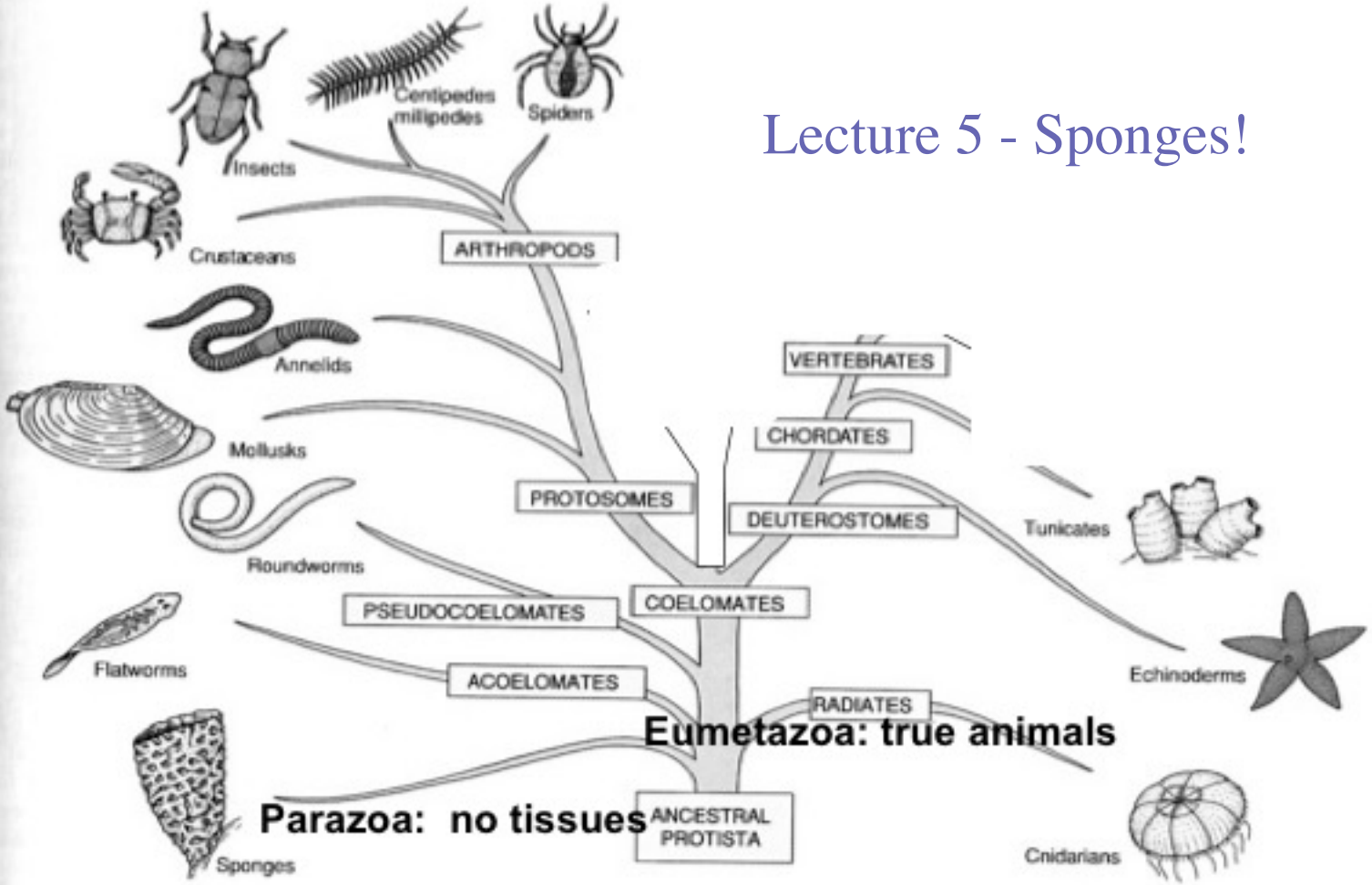
Animal Kingdom



Lecture 5 - Sponges!

Simplest metazoan (multi-cellular)

Metazoan origins – unicellular ancestors

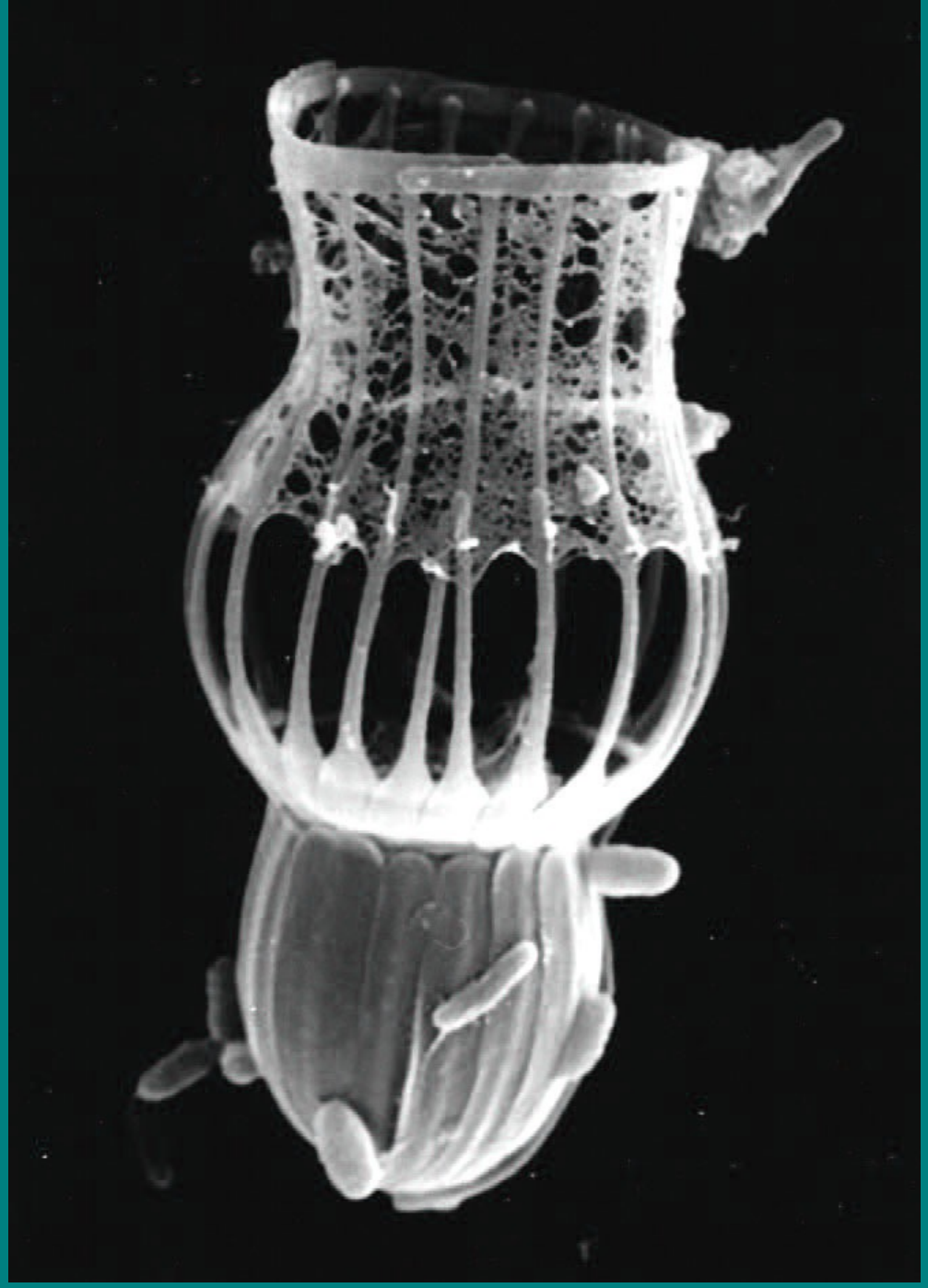
- Originated during the Precambrian (1.2 billion - 670 million years ago)
- From what? Two hypotheses:
  - Multinucleated ciliate became compartmentalized
  - Cells in a colonial flagellate became specialized

