VASCULAR PLANT MORPHOLOGY

LABORATORY 5

Class Sphenopsida

Species of this class are characterized by having articulated or jointed stems that bear whorled branches and leaves. The fertile structures of the sporophyte are usually aggregated into terminal strobili and consist of a stalked, peltate **sporangiophore**. Each sporangiophore bears several sporangia on the under surface, and the sporangia are **recurved** back toward the stem or cone axis. In some of the fossil members, whorls of sporangiophores alternate with whorls of leaves (called bracts in this instance), but in *Equisetum* the cone contains only sporangiophores. Probable sphenopsids are known from the Upper Devonian, but the class reached its zenith during the Carboniferous Period. Some of the fossil forms were arborescent and reached heights of twenty meters or more. Some of the extinct forms were heterosporous, and one species produced seed analogues with only one functional megaspore per sporangium. *Equisetum*, however, is homosporous. Of the various orders generally recognized in the Sphenopsida, we will deal with only one in laboratory, the Equisetales.

Order Equisetales

Genus *Equisetum*

Equisetum is the sole living genus of the Sphenopsida. About 15 species are recognized in The Flora of North America, and these occur in wide range of habitats.

General Features of Sporophytes

Examine fresh or preserved material of *Equisetum hyemale* and note the aerial stems with sheaths of small, scale-like leaves at the nodes. This species produces only one type of aerial stem, which is both photosynthetic and bears terminal cones. Cones may or may not be present.

Examine material of *Equisetum arvense*, a species that is often found along railroad right-of-ways. This species produces aerial branching systems of two types; i.e., the branching is dimorphic. Very early in the spring, brownish fertile stems break through the soil and bear terminal cones. These cones are made up of sporangiophores, and the fertile stems are ephemeral. Later in the spring, the same rhizomes produce green, vegetative branching systems. These systems have whorls of scale leaves, and branches of several orders arise in whorls.

Draw one of the *Equisetum* species, preferably one with dimorphic branching.

Anatomy of the Stem

The stem of *Equisetum* contains very little vascular tissue and is entirely primary, even in the tropical forms that often reach 20 feet in height. Examine a stem longitudinal section to see the intercalary meristems, that are responsible for most of the elongation of the stem. Examine a cross-section of a stem and locate a ring of large canals in the cortex. These are the **vallecular canals**. An additional ring of canals is present deeper within the stem. These are smaller in diameter and mark the position of the first-formed xylem, or protoxylem, that became disorganized as the stem elongated after the cells matured. The resulting canals are called **carinal canals**. Metaxylem cells can be seen just outside of the carinal canals-- two groups of cells per vascular bundle. These xylem cells flank a region of primary phloem.

Note that each vascular bundle is opposite a ridge on the outer surface of the stem. These ridges mark the location of sclerenchyma tissue in the cortex. The vallecular canals alternate in position with the carinal canals, a vallecular canal occurring opposite each of the furrows on the outer surface of the stem. Stomata generally occur in the furrows and are sunken below the surface. In most species the central portion of the stem (pith) becomes hollow in the internodes. Diagram the cross- section of the stem. Examine transverse sections of rhizomes and roots. How are they similar in anatomy to the stem?

Structure of Strobilus

Examine a longitudinal section through a cone that shows the structure of the cone units. Each of these units is a sporangiophore consisting of a stalk attached to the cone axis, a terminal fleshy head and a number of sporangia. The sporangia are pendant from the head, where they are attached to its inner surface and extend horizontally from the head toward the stem. These sporangia may be described as being recurved toward the stem. Note that the cone is homosporous and that the sporangia are relatively massive. Diagram a portion of this longitudinal section of the cone.

Using either fresh or preserved cone material, dissect out a single sporangiophore. Note the appearance of the outer fleshy head. How are the sporangia arranged? What type of symmetry does this cone unit have? Does this appear to be a type of sporophyll? Draw the isolated sporangiophore.

Crush a sporangium onto a microscope slide. Note that the spore body is surrounded by coiled appendages called **elaters**, that are formed as thickenings of the spore wall. As the spores dry out, the elaters will snap open violently, and the spores will separate and partially disperse. Would these elaters seem to have some adaptive advantage?

Gametophyte Phase

The gametophytes of *Equisetum* are potentially bisexual, but sequential development of the antheridia and archegonia generally ensures cross-fertilization. The mature gametophyte is lobed, green, and about 1/4 inch in diameter. Rhizoids anchor the plant to the substrate. Look at the gametophytes of *Equisetum* that are illustrated by Eames (1936; Page 100). How many sporophytes are produced by a single gametophyte. What does this suggest about the ancestral life cycle of vascular plants?

Life Cycle Exercise

Go to the “Equisetum Life Cycle” flash video on the course web site, and check to see how well you understand this plant.