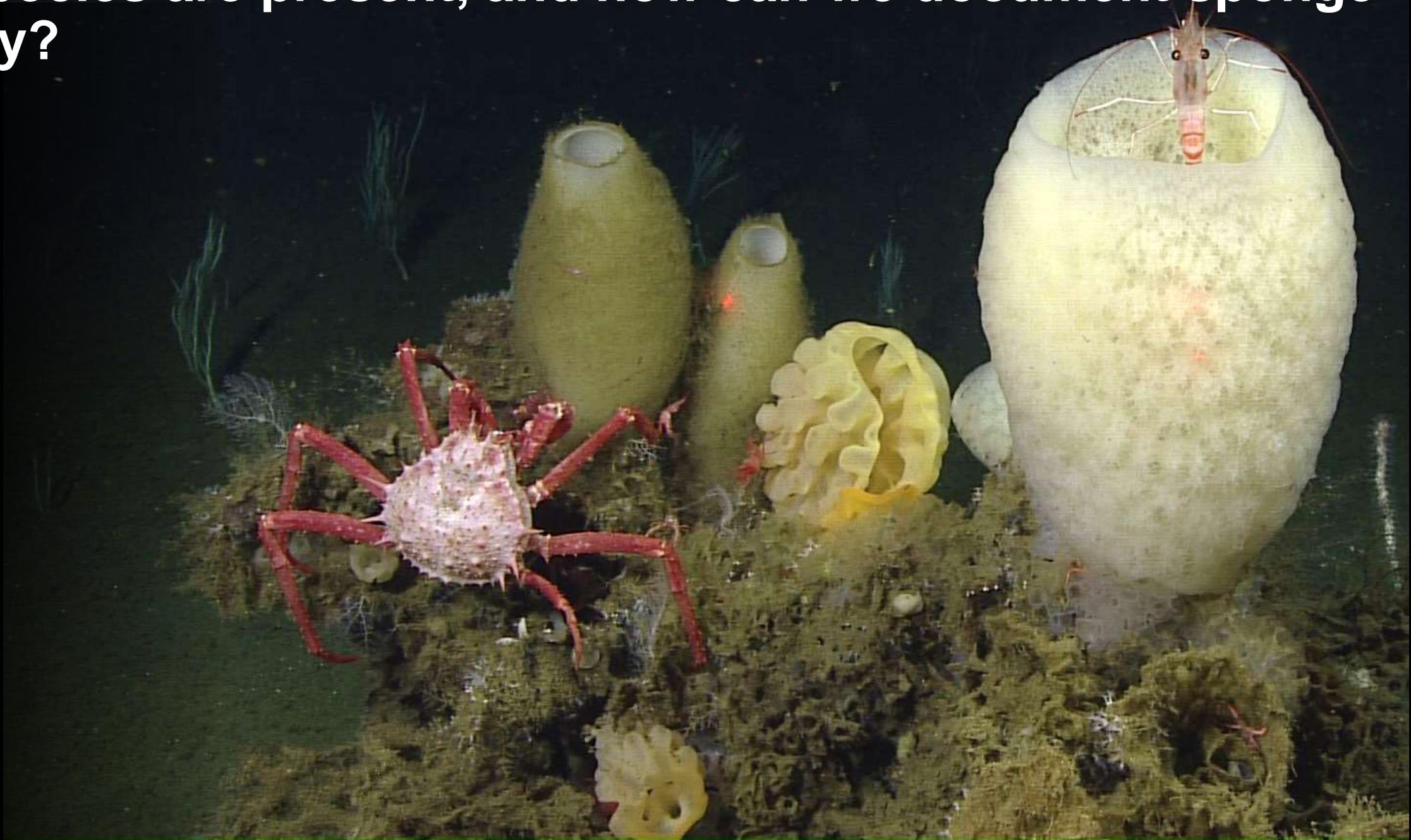
Credit: NOAA MBNMS / Ocean Exploration Trust  
Davidson Seamount, Monterey Bay National Marine Sanctuary

# Sometimes discovery happens completely by accident

*E/V Nautilus*  
Near Channel Islands NMS

Near Channel Islands National Marine Sanctuary

What species are present, and how can we document sponge diversity?



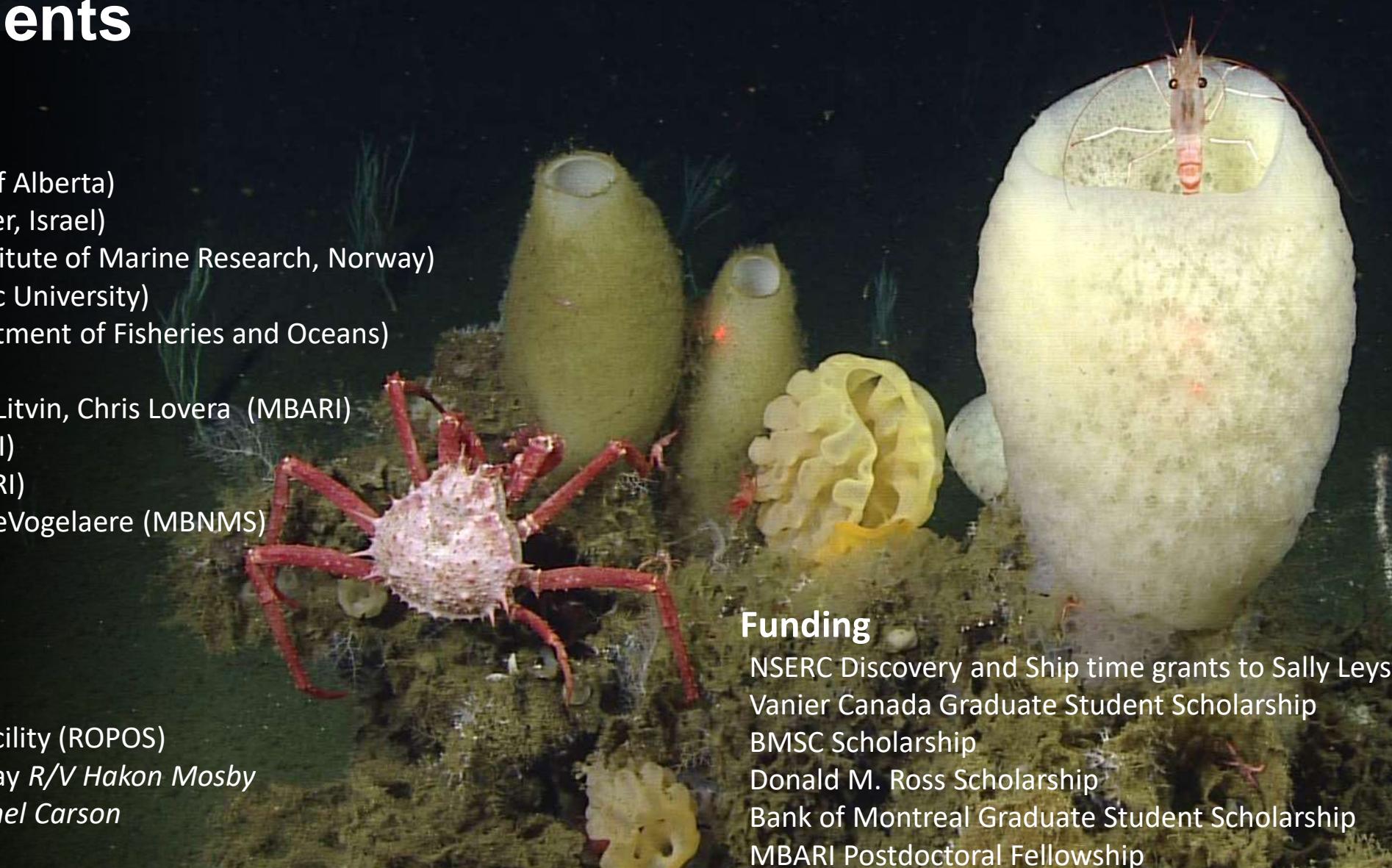
# Acknowledgements

## Collaborators

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Chad King, Erica Burton, Andrew DeVogelaere (MBNMS)

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Canadian Scientific Submersible Facility (ROPOS)  
Institute of Marine Research Norway R/V *Hakon Mosby*  
MBARI R/V *Western Flyer*, R/V *Rachel Carson*



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# Questions?

