Section E: Pteridophytes: Seedless Vascular Plants

1. Pteridophytes provide clues to the evolution of roots and leaves
2. A sporophyte-dominant life cycle evolved in seedless vascular plants
3. Lycophyta and Pterophyta are the two phyla of modern seedless vascular plants
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Introduction

• The seedless vascular plants, the pteridophytes consists of two modern phyla:
  • phylum Lycophyta - lycophytes
  • phylum Pterophyta - ferns, whisk ferns, and horsetails
• These phyla probably evolved from different ancestors among the early vascular plants.
1. Pteridophytes provide clues to the evolution of roots and leaves

- Most pteridophytes have true roots with lignified vascular tissue.

- These roots appear to have evolved from the lowermost, subterranean portions of stems of ancient vascular plants.
  - It is still uncertain if the roots of seed plants arose independently or are homologous to pteridophyte roots.
• Lycophytes have small leaves with only a single unbranched vein.
  • These leaves, called microphylls, probably evolved from tissue flaps on the surface of stems.
  • Vascular tissue then grew into the flaps.

Fig. 29.24a
• In contrast, the leaves of other vascular plants, megaphylls, are much larger and have highly-branched vascular system.
  • A branched vascular system can deliver water and minerals to the expanded leaf.
  • It can also export larger quantities of sugars from the leaf.
  • This supports more photosynthetic activity.
The fossil evidence suggests that megaphylls evolved from a series of branches lying close together on a stem.

One hypothesis proposes that megaphylls evolved when the branch system flattened and a tissue webbing developed joining the branches.

Under this hypothesis, true, branched stems preceded the origin of large leaves and roots.

Fig. 29.22b
2. A sporophyte-dominant life cycle evolved in seedless vascular plants

- From the early vascular plants to the modern vascular plants, the sporophyte generation is the larger and more complex plant.
  - For example, the leafy fern plants that you are familiar with are sporophytes.
  - The gametophytes are tiny plants that grow on or just below the soil surface.
  - This reduction in the size of the gametophytes is even more extreme in seed plants.
Ferns also demonstrate a key variation among vascular plants: the distinction between homosporous and heterosporous plants.

A **homosporous** sporophyte produces a single type of spore.

- This spore develops into a bisexual gametophyte with both archegonia (female sex organs) and antheridia (male sex organs).
• A heterosporous sporophyte produces two kinds of spores.
  • Megaspores develop into females gametophytes.
  • Microspores develop into male gametophytes.
• Regardless of origin, the flagellated sperm cells of ferns, other seedless vascular plants, and even some seed plants must swim in a film of water to reach eggs.
• Because of this, seedless vascular plants are most common in relatively damp habitats.
3. Lycophyta and Pterophyta are the two phyla of modern seedless vascular plants

- *Phylum Lycophyta* - Modern lycophytes are relicts of a far more eminent past.
  - By the Carboniferous period, lycophytes existed as either small, herbaceous plants or as giant woody trees with diameters of over 2m and heights over 40m.
  - The giant lycophytes thrived in warm, moist swamps, but became extinct when the climate became cooler and drier.
  - The smaller lycophytes survived and are represented by about 1,000 species today.
• Modern lycophytes include tropical species that grow on trees as epiphytes, using the trees as substrates, not as hosts.

• Others grow on the forest floor in temperate regions.

• The lycophyte sporophytes are characterized by upright stems with many microphylls and horizontal stems along the ground surface.

• Roots extend down from the horizontal stems.
• Specialized leaves (sporophylls) bear sporangia clustered to form club-shaped cones.

• Spores are released in clouds from the sporophylls.

• They develop into tiny, inconspicuous haploid gametophytes.
  • These may be either green aboveground plants or nonphotosynthetic underground plants that are nurtured by symbiotic fungi.
• The phylum Pterophyta consists of ferns and their relatives.

• **Psilophytes**, the whisk ferns, used to be considered a “living fossil”.

• Their dichotomous branching and lack of true leaves and roots seemed similar to early vascular plants.

• However, comparisons of DNA sequences and ultrastructural details, indicate that the lack of true roots and leaves evolved secondarily.
• **Sphenophytes** are commonly called **horsetails** because of their often brushy appearance.

• During the Carboniferous, sphenophytes grew to 15m, but today they survive as about 15 species in a single wide-spread genus, *Equisetum*.

• Horsetails are often found in marshy habitats and along streams and sandy roadways.

*Fig. 29.21c*  
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• Roots develop from horizontal rhizomes that extend along the ground.

• Upright green stems, the major site of photosynthesis, also produce tiny leaves or branches at joints.
  • Horsetail stems have a large air canal to allow movement of oxygen into the rhizomes and roots, which are often in low-oxygen soils.

• Reproductive stems produce cones at their tips.
  • These cones consist of clusters of sporophylls.
    • Sporophylls produce sporangia with haploid spores.
• **Ferns** first appeared in the Devonian and have radiated extensively until there are over 12,000 species today.
  
  • Ferns are most diverse in the tropics but are also found in temperate forests and even arid habitats.

• Ferns often have horizontal rhizomes from which grow large megaphyllous leaves with an extensively branched vascular system.
  
  • Fern leaves or fronds may be divided into many leaflets.
• Ferns produce clusters of sporangia, called sori, on the back of green leaves (sporophylls) or on special, non-green leaves.

• Sori can be arranged in various patterns that are useful in fern identification.

• Most fern sporangia have springlike devices that catapult spores several meters from the parent plant.

• Spores can be carried great distances by the wind.

Fig. 29.24a, b
4. Seedless vascular plants formed vast “coal forests” during the Carboniferous period

- The phyla Lycophyta and Pterophyta formed forests during the Carboniferous period about 290-360 million years ago.

- These plants left not only living representatives and fossils, but also fossil fuel in the form of coal.

Fig. 29.25
• While coal formed during several geologic periods, the most extensive beds of coal were deposited during the Carboniferous period, when most of the continents were flooded by shallow swamps.

• Dead plants did not completely decay in the stagnant waters, but accumulated as peat.

• The swamps and their organic matter were later covered by marine sediments.

• Heat and pressure gradually converted peat to coal, a “fossil fuel”.

• Coal powered the Industrial Revolution but has been partially replaced by oil and gas in more recent times.

• Today, as nonrenewable oil and gas supplies are depleted, some politicians have advocated are resurgence in coal use.

• However, burning more coal will contribute to the buildup of carbon dioxide and other “greenhouse gases” that contribute to global warming.

• Energy conservation and the development of alternative energy sources seem more prudent.