The Lower Vascular Plant Divisions
The Fern Allies

Introduction

The vascular plants are divided artificially into two major groups, the seedless (or spore-dispersing) vascular plants and the seed plants. There are four major divisions of seedless vascular plants: Psilophyta, Lycophyta, Sphenophyta, and Pterophyta. The first three divisions, often referred to as the "fern allies" , have few living representatives although they are well represented in the fossil record. All of the vascular plants have a dominant sporophyte generation, and a reduced, often, dependent gametophyte stage.

Exercise A
Psilophyta: The Whisk Ferns

The Psilophyta are represented by two living genera, *Psilotum* and *Tmesipteris*, both of which have very simple sporophytes.

Examine the living specimens and herbarium specimens of *Psilotum* . *Psilotum* is unique among living vascular plants because it lacks both vascular roots and leaves. Only the stem is vascular. The scalelike structures along the stem are called **enations**.

Note the dichotomous (forking) branching pattern of the aerial portion of the plant body. The below-ground portion of the plant axis is a rhizome (an underground stem) bearing rhizoids for the absorption of water.

Note the three-parted sporangia, which are borne on short side branches. *Psilotum* is homosporous; that is, it produces only one type of spore. Although *Psilotum* is homosporous, the gametophytes are bisexual; both archegonia and antheridia are produced on the same gametophyte. The non-photosynthetic gametophytes develop in association with mycorrhizae.

Tmesipteris is an epiphyte that grows on tree ferns and other plants.

Exercise B
Lycophyta: The Lycophytes

The living representatives of the Lycophyta are all relatively small plants, with true roots, true stems, and true leaves. The leaves are microphylls, having just one vascular connection or vein. The fossil members of this division, however, include many woody, treelike forms (the Lepidodendrids), which numbered among the dominant plants of the coal-forming forests of the Carboniferous period.

Examine the living specimens and herbarium specimens of *Lycopodium* and *Selaginella.* Identify the roots, stems, and leaves (microphylls) of these genera. *Selaginella* species are common in both temperate and tropical rain forests, although it is frequently confused with mosses. Some species of *Selaginella*, including the "Resurrection plant", are found in very dry habitats. *Lycopodium* species grow in many wooded areas throughout temperate ecosystems.

Examine the preserved, or herbarium specimens of *Isoetes*. Although the leaves of *Isoetes* are much larger than those of *Lycopodium* and *Selaginella*, they are still microphylls. In *Isoetes*, the leaves are attached to a cormlike structure (a fleshy stem). *Isoetes* is aquatic.

The sporangia of the Lycophyta are borne on leaves which are very similar to the sterile (non sporangia-bearing) leaves of the plant. The sporangium-bearing leaf is called a sporophyll. In *Selaginella* and in most species of *Lycopodium*, the sporophylls occur in compact aggregates called cones, or strobili. Examine the strobili on the specimens provided. In *Isoetes* , sporangia arise at the bases of the leaves, with a single sporangium per leaf.

Lycopodium is homosporous, producing one type of sporangium. Observe the prepared slide of *Lycopodium* strobilus and locate the sporangia. The gametophytes produce both archegonia and antheridia.

Selaginella and *Isoetes* are heterosporous. They produce two types of sporangia: megasporangia (female) and microsporangia (male). Spores develop into either female gametophytes (which produce archegonia) or male gametophytes (which produce antheridia). Observe the prepared slide of the *Selaginella* strobilus. Locate the larger megasporangia and the smaller microsporangia. Compare the strobilus of *Selaginella* with the strobilus of *Lycopodium*.

It is exceedingly rare to find gametophytes of the Lycophyta. Most are subterranean and very tiny. However, sporophyte plants develop from the gametophyte structure so that whenever you find a sporophyte plant, you can be assured that a gametophyte was once there. (Once a sporophyte plant becomes established, the gametophyte degenerates.)

Exercise C
Sphenophyta: The Horsetails

Although once a very abundant and diverse group of plants, the Sphenophyta today are represented by a single herbaceous genus, *Equisetum*.

Examine the living and herbarium specimens of *Equisetum*. The sporophyte of *Equisetum* differs from that of the other fern allies in having jointed and ribbed stems with the leaves (microphylls) arranged in whorls at nodes.

Feel the coarse texture of the stems. The stems of *Equisetum* contain silica. Note that the stems, rather than the leaves of *Equisetum* are photosynthetic.

Examine the cones or strobili on the specimens provided. The sporangia are borne on umbrella-like structures called sporangiophores, rather than on sporophylls.

Examine the prepared slide of the *Equisetum* strobilus. Is *Equisetum* homosporous or heterosporous?

Examine the prepared slide of *Equisetum* spores. Note that four threadlike structures, called elaters, surround each spore. The elaters, which are sensitive to humidity changes, are used to disperse the spores. When the sporangium breaks open, the sudden change in humidity causes the elaters to uncoil which "whips" the spore out of the sporangium to be carried by air current to a new location. The gametophytes of *Equisetum* are green, free-living, and bisexual.