

## Chapter 14. **Pteridophytes: Ferns & allies**

# The Ferns: Pteridophytes

## **PTERIDOPHYTES** (Ferns and fern allies)

**General physiognomy.** The Pteridophytes (Ferns and fern allies) are vascular plants. Most of them have leaves (known as fronds), roots, and sometimes true stems or trunks as in the tree ferns. Most true ferns show vascularized rachises (frond stems), pinnately or fractally-compound fronds, and sori (spore clusters) arranged along the underside of each frond segment. Fronds in the largest species of ferns can reach more than a meter in length. Many ferns from tropical rain forests are epiphytes, which means they only grow on other plant species and their water supply comes from the damp air or from rainfall running down branches and tree trunks. Although true ferns are always leafy, some fern allies such as the horsetails (*Equisetum arvense*) may have very reduced leaves and photosynthetic stems. There are also floating aquatic ferns such as the water fern (*Salvinia molesta*) and mosquito ferns (*Azolla* spp.).

**Vegetative morphology.** Small to medium-sized ferns in California develop from a usually short underground rhizome. Fronds are divided into many small segments (pinnules) attached to a tough, often wiry, rachis and stipe (frond stems), with pinnately to many times compound (fractal) fronds, and sori (spore clusters) arranged along the underside of each frond segment. In most ferns, leaves grow from apical cells in the tip of the frond, and these delicate embryonic cells are protected by hairs or scales and by the curled-over spiral of the unrolling leaf tip, which gives fern fronds a typical spiral curl shape at their tip. When the blade formation is complete, there is no longer an embryonic tip and the spiral leaf tip disappears.

**Reproductive morphology.** Leafy ferns reproduce by microscopic spores borne in spore sacs (sporangia) arranged into sori (brown patches) on the backside of the fronds (in some fern allies, such as the horsetail ferns, the sporangia may be housed in terminal cone-like strobili at the tip of the stems). Each sorus consists of several to numerous tiny spore sacs that follow the under edge of each frond pinnule. The edges of pinnules often curl under to protect the young sori until spores mature and are ready to be shed. The mature, microscopic brown or black spores are released from their spore sacs into the air where, because of their microscopic size, they may float for long periods of time, allowing the wind to move them long distances into new habitats.

**Life cycle.** Ferns have a life cycle referred to as “alternation of generations”, characterized by two alternating phases. The large, leafy ferns we normally see are diploid individuals with two sets of chromosomes ( $2n$ ), where the basic number of chromosomes ( $n$ ) varies from species to species. Diploid ferns (known as the “**sporophyte**” phase of the life cycle) produce haploid spores by **meiosis** (a process of cell division which recombines the chromosome pairs and then reduces the number of chromosomes by a half). This process —recombination and reduction— occurs in the **sori** under the fronds. The sori are pustule-like structures that contain microscopic cup-like structures, the **sporangium**, from where haploid **spores**, with only  $n$  chromosomes, are released.

The haploid spores are extremely light, like pollen grains, and may fly long distances suspended in the air. Eventually, if they fall in an environment with the right characteristics, spores germinate and produce a small, haploid plant known as the **prothallus**. Prothalli are small, short-lived, heart-shaped structures, typically 2-5 millimeters wide, with a number of rhizoids (root-like hairs) growing underneath. The fern prothalli are free-living organisms: Some are green and can conduct photosynthesis while others lack chlorophyll and nourish themselves from decomposing organic matter in the forest understory. Once established, the prothalli develop the sex organs of the fern by simple cell

division: (a) the ovule-producing **archegonium** (female) and (b) the sperm-producing **antheridium** (male).

Because this haploid phase of the fern life-cycle yields gametes (ovules and sperm) it is known as the "**gametophyte**". In the prothallus's antheridium, mobile, flagellate sperm is produced, which moves into the archegonium and fertilizes the egg. The fertilized egg is now a diploid ( $2n$ ) embryo (or **zygote**) and grows by simple cell division (mitosis) into a new diploid sporophyte (the typical leafy fern plant), which re-initiates the cycle.

