Phylum Porifera

-- 5000 -10000 spp.
-- mostly marine some fw
none terrestrial
-- 3 classes, most important distinction are skeletal characteristics

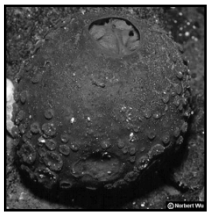
Table 1. Condensed results of toxicity in sponges of San Juan Island, Washington, USA; Santa Catalina Island, California, USA; Zihuatanejo Bay, Guerrero, Mexico; and La Blanquilla, Veracruz, Mexico

Study area and depth	No. of sponge species tested	No. and (%) of toxic species	No. of highly toxic species	No. of moderately toxic species	No. of mildly toxic species	No. of very mildly toxic species
San Juan Island, Washington, USA (48°33'N; 123°01'W) 0-50 m	34	3(9%)	3	-	-	-
Santa Catalina Island, California, USA (33°26'N; 118°29'W) 0-40 m	44	9(20%)	5	4	-	-
Zihuatanejo Bay, Guerrero, Mexico (17°37'N; 101°34'W) 1-20 m	11	7(64%)	1	1	-	5
La Blanquilla, Veracruz, Mexico (19°13'N; 96°06'W) 1-15 m	36	27(75%)	12	2	5	8

Green 1977, *Marine Biology*

Phylum Porifera

I. General Ecological Characteristics
II. Body Plan
III. Metazoan Characteristics
A. Cell types
B. Allorecognition
C. Reproduction and Embryology
D. Other metazoan homologies.
IV. Sponge Phylogeny



I. General Ecological Characteristics

Sponges are:

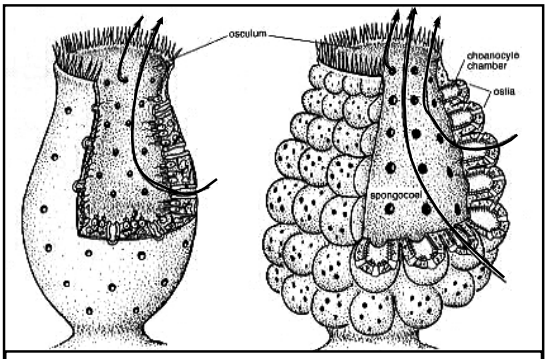
- Sessile, benthic
- Filter feeders
- Competitors for space
- Fed upon by specialist predators
- Grow in many forms, solitary, colonial, branching, as thin sheets over substrates
- From few cm to over 1 m in size
- Estimated in some cases to be several hundred years old

II. General Characteristics of the Poriferan Body Plan

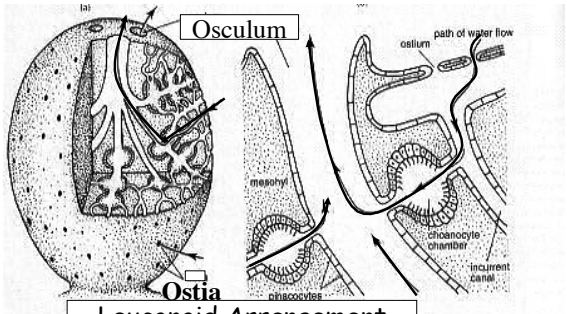
3 major types of body construction

Asconoid
Syconoid
Leuconoid

(this has little to do with the classification of sponges, which is based on skeletal morphology)



Asconoid Sponge Syconoid Sponge



Leuconoid Arrangement

These are the largest, and most sponges have this type of construction

P.O.D.

Sponge Feeding Movie

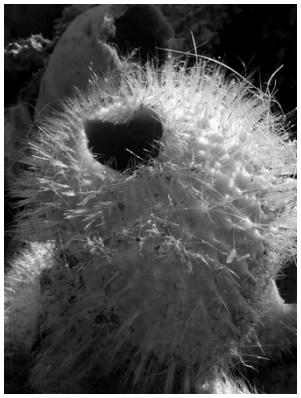
Simulations of Sponge Feeding

http://www.biology.ualberta.ca/facilities/multimedia/uploads/zoology/Porifera.swf

http://www.youtube.com/watch?v=RmPTM965-1c&feature=related

Carnivorous sponges from deep water and shallow caves

Evolution of macrophagy from a microphagous, filter feeding life style



II. Other Characteristics of the Poriferan Body Plan

No true muscular system
Lacking sensory organs, nervous system
Often amorphous and asymmetrical,
no anterior, posterior, oral surfaces

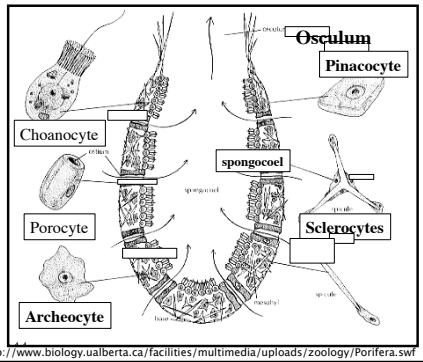
Begs the question: Colony of protista or
a simple metazoan (i.e. an integrated animal ?)

