Gnetophyta

Gnetophyta - Taxonomy

3 very distinct lineages:

Gnetopsida

Ephedraceae

Ephedra

Gnetales

Gnetaceae

Gnetum

Welwitschiales

Welwitschiaceae

Welwitschia

Gnetophyta - Shared Characters

c. 80 spp. in total

Opposite or whorled leaves

Vessels in xylem

- **Only gymnos. with vessels & tracheids**

Compound ♂ *and* ♀ strobili

Further reduction of male and female gametophytes

Sperm not motile

Gnetophyta

- Seeds with 2 integument layers
  - Inner forms micropylar tube that exudes pollen droplet
  - Outer derived from a fused pair of bracts (not true integument)
- Short fossil record (< 65 MYA for Ephedrales and Gnetales, but 250 MYA for Welwitschiales)

Gnetophyta – Evolution

- Share features with gymnosperms AND angiosperms
  - Gymno: seeds not enclosed in ovary
  - Angio: vessels in wood, somewhat flower-like structures, double fertilization
- BUT some primitive angiosperms do not have vessels (e.g., Winteraceae)
- Recent data suggest a relationship to Pinaceae

Ephedrales

- ~ 40–50 species
- Native to arid/Mediterranean regions of N. & S. America & Eurasia
- 6 species native in SW USA
  - “Joint Fir”, “Mormon Tea”
  - Soothing properties used by Mormon pioneers

Ephedra

- ***Ephedra sinica*** **(from Asia)**
  - **Original source of Ephedrine and Pseudo-ephedrine**
- **Both compounds increase heart-rate, metabolism**
  - **Diet aids (dangerous**
  - **Methamphetamines (Ephedrine)**
  - **Decongestant (Pseudo-ephedrine)**

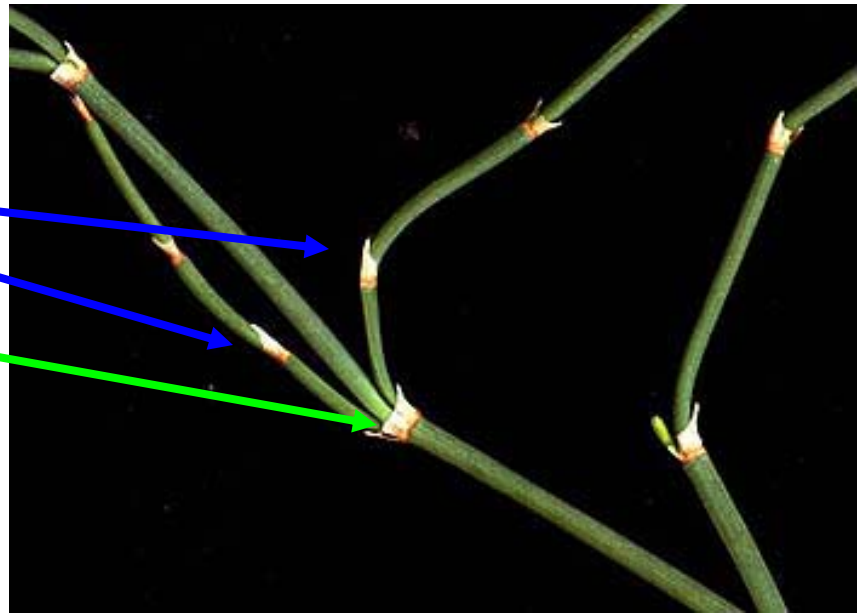
Ephedra: Vegetative Morphology

Branching shrubs

Whorled, scale-like leaves

Jointed stems

(Superficially similar to *Equisetum*)