Metazoan origins – unicellular ancestors

Anisonema (choanoflagellate)

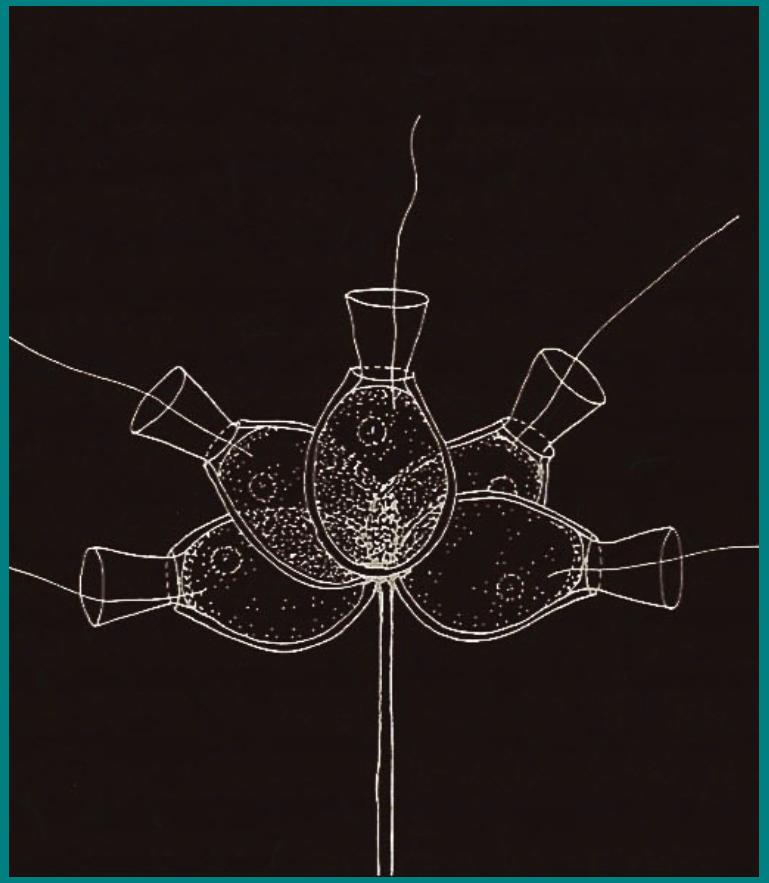
Choanoflagellates

SEM of the basket-like lorica of Diplotheca costata*(approx 12 µm long)*



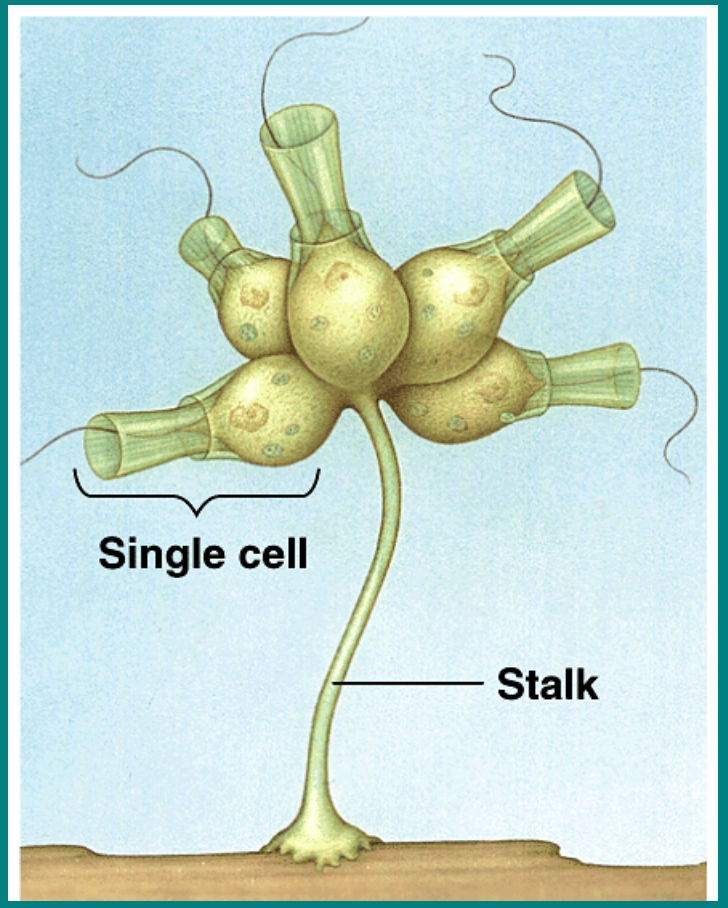
Choanoflagellates

Codosiga

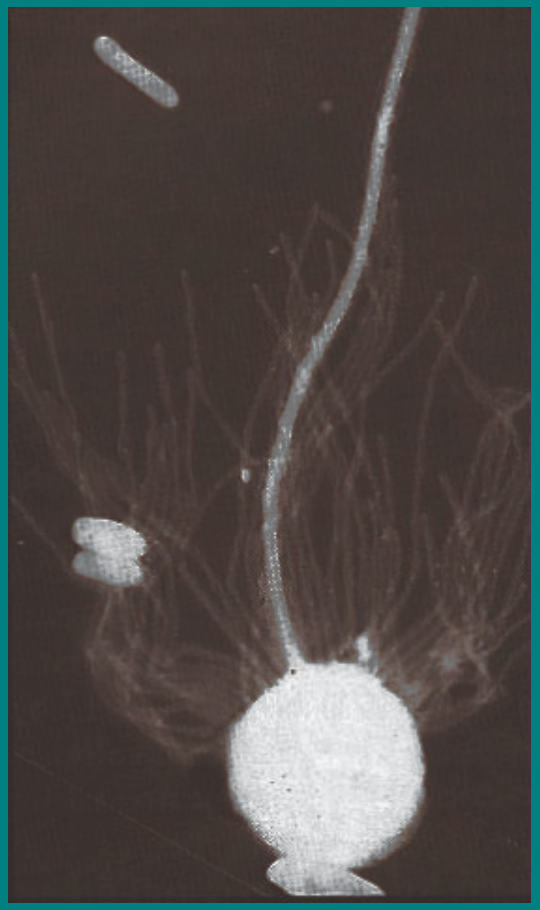


Drawing of a spherical colonial choanoflagellate Sphaeroeca lackeyi. Individual cell bodies are 10 μm long

