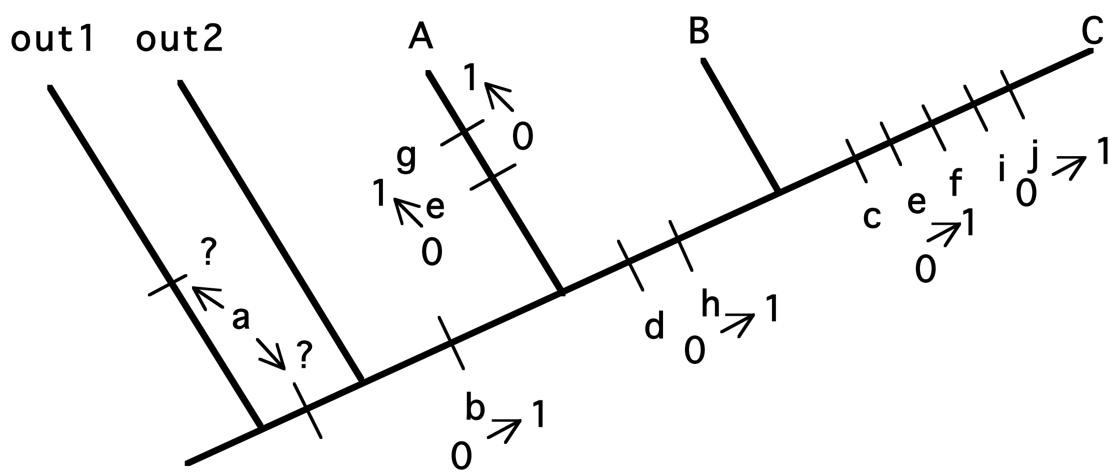
IB 168: Systematics of Vascular Plants Spring 2009

Key concepts -- Lecture 3 (1/28/09; end of Phylogenetics/Tracheophyte introduction)

<u>Not all shared characteristics are informative about phylogenetic relationships</u>
Hennig (1966): Shared, derived character-states are useful for resolving phylogeny, but shared, ancestral characteristics are not.
<u>Apomorphy</u> (= apomorphic character-state): A derived state (either shared or unique).
<u>Autapomorphy</u>: A unique, derived state; diagnostic for a terminal taxon but not informative about its relationships to other taxa.
<u>Synapomorphy</u>: A shared, derived state; diagnostic of phylogenetic relationships. Synapomorphies are the basis for resolving monophyletic groups.
<u>Plesiomorphy</u>: An ancestral state.
<u>Symplesiomorphy</u>: A shared, ancestral state; not diagnostic of relationships. Symplesiomorphic similarities often have been the basis for recognition of **para**phyletic groups.



In the tree above, character state 1 of char. b is synapomorphic for clade A+B+C but symplesiomorphic for clade B+C. Similarly, char. state 1 of char. h is synapomorphic for clade B+C but plesiomorphic for taxon B. Char.-state 1 of char. j is autapomorphic for taxon C, as is char. state 1 of char. g for taxon A.

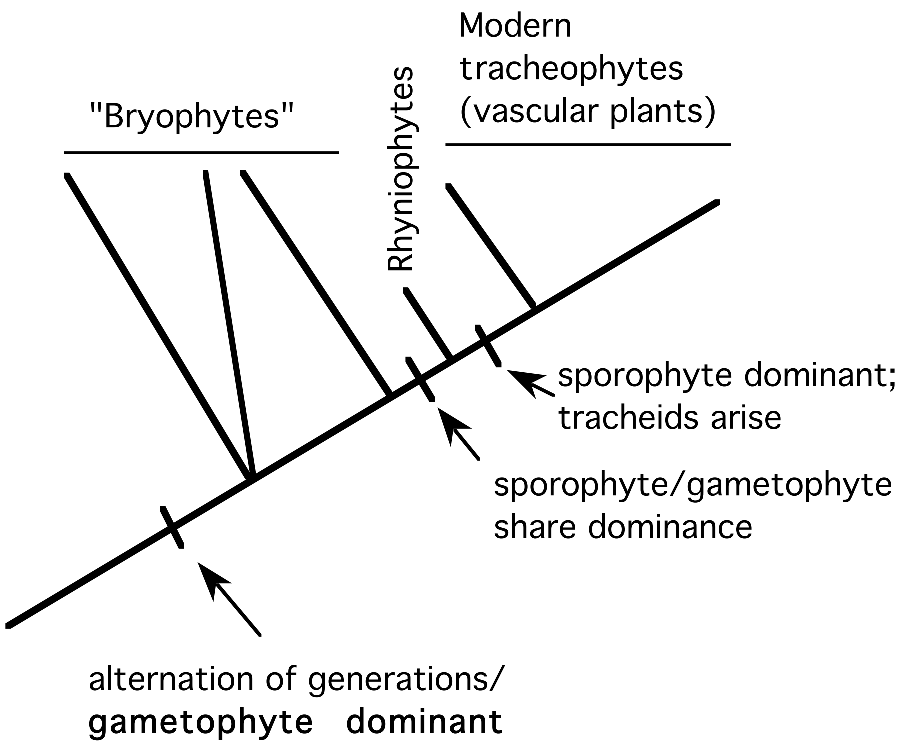
<u>Possession of the same character-state by different taxa may be attributable to common ancestry of those taxa or independent evolution of the character-state</u>

<u>Homology</u> (in systematic sense): Similarity due to common ancestry; a homologous characteristic is one that was passed along to different groups from their common ancestor (both synapomorphies and symplesiomorphies represent homologous characteristics). For example, char. state 1 of character b in the above tree is homologous in taxa A, B, and C, as is presence of char. state 0 of character h in out2 and A (even though symplesiomorphic).