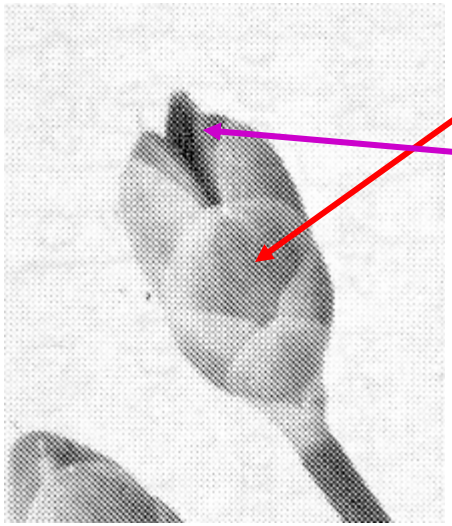
Ephedra: Reproductive Morphology

- **Usually dioecious**
  - **Some species monoecious**
- **Female and male strobili**
  - **Complex and compound**
  - **Similar sized**
  - **Scattered along stems**

Ephedra: Megastrobilus

- **Compound**
  - **Ovules borne on lateral branches**
  - **Pair of bracteoles = "outer" integument**

Megastrobilus

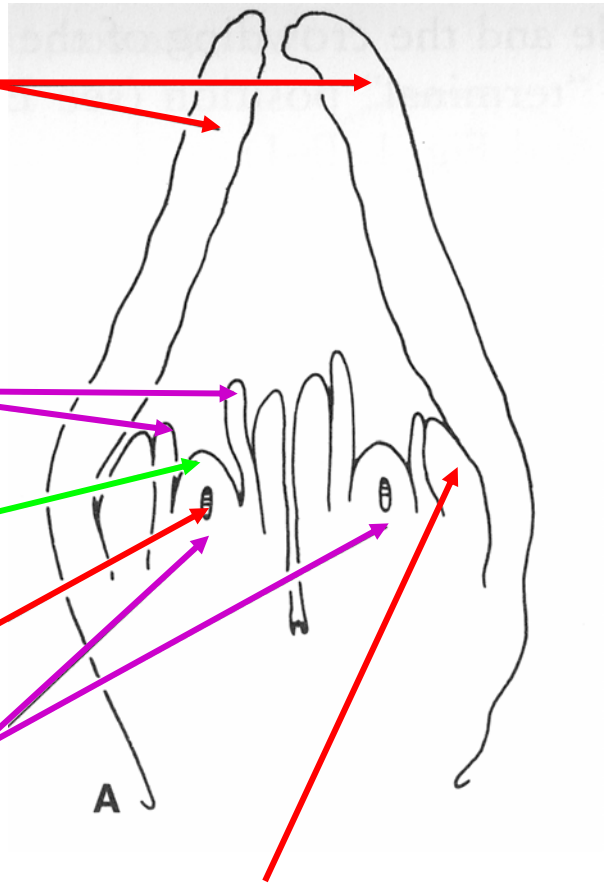


Megastrobilus

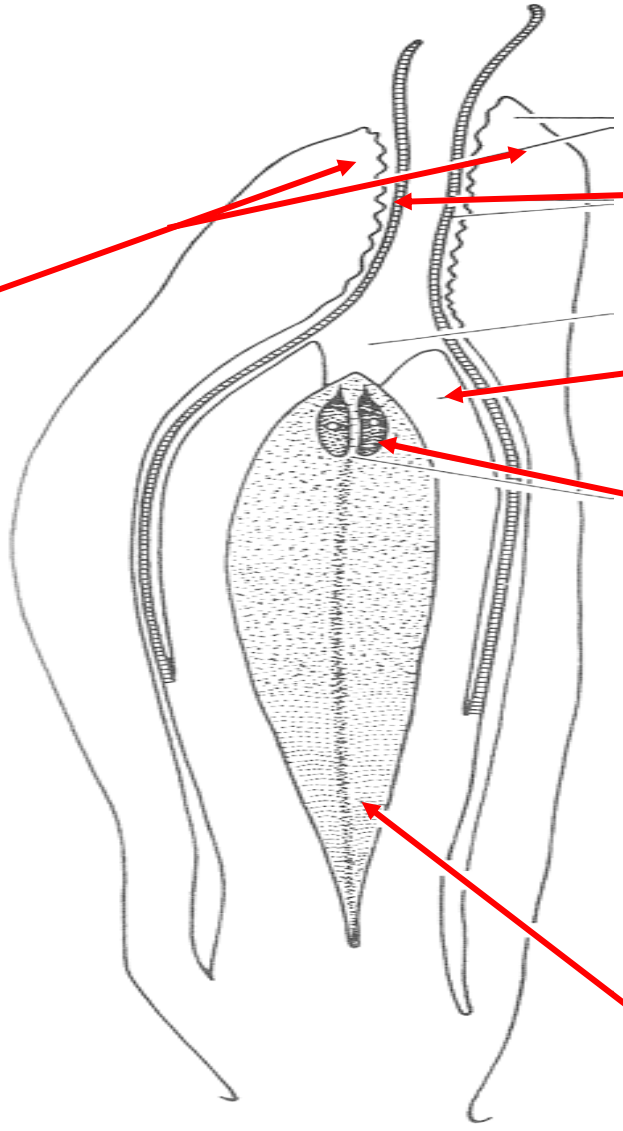
Inner integument

Nucellus

Ovules



Megagametophyte



outer envelope

integument

nucellus

archegonia

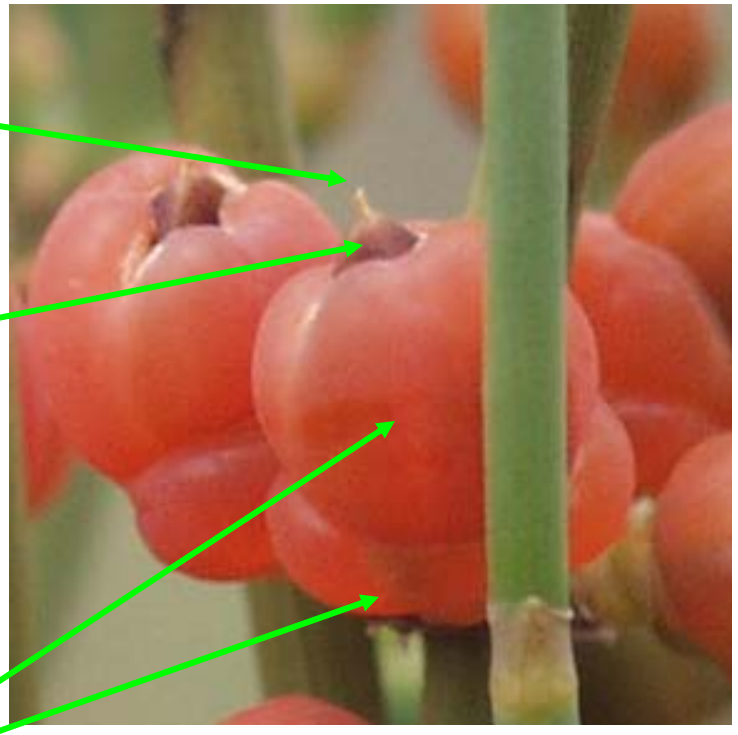
megagametophyte

Ephedra: Seed

"Inner" integument remnants

Seed

Bracts



Microstrobilus

Gnetum

- **30 species**
- **Humid tropics**
  - **S. America, Africa, SE Asia**
- **Mostly woody vines**
  - **Lianas (rare among gymnosperms)**
- **Leaves opposite, broad, with *net venation* (similar to many angiosperms)**

Gnetum – reproductive morphology

- "Functionally dioecious"
  - Megastrobilus with abortive microsporangia
  - Microstrobilus with abortive megasporangia
- No real archegonium
  - Any cell (or 2 cells) can function as egg

Gnetum

male

female

Welwitschia

Monotypic – *W. mirabilis*

- **(Latin: *mirabilis* = wonderful)**

One of the weirdest plants on the planet!