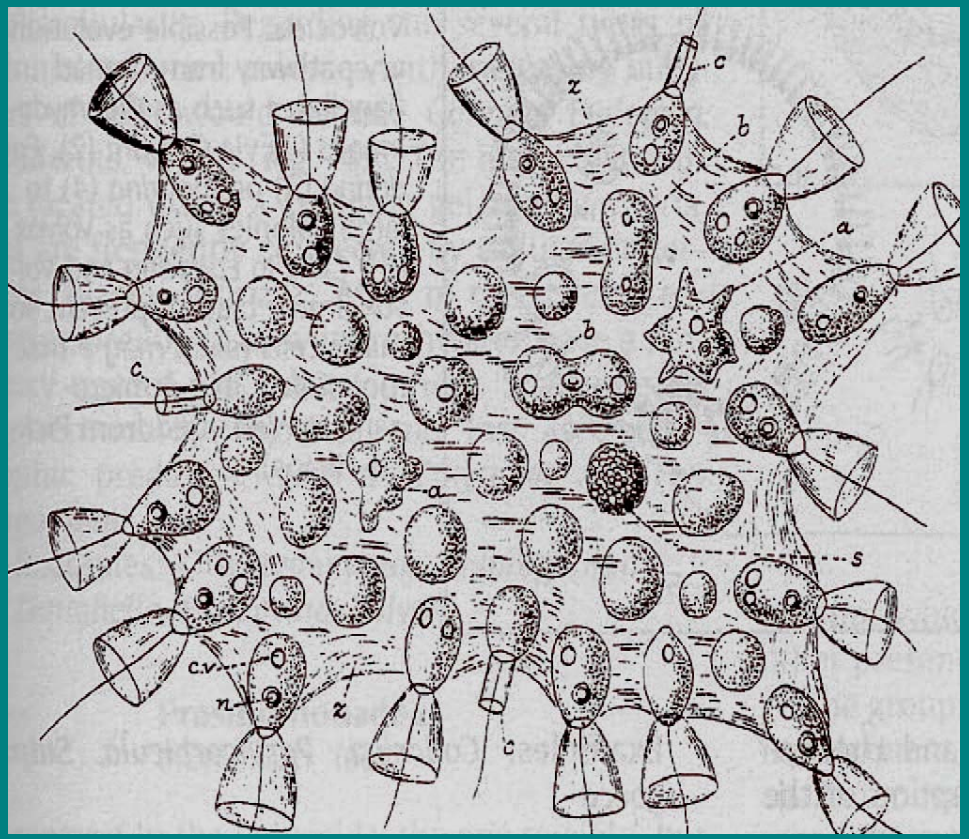
Colonial Choanoflagellates



Choanoflagellates

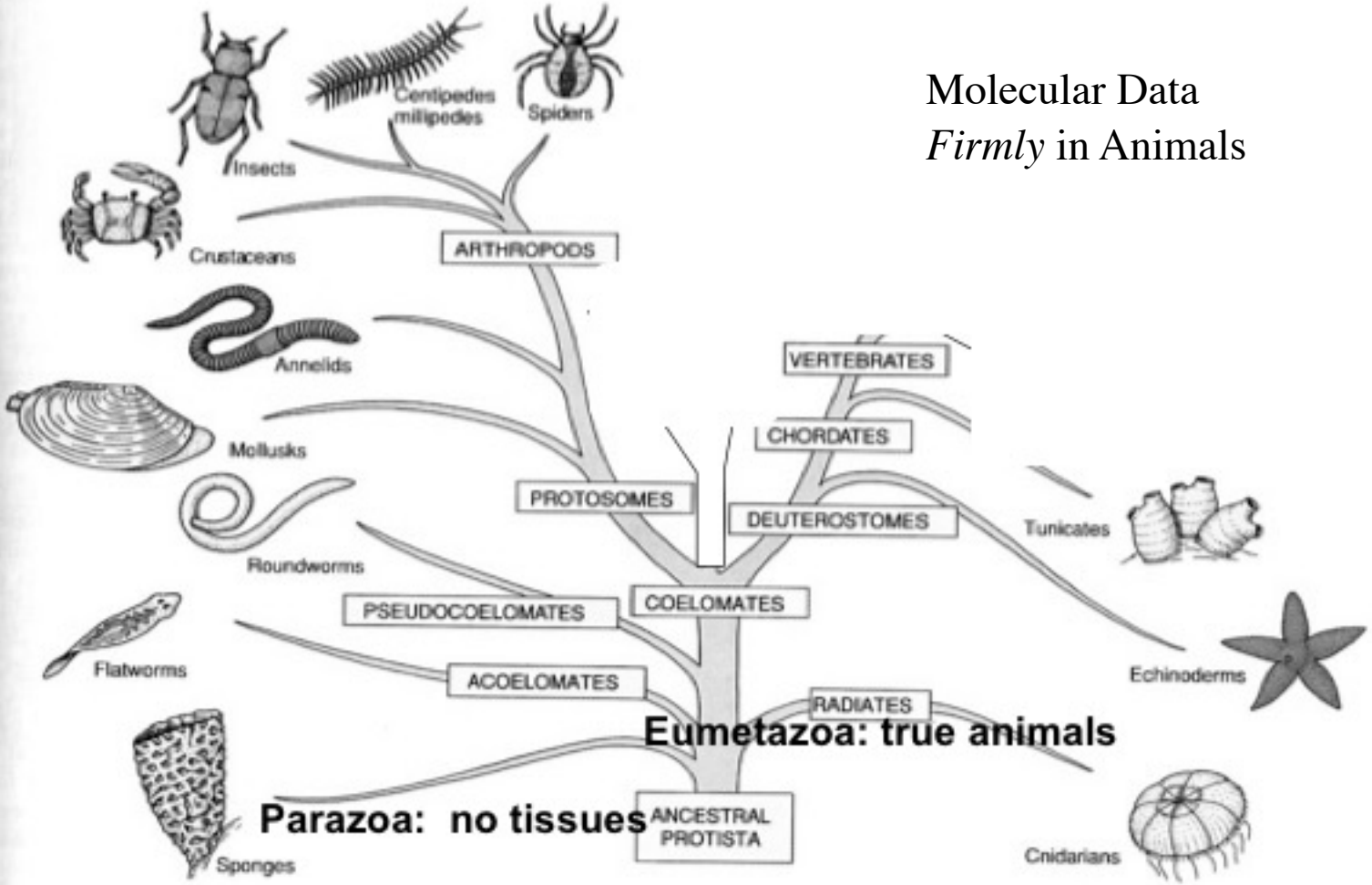


Whole mount of a freshwater sponge choanocyte. Note the single anterior flagellum and the collar of thread-like tentacles. Cell body is approx 6 μm long.



