BIOLOGICAL DIVERSITY
CHAPTER 30: GREEN PLANTS (text)
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30.1 Defining Plants

- green algae and land plants shared a common ancestor
- plants are autotrophic
- fungi were important to the colonization of land by plants
  - increased plants' nutrient uptake from the ground

- Land plants evolved from freshwater algae
  - hard life conditions on land
  - green algae had two major clades
    - chlorophytes
    - charophytes
  - unlike charophytes, land plants have multicellular haploid and diploid stages
    - diploid embryos
    - over time, trend has been for embryo protection and smaller haploid stage in the life cycle
- Land plants have adapted to terrestrial life
  - cuticle: waxy covering secreted to the exposed surfaces to keep water inside of the plant
    - limits gas exchange required for respiration and photosynthesis
  - stomata: tiny, mouth-shaped openings responsible for gas diffusion into and out of the plant
  - tracheids: specialized cells that organize the transport of water and minerals
    - land plants can either have them, or not have them
    - tracheophytes have specialized cells
    - xylem: water transport
    - phloem: food transport
    - xylem and phloem have strands of tissue in the stems, roots, and leaves
  - all land plants have haploid and diploid generations
    - evolutionary shift between towards a dominant diploid generation allows for increased genetic variability in land plants
  - land plants have haplodiplontc life cycles
    - undergo mitosis after both gamete fusion and meiosis
    - results in multicellular haploid individual and a multicellular diploid individual
- The haplodiplontic cycle produces alternation of generations
  - land plants produce gametes by mitosis in a multicellular, haploid individual
    - diploid generation (sporophyte) alternates with the haploid generation (gametophyte)
  - diploid sporophyte produces haploid spores by meiosis
    - meiosis takes place in the sporangia, where diploid spore mother cells (sporocytes) undergo meiosis
      - each produces four haploid spores
      - spores are the first cells of the gametophyte generation
        - spores divide by mitosis and produce a multicellular, haploid gametophyte
          - source of the gametes

        - when gametes fuse, they create a zygote that is diploid and the first cell of the next sporophyte generation
        - zygote grows into a diploid sporophyte by mitosis and produces sporangia
            - meiosis ultimately occurs
- The relative size of haploid and diploid generations vary
    - haploid generation consumes a larger portion of the life cycle in mosses and ferns than it does in gymnosperms and angiosperms

30.2 Chlorophytes and Charophytes: Green Algae

- Charophytes are the closest relatives to land plants
    - charophytes: clade of streptophytes, also some green algae
        - closely related to land plants
        - haplontic life cycles
            - evolution of a diplontic embryo and haplodiplontic life cycle occurred after the move onto land

30.3 Bryophytes: Dominant Gametophyte Generation

- bryophytes are the closest living descendants of the first land plants
    - nontracheophytes: lack tracheid- specialized transport cells
    - mycorrhizal associations: tight symbiotic relationship between plants and fungi
        - enhanced water uptake
- Bryophytes are unspecialized but successful in many environments
    - most bryophytes are small
    - have conducting cells instead of tracheids for water and nutrients
    - liverworts, mosses, and hornworts
    - gametophytes are photosynthetic and more conspicuous than sporophytes
    - require water to reproduce sexually
    - usually found in moist places
- Liverworts are an ancient phylum
    - contain air chambers with upright branching rows of photosynthetic cells, each with a pore at the top to facilitate gas exchange
        - unlike a stoma (cannot close)
    - reproduction similar to mosses
        - asexual reproduction occurs when lens-shaped pieces of tissue that are released from the gametophyte grow to form new gametophytes
- Mosses have rhizoids and water-conducting tissue
    - gametophyte consists of small and leaf like structures
    - anchored into the ground by rhizoids: consists of cells that absorb water, but not nearly the amount of water taken in by a root (rhizoid is not a root)
    - moss leaf-like structures have little in common with leaves of vascular plants
        - lack vascular strands and stomata
        - all cells are haploid
- Hornworts developed stomata
    - among the earliest land plants, but the earliest fossil spores date from Cretaceous period (when angiosperms were emerging)
    - hornwort sporophytes resemble tiny green broom handles
        - rise from even smaller gametophytes (less than 2 cm)

- sporophyte has stomata for gas exchange, is photosynthetic, and usually has a single, large chloroplast

30.4 Tracheophyte Plants: Roots, Stems, and Leaves

- *Cooksonia* is the first known vascular plant, appeared ~420 mya

- Vascular tissue allows for distribution of nutrients
  - vascular tissues: efficient water and food conducting systems
    - consist of strands of cylindrical or elongated cells that form a network throughout a plant
    - extends from near the tips of the roots, through the stems, and to the leaves
    - two types of vascular tissue:
      - xylem: conducts water and dissolved minerals up from the roots
      - phloem: conducts sucrose and hormones throughout the plant
    - vascular tissues increases the height and size of tracheophytes
      - develops in the sporophyte, not gametophyte
  - cuticle and stomata are also characteristics of tracheophytes
- Tracheophytes include seven extant phyla grouped into three clades
  - three clades of vascular plants exist today
    - lycophytes (club mosses)
    - pterophytes (ferns)
    - seed plants
- Stems evolved prior to roots
  - fossils of early vascular plants show stems, but no roots or leaves
    - stunted the growth of plants
- Roots provide structural support and transport capability
  - true roots are only found in the tracheophytes
  - roots have a dual function
    - transport
    - support
  - roots have evolved at least two separate times
- Leaves evolved more than once
  - leaves increase surface area of the sporophyte
    - enhances photosynthesis
- Seeds are another innovation in some phyla
  - highly resistant structures well suited to protecting a plant embryo from drought and from predators
  - most seeds provide food for the growing plant
  - lycophytes and pterophytes do not have seeds

30.5 Lycophytes: Dominant Sporophyte Generation and Vascular Tissue

- earliest vascular plants lacked seeds
- lycophytes are the sister group to all vascular plants
- sporophyte stage is dominant stage
  - sporophytes have leafy stems that are seldom more than 30 cm long

30.6 Pterophytes: Ferns and Their Relatives

- Whisk ferns lost their roots and leaves secondarily
  - sporophytic generation consists of evenly forking green stems without roots