What is a Metazoan?

In other words what are the inherent characteristics of an animal body plan that are different from that of a colonial heterotrophic organism?

III. Metazoan-like Characteristics of Sponges

A. 5 different principal cell types (20 total)



http://www.biology.ualberta.ca/facilities/multimedia/uploads/zoology/Porifera.swf

Stem cells – have the capacity of self-replication and to give rise to more than one type of mature daughter cells

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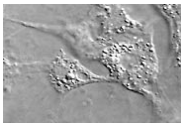


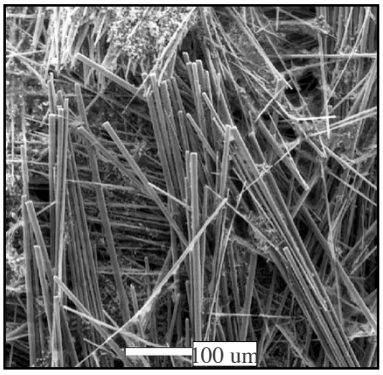
Image courtesy of BioMEDIA ASSOCIATES

Archeocytes – in sponge embryos are considered *totipotent* stem cells that can give rise to an entire organism
- in adults they produce a few cell types (sclerocytes, germ cells, etc.) but not an entire organism; they are considered *pluripotent*

Muller (2006) *Seminars in Cell and Developmental Biology #17:481-491*

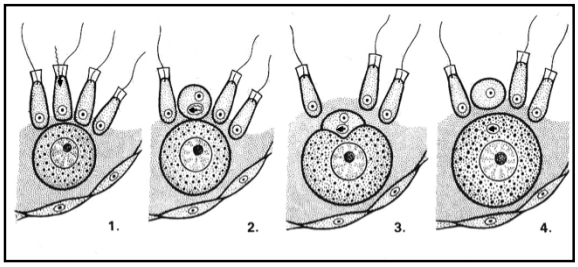
Sclerocytes synthesize sponge spicules

Monoaxial Spicules



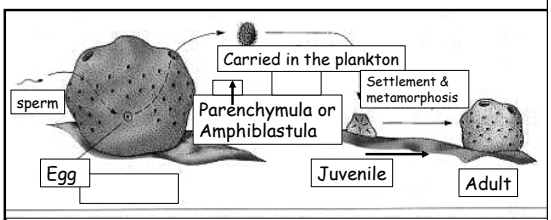
III. Metazoan-like Characteristics of Sponges

B. Complex reproduction



III. Metazoan-like Characteristics of Sponges

Unique but complex embryonic development, with a hollow blastula stage but does not form a gastrula



Sexual reproduction involves fertilization, release of a planktonic larva, and its eventual settlement and metamorphosis on the bottom.

III. Metazoan-like Characteristics of Sponges

C. Other sponge metazoan homologies: Epithelium

-

collagenous sublayer

-

(only Calcarea has full "animal-like" desmosomes)

-- extracellular matrix

-- spongin is collagen-like molecule

-- ubiquitin protein similarity (tag other proteins for proteolysis)

III. Metazoan-like Characteristics of Sponges

C. Other sponge metazoan homologies: Regulation of Development

-- True Hox genes are not found, but many homologous developmental transcription factors are conserved

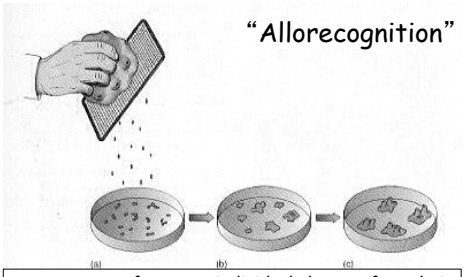
-- Most of the developmental signaling pathways (Wnt, Notch) and they are expressed along the same embryonic "axis" in sponges (and Cnidaria).

Many of these signaling pathways and transcription factors have not been found in Protists.

From Adamaska et al., 2011

III. Metazoan-like Characteristics of Sponges
D. Non-self recognition

"Allorecognition"



Some sponges form new individuals hours after their cells are separated from one another. If species are combined, the cells segregate with their own

"Metazoan-like Characteristics of Sponges"

Allorecognition ⇒ Histoincompatability

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)	5 Number of pairs tested
A & B	9.0 ± 1.9	24	3.8 ± 0.9	10
A & C	8.9 ± 6.9	30	4.2 ± 1.3	13
B & C	7.2 ± 2.2	21	4.0 ± 1.2	11

"Metazoan-like Characteristics of Sponges"

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Immune response:
- antagonism toward foreign substances
- antagonism must be specific toward that substance
- future responses should be altered by the first response

The sponge immune response is mediated by molecules which have been found to control histo-recognition in deuterostomes including Immunoglobulin-like domains and citokines