Drawing of Proterospongia haeckeli, *which Kent (1880–82) considered to be a missing link between choanoflagellates and sponges. Colony is 40–50 μm wide.*

Animal Kingdom



Molecular Data
Firmly in Animals

Simplest metazoan (multi-cellular)

Phylum Porifera: the sponges

- ~ 10,000 species
- Sessile
- Porous filter feeders
- Negligible movement
- No nervous system or coordinated behavior
- Abundant and important in marine ecosystems: provide habitat and protection

Sponge characteristics

- **Simple metazoa lacking true tissues or organs**

- Essentially an assemblage of several cell types embedded in a jello-like matrix, often supported by spicules

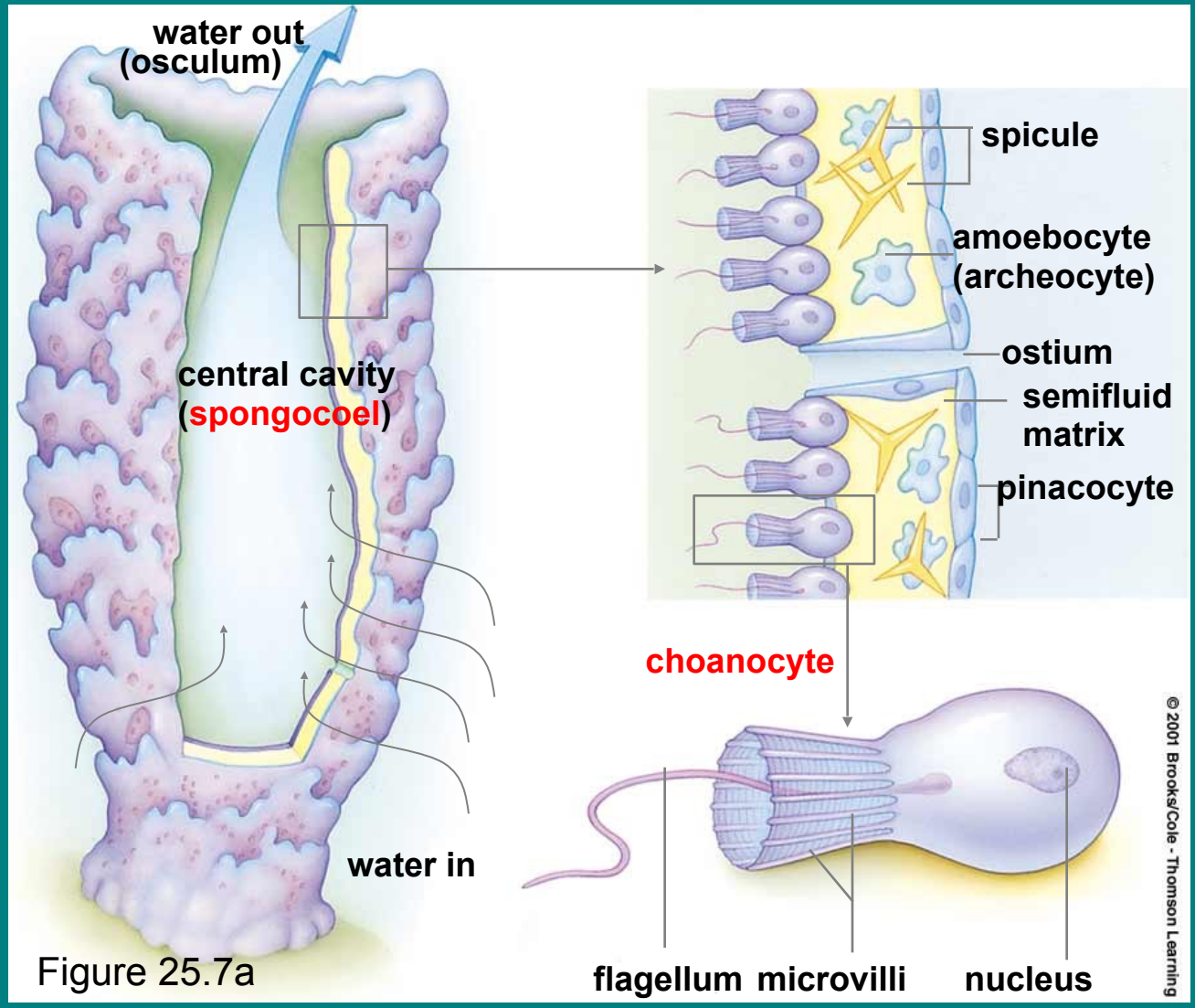
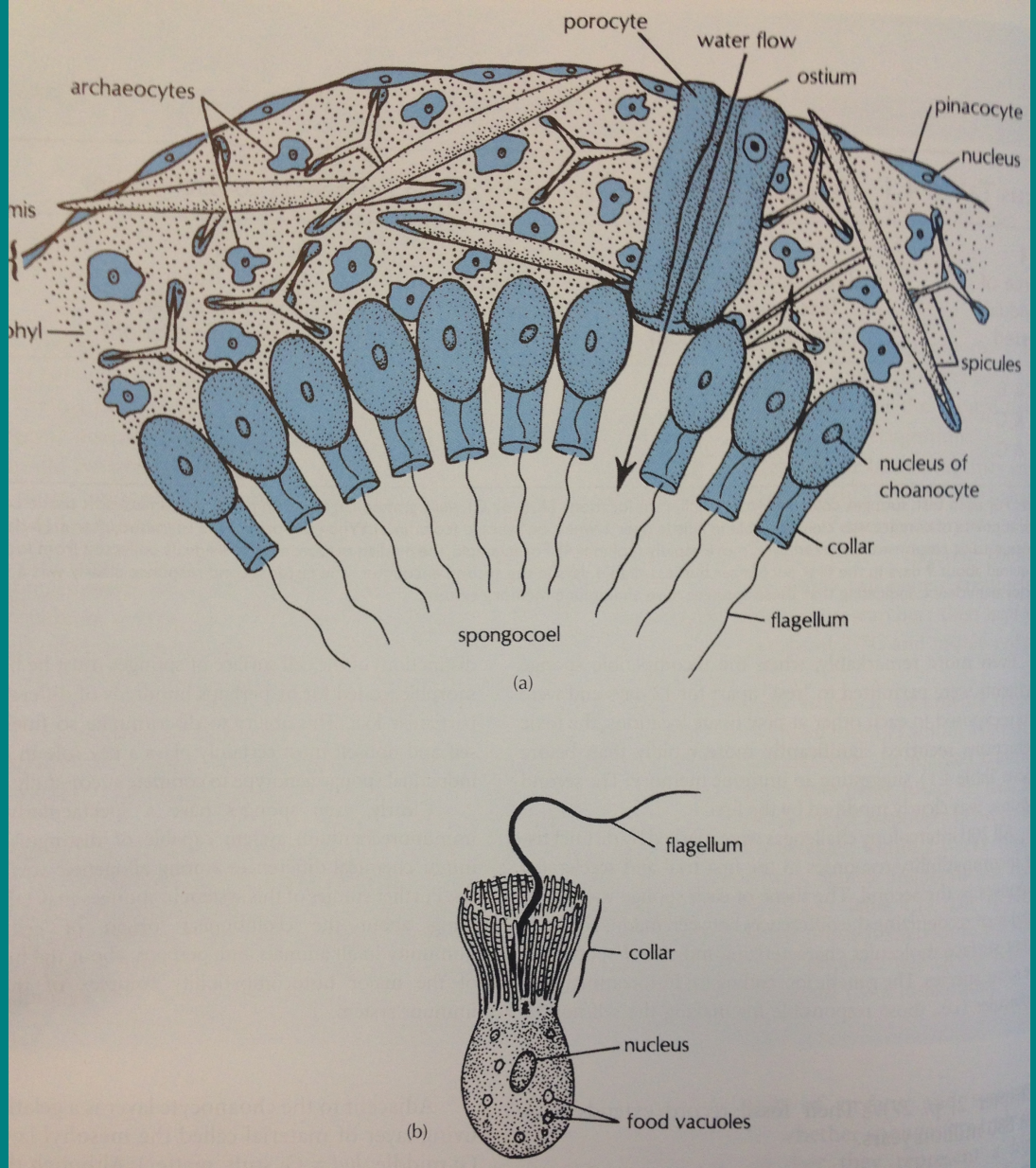


