

VASCULAR PLANT MORPHOLOGY

LABORATORY 8

Order Cycadales

The living cycads are naked seeded plants (gymnosperms) that are often associated with several extinct groups such as the seed ferns, cycadeoids, and some lesser groups. Members of this class have seeds that are foliar, i.e., borne on the leaf. In addition, most have relatively little secondary vascular tissue production (in contrast to the conifers and their allies) and the stem has much parenchyma with a broad cortex and large pith area. The secondary xylem is very parenchymatous with broad rays and relatively few tracheids in comparison with the conifers. This type of secondary wood is described by the term **manoxylic**, while the more compact appearing secondary wood of the conifers is termed **pycnoxylic**.

Some authors recognize up to three families of cycads, but for the purposes of this course we will consider them all to belong to the Cycadaceae. The living genera of Cycadales with their number of species and geographical distribution are listed below.

Cycas (25 spp.) India, Madagascar, Australia, Burma and islands in the Indian and Pacific Oceans

Encephalartos (12 spp.) East and South Africa

Stangeria (1 sp.) South Africa

Macrozamia (14 spp.) East Australia

Bowenia (2 spp.) East Australia

Zamia (35 spp.) South and Central America

Dioon (3 spp.) Mexico, Florida

Ceratozamia (6 spp.) Mexico

Microcycas (1 sp.) Cuba

Lepidozamia (1 sp.) Australia

Chigua (1 sp.) South America

Habit and Overall Appearance

Examine material of such representative genera as *Zamia*, *Cycas* and *Macrozamia*. Note the fernlike leaves, thick foliar areas with coriaceous texture, and the overall form of the stem. How would you describe the shape of the *Zamia* stem?

The plants may or may not have cones. In the Cycadales, the plants are monosporangiate, i.e. the condition present is dioecy, and cones are either pollen (microsporangiate) or seed (megaspore) producing types on a given plant. Sketch the overall habit of a typical plant.

Examine the vegetative leaf of *Cycas*. How does it compare to the leaves of ferns, seed ferns and cycadeoids? Now examine a section through the petiole of a typical cycad. You may either cut a section of the *Cycas* petiole or examine a prepared slide. If you do both, note how they compare. Note the thickness of the Sclerenchyma areas and the somewhat xerophytic structure. Vascular strands in the leaves are generally mesarch, a fernlike feature. Stomata can be seen on the petiole as well as great deal of sclerenchymatous tissue. Diagram a portion of a *Zamia* petiole.

Obtain a transverse section of a *Zamia* stem. Note the broad cortex, the relatively large pith in the center, and the ring of vascular bundles. These bundles are separated by rays of parenchyma. Each bundle is collateral with an inner xylem, a cambium and an external zone of phloem. Are secondary tissues present? Are they abundant? You may also find mucilage ducts in the cortex and small vascular strands to the leaves (leaf traces). What type of primary xylem development is present? Diagram the transverse section of the stem.

Megasporophylls

Among the living cycads, the genus *Cycas* has what is apparently the most unspecialized megasporophylls. These are very leaf-like in appearance. Examine a megasporophyll of this genus and locate the ovules, which are present in two rows along the opposite sides of the lower part of the sporophyll.

Now examine a megasporophyll of a form such as *Zamia*, which apparently represents the most highly modified type. The distal part of the sporophyll now consists of a fleshy peltate head which bears a pair of ovules on its inner surface. These are oriented so that the micropyles face the cone axis. Note also the narrow stalk of the sporophyll. Sketch these representative megasporophylls.

Megasporangiate cone

Examine a megasporangiate cone of *Zamia*. Note how the megasporophylls are closely appressed about the cone axis and that the ovules are enclosed and hidden from sight. Examine partial transverse sections of young *Zamia* megasporangiate cones. Note the developing ovules. Sketch the cone.

Microsporophylls

Examine an intact microsporangiate cone of *Zamia*. Compare it to the megasporangiate cone. How does it differ? Of what is it composed? Sketch this microsporangiate cone.

Obtain an isolated piece of cone having several microsporophylls. Note the overall form of the cone units, and the numerous microsporangia on the lower surfaces of the microsporophylls. Examine the sporangia with a binocular dissecting scope. How do they compare in size with those of the ferns you have studied? Do they appear to be of the lepto- or eusporangiate type? What is produced in these sporangia? What are the sporangia sometimes called? Draw a typical microsporophyll as it appears from the lower surface. Examine transverse section of young microsporangiate cones noting the sporangium wall thickness and the vascular pattern of the axis.

Obtain a relatively young megasporophyll or isolated ovule of *Zamia*. Locate the micropylar end and the micropyle. Cut the ovule to produce a median longitudinal section. Locate the megasporangium or nucellus which has pulled away from the integuments in the area of the micropyle. You should be able to see the relatively colorless and gelatinous appearing megagametophyte which may be removed easily from the ovule.

Examine a relatively old ovule. Prepare a median longitudinal section. You should be able to locate the outer layers of the integuments which are fleshy, an inner portion of the integument which is

hard or stony, and a large, relatively light colored megagametophyte. In the micropylar region of the megagametophyte you may see several large hollow areas; these are the archegonia whose contents were plasmolyzed by the preservative. You may also see the relatively disintegrated micropylar end of the nucellus where the pollen tubes and microgametophytes are developing. Is this a pollen chamber? Note also how the nucellus has developed a tent-pole like appearance in this area.

Now obtain a prepared slide of a longitudinally sectioned ovule. Locate the megagametophyte and nucellus. Locate also the integuments. You should be able to see vascular strands in this tissue. At the micropylar end of the gametophyte you will see one or more large, elliptical appearing archegonia. Note that the archegonium has a wall made up of relatively small cells in contrast to the typical cells of the lower part of the gametophyte. Note also that a neck is present, but is very much reduced, at the micropylar end of the archegonium. You may also see the nucleus of the egg near the archegonial neck. The cytoplasm of the egg fills the archegonium.

Examine the nucellus in the region where it is tapered toward the micropyle. Within the nucellar tissue you will see developing pollen tubes which often appear as hollow channels. Nuclei of the microgametophytes may also be visible. How complex is the mature microgametophyte of a typical cycad? Diagram this longitudinal section of the ovule. Now examine the demonstration slide that shows a pollen grain with a microgametophyte in the stage of development where blepharoplasts are present. Draw this microgametophyte and review its development.

In cycads the development of the microgametophyte is very slow, and about 4 to 6 months pass from the time of pollination until the time of fertilization. During this time the megagametophyte develops and the archegonia and eggs are produced. The cycads have relatively massive motile sperm, which are visible with the naked eye in living material. Two sperm, which are somewhat top-shaped are produced per microgametophyte.

Embryonic Sporophyte and Seed Germination

Examine a prepared slide of a longitudinal section showing an early stage in the development of the embryonic sporophyte. This is the so-called proembryo. Note the cavity in which the embryo is developing and how the growing area of the embryo is directed downward into the surrounding megagametophyte. Why is this gametophyte often referred to as an endosperm?

Cycad seeds germinate in a fashion that is similar to most other seed plants. The radicle grows out first to produce the primary rooting system (see first page of the course web site). This occurs either by splitting open the integument (the genus *Cycas*), or by a specialized structure of the micropylar region producing a large hole through which the root emerges.