

BIOLOGY OF NONVASCULAR AND LOWER (SEEDLESS) VASCULAR PLANTS

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With the exception of algae, including seaweeds, all of the organisms that are considered weeds are in the plant kingdom (Kingdom Plantae). Organisms in the plant kingdom can be divided into four categories, each of which includes several Divisions (Phyla):

1. Nonvascular plants (3 divisions)
2. Seedless vascular plants (4 divisions)
3. Gymnosperms (plants with “naked seeds”, 4 divisions)
4. Angiosperms (flowering plants, 1 division)

These four categories are thought to have evolved in the numerical order presented, with nonvascular plants being the most ancient and flowering plants being the most recent to evolve. Within each of the four groups, each division contains anywhere from one to several hundred plant families and each family contains a few to several tens of thousands of plant species. Most weeds are angiosperms, occurring in the single division Anthophyta. However, a few plants in the nonvascular and seedless vascular plant categories can be weedy, as well.

One of the distinguishing features of members of the plant kingdom is a life cycle that includes alternation of generations. That is, during the life cycle of each individual, there is a diploid (2N) stage (sporophyte) and a haploid (N) stage (gametophyte). Over the course of evolutionary time, the diploid stage has come to dominate the plant life cycle so that in angiosperms, the recognizable plant is the diploid stage while the inner organs of flowers comprise the very reduced haploid stage. In the most ancient plants, the nonvascular plants, however, the recognizable plant is haploid and the diploid stage is very small and attached to the haploid stage. Regardless of which stage (haploid or diploid) dominates, in all plants the life cycle consists of the following events—the sporophyte produces haploid spores, which grow into the gametophyte; the gametophyte produces gametes (egg and sperm), which fuse to produce a zygote, which grows into the sporophyte. Spores are very different from gametes (which can fuse) and seeds (which contain embryonic plants). Although they are not particularly hardy, spores are dispersed from the plant and can contribute to its spread.

Haploid organisms have only one copy of each gene and do not possess the level of variation or ability to adapt to a diversity of environments that diploid organisms have. Nonvascular plants also, by definition, have no vascular tissue and therefore cannot transport water or carbohydrates throughout the plant body. While some nonvascular plants are distributed worldwide, they are nevertheless very small and limited in the range of environments they can occupy.

Nonvascular Plants

There are three divisions of nonvascular plants—mosses (Division Bryophyta), liverworts (Division Hepatophyta, named for the resemblance of some to small livers), and hornworts (Division Anthocerotophyta, named for the horn-like appearance of their reproductive structures). Nonvascular plants have no vascular tissue and no organs (stems, roots, leaves, or flowers). Although some appear to have leaves, these are not true leaves because they possess no vascular tissue; rather they are just outgrowths of tissue from the main axis of the plant. Nonvascular plants have no roots; instead, they are lightly anchored to the soil with rhizoids (tissue outgrowths from the base of the plant). These plants consist of parenchyma (generalized) cells, meristems (where cell division occurs), and a cuticle on their top surfaces. In the life cycle the gametophyte is the dominant stage while the sporophyte is very small and

not free-living. The gametophyte is perennial, photosynthetic, and can reproduce asexually (without sexual recombination) by vegetative tissue fragments.

There are over 9,500 species of mosses and they are found throughout the world. Mosses can be one of three types—peat mosses (*Sphagnum*), granite mosses, and leafy mosses. Peat mosses are found covering vast acreages in the northern hemisphere where they are harvested for fuel and other commercial uses (including planting mixes). Granite mosses are found at high elevations and are less common than the other two types. Leafy mosses are found throughout the world and in some situations, such as in greenhouses and landscapes, they can be weedy. Like mosses, liverworts are also very small plants. There are approximately 6,000 species of liverworts in the world and all are one of two types—liver shaped (thallose) or leafy. Some liverworts, like some mosses, are weedy in greenhouses, where they can be found growing on the surface of the potting medium. Hornworts are extremely rare and rarely encountered.

Seedless Vascular Plants

There are four divisions of seedless vascular plants, also called lower vascular plants to reflect their less complex anatomy and morphology relative to seed plants (gymnosperms and angiosperms, also called higher vascular plants). These divisions include the whisk ferns (Division Psilophyta), club mosses (Division Lycophta), horsetails (Division Arthrophta), and ferns (Division Pteridophyta). Seedless vascular plants arose on land approximately 420 to 500 million years ago as the first vascular plants and are thought to be ancestral to seed plants. In addition to vascular tissue (xylem, which transports water, and phloem, which transports carbohydrates), as a group they possess true stems, roots, and leaves (but no flowers or seeds). In the life cycle of seedless vascular plants the sporophyte is the dominant stage while the gametophyte is very small and free living. The sporophyte is perennial, photosynthetic, and can reproduce asexually.

Whisk ferns are the simplest of the seedless vascular plants, possessing only stems, rhizomes, and sporangia (structures in which spores are produced). They have no true roots or leaves; rather they have rhizomes and leaf-like structures that are just tissue outgrowths from stems. This small division consists of one family and two genera, the most well-known of which is *Psilotum*. Species of this genus grow in the gulf coast states and Hawaii. Club mosses are somewhat more advanced than whisk ferns, possessing stems, rhizomes, sporangia in cones, and true roots (but no true leaves). The most well-known of the three genera in this division is *Selaginella*, some species of which can be weedy in greenhouses. In the Division Arthrophta are the horsetails, which all occur in one family and one genus of 15 species, *Equisetum*. These plants have stems, rhizomes sporangia in cones, roots, and true leaves (although the leaves are quite small in some species). *Equisetum* plants are known for the high levels of silica in their stems, which give them an abrasive feel and resulted in their use by indigenous people for scouring purposes. These plants can be weedy in some situations.

Ferns are the most advanced and most numerous of all the seedless vascular plants. As a group ferns possess all the plant organs except flowers (stems, roots, and leaves), although in many ferns the stem is not elongated and upright. All ferns are herbaceous and perennial. In most ferns the sporangia are located in clusters (sori) on the underside of the leaves in distinctive patterns, such as rows. There are over 10,000 species of ferns in existence today and they grow around the world in many different habitats. Some ferns, such as bracken fern, can be very weedy.

Summary

Nonvascular and seedless vascular plants are botanically and evolutionarily important. Nonvascular plants represent the simplest and the earliest to evolve land plants. Seedless

vascular plants, as a group, represent the steps in evolution from the very simplest vascular plants to the most highly advanced seed plants that possess all the true plant organs—stems, roots, leaves, and in angiosperms, flowers. Although a few of the plants in these two categories can be weeds under certain circumstances, most are an integral part of their natural landscape and do not escape, spread, or cause adverse effects on human activities.