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# Dynamics of reefs over time

- Reef sponges are valued as “ecosystem engineers”



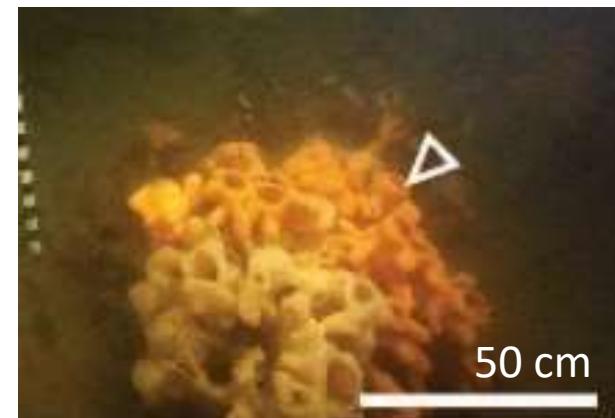
Credit: S Leys/CSSF/DFO  
Malcolm Island

But they are living animals. What happens to them over time?

# Growth



2011



2013

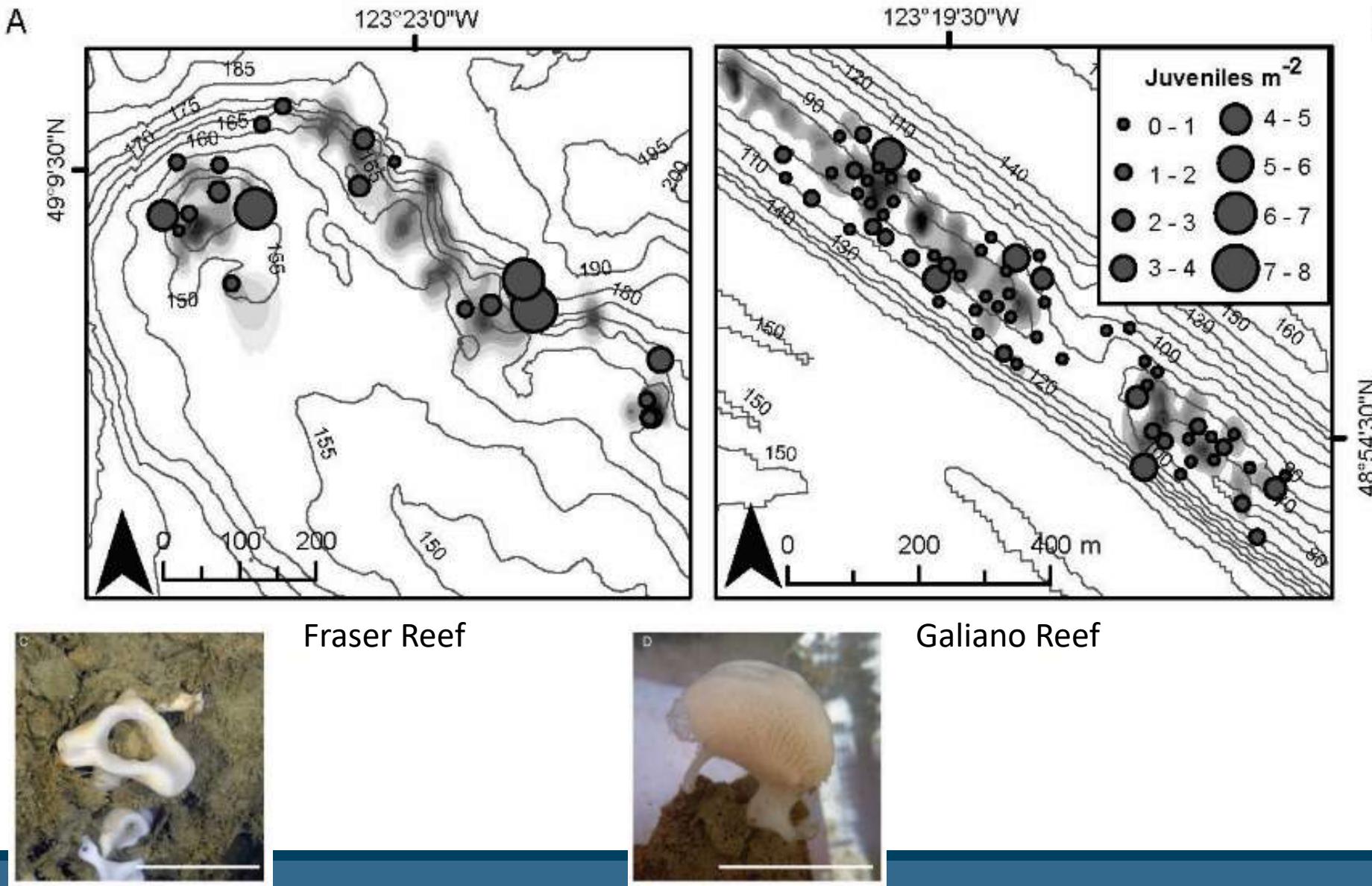


2014

Death

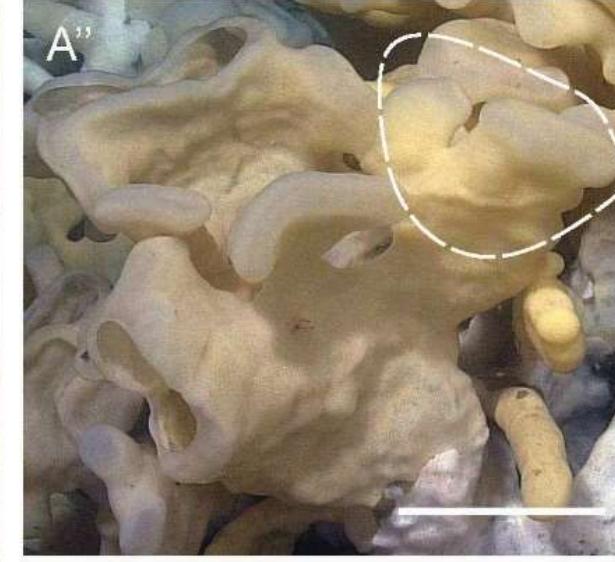
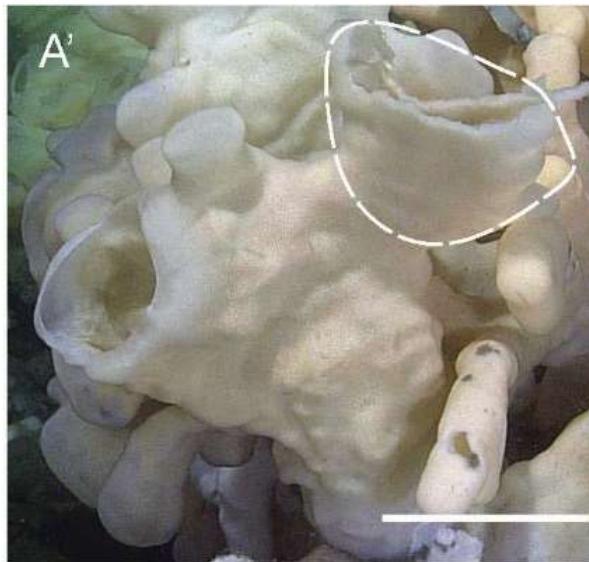
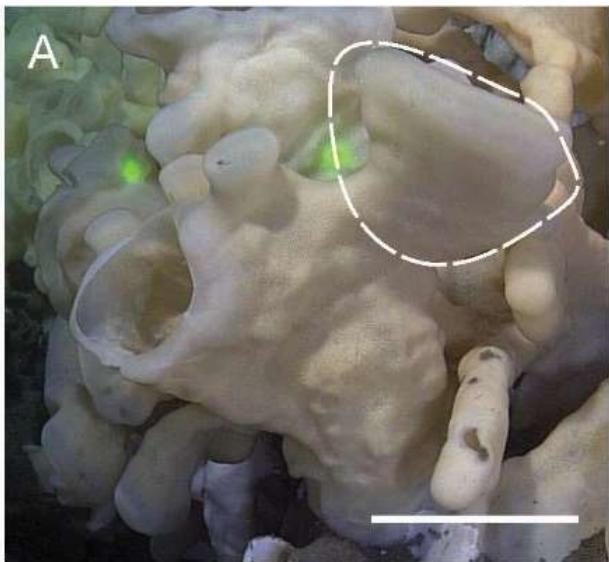


