Laboratory 8: Ginkgo, Cycads, and Gnetophytes

This is the third and final lab concerning the gymnosperms. Today we are looking at Ginkgo, the Cycads, and the Gnetophytes, the so-called non-coniferous gymnosperms. While these groups do not have cones like the true conifers, many do produce strobili.

Order Ginkgoales: leaves simple (with dichotomously branching venation); dimorphic shoots; water-conducting cells are tracheids; dioecious; generally two ovules produced on an axillary stalk or "peduncle"; microsporangiate strobili loose and catkin-like; multi-flagellate sperm.

Ginkgoaceae – 1 genus, 1 sp., cultivated relict native to China
Tree, tall, stately with curving branches attached to a short trunk. Leaves fan shaped, deciduous, attached in whorls to the end of "short shoots" growing from the longer branches ("long shoots"); veins of the leaves dichotomously branched; dioecious; paired ovules at the end of a stalk and naked, hanging like cherries; seeds enclosed in a fleshy whitish-pink covering.

Ginkgo

Order Cycadales: pinnately-compound leaves, whorled, attached spirally at the stem apex; main stem generally unbranched; circinate vernation in some representatives; water-conducting cells are tracheids; dioecious; both male and female cones are simple structures; seeds generally large and round, unwinged; numerous microsporangia per microsporophyll; multi-flagellate sperm.

Cycadaceae – 1 genus, 17 spp., Africa, Japan, and Australia
Stems palm-like and rough, usually not branched; leaves fern-like, pinnately compound, thick and leathery; attached spirally at the stem apex, young pinnae with circinate vernation, leaf bases remaining after the leaves drop; dioecious; whorls of wooly-covered micro- and megasporophylls alternate with whorls of scales and foliage leaves at the stem apex; ovules born along the sporophyll margins; seed almond or plum like; ovules borne along the margin of the leaf-like megasporophyll.

Cycas

Zamiaceae – 8 genera, 125 spp., tropical America
Stems palm-like and rough, usually not branched; leaves pinnately compound, thick and leathery, some may reach 3-4 m in length, attached spirally at the stem apex; the young pinnae or leaves of some species have circinate vernation, others are straight; dioecious; microsporangia and megasporangia produced in strobili, ovules attached to megasporophyll, strobili vary greatly in size up to 7 dm in length; seeds are cherry like and may be brightly colored.

Ceratozamia
Encephalartos
Zamia
Order Gnetales: leaves variable in size and shape but either opposite or whorled; sperm not flagellated (delivered to the egg by the tube nucleus); both male and female cones are compound structures; water-conducting cells are tracheids and vessel-members.

Gnetaceae – 2 genera, 29 spp., tropical
Woody vines, rarely shrubs or trees; leaves opposite, simple, thick, ovate to oblong with netted veins and resembling the leaves of flowering plants; dioecious; male strobilus slender elongate with microsporophylls arising in the axis of bract-like leaves, "inflorescence-like"; female strobilus with ovules in 5-8 separated whorls; seeds large, fleshy. Micropyle opening within an elongated extended tube.

Gnetum

Ephedraceae – 1 genus, 65 spp.; N hemisphere and South Am.
Shrubby or trailing, stems scraggly, diffusely branched, jointed, green and photosynthetic, "horsetail-like"; leaves decussate, opposite, or whorled reduced to dry brown-tan scales; usually dioecious; male pollen cone with compound, stalked microsporophylls; surrounded at the base by paired bracts; female ovulate cone reduced, 1-4 at a node; ovules single or in pairs, surrounded by a fleshy cup attached at the base, the micropyle opening within an elongated extended tube; strobili at maturity become dark and leather-like covered seeds, colored scarlet. Pollen striated “football shaped”.

Ephedra

Welwitschiaceae – 1 genus, 1 sp., Namib Desert
Woody, fleshy inverted conical stem, protruding slightly above ground level, may be over 1 m in diameter at ground level; leaves 2, opposite, leathery ribbon-like, continual basal growth persisting throughout the plant’s life, but becoming tattered and ripped by wind into many ribbons; dioecious with strobili on compound-branched axes; microsporophylls of male cone surround a sterile ovule (like stamen around a pistil) enclosed by bracts; fertile ovule of female cone enclosed by bracts. Pollen striated “football shaped”. Micropyle opening within an elongated extended tube.

Welwitschia
Figure 9-6. Features of Ginkgoaceae. A–E. *Ginkgo biloba*. A. Twig in deciduous dormant condition illustrating long and short shoots. B. Fan-shaped leaf with close-up of dichotomous venation. C. Short shoot from male tree bearing catkin-like microsporangiate strobili (pollen cones). D. Short shoot from female tree bearing paired stalked ovules. E. Stalk with one seed developed and one undeveloped ovule.

Figure 16-5. *Ginkgo biloba*. A, spur shoot with expanding leaves and microsporangiate strobili; B, spur shoot with young leaves and pairs of ovules borne on slender stalks.

Fig. 56. Ginkgoaceae. *Ginkgo biloba*. a. fruiting branch, × 1; b. pistillate strobilus, × 4; c. anther, × 8; d. staminate inflorescence, × 1; e. seed, × 1; f. seed, vertical section, × 1/2. (From L. H. Bailey, *Manual of cultivated plants*, The Macmillan Company, 1949. Copyright 1924 and 1949 by Liberty H. Bailey.)
FIGURE 18-4  *Gnetum indicum*. Terminal portion of shoot showing seeds and three pairs of simple leaves with pinnate-reticulate venation (actual size);


Figure 63. Ephedraceae. *Ephedra* Torreyana: a, staminate branch in flower, habit, × ¼; b, staminate inflorescence, × 4; c, staminate flower with bract, × 3; d, "pistillate" inflorescence, habit, × 3; e, same, expanded, × 3.

Figure 9-4. Examples of Ephedraceae. A-B. *Ephedra californica*. A. Closeup of vertically ridged young branchlet with opposite, connate, scale leaves. B. Older twig after leaves have withered and fallen.
C-E. *Ephedra viridis*. C. Branchlets with ovulate strobili and opposite scale leaves. D. Whorl of ovulate strobili with perianth like scales subtending terminal ovules. E. Pollen cone showing many spiraling scales and branched microsporophylls with terminal microsporangia (pollen sacs).

Figure 8.21 Ephedraceae. *Ephedra distachya*. (A) staminate branch; (B) staminate strobilus; (C) staminate reproductive structure; (D) ovulate strobilus; (E) ovulate reproductive structure. (From Flora ibérica 1986.)
**Figure 18-24** Fertile shoot and subtending bract from microsporangiate strobilus of *Welwitschia*. [Based on Les Gnéophytes by P. Martens. In *Handbuch der Pflanzenanatomie*, Band XII, Teil 2. Gebrüder Borntraeger, Berlin, 1971.]

**Figure 18-25** Fertile shoot and subtending bract from megasporangiate strobilus of *Welwitschia*.