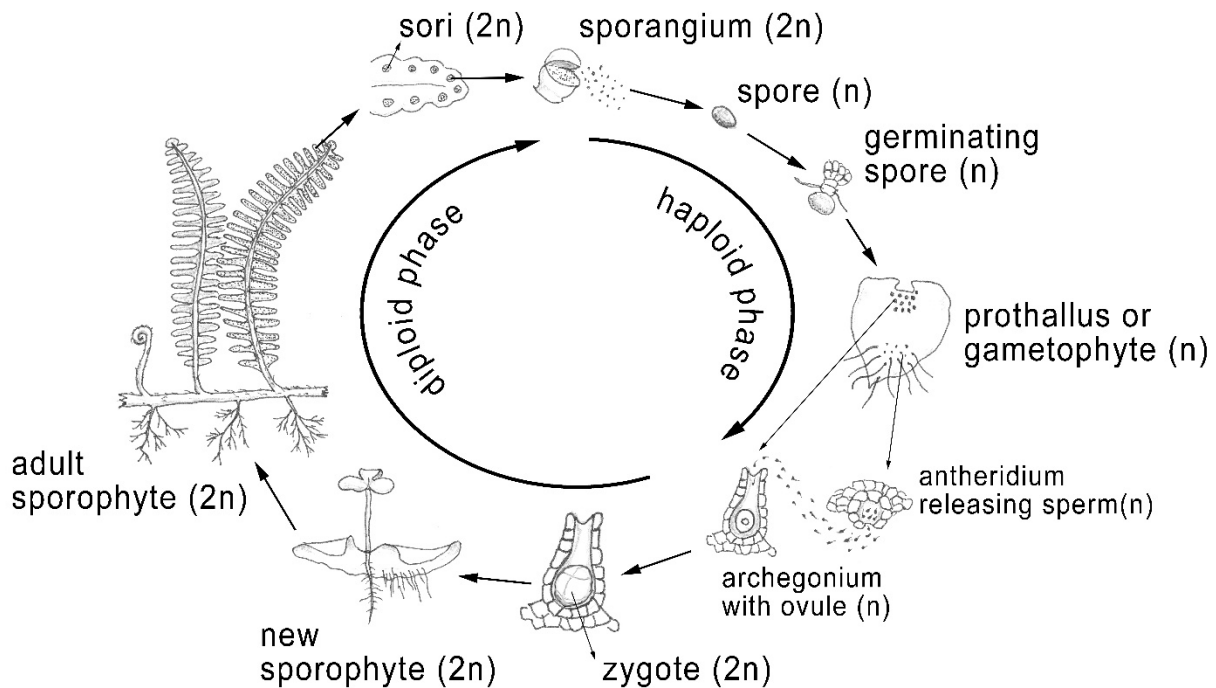
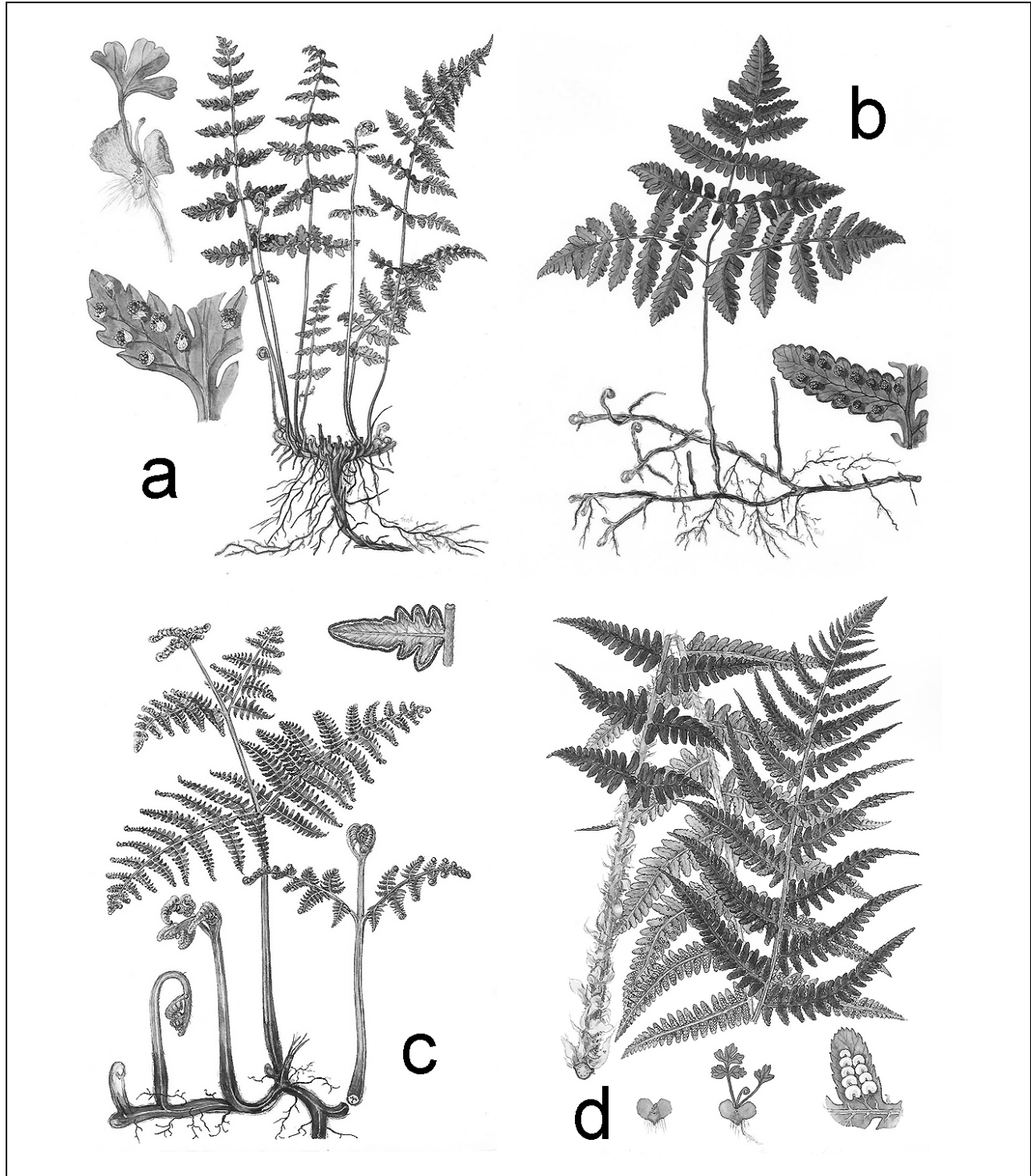