# Juvenile recruitment

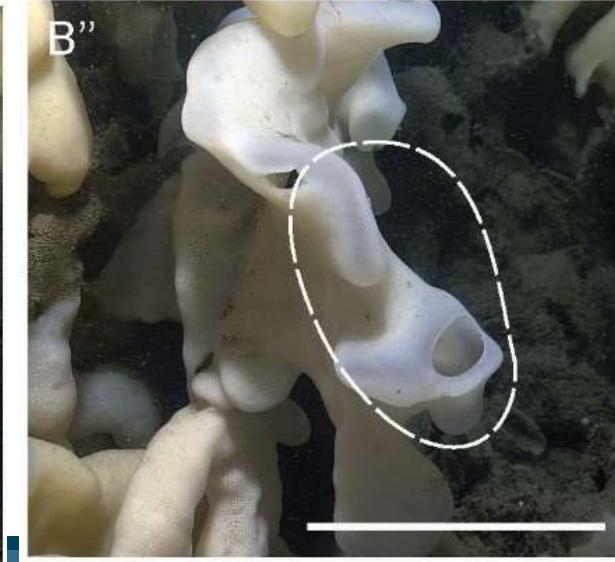
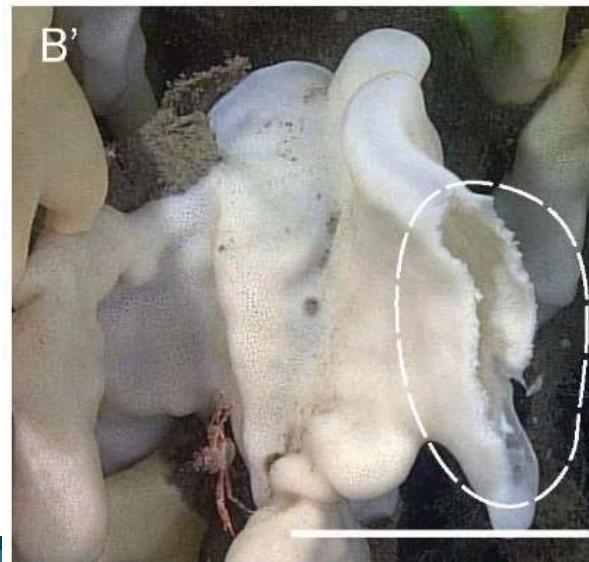
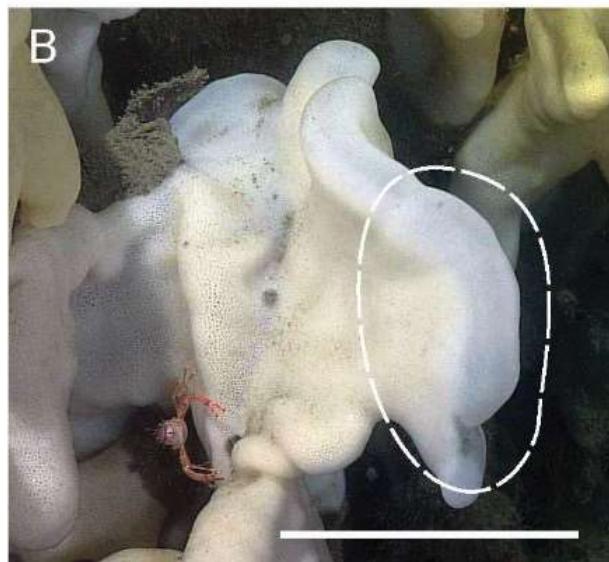


