

Seedless Vascular Plants
Chapter 17

Evolution of Vascular Plants

- embryophytes
 - bryophytes and vascular plants share many characteristics
 - trace ancestry back to *Coleochaete*-like organism
- important developments
 - to grow large on land, must have conducting tissue
 - lignin synthesis
 - apical meristem
 - branched sporophyte
- eventually more specialized into organs
- gametophyte becomes reduced
- seeds evolved in one line
- dominant plants in terrestrial habitats
- numerous and diverse by Devonian period
 - 408-362 mya
- seven phyla with living representatives

Organization of the Vascular Plant Body

- organs of the plant
 - root system
 - shoot system
 - stems
 - leaves
- three tissue systems
 - dermal
 - vascular
 - ground
- primary growth
- secondary growth
 - lateral meristems
 - vascular cambium
 - cork cambium
- tracheary elements
 - conducting cells of xylem
 - tracheids
 - vessel elements
- stele

- central cylinder of pith and primary vascular tissues
- protosteles
 - solid cylinder of vascular tissue
 - phloem surrounds xylem or interspersed
- siphonostele
 - central pith surrounded by vascular tissue
- eustele
 - discrete strands around a pith
- evolution of roots and leaves
 - roots relatively simple structures
 - leaves arise as leaf primordia from apical meristem
 - microphylls
 - megaphylls

Reproductive Systems

- vascular plants
 - oogamous
 - alternation of heteromorphic generations
- homosporous plants
 - produce one kind of spore as result of meiosis
- heterosporous plants
 - two types of spores in two different kinds of sporangia
 - microspores and megaspores
- gametophyte evolution
 - smaller, simpler
 - homosporous have free-living gametophytes
 - angiosperms

Phyla of Seedless Vascular Plants

- some very important during Devonian (~360 mya)
- extinct phyla
 - Rhyniophyta
 - Zosterophyllophyta
 - Trimerophyta
 - Progymnospermophyta
- phyla with living representatives
 - Lycopodiophyta
 - Pteridophyta
- four major plant groups
 - early vascular plants
 - Rhyniophytes
 - Zosterophyllophytes

- Trimerophytes
- 425 to 370 mya
- pteridophytes, lycophytes, progymnosperms
 - 375 to 290 mya
- seed plants
 - 380 mya
- flowering plants
 - 130 mya (fossil record)
 - abundant within 30 to 40 mya

Early Vascular Plants

- Phylum Rhyniophyta
 - earliest known, well understood vascular plants
 - seedless
 - simple, dichotomously branching stems
 - terminal sporangia
 - *Cooksonia*
 - gametophytes relatively large, branched
 - some likely had alternation of isomorphic generations
- Phylum Zosterophyllophyta
 - leafless, dichotomously branched
 - stems had cuticle
 - only upper stems had stomata
 - ancestors of lycophytes
- Phylum Trimerophytophyta
 - larger, more complex branching
 - leafless
 - large vascular strand so taller

Phylum Lycopodiophyta

- 1200 living species, 10-15 genera, all herbaceous
- some extinct, included trees
 - dominant during Carboniferous
- Lycopodiaceae
 - almost all living lycophytes in this family
 - 400 species, mostly tropical
 - sporophyte
 - branching rhizome
 - stem and root protostelic
 - homosporous
 - bisexual gametophytes
 - green, irregularly lobed
 - underground, nonphotosynthetic, mycorrhizal

- development and maturation of archegonia and antheridia may take 6-15 years
- water required for fertilization
- sporophyte eventually becomes independent
- Selaginellaceae
 - 750 spp. of *Selaginella*
 - mostly tropical
 - resurrection plant, *Selaginella lepidophylla*
 - heterosporous
 - water required for fertilization
- Isoetaceae
 - *Isoetes* (quillwort)
 - nearest living relative of ancient tree lycophytes of Carboniferous
 - Sporophyte
 - Fleshy, underground stem
 - Microphylls
 - Roots
 - Heterosporous
 - Specialized cambium that produces secondary tissues
 - Some have CAM photosynthesis

Phylum Pteridophyta

- includes ferns, whisk ferns, horsetails
- Ferns: 11,000 species
- abundant in fossil record from carboniferous to modern times
- largest group of plants other than angiosperms
- most diverse group of plants in form and habit
- most diverse in tropics
 - important members of plant community
 - 1/3 grow as epiphytes
 - ~380 species in U.S. and Canada
 - 1000 species in Costa Rica
- various forms
 - some small, undivided leaves
 - some climbing
 - tree ferns
- sporangia
 - eusporangiate
 - parent cells in surface of tissue from which sporangium produced
 - characteristic of all vascular plants except...
 - leptosporangiate

- arise from one superficial initial cell
 - smaller than eusporangia
- most ferns homosporous
 - two orders of living water ferns heterosporous
- eusporangiate ferns
 - Ophioglossales
 - *Botrychium* (grape fern)
 - *Ophioglossum* (adder's tongue)
 - each leaf consists of a blade and fertile segment
 - gametophytes subterranean, elongate, with rhizoids and endophytic fungi
 - gametophytes very different from other living ferns
 - Marattiales
 - ancient group extending back to Carboniferous
 - 6 living genera, 200 species
- homosporous, leptosporangiate ferns
 - Filicales
 - >10,500 species, 320 genera, 35 families
 - most familiar ferns
 - siphonostelic rhizomes
 - leaves/fronds/megaphylls
 - sori
 - free-living, bisexual gametophytes
 - prothallus
 - water required for sperm to swim to egg
 - sporophyte quickly becomes independent of gametophyte
 - a few species have persistent gametophytes
- heterosporous, leptosporangiate ferns
 - water ferns
 - Marsileales and Salviniiales
 - grow in mud or damp soil or water
 - *Azolla*
 - symbiotic with cyanobacteria
 - important for rice paddies
 - *Salvinia*
 - native species in this area
 - Giant *Salvinia* from South America
- Psilotales
 - *Psilotum*
 - whisk fern
 - native to this area
 - homosporous
 - bisexual gametophytes with symbiotic fungus
 - sperm require water to swim to egg
 - *Tmesipteris*
 - South Pacific
 - epiphyte

- Equisetales
 - horsetails
 - extend back to Devonian
 - maximum abundance 300 mya (Paleozoic)
 - calamites
 - *Equisetum*, 15 species
 - may be oldest surviving genus on earth
 - “horsetails” or “scouring rushes”
 - homosporous
 - gametophytes green, free-living, bisexual or male

Summary

- general characteristics of all vascular plants
- three types of steles
- evolution of leaves and roots
- homosporous vs. heterosporous
- characteristics of seedless vascular plants