Figure 25.7a



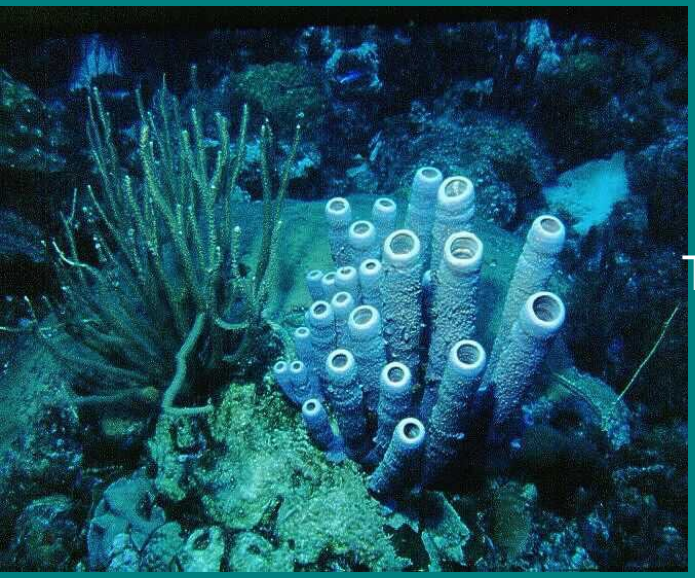
matic illustration of the body wall of a sponge.
f a choanocyte.

(a) From Hyman, *The Invertebrates*, Vol. III. Copyright © 1951 McGraw-Hill Company, New York. Reprinted by permission. (b) After Rasmont.

ayer. These support elements may be calcareous
s **spicules,** or they may be fibers composed of a
us protein called **spongin**. The cells secreting

At certain times of the year, many freshwater spo
species (and a few marine species) produce dormant str
tures called **gemmules**. To begin the process, archaeocy
ells a

Sponge diversity



Tube sponge

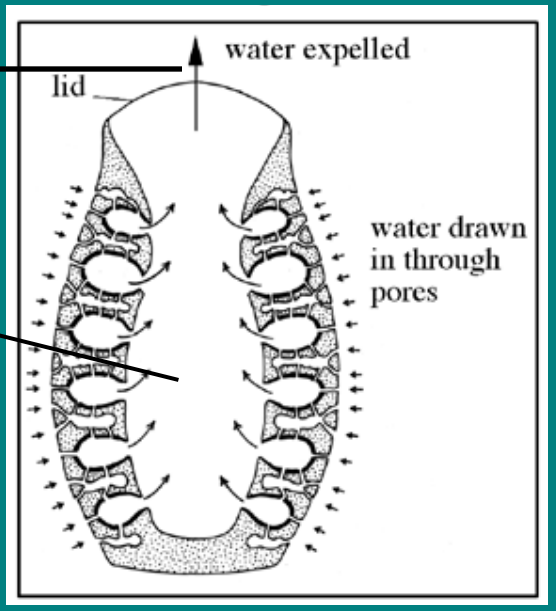
Encrusting sponges

Class **Hexactinelidda: Venus' flower basket**

Water movement and maximizing filtering area

osculum

spongocoel



- The body of a simple sponge resembles a sac perforated with holes
  - Water is drawn through the pores into a central cavity, the **spongocoel**, and flows out through a larger opening, the **osculum**
  - More complex sponges contain branched canals and several oscula