# Recovery from disturbance: small-scale

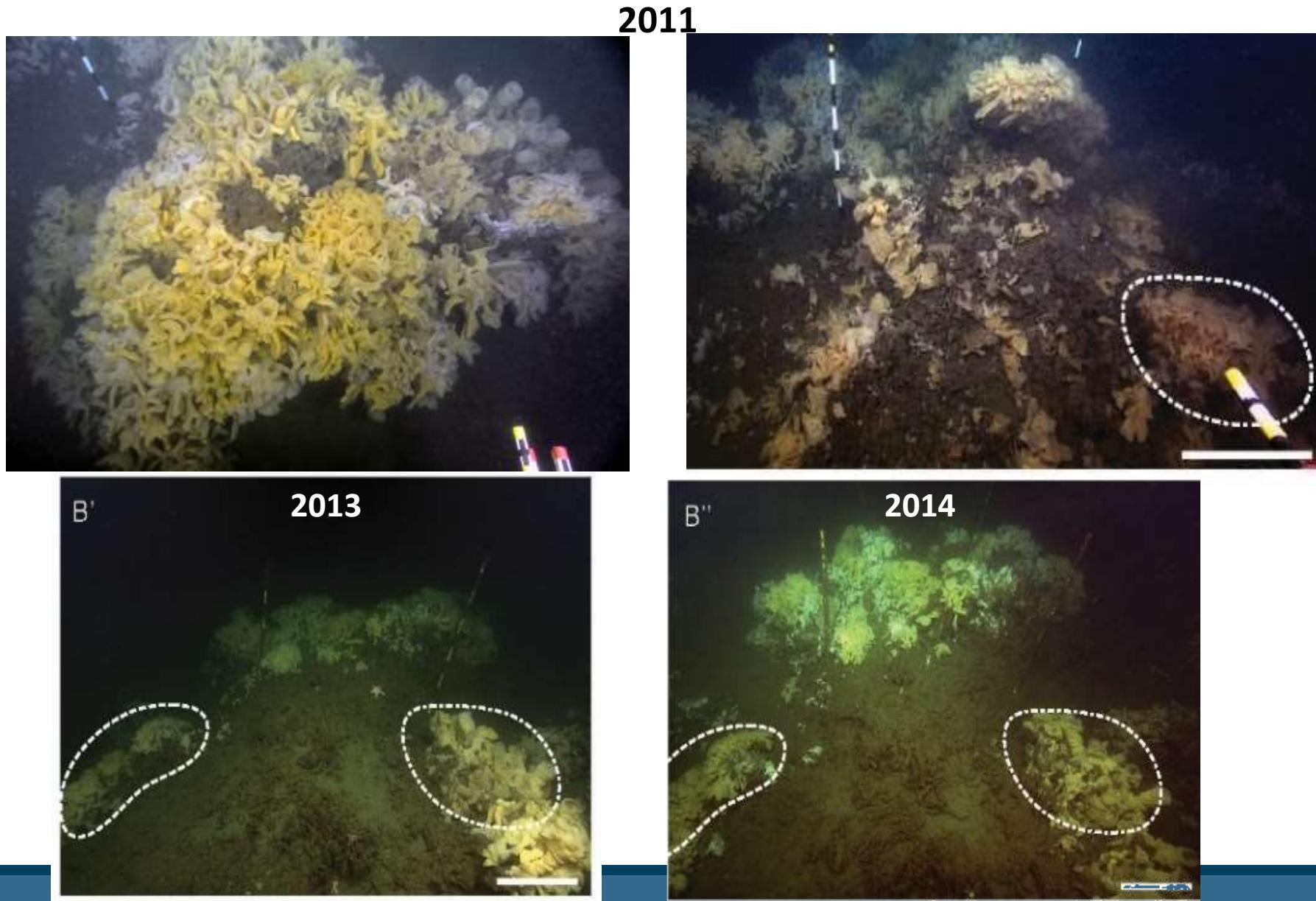
2013



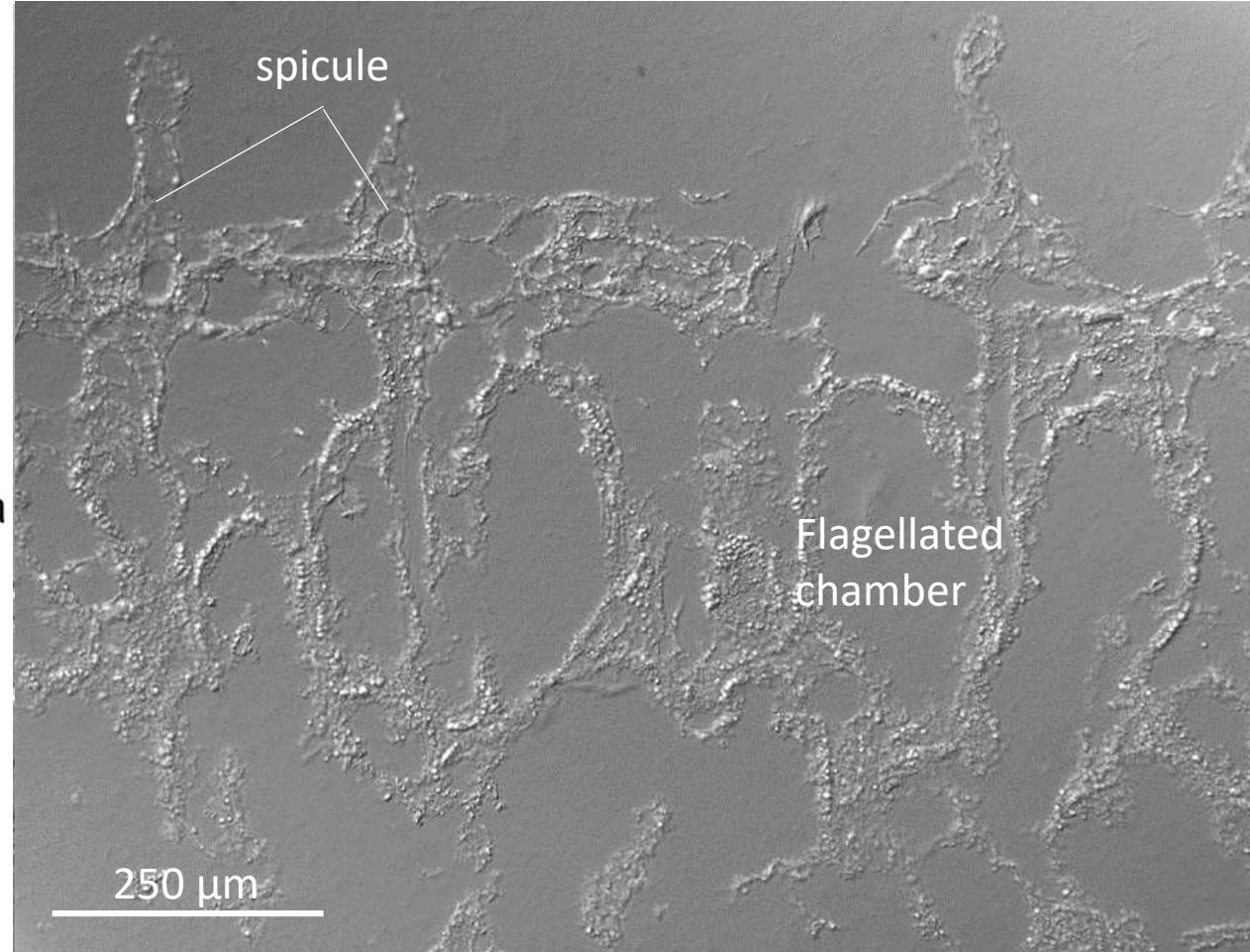
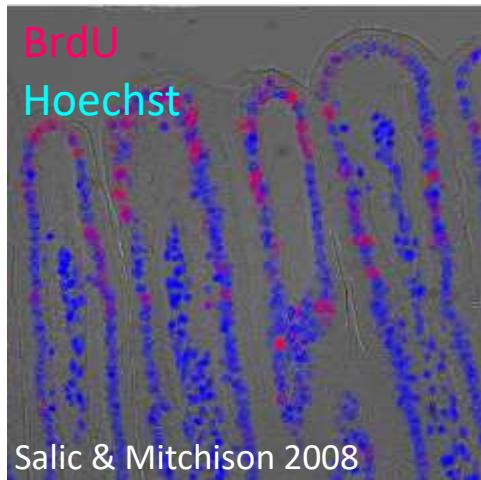
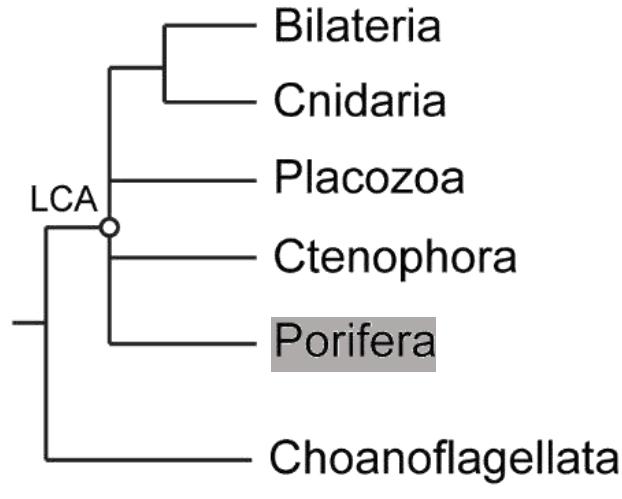
2014



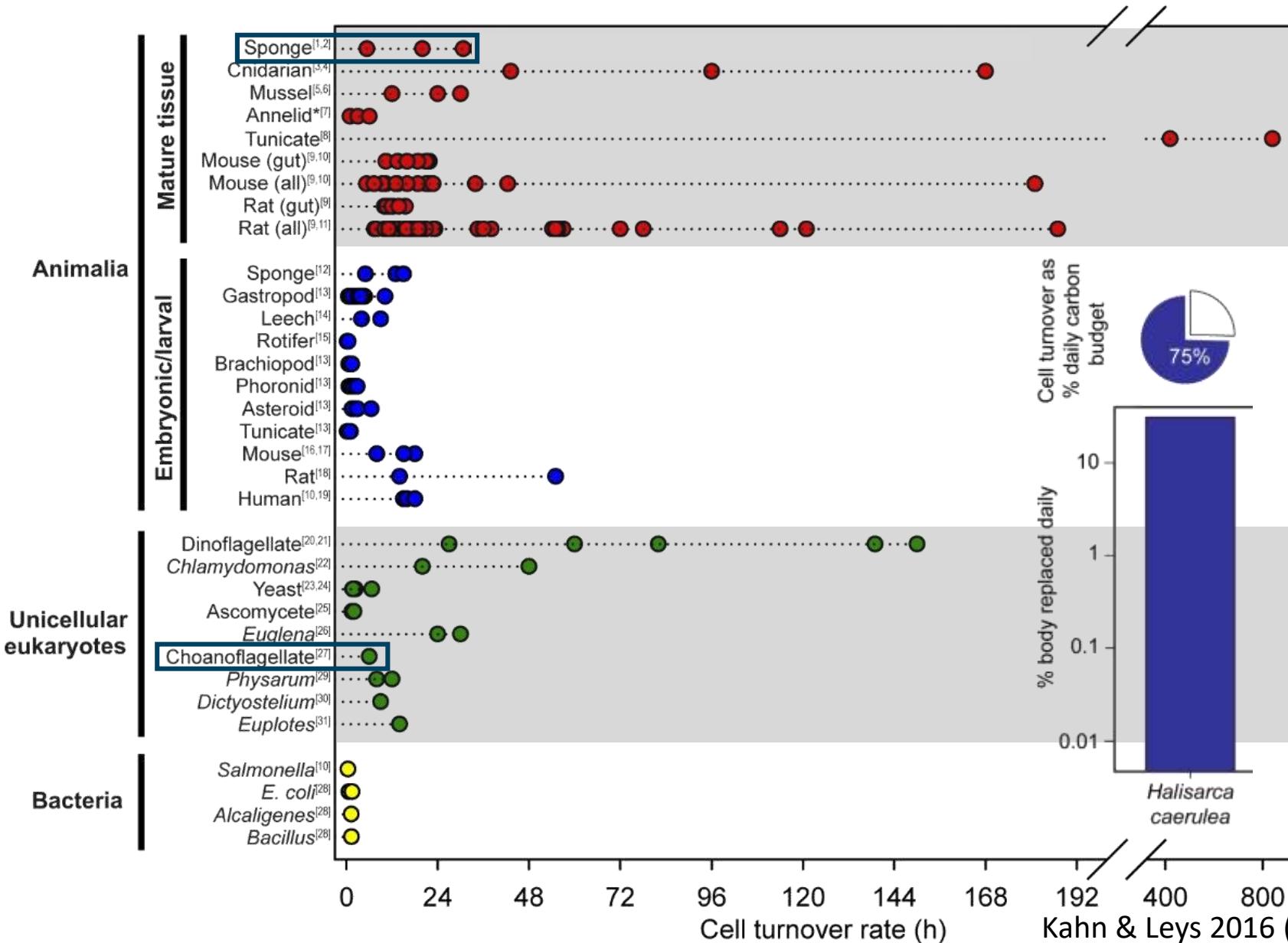
# Recovery from disturbance: large-scale