Figure 1. The fern life-cycle.

**Taxonomic relationships.** Because of reproduction by spores from sori (or terminal strobili in horsetail ferns), ferns really are not likely to be confused with any seed-bearing plant family. There are, however, many different fern families, several of which are native to California. Although a detailed description of the fern families is beyond the scope of these course notes, some life forms of fern allies should be mentioned, apart from the typical frond-bearing plants.

The **whisk ferns** (*Psilotum* spp., family Psilotaceae) are very simple, primitive plants with green stems but no fronds. The **quillworts** (Isoetaceae) are mostly aquatic or semi-aquatic plants with simple, linear leaves that are hollow and quill-like arising from a central corm. The **clubmosses** (*Selaginella*, division Lycophyta) represent the oldest division of vascular plants (ca. 410 million years old); their leaves are small and have only a single vein rather than the much more complex fronds in true ferns. The **water ferns** (families Salviniaceae and Marsiliaceae) are strictly aquatic and do not look particularly fern-like; the salvinias are natant, or floating, plants, while the marsilias are rooted and their three-foliated leaves look very much like those of a clover. Finally, the **horsetails** (*Equisetum*, family Equisetaceae) represent a "living fossil"; that is, the only living genus in a Paleozoic plant family that is now otherwise extinct. Their characteristic leaves arranged in whorls around the nodes of green, hollow, ridged stems makes the group quite distinct from all other plants.



**Ferns-at-a-glance:** Vascular plants with leafy, pinnately or fractally-compound fronds, and sori (spore clusters) arranged along the underside of frond segments. True ferns in California develop from a usually short underground rhizome, from where the frond rachis grows. Depicted, four ferns from the California sierras: (a) Bladder fern *Cystopteris fragilis*, (b) oak-fern *Gymnocarpium dryopteris*, (c) braken *Pteridium aquilinum*, and (d) male-fern *Dryopteris filix-mas* (illustrations modified from *Scandinavian Ferns* by B. Øllgaard and K. Tind, Rhodos, 1993).

**Biodiversity and distributions.** Ferns differ from the rest of the vascular plants (angiosperms and gymnosperms) in that they do not have seeds or flowers; they reproduce via spores, like mosses. Once the dominant lifeform on earth (during the Jurassic and the Cretaceous periods), now there are around 12,000 species of Pteridophytes globally. Because of the ability of spores to fly in the air for very long distances carried by prevailing winds, many ferns, such as the bracken or the common horsetail, are among the most widely distributed and cosmopolitan of plants.

**Economic uses and ethnobotany.** Ferns are not as important economically as seed plants but have considerable importance in some societies. Fiddleheads are the furled fronds of young ferns harvested for use as vegetables. The name “fiddlehead” derives from the resemblance the developing frond tip has to the curled ornamentation on the end of stringed instruments such as a violins. Many ferns are used as medicinal plants in traditional medicine throughout the world. Many ferns are grown in horticulture as landscape plants, for cut foliage and as houseplants. Perennial ferns are often planted in gardens. Tropical tree ferns are often cut to cut the fibrous vascular tissues of their stems as a growth medium for orchids in plant nurseries. Ferns have been found to be useful in the removal of heavy metals, especially arsenic, from contaminated soils. Ferns are generally not poisonous to humans and many species are edible.

**California genera and species.** The group of ferns and fern allies comprises nine families and some 30 species in southern California. Some of the most common ones are the following:

*Pentagramma triangularis* (golden-back fern) – Common in shady, dry, rocky locations in canyons and hillslopes throughout Southern California. Small sori under the frond’s pinnules turn golden-brown in color.



*Equisetum arvense* (horsetail) – Common throughout our region, with both branched, sterile stems and unbranched, fleshy stems bearing the sporangia. Dies back in late summer, to return next spring from underground rhizomes.



*Azolla filiculoides* (mosquito fern) – Tiny, floating annual water-fern of the family Salviniaceae that often covers the surface of fresh-water reservoirs aiding in mosquito control. It dies back in fall, after reproducing in spring and summer by spores.

