Phylum Porifera

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

Green 1977, Marine Biology

<table>
<thead>
<tr>
<th>Site</th>
<th>No. of species</th>
<th>No. of species</th>
<th>No. of species</th>
<th>No. of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Juan Island, Washington, USA</td>
<td>32</td>
<td>20</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Santa Catalina Island, California, USA</td>
<td>24</td>
<td>15</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Kudat, Sabah, Malaysia</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ta Khung, Thailand</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Electric Reef, Australia</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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

Osculum

Ostia

Leuconoid Arrangement

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

- Spongocoel
- Choanocyte
- Porocyte
- Pinacocyte
- Osculum
- Sclerocytes

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

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.


Sclerocytes synthesize sponge spicules

Monoaxial Spicules

Image courtesy of BioMEDIA ASSOCIATES

100 μm
### III. Metazoan-like Characteristics of Sponges

#### B. Complex reproduction

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

---

#### 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)

---

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

**III. Metazoan-like Characteristics of Sponges**

**D. Non-self recognition**

"Allorecognition"

<table>
<thead>
<tr>
<th>Source of individuals tested</th>
<th>Days to react in first test (median ± one standard deviation)</th>
<th>Number of pairs tested</th>
<th>Days to react in second test (median ± one standard deviation)</th>
<th>Number of reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; A</td>
<td>96 ± 1.9</td>
<td>24</td>
<td>38 ± 0.9</td>
<td>10</td>
</tr>
<tr>
<td>A &amp; C</td>
<td>89 ± 6.8</td>
<td>20</td>
<td>42 ± 1.2</td>
<td>13</td>
</tr>
<tr>
<td>A &amp; G</td>
<td>77 ± 1.7</td>
<td>27</td>
<td>40 ± 1.2</td>
<td>11</td>
</tr>
</tbody>
</table>

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 historecognition in deuterostomes including Immunoglobulin-like domains and cytokines.

---

**Summary**

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

-- They should be considered metazoan since they have fundamental characteristics of multicellular animals.

-- They are derived from flagellated protists but may be an early and now distant branch of the metazoa; animals are monophyletic.
IV. Phylogeny of Sponges

**textbook version**

- Basleriata
- Cnidaria
- Ctenophora
- Spongia
- Choanoflagellata
- Fungi
- Amoebas
- Plants

---

**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**

---

**Ecdysozoa: molting animals**
- Spiralia: spiral cleavage etc.
- Deuterostomia: radial cleavage etc.
- Triploblastica: 3 germ lines

**Eumetazoa: organs**

1. Metazoa
2. Deuterostomes
3. Basal lamina, true epithelium
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)
  - 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 metazoan phylum
Largest known mt genome 46 kbp, 2x that of most metazoas
- introns and other intragenic spacers and large protein coding regions that are usually lacking in other animals
- Blue: known mt proteins
- Grey: ribosomal genes
- Green: unknown open reading frames (a sponge)

Conclusions?