# Tissue turnover and growth: a primer of sponge anatomy



# Cell proliferation in context with other animals & cells





*Aphrocallistes vastus*



*Sycon coactum*

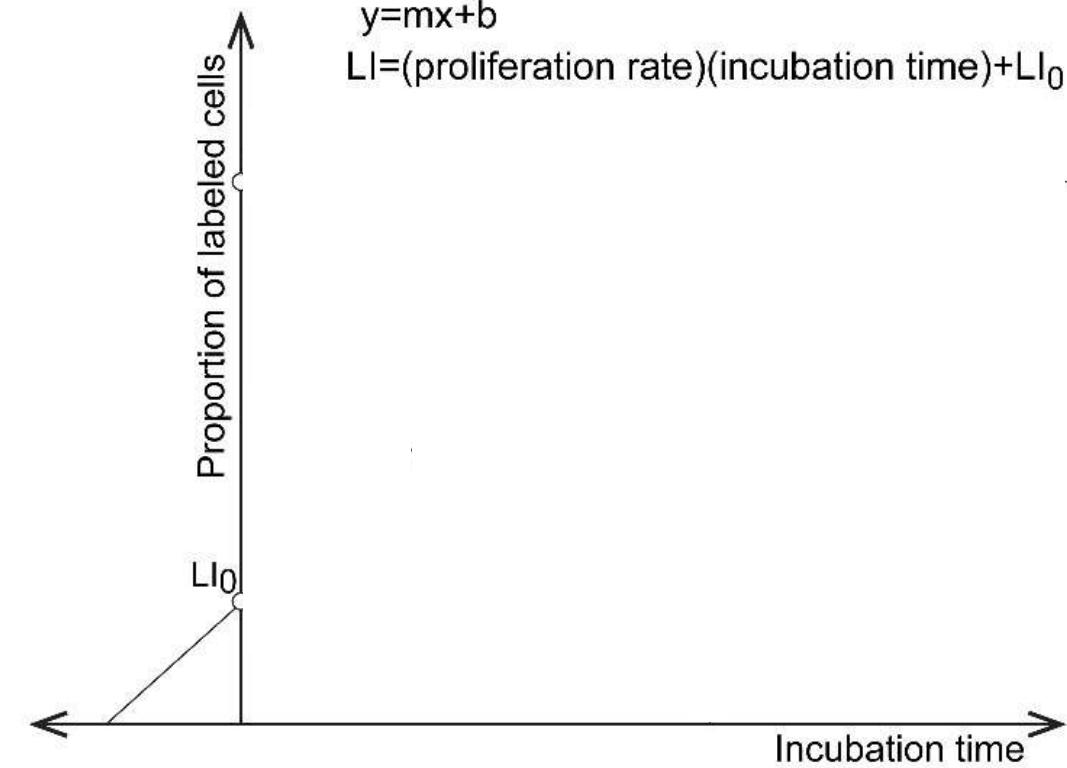


*Haliclona mollis*

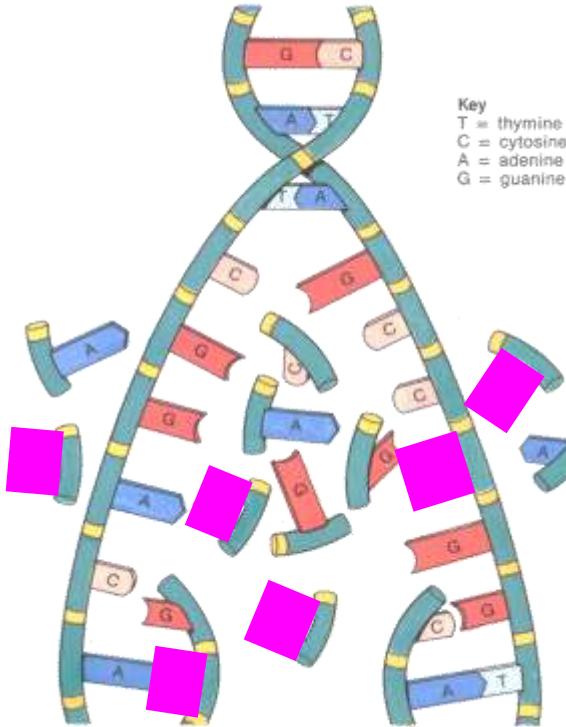


*Spongilla lacustris*

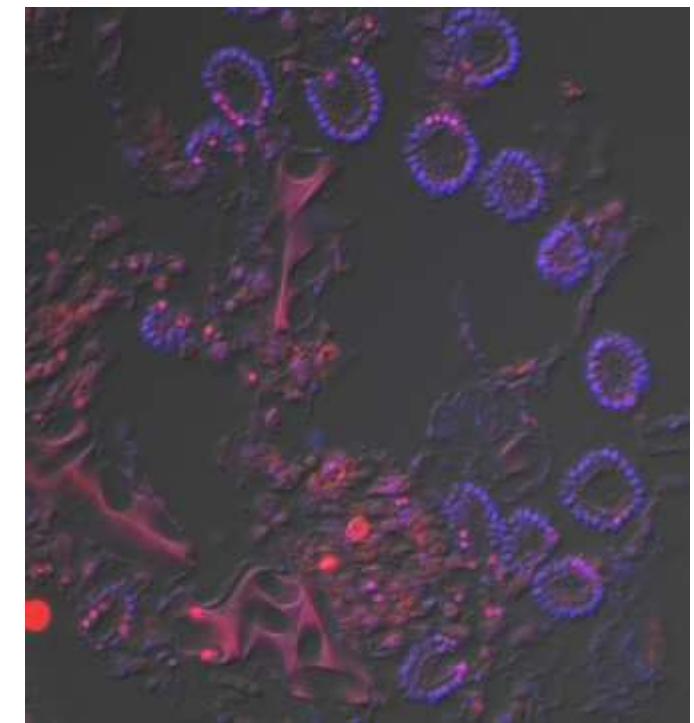
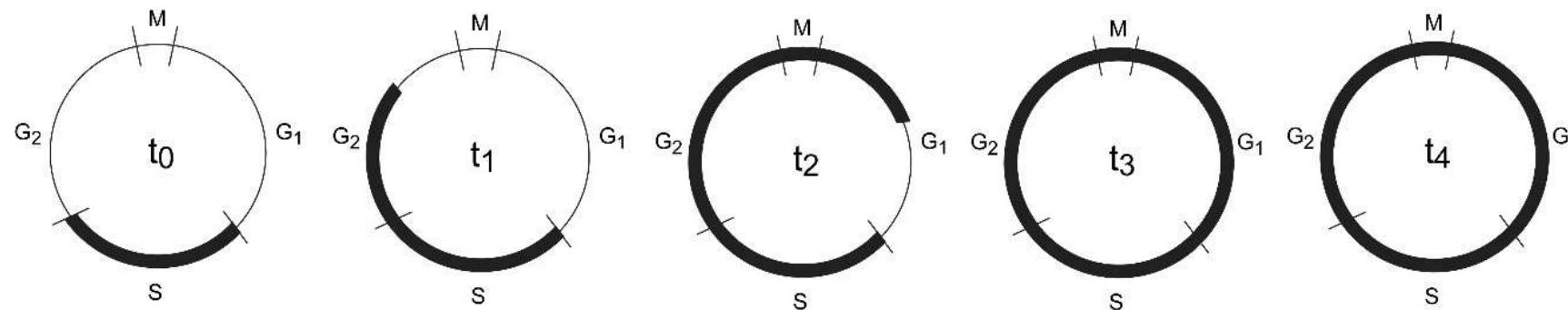
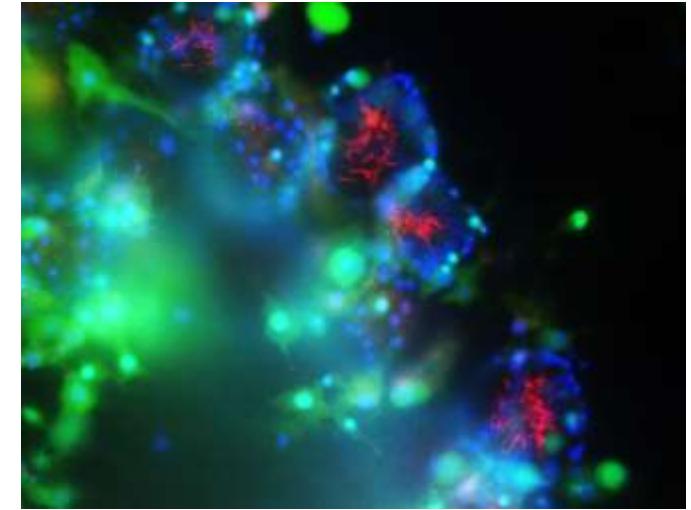
# Detecting cell turnover