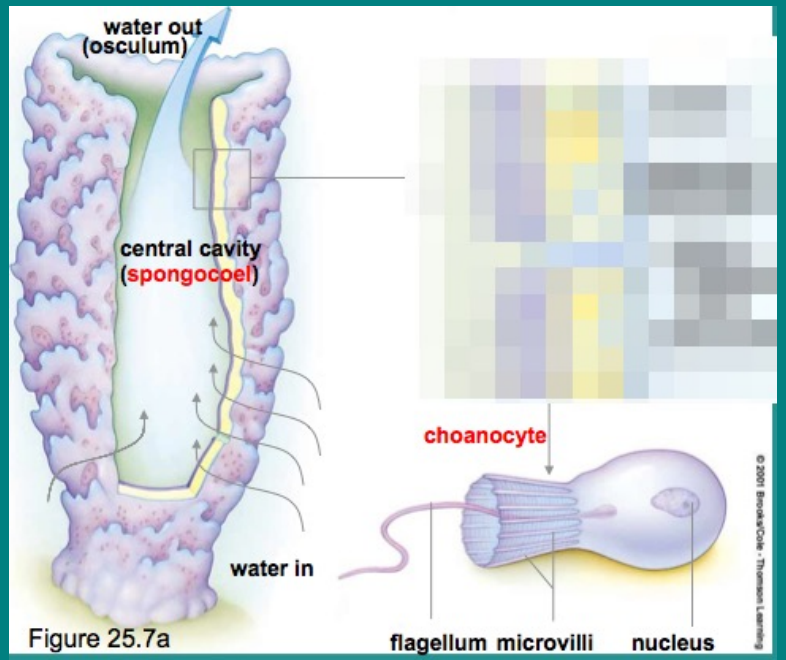


Figure 25.7a

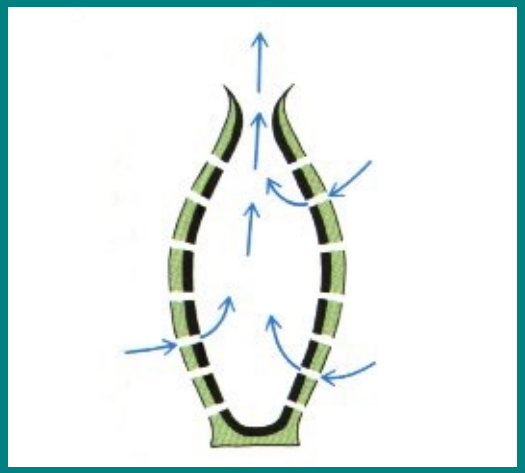
Form and function

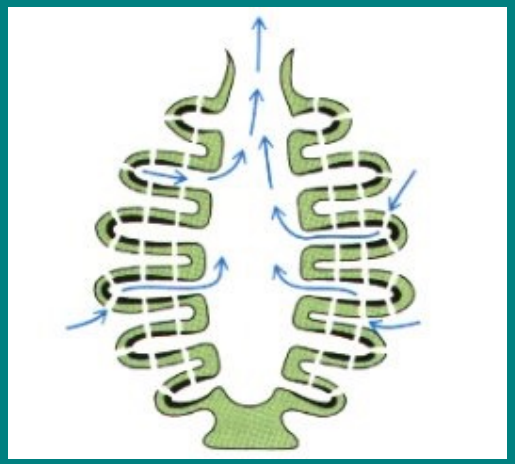
- Nearly all: suspension filter feeders

Asconoid: flagellated spongocoel

Syconoid: flagellated canals

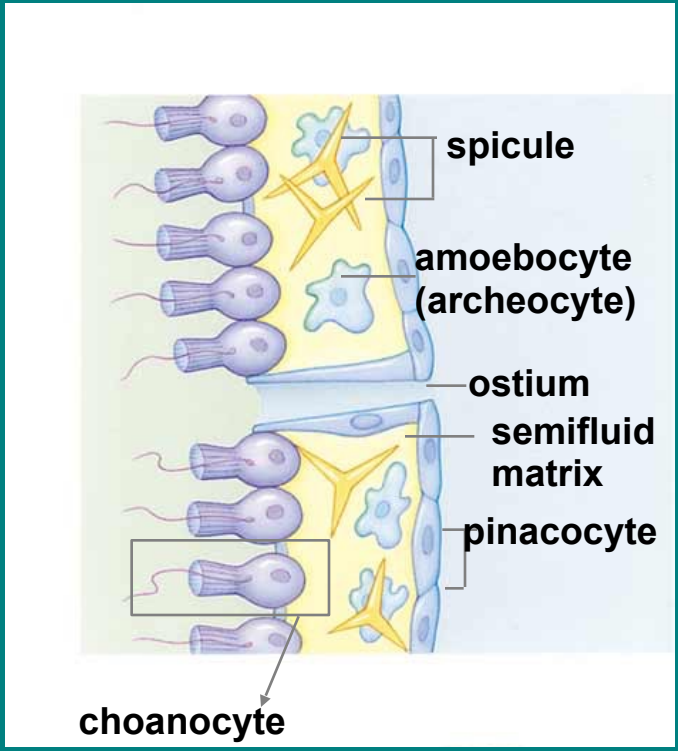
Leuconoid: flagellated chambers





Sponge cells I

- Sponge body consists of two cell layers separated by a gelatinous region, the **mesohyl**
- Flagellated **choanocytes,** or collar cells, line the spongocoel (internal water chambers) create a flow of water through the sponge with their flagella, and trap food with their collars
- **Pinacocytes**: closest to true tissue - thin, flat epithelial cells that cover the external and part of the internal surface
- **Myocytes and porocytes:** contractile cells which surround canal openings and pores that contract to regulate flow through the sponge.

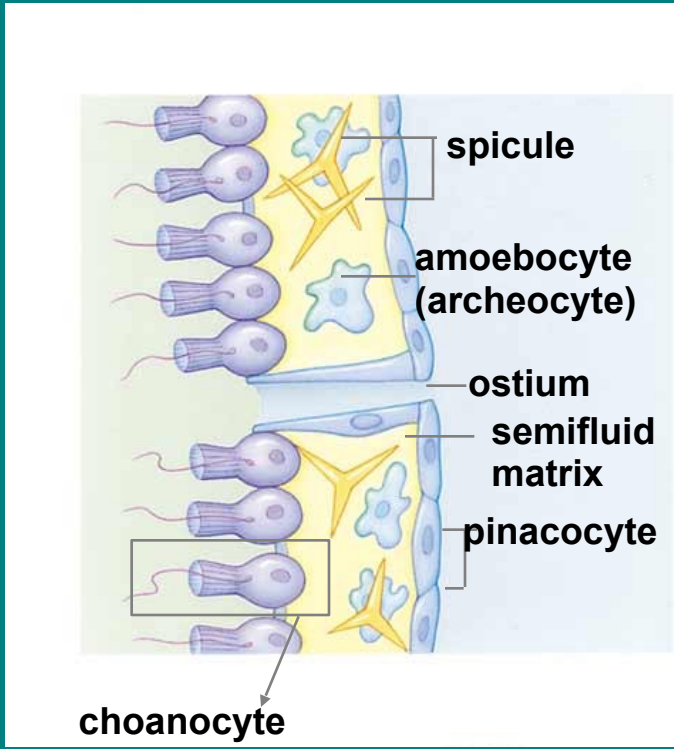


Sponge cells II

- **amoebocytes**: mobile, take up food from water and from choanocytes, digest it, and carry nutrients to other cells; secrete tough skeletal fibers within the mesohyl:
  - spicules of calcium carbonate or silicon dioxide
  - collagenous protein fibers called spongin

  Can differentiate into all other more specialized cells

Amazing!