Coastal deserts of SW Africa (Namibia)

- **<1” rainfall per year, so plants get water from ocean fog that rolls in every night**

Can live > 2,000 years

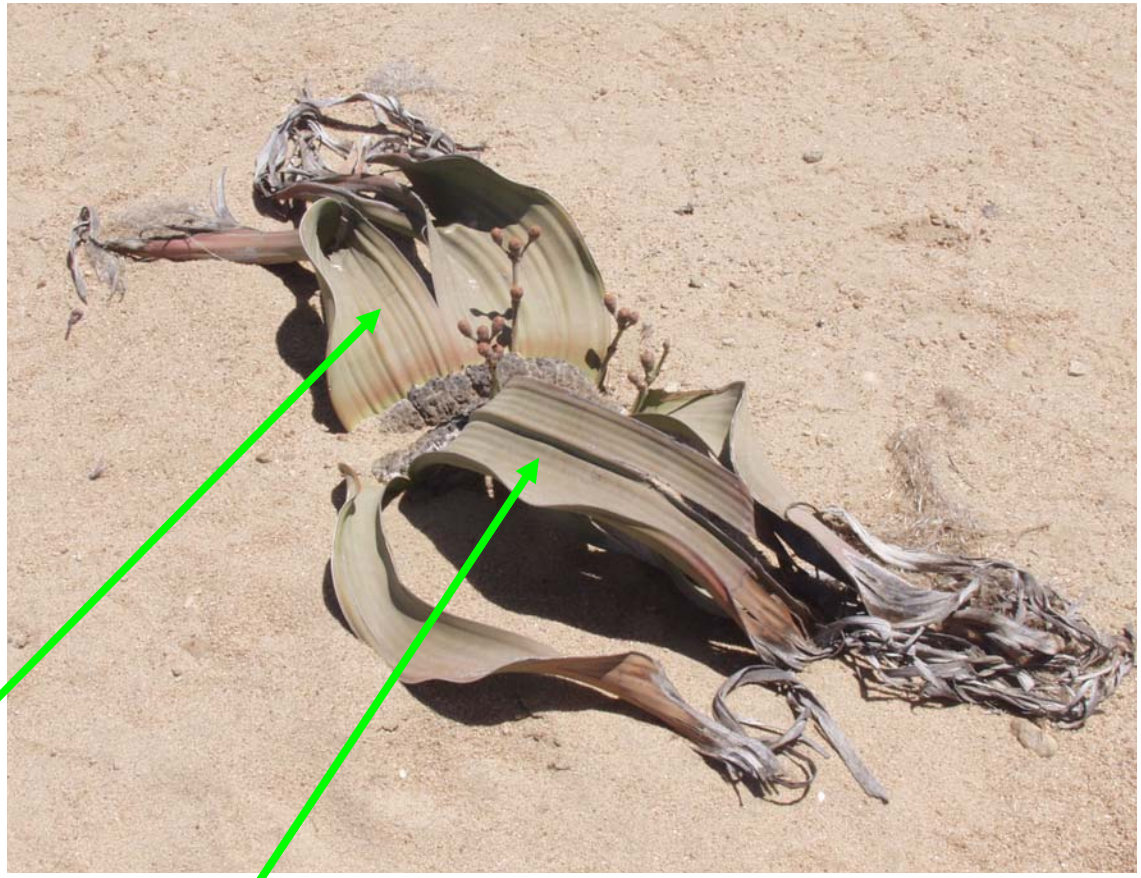
Most of plant is underground

Welwitschia

- **Only 2 permanent leaves for the entire plant, for its entire lifespan!**
  - **Grow continually from basal meristems**
  - **Leaves shredded over time by wind**
- **Huge taproot (up to 30-40’ deep)**
  - **Plus “surface” roots that suck up the moisture from the nightly fog**
- **Dioecious**