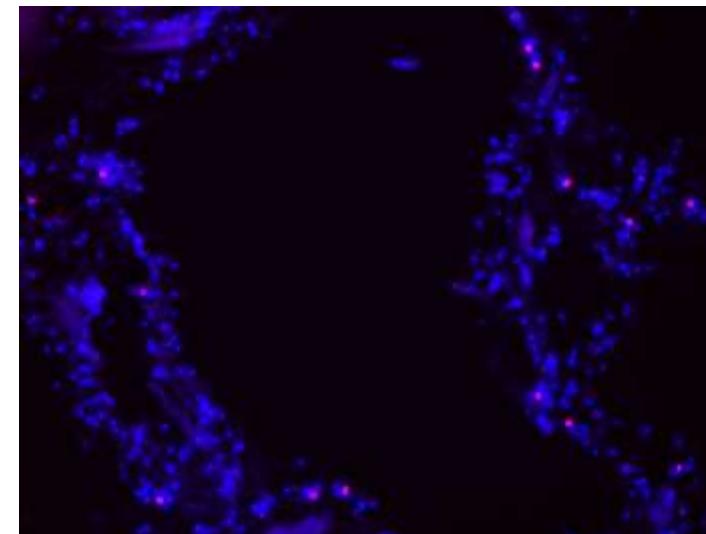
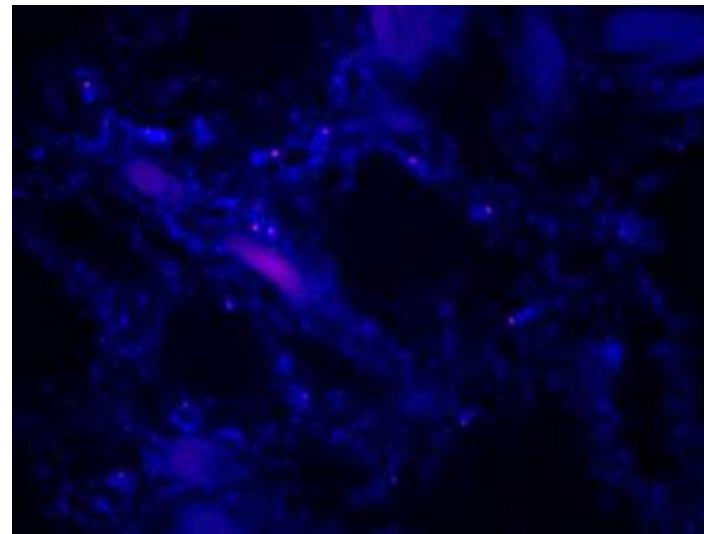
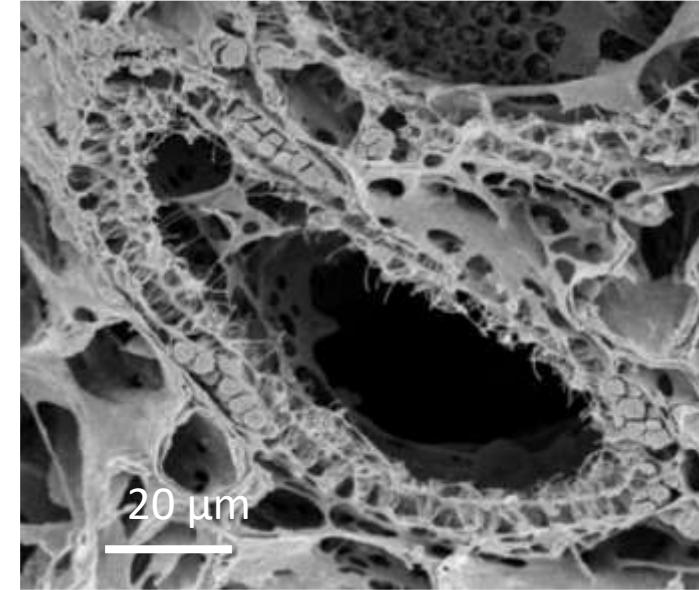
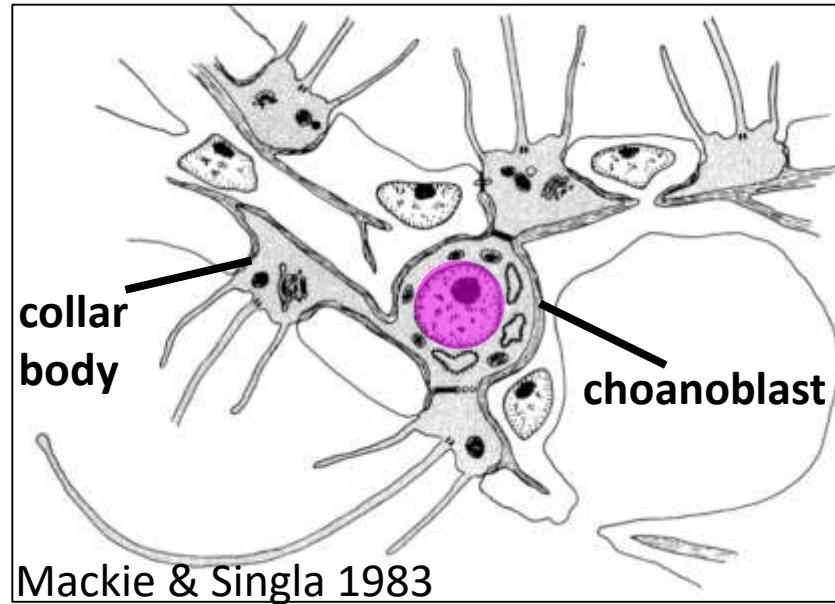
EdU (5-ethynyl-2'-deoxyuridine)



Key  
T = thymine  
C = cytosine  
A = adenine  
G = guanine

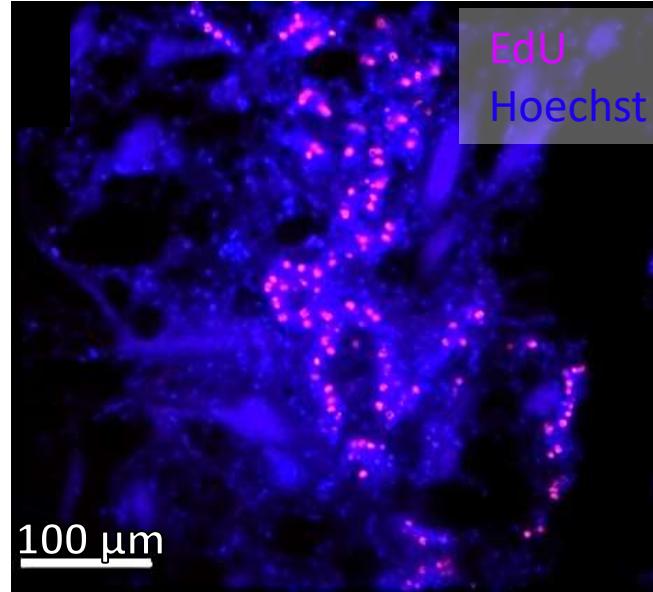


# There were very few EdU-labeled choanoblasts in the glass sponge



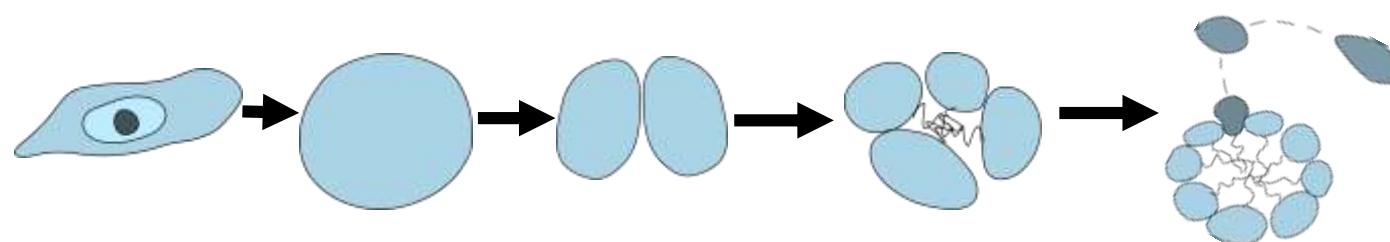
# How are flagellated chambers built and maintained?

