Phylogeny of Life on Earth

Eocyte Tree

"The affinities of all the beings of the same class have sometimes been represented by a great tree... As buds give rise by growth to fresh buds, and these if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever branching and beautiful ramifications."

Charles Darwin, 1859

Phylogeny of Life on Earth
(from TREE OF LIFE PROJECT)

The major branches of living organisms (Domains)

- Eubacteria ("true bacteria", archaebacteria, and chlamydobacteria)
- Eukaryaetes (Protista, Plants, Fungi, Animals, etc.)
- Archea (Methanogens, Haloarcha, Sulfiobius, and relatives)

Goals:

To explore in broad terms the phylogeny of Metazoa and the diversity of invertebrate animals.
- Improve your ability to interpret phylogenetic trees
- Become familiar with the current understanding of the phylogeny of major groups of organisms
- Review Linnean taxonomic classification
- Identify/learn about unique characteristics of invertebrates, especially those living in water

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Invertebrate Diversity
(with an introduction to biological classification)

Loosely based on Ch 1, Pechenik
Within the Animal Kingdom or Metazoa, there are about 32-33 distinct groups or phyla. What is a Phylum?

- Grouping of organisms that have a common design (body plan), and share one or a group of fundamental characters that distinguish them from other phyla.
- Or simply, a primary division of a kingdom, as of the animal kingdom, ranking next above a class in size.
  - Ex. Phylum Arthropoda: jointed exoskeleton
  - Ex. Phylum Chordata
  - Why not phylum Vertebrata???

What is a Species?

A group of similar organisms that can potentially interbreed successfully in nature. Is a species a natural unit?

- What about Class
- Order
- Family
- Genus?

Phylocode

More important to understand phylogeny then it is to perfect taxonomy.
Two Newest Phyla
Phylum Micrognathozoa
Discovered in a cold spring in Greenland
by R.M. Kristensen & P. Funch (2000)

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Rather than new discoveries of higher taxa, most phylogenetic research today is focused on understanding the relationships and evolution of known groups.

Xenoturbella: The Fourth Deuterostome Phylum
by the Date of Woman

2008
Genesis 46:580-586

1915 described as a flatworm
1997 a mollusk based on r-DNA

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Dendrogramma enigmatica
incerti sedis

Collected from 400-1000m
Off Tamania in 1986

Not Ph Ctenophora
Or Ph Cnidaria

Where do invertebrates live?

- Most species live in terrestrial habitats, (roughly 900 K or about 80% of all species)
- However, only 9 phyla have invaded land and only two are highly successful terrestrial inhabitants
- 16 phyla are exclusively marine; in the oceans we find the greatest higher order diversity
- Three phyla occur only as parasites
Exclusively parasitic phyla:

**Acanthocephala**: spiny-headed worms; gut parasites of vertebrates, especially fishes, mammals

**Nematomorphs**: horsehair worms, juvenile parasites in arthropods

**Mesozoa**: also degenerate animals that parasitize invertebrates, particularly cuttlefish and octopuses

Parasitism:
-- most phyla have parasitic groups
-- 3 phyla are exclusively parasitic

What invertebrates have been most successful in colonizing terrestrial habitats?

**Centipedes**

**Insects**

**Arthropods!!**

**Chelicerates**

Why Arthropods?

Cuticle provides support and a barrier to water loss. A waxy component makes the cuticle waterproof

**Body wall of an arthropod.** The epidermis is thin and non-keratinous. Desmoskeletons reinforce it as a composite of chitin and proteins. The epidermis secretes the cuticle and is underlain by a basement membrane.

Why Arthropods? The tracheal respiratory system

Based on Pechenik table 1.1

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<th>Water</th>
<th>Air</th>
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<td>Viscosity (resistance)</td>
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<td>Oxygen solubility</td>
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<td>Oxygen Diffusion</td>
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<tr>
<td>Nutrient Content</td>
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What are the implications of each of these differences for organisms living in these habitats?
Unique Features of Aquatic Animals

1. Gas exchange through gills, body wall
2. Absorption of dissolved nutrients
3. Fertilization by broadcast spawning
4. Rigid skeletal support not necessary
5. Drifting way of life possible
6. Suspension and filter feeding
7. Sedentary life style possible

Works well for animals of very small size, animals that are flat, and animals that are mostly water: cnidarians, sponges, flatworms

Larger animals, animals with thicker integuments require gills, kidneys and other organs

Not common in arthropods, cephalopods

Limitations due to diffusion and dispersal of gametes.

Due to the density of water, a rigid skeletal support not necessary; Drifting way of life possible

Hydrostatic skeleton

Two ways to be a drifter

Plankton Video
**Unique Features of Aquatic Animals**

Suspension and filter feeding is common and sedentary life styles are possible.

- Fan worms
- Cnidarians (black sea rod)
- Sponges

**Problem with suspension feeding:** getting sufficient food from a diffuse source.

Two solutions to concentrating food:
1. Let currents do the work and use an effective prey capture device (e.g., cnidarian stinging cells).
2. Use cilia to create a current, and mucus or cilia to capture food particles:
   - Ciliary reversal mechanism
   - Opposed band mechanism (deuterostomes vs. protostomes)

**Sedentary life style is possible.**

Modular growth is prevalent among some groups.

- Modular vs. unitary life styles
- Ramets and genets
- What might be the advantages of modular body plan?
- Growth vs. reproduction

**Modular growth is prevalent among some groups.**

Why aren't all animals modular?

**Table 1.** Mean species richness in millions of years for global and regional scleractinian corals.

<table>
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Source: Jackson and Coates, 1966.