

Gymnosperms
Chapter 18

Evolution of Plants

- bryophytes
- seedless, vascular plants
- seed plants
 - gymnosperms
 - angiosperms

Evolution of the Seed

- why are seeds advantageous?
- all seed plants heterosporous
- definition of seed
 - mature ovule containing an embryo
- ovule evolution
 - megaspore retained in megasporangium (nucellus)
 - number of megaspore mother cells reduced to one
 - only one of four megaspores survives
 - megagametophyte highly reduced, retained in megasporangium
 - embryo (young sporophyte) develops within megagametophyte
 - integument envelops megasporangium
 - apex of megasporangium modified to receive microspores (pollen grains)
- fossil record
 - unclear exact order of events above
 - oldest seeds from late Devonian (365 mya)
 - gradually integuments fused until only opening left at apex (micropyle)
- five phyla of seed plants with living representatives
 - arose in late Devonian, 365 mya
 - seed plants typically possess megaphylls
 - *Cyadophyta*
 - *Ginkgophyta*
 - *Coniferophyta*
 - *Gnetophyta*
 - *Anthophyta*

Progymnosperms

- Late Paleozoic
- in between trimerophytes and seed plants
- spores

- bifacial vascular cambium
- one group had eustele

Extinct Gymnosperms

- seed ferns (Pteridospermales)
- Cordaitales (conifer-like)
- cycadeoids (Bennettitales)

Living Gymnosperms

- Cycadophyta
- Ginkgophyta
- Coniferophyta
- Gnetophyta
- ovules and seeds exposed
- female gametophyte produces several archegonia
- fertilization
- no antheridia in seed plants
- sperm differ among groups
 - nonmotile in conifers and gnetophytes
 - more similar to seedless plants in cycads and ginkgo

Phylum Coniferophyta

- most numerous, most widespread, most ecologically important gymnosperms
- 70 genera, 630 species
- Late Carboniferous (300 mya)
- during Early Tertiary some genera more widespread
- leaves have many drought-resistant characteristics
- pines (*Pinus*)
 - 90 species
 - dominate many areas of N. America and Eurasia
 - cultivated in Southern Hemisphere
 - unique leaf arrangement
 - leaves adapted for low soil moisture
 - most species retain leaves for 2-4 years
 - bristlecone pines retain leaves up to 45 years
 - secondary xylem
 - xylem primarily tracheids
 - phloem primarily sieve cells
 - life cycle
 - two years to complete

- microsporangia and megasporangia borne on separate cones (strobili) on same tree
- microsporangiate cones
 - small (1-2 cm)
 - microsporocytes (microspore mother cells)
 - meiosis in early spring
 - immature male gametophyte
- megasporangiate (ovulate) cones
 - much larger, more complex, compound structure
 - seed scale complex
 - » ovuliferous scale with two ovules on upper surface
 - » subtending sterile bract
 - scales in spiral
 - ovule
 - » multicellular nucellus (megasporangium) that contains one megasporocyte (megaspore mother cell)
 - » massive integument with opening (micropyle)
- pollination
 - occurs in spring
 - scales on ovulate cone widely separated
 - pollination drops
 - pollen grain grows pollen tube into nucellus
 - about a month later, megaspores produced
 - one megaspore becomes megagametophyte
 - generative cell of male gametophyte undergoes division about 12 months after pollination
 - remember: no antheridia in seed plants
- fertilization
 - about 12 months after pollination
 - pollen tube reaches egg cell in archegonium
 - one sperm cell will fertilize egg
 - usually all eggs fertilized but only one embryo develops fully
- seed
 - two diploid sporophytic generations
 - one haploid gametophytic generation
 - seeds usually shed in fall of second year
- other important conifers
 - different life cycle from pines
 - only one year
 - Family Pinaceae
 - firs (*Abies*)
 - larches (*Larix*)
 - spruces (*Picea*)
 - hemlocks (*Tsuga*)
 - Douglas firs (*Pseudotsuga*)
 - Family Cupressaceae
 - cypress (*Cupressus*)
 - juniper (*Juniperus*)
 - Family Taxaceae

- yew (*Taxus*)
- Family Araucariaceae
 - Southern hemisphere
 - *Araucaria*
 - Panama pine: valuable timber in S. America
 - Monkey puzzle tree
 - Norfolk Island pine
- Family Taxodiaceae
 - bald cypress (*Taxodium*)
 - redwood (*Sequoia*)
 - much more widespread in Tertiary
 - tallest living plant: *Sequoia sempervirens*
 - *Metasequoia* (dawn redwood)
 - very important 90-15 mya
 - discovered remnant forest in China in 1948
 - not reproducing
 - seeds now planted all over world

Phylum Cycadophyta

- cycads: 11 genera, 140 species
- palmlike plants, mainly tropical and subtropical
- 250 mya during Permian
- abundant during Mesozoic
- only one species native to U.S.
 - *Zamia pumila*
- distinct trunk covered with leaf bases
- true secondary growth
- often highly toxic
- reproductive units
- pollination

Phylum Ginkgophyta

- one living member: *Ginkgo biloba* (maidenhair tree)
- fan-shaped deciduous leaves, dichotomously branching
- slow-growing tree
- changed little over 150 my
- unisexual plants

Phylum Gnetophyta

- 3 genera, 70 species
- *Gnetum*
 - 30 species

- trees, climbing vines
- large, leathery leaves
- moist tropics
- *Ephedra*
 - 35 species
 - branched shrubs with small, scalelike leaves
 - superficially resembles *Equisetum*
 - arid or desert regions
 - only genus of gnetophytes found in U.S.
- *Welwitschia*
 - exposed plant produces two leaves
 - most buried in sand
 - coastal desert of southwestern Africa
- share angiosperm-like features

Summary

- seed plants
- seed develops from ovule
- progymnosperms
- basic gymnosperm life cycle
 - pollination and pollen tube formation
- four phyla of living gymnosperms