- *Aphrocallistes vastus*

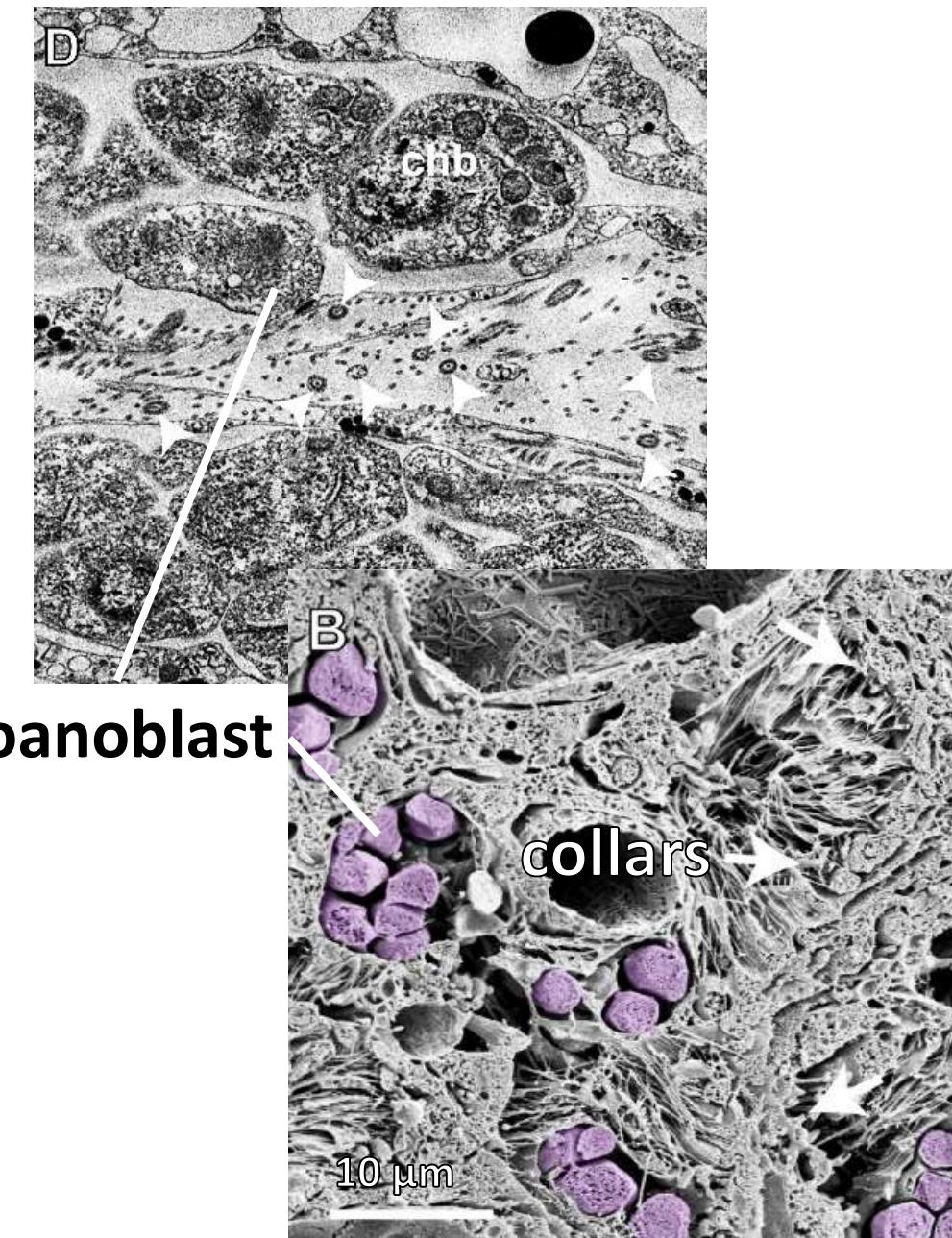
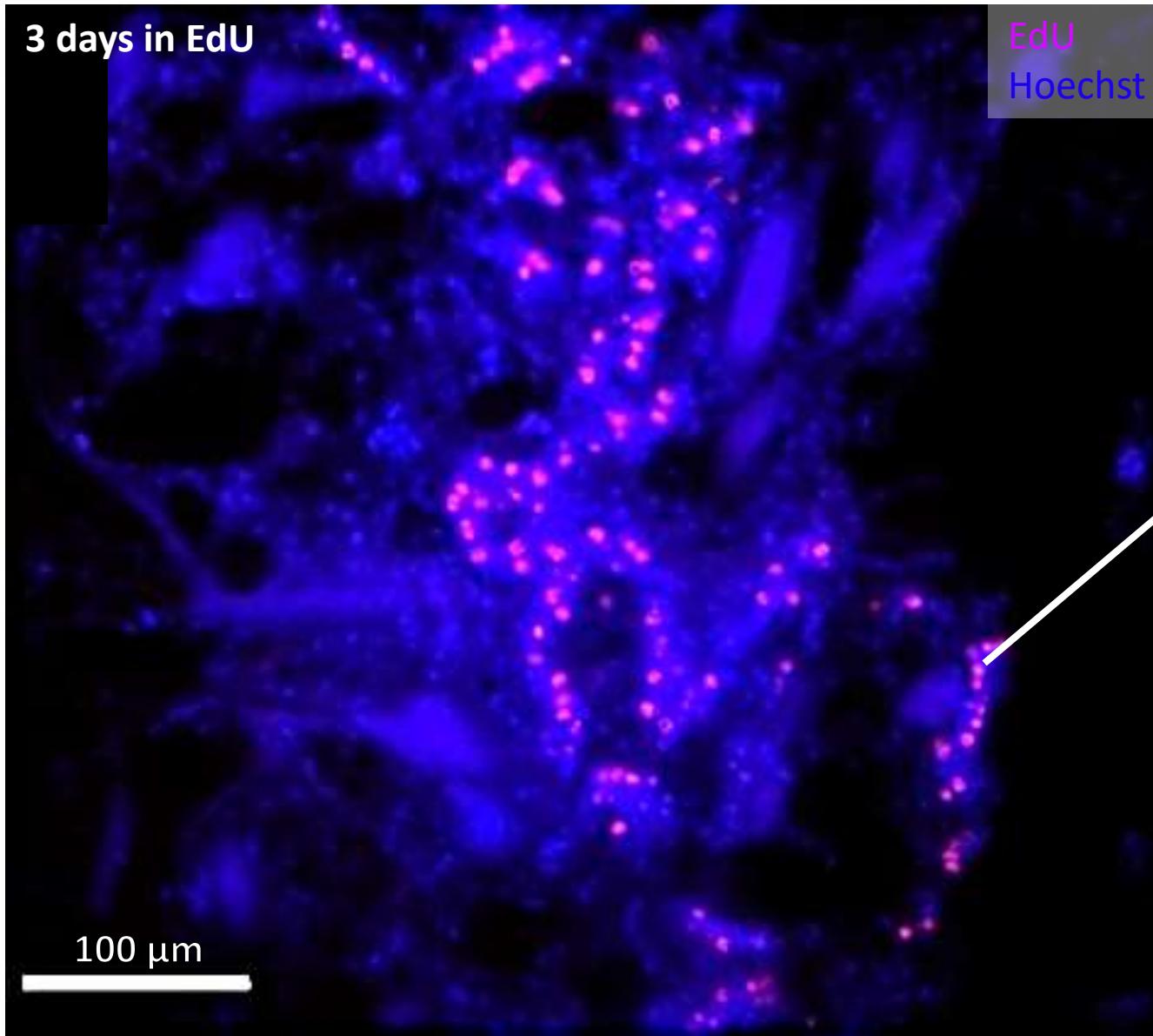


