

Evolution of the Angiosperms Chapter 20

Angiosperm Evolution

- in fossil record early in Cretaceous (at least 130 million years ago)
- dominated global vegetation by 90 million years ago
- modern families and genera by 75 million years ago

Chapter Outline

- Relationships of the angiosperms
- Origin and diversification of the angiosperms
- Evolution of the flower
- Evolution of fruits
- Biochemical evolution

Relationships of the Angiosperms

- Fossil record
- Phylogenetic analyses (cladistics)
- Two competing hypotheses
 - Could not have appeared before 225 mya

Origin and Diversification of Angiosperms

- Unique characteristics
 - Flowers
 - Closed carpels
 - Double fertilization leading to endosperm formation
 - 3-nucleate microgametophyte
 - 8-nucleate megagametophyte
 - Stamens with two pairs of pollen sacs
 - Sieve tubes and companion cells in phloem
- Derived from single common ancestor
- 3% of angiosperms are not monocots or eudicots
- magnoliids: leading to eudicots
 - magnolias, laurel family, pipevine family, spicebush family
- Small, isolated families arose prior to monocot-eudicot/magnoliid split
 - Waterlilies
 - Amborellaceae
- First angiosperm fossil
 - *Archaeofructus*
 - Seeds enclosed in carpels/fruits

- Stood in shallow water
- No sepals or petals

Evolution of the Flower

- Parts of the flower provide clues to angiosperm evolution
 - Perianth did not have distinct sepals and petals
 - Petals
 - modified leaves specialized for attracting pollinators
 - Or from stamens that became sterile
 - Often fuse to form tubular corolla
 - Sometimes stamens, sepals fuse too
 - Stamens diverse in structure and function
 - Some woody magnoliids: broad, colored, scented
 - Other archaic flowers: fleshy
 - Living flowers: usually filamentous stamens with thick, terminal anthers
 - Carpels of early angiosperms unspecialized
 - No stigma area
 - Not fused
 - Usually more ovules than contemporary families
- Four evolutionary trends among flowers
 - Few to many parts indefinite in number to few parts that are definite in number
 - Floral whorls often reduced from 4 to 3, 2 or 1; can't see spiral arrangement; parts often fused
 - Ovary from superior to inferior, perianth differentiated
 - Radial symmetry to bilateral symmetry
- Specialized families
 - Asteraceae
 - Eudicots, ~22,000 spp.
 - Small epigynous flowers bunched in head
 - 5 stamens usually fused to each other and corolla
 - 5 petals fused to each other and ovary
 - Sepals absent or pappus
 - Two flower types
 - Disk
 - Ray
 - Flowers mature in spiral pattern
 - Orchidaceae
 - Monocots, ~24,000 spp., 140 spp. native to US/Canada
 - 3 carpels fused, ovary inferior
 - Thousands of minute ovules/ovary
 - Usually only one stamen fused with style and stigma into column
 - Modified petals and sepals; bilaterally symmetrical
 - Huge range of size
 - Some saprophytic
 - Clone plants for commercial use
- Animals cause most floral evolution

- Co-evolution of plants and pollinators
 - Wind-pollinated vs. animal-pollinated
 - Closed carpel protects from herbivory
 - Bisexual flower more efficient
 - Promote consistency in type of visitor
 - Bees
 - Butterflies and diurnal moths
- Bird and bat pollinated flowers
 - Birds
 - Bats
- Wind pollinated flowers
- Floral pigments
 - Flavonoids
 - Anthocyanins
 - Flavonols
 - Carotenoids
 - Patterns differ depending on reflection

Evolution of Fruits

- Mature ovary
 - Simple, aggregate, multiple
 - Fleshy
 - Berries, drupes, pomes
 - Dry
 - Dehiscent, indehiscent
- Fruits/seeds evolved in relation to dispersal agents
 - Wind
 - Water
 - animal

Biochemical Coevolution

- Secondary metabolites
- Plant-herbivore co-evolution

Summary

- Success of angiosperms
- Archaic angiosperms
- Flower whorls evolved differently
- Pollination agents
- Fruit/seed dispersal agents
- Secondary metabolites