Sponge physiology

- All activities depend on water flow: most are filter feeders
- *Leuconia* ~10 cm tall, 1 cm diameter: 81,000 incurrent canals water at a velocity of 0.1 cm/sec, slows in the 2 million flagellated chambers to 0.001 cm/sec, expelled at 8.5 cm sec
- Large sponges may filter 1500 liters water daily (up to 20,000 times its volume)
- Digestion entirely intracellular (amoebocytes) except:
- members of the family **Cladorhizidae** are carnivores: digestion is extracellular
- other sponges harbor symbionts (green algae, dinoflagellates, or cyanobacteria) from which they also derive nutrients
- No respiratory or excretory organs

Four New Species of Carnivorous Sponges Discovered in Pacific Ocean

Apr 15, 2014 by Sci-News.com

« PREVIOUS |

Published in
Biology

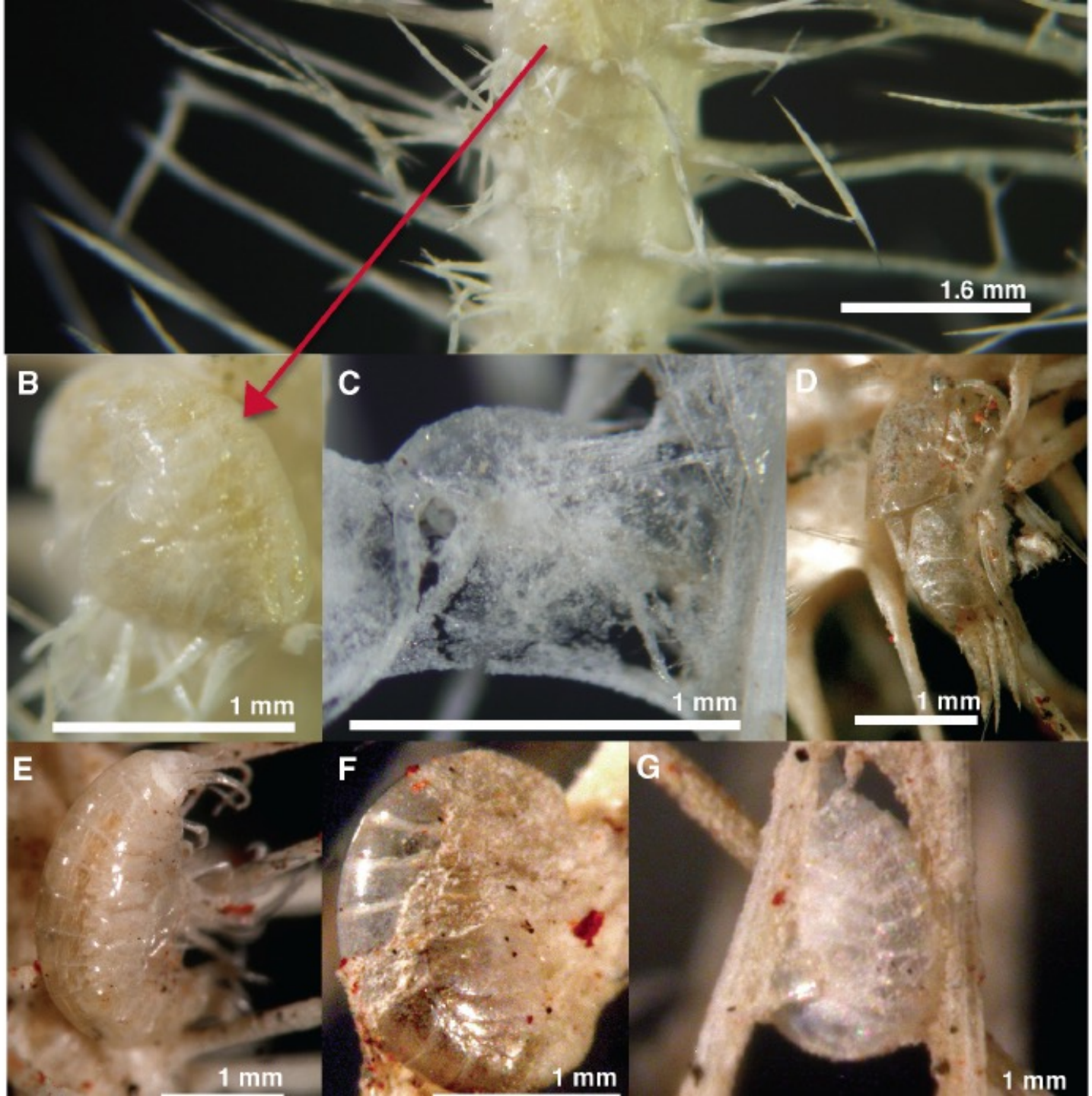
Tagged as
California
Pacific Ocean

Marine biologists from the Monterey Bay Aquarium Research Institute (MBARI) and three Canadian research organizations have described four new species of carnivorous sponges: *Asbestopluma monticola*, *Asbestopluma rickettsi*, *Cladorhiza caillieti* and *Cladorhiza evae*.

Biologists first discovered that some sponges are carnivorous about 20 years ago. Since then only 7 species have been found in the northeastern Pacific.

-most carnivorous sponges have no choanocytes. ????

https://www.youtube.com/watch?v=oJeyOU4eSKw


1.6 mm
B
1 mm
C
1 mm
D
1 mm
E
1 mm
F
1 mm
G
1 mm

Jean Vacelet · Eric Duport

Prey capture and digestion in the carnivorous sponge *Asbestopluma hypogea* (Porifera: Demospongiae)

Transmission electron microscopy observations have been made during the digestion process. The prey is engulfed in a few hours by the sponge cells, which migrate from the whole body towards the prey and concentrate around it. A primary extracellular digestion possibly involving the activity of sponge cells, autolysis of the prey and bacterial action results in the breaking down of the prey body. Fragments of the prey, including connective cells and muscles, are then phagocytosed and digested by archaeocytes and bacteriocytes. The whole process takes 8–10 days for a large prey. This unique feeding habit implies the capture and digestion of a macro-prey without any digestive cavity. It would appear to be an adaptation to life in deep-sea oligotrophic environments. Carnivorous sponges provide actual evidence, through a functional example, that a transition is possible from the filter-feeder poriferan body plan towards a different organizational plan through loss of the aquiferous system, a transition that has been hypothesized for the early evolution of Metazoa.

