

Laboratory 23 - Gnetophyta: Vegetative and Reproductive Morphology

I. Vegetative Morphology

A. General Organography

The study of the morphology of the Gnetales has historically been colored by the politics of the regions in which these genera thrive. Perhaps the best understood of these is the North American genus *Ephedra*. Examine the general organography of the following specimens of *Ephedra* as represented by herbarium specimens and pickled material:

Ephedra antisiphiletica
E. distachya
E. intermedia
E. gerardina

Where are the leaves and how are they arranged? What is the pattern of branching in each species? In what ways are the leaves of *Ephedra* and *Equisetum* similar? How do they differ?

For each of *Gnetum* and *Welwitschia* examine drawings and photographs available in the laboratory. What is the major distinguishing feature of each of these genera? Can you account for the bizarre organography of the genus *Welwitschia*? What is the morphological interpretation of the large white "scale bodies" that are evident at the summit of the shoot of this plant?

B. Anatomy of the Stem and Wood

Obtain a prepared slide showing a cross-section of a young stem of *Ephedra*, still in the primary stages of its growth. Identify all the cellular and tissue components, especially the vascular bundles, pith, large cortex, and thick epidermis. Now obtain and examine an older twig of *Ephedra* in cross and longitudinal section. Is it possible to distinguish between the tracheids and vessel elements in these stems? What are the major differences between tracheids and vessel elements? These differences are evident in macerated tissue of *Ephedra*, as illustrated in Fig. 18-10 of Gifford and Foster. Can you distinguish between the primary and secondary xylem in longitudinal section? Do any other non-angiospermous plants have vessel elements in their life cycles? Examine the demonstration slides of *Gnetum* wood. How is it similar to *Ephedra*? How does it differ?

II. Reproductive Morphology

A. *Ephedra*

Obtain a preserved androstrobilus of *Ephedra* and identify the perianth, subtending bract and microsporophylls. What is the phyllotactic pattern of the strobilus? Of the inflorescence as a whole? What is the position of attachment of each strobilar part? Now, obtain a prepared slide of the male strobilus and identify the same features. Why is this considered to be a compound strobilus? Locate the thin perianth and the enclosed sporophylls. How do the sporophylls differ from those in the angiospermous stamen? Observe the pollen grains of *Ephedra* in this slide and in SEM in Fig. 18-15 of Gifford and Foster. Pollen grains such as those of *Ephedra* and *Welwitschia* have been found as early in the fossil record as the Permian; however, there is no megafossil evidence (unfortunately) for this fascinating group.

The gynostrobilus or female strobilus of *Ephedra* consists of from five to seven pairs of decussate sterile bracts which subtend two ovules borne on short branches in the axils of the uppermost bracts. Obtain a single gynostrobilus and locate the sterile bracts, the ovule, its surrounding involucre and the elongated integumentary tube which constitutes the micropyle of *Ephedra*. By what means can this be distinguished as a compound strobilus? Obtain a prepared slide showing the ovule of *Ephedra*. Can you identify the archegonium, embryo, and developmental stage that is shown? Do other members of the Gnetales possess an archegonium? Now observe and sketch some of the stages of early embryology in this rare and beautiful series of slides of *Ephedra*. Can you determine the fate of the first sperm cell fusion? Of the second?

B. *Gnetum* and *Welwitschia*

We are most fortunate that we have any material available on these fascinating plants, meager though it may be. Observe the organization of the inflorescence of *Gnetum*. This is obviously a female structure, since it has seeds. Observe the illustrations in Bierhorst and Chamberlain to see the organization of the male inflorescence. Also, observe the male strobilus of *Welwitschia* available in lab. Why is this considered a compound strobilus? Is there any external evidence to support this conclusion? Refer to texts for the structure of the female strobilus and the embryology of both. Marten's book entitled "Les Gnetophytes" (1970) is an excellent source for published interpretations of these plants (especially if you can read enough French to understand the figure captions). The embryology of these plants is bizarre and the reports, contradictory. Their reproduction remains as perhaps the most major basic biological problem of our time and one that has not received nearly enough research interest.