Homoplasy: Similarity due to independent evolution; a homoplastic or homoplasious characteristic is misleading about relationship, even if it has the same genetic basis in groups where it evolved independently. Homoplastic characteristics can arise via evolutionary convergence, parallelism, or reversal. For example, presence of char. state 1 in character e in both taxa A and C in the tree on the previous page is an example of homoplasy.

Early vascular-plant evolution

Phylogenetic data have demonstrated that the sporophyte-dominant, tracheophyte life-cycle evolved from a gametophyte-dominant life-cycle. We know this based on two lines of evidence: (1) **Paraphyly of "bryophytes"** (mosses, liverworts, hornworts) and (2) recognition that the **earliest tracheophytes** (Rhyniophytes, now extinct) **had sporophyte and gametophyte generations that appeared similar morphologically**. The grade of "bryophyte" lineages below the base of the tracheophytes illustrates that gametophyte-dominance came first; Rhyniophyte fossils suggest that the two phases of the life cycle were co-dominant prior to the transition to sporophyte dominance in early tracheophyte evolution.



Why sporophyte dominance? Many possible reasons, for example, (1) benefits of masking deleterious mutations in the diploid (sporophyte) phase, (2) greater variability of genetic expression, (3) truncation of gametophyte generation, with the vulnerabilities of requiring a medium for free-swimming sperm.

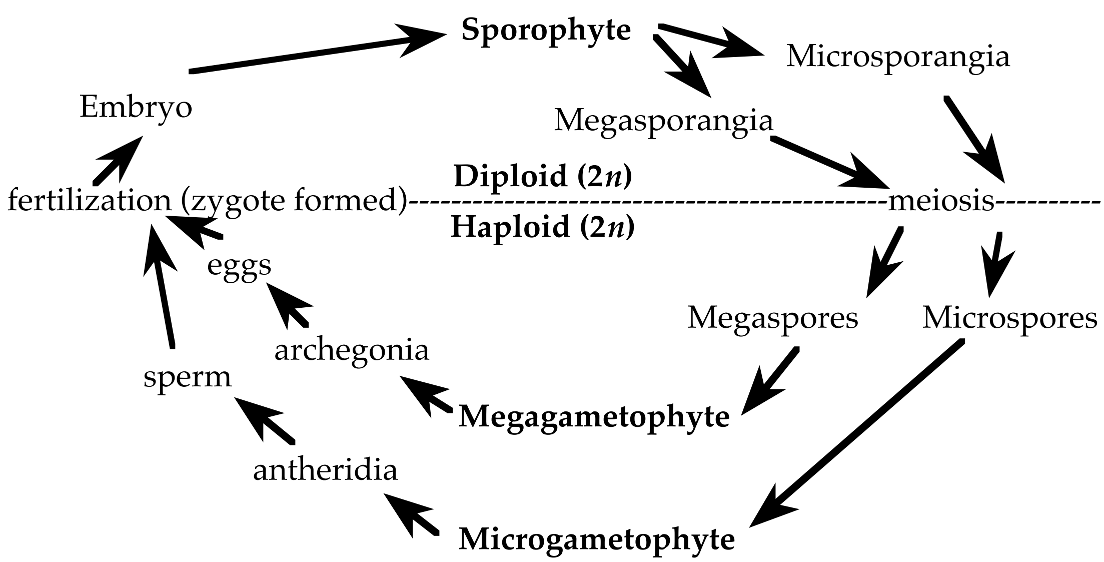
Tracheophyte phylogeny consists of **three principal branches**:

1) Lycophytes: earlier thought to be "fern allies" but ferns are more closely related to seed plants than to Lycophytes.
2) Ferns, including two families (Equisetaceae and Psilotaceae) that until recently were thought to fall well outside the fern lineage.
3) Seed plants: monophyletic -- all modern seed plants from one origin of seed.

All three major lineages of tracheophytes have evolved ***heterospory** (see below) independently:

Lycophytes (heterospory probably evolved once in common ancestor of Selaginellaceae and Isoëtaceae, after branching off of Lycopodiaceae, which is homosporous).
Ferns (heterospory evolved in common ancestor of two families of water ferns -- Marsileaceae and Salviniaceae; all other ferns are homosporous).
Seed plants (all are heterosporous; heterospory had to evolved prior to origin of the seed, as will be discussed in lecture on origin of seed plants).

***Heterospory**: Production of **two different kinds of spores** (megaspores & microspores; each from different sporangia -- megasporangia and microsporangia) by the sporophyte; each type of spore matures into a **unisexual gametophyte**, either male or female. In contrast, spores of homosporous plants mature to be bisexual gametophytes, with both male and female gametangia.



Why heterospory? Unclear. Some have suggested selection for outcrossing, although homosporous plants have mechanisms to promote outcrossing. Heterospory is associated with reduction and protection of the gametophyte phase, which develops inside the protective spore-wall.