Summary

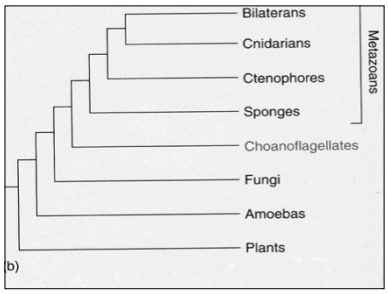
-- Sponges lack complexity, but their body plan is ecologically and evolutionarily successful

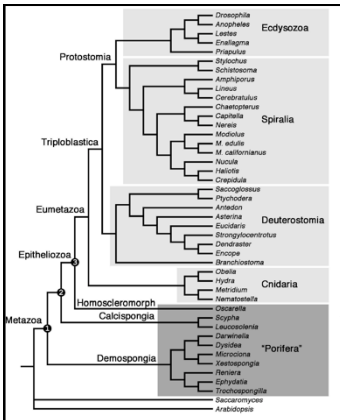
--They should be considered metazoans since they have fundamental characteristics of multicellular animals;

--They are derived from flagellated protists but may be a early and now distant branch of the metazoa; animals are monophyletic

IV. Phylogeny of Sponges

textbook version





Ecdysozoa: molting animals

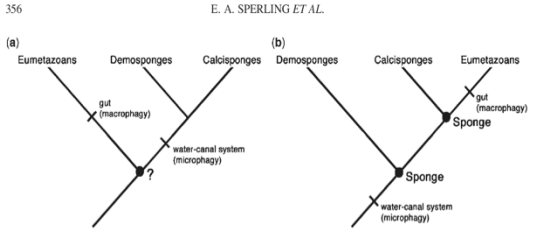
Spirilia: spiral cleavage etc

Deuterostomia: radial cleavage etc.

Triploblastica: 3 germ lines

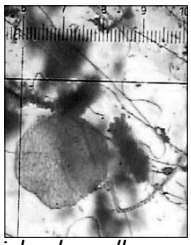
Eumetazoa: organs

3. Basal lamina, true epithelium
2. Desmosomes
1. Metazoa

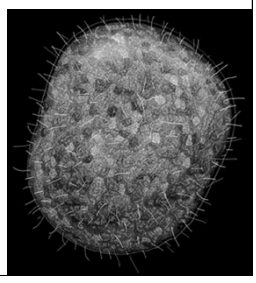


Phylum Placozoa

-- 2-3 mm, 25 um- thick, resembling a large ameba
-- Lacks anterior posterior polarity
-- Asexual reproduction is prevalent
--The most primitive animal?



Trichoplax adhaerens



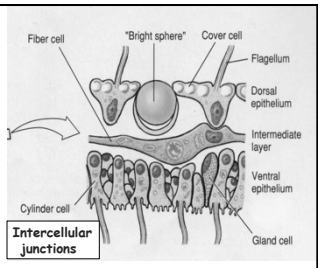
Phylum Placozoa

epithelium-like layer

Fiber synctium →

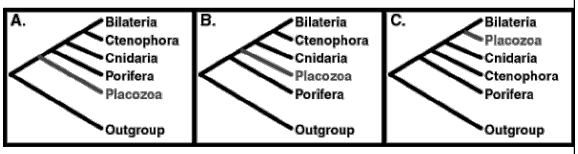
thick glandular layer

Flagellated cells



-- Feed ventrally by absorption of digested material
-- Lack organs but tissue-like outer walls (no basement membrane)
-- A bit more than 2000 cells
-- Only 4 different cell types (20 in sponges; > 220 in mammals)
-- Smallest genome of all animals

Three competing Scenarios



A. Earliest view of them as the basal metazoan
B. Special cellular junctions consisting of two opposing dense plaques (desmosomes) not found in most sponges
C. 16S rRNA data…maybe secondarily simplified from more complex ancestors?

Mitochondrial genome of *Trichoplax adhaerens* supports Placozoa as the basal lower metazoan phylum

Dellaporta, Stephen L. et al. (2006) Proc. Natl. Acad. Sci. USA 103, 8751-8756

Largest known mt genome 46 kbp, 2x that of most metazoa

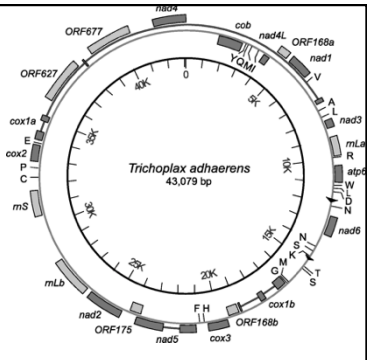
with introns and other intrageneic spacers and large protein coding regions that are usually lacking in other animals

Blue: known mt proteins

Gray: ribosomal genes

Green: unknown open reading frames

Red lines: introns



(a sponge)

Figure 2 | Metazoan phylogeny and *Trichoplax*. Bayesian phylogeny of metazoans places *Trichoplax* as the sister group to cnidarians and bilaterians. Maximum parsimony applied to the same alignment results in a single tree with the same topology shown here. Posterior probabilities are reported above each branch; likelihood bootstrap support values are reported below.

Conclusions?