- *Spongilla lacustris*

- Very few instances of mitosis documented in the literature

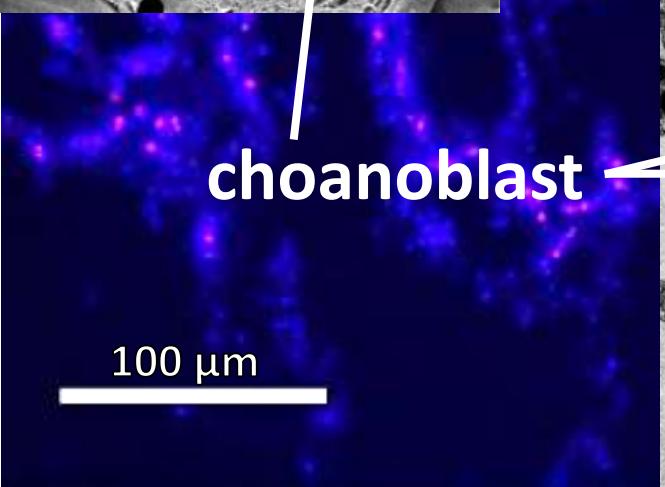
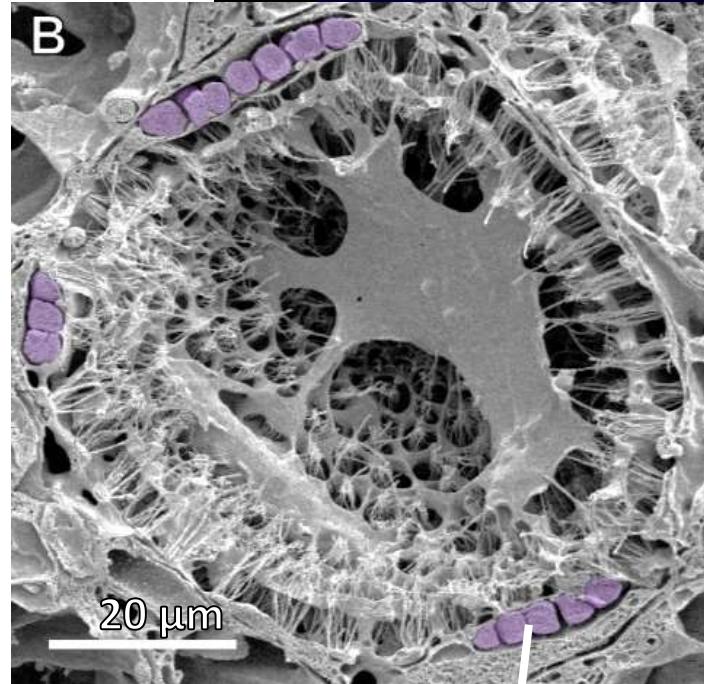


# Chamber formation: *A. vastus*

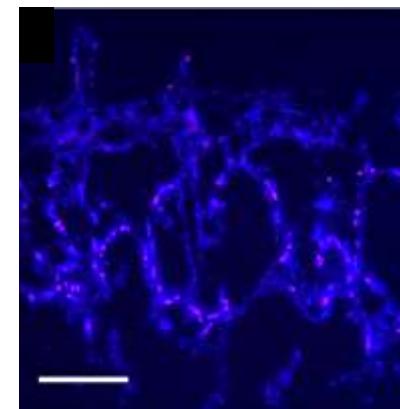
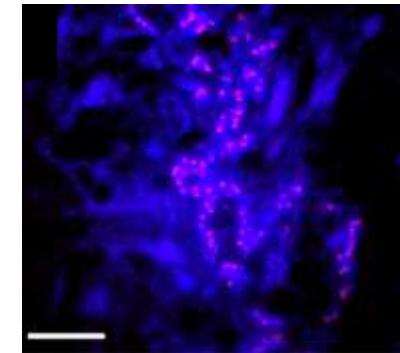
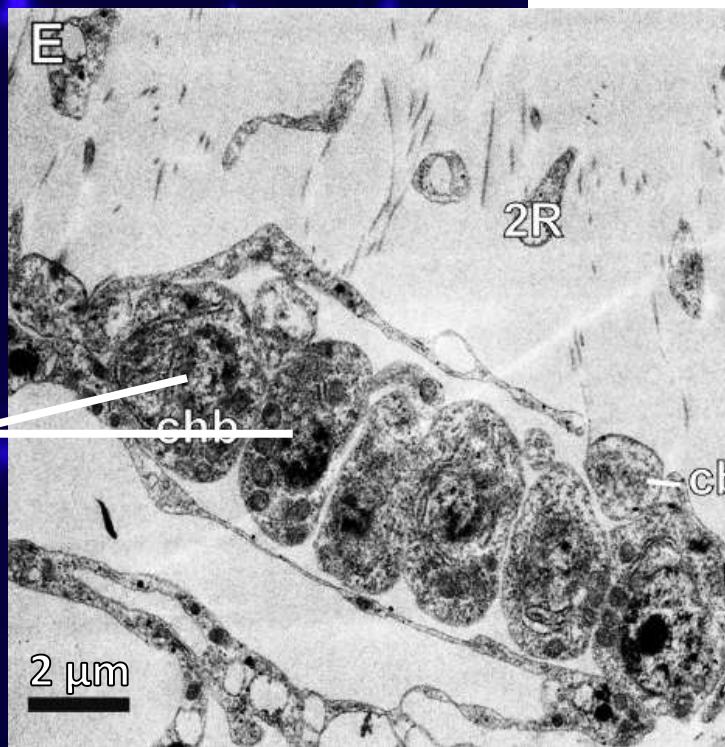


# Chamber formation: *A. vastus*

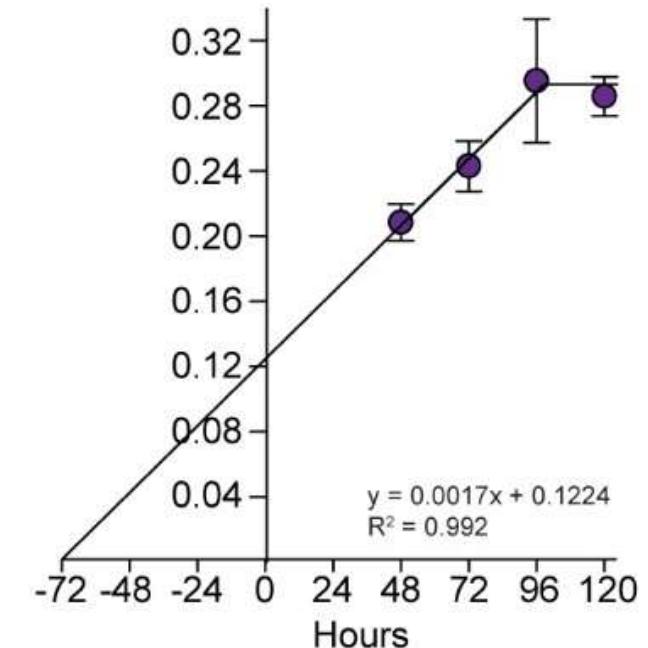
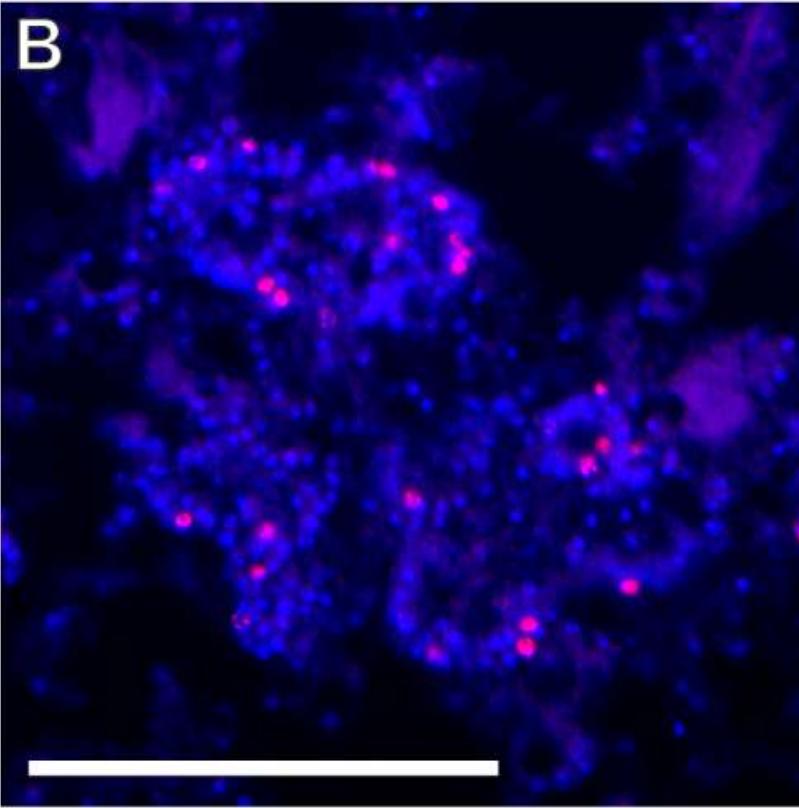
3 days in EdU, 1 day chase



EdU  
Hoechst



# Cell turnover rates of different sponges



	<i>Sycon coactum</i>	<i>Spongilla lacustris</i> (gemmales)	<i>Spongilla lacustris</i> (adult)	<i>Haliclona mollis</i>	<i>Aphrocallistes vastus</i> (growing)
Proliferation rate (% cells h <sup>-1</sup> )	0.7±0.1	2.0±0.36	0.19±0.03	0.25±0.04	0.17±0.02
Length of cell cycle (h)	30.7	34.6	≥159	176	170

# Cost of cell turnover