Young Plant

- Leaves still somewhat intact



1st leaf

2nd leaf

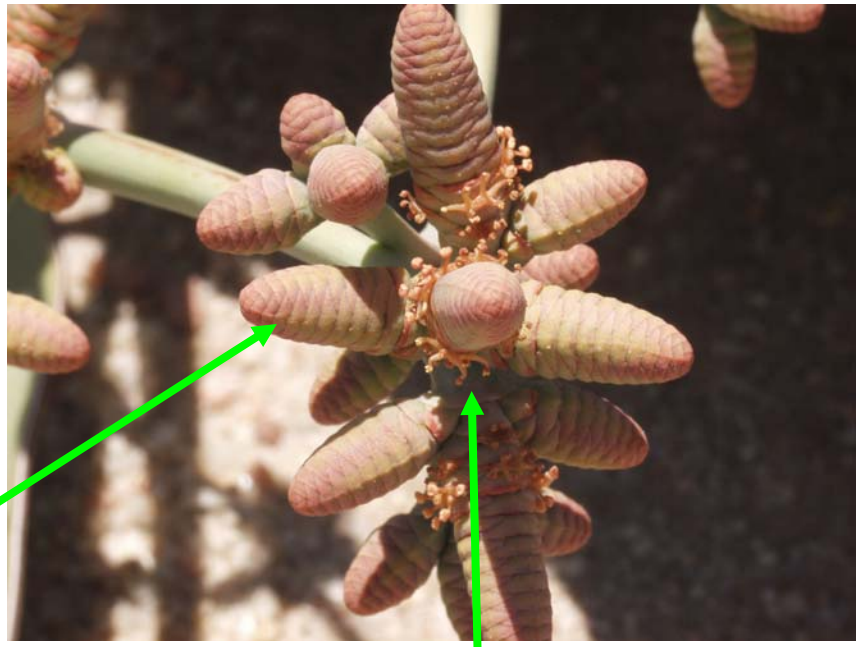
Older plant

- **Still only 2 leaves!**

Welwitschia

- 2 "scaly bodies" sometimes interpreted as leaves
- Scars are from old strobili

Microstrobili



Microstrobili

Stamen-like appearance

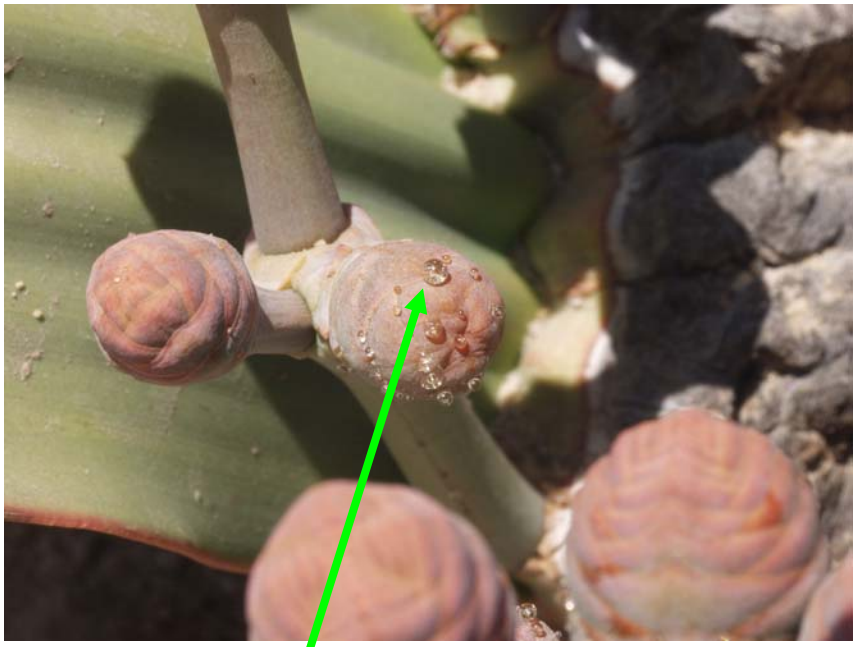
Megastrobili

Fertilization bizarre

- Megagametophyte highly reduced (no archegonia)
- Also produces a tube with grows to meet the pollen tube
- Zygote then travels back into megagametophyte

Megastrobili

Megastrobilus



Pollen droplet

Seed

Recap

- Do gymnosperms for a monophyletic group?
  - A definite maybe
  - Recent data (Soltis et al., 2002) suggest that extant ones do (based on 8 genes from 3 genomes)
  - Likely paraphyletic if extinct lineages included
- Gnetophyta probably NOT sister to angiosperms
  - Morphological characters convergent

Recent Phylogeny