Sponge reproduction

Asexual reproduction: by bud formation and by regeneration following fragmentation

Sexual reproduction: most sponges are **hermaphrodites**, with each individual producing both sperm *and* eggs, and **viviparous** (offspring develop in parent)

- Gametes arise from choanocytes or amoebocytes.
- Eggs are retained; sperm are carried out via the osculum
- Sperm are drawn into neighboring individuals and fertilize eggs in the mesohyl (choanocytes deliver the sperm…)
- Zygotes develop into flagellated, swimming larvae that disperse from the parent
- Larvae develops into a sessile adult on suitable substrate

Regeneration and somatic embryogenesis

Regeneration: repair of injuries and restoration of lost parts

Somatic embryogenesis: entire new sponges can develop from fragments or aggregates of cells

Immune System (RFB)

Immunocompetence in the Lowest Metazoan Phylum: Transplantation Immunity in Sponges

Abstract. *Isografts of* Callyspongia diffusa *fuse compatibly, but allografts are invariably incompatible. Extensive polymorphism of cell-surface histocompatibility markers is evident. The histocompatibility barriers range from strong to weak depending on the interclonal combination, but early rejection with conspicuous cytotoxic sequelae is typical. Reaction times of first-set, second-set, and third-party grafts indicate highly discriminating transplantation immunity with a specific memory component.*

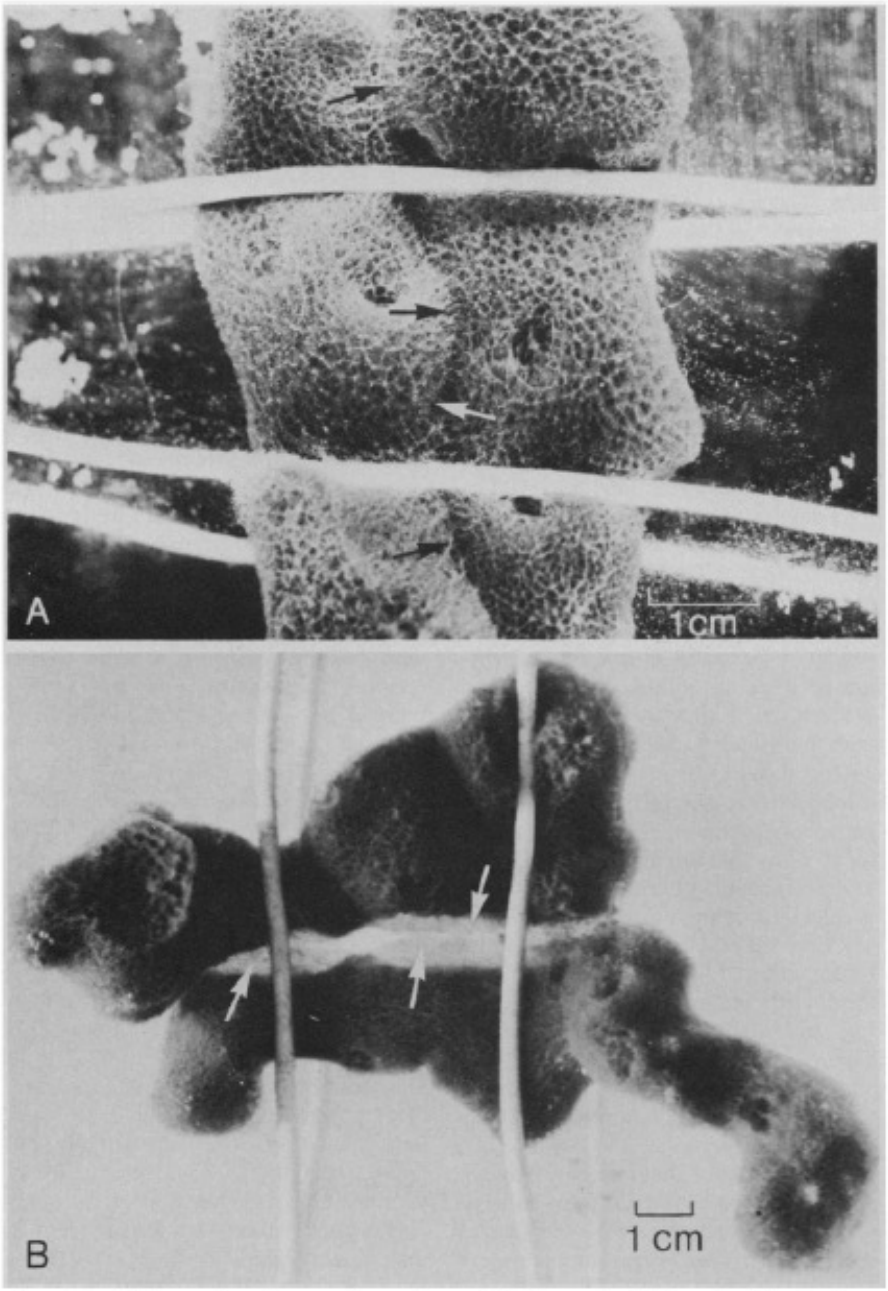


Fig. 1. Parabiotic reactions between intact fingers of *Callyspongia* held together by vinyl-covered wire tie-downs on Plexiglas plates. (A) Compatible interfacial fusion (arrows) of syngeneic or isogeneic parabionts after 2 to 3 days in contact. (B) Incompatible bilateral cytotoxicity between allogeneic parabionts showing skeletal framework (arrows) after local soft tissue necrosis at 7 to 9 days.

Immune System (RFB)

Focus Table 4.1 Reaction Times of *Callyspongia diffusa* Fragments to Each Other

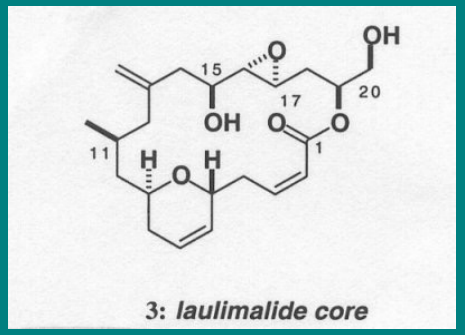
1 Source of Individuals Tested	2 Days to React in First Test (median ± one standard deviation)	3 Number of Pairs Tested	4 Days to React in Second Test (median ± one standard deviation)
A & B	9.0 ± 1.9	24	3.8 ± 0.9
A & C	8.9 ± 6.9	30	4.2 ± 1.3
B & C	7.2 ± 2.2	21	4.0 ± 1.2

Predation, competition, chemical warfare and drugs

Sponges have few enemies: “eating one is the equivalent of eating a mouthful of glass splinters embedded in an evil smelling gristle”

Predation, competition, chemical warfare and drugs

- What is the link between marine chemical warfare and human health?
- Production of anti-bacterial compounds
- Production of anti-cancer drugs
(AS-2 from the purple Pacific rope sponge)
- Production of anti-inflammatory drugs
- Production of drugs that suppress
organ rejection



3: *laulimalide core*

From the Okinawan ocean sponge *Fasciospongia rimosa:* microtubule-stabilizing agent - suppresses cell division

Associations

Sponges provide habitat for a variety of animals living as commensals or parasites
e.g. 16,000 shrimp living in a sponge of interior space equivalent to a 55-gallon drum

Cleaning gobies

Dromia personata wearing a stylish sponge hat

Associations

An odd coevolutionary relationship

Young shrimp enter the ‘cage’: live on drifting plankton, grow so large that they are effectively imprisoned

Class **Hexactinelidda: Venus’ flower basket**