

# Introduction to Botany. Lecture 36

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# Outline

## 1 Questions and answers

## 2 Seed and seed plants

- “Higher” seed plants
- Conifers
- Gnetophytes



## 1 Questions and answers

## 2 Seed and seed plants

- “Higher” seed plants
- Conifers
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# Previous final question: the answer

Why is the life cycle of seed plants “bad”?



# Previous final question: the answer

Why is the life cycle of seed plants “bad”?

- Slow
- Ineffective
- Fertilization complicated



# Seed and seed plants

## "Higher" seed plants



# Spermatophyta classes

"Lower":

- **Ginkgoopsida**, ginkgo class
- **Cycadopsida**, cycads

"Higher":

- **Pinopsida**, conifers
- **Gnetopsida**, gnetophytes or chlamydosperms
- **Angiospermae**, or Magnoliopsida, flowering plants



# Seed and seed plants

## Conifers



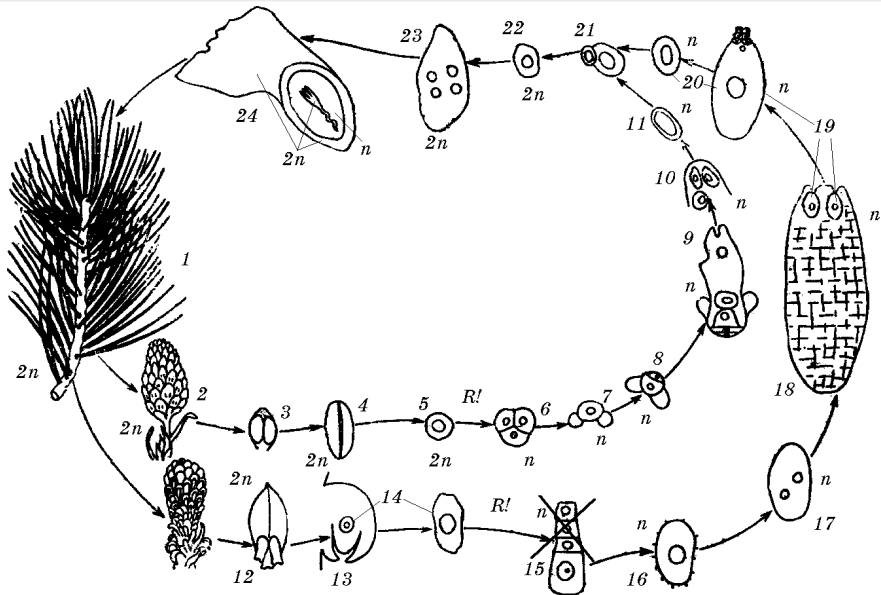


# Pinopsida

- Three orders, several families and  $\approx 300$  species
- Mostly temperate evergreen trees, but some are deciduous (like *Larix*, *Pseudolarix*, and part of Cupressaceae)
- Stem with large amount of xylem, relatively small cork and minute pith
- Ovules are always attached to specialized leaves (seed scales) and together with bract scales they are compacted in cones; microsporangia are attached to microsporophylls and also occur in cones of simpler structure
- Male gametes without flagella (spermatia), consequently, pollen grains grow into **pollen tubes**
- Female gametophyte is more reduced than in cycads and *Ginkgo*
- Seeds are wind- and animal-distributed, life cycle shorter but still up to two years



# Life cycle of conifers: another view



# Pinopsida orders and families

- *Pinales*
  - **Pinaceae.**
- *Araucariales*—*grow mostly in tropics or in South Hemisphere.*
  - *Araucariaceae*
  - *Podocarpaceae*
- *Cupressales*
  - *Sciadopityaceae*
  - *Cupressaceae (incl. Taxodiaceae)*
  - *Cephalotaxaceae*
  - *Taxaceae*



# Pinaceae

- Have resin and needle-like leaves, often in shortened shoots, **brachyblasts**. Large cones with paired (seed and bract) scales.
- Biggest conifer family, include large genus *Pinus* (pine) and other genera like *Larix* (larch), *Cedrus* (cedar), *Picea* (spruce), *Abies* (fir) etc.



# Cupressaceae and Taxaceae

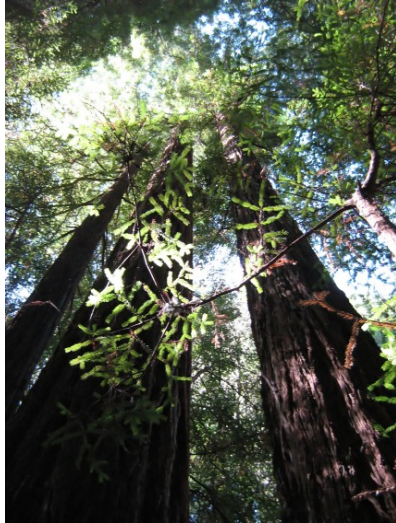
- **Cupressaceae**—cypress family. No resin. Cones are small, with fused bract and seed scales. Leaves are dimorphic, needle-like and scale-like. Part of genera (formerly belong to Taxaceae family) are deciduous but with branches instead of leaves. Genera: *Cupressus* (cypress), *Juniperus* (juniper), *Taxodium* (bald cypress), *Sequoia* (coastal red cedar), *Sequoiadendron* (mountain red cedar), *Metasequoia* etc.
- **Taxaceae**—yew family. Female cones are modified in berry-like structures with one enlarged red scale. Leaves are needle-like. No resin. *Taxus* (yew) provides famous reddish-brown, springy wood.



# *Pseudolarix amabilis* (Pinaceae), spring



# *Sequoia sempervirens* (Cupressaceae)



# *Taxus baccata*, Taxaceae





# Seed and seed plants

## Gnetophytes



# Gnetopsida

- Small class of only three genera (*Ephedra*, *Welwitschia*, *Gnetum*), which are so different that botanists place them in different orders (and sometimes even subclasses).
- Tropical trees (*Gnetum*) or desert shrubs (*Ephedra*) or nobody-knows-what (*Welwitschia*)
- Stem structure is similar to conifers but *Gnetum* and *Welwitschia* have vessels (like angiosperms)
- Ovules are solitary, **covered with additional outer integument** (however, **this is not a pistil** because micropyle come out of this cover)
- Male gametes are spermatia, have pollen tube and **no archegonia** in *Gnetum* and *Welwitschia* (like in angiosperms). Multiple fertilization and polyembryony is widespread, *Ephedra* and *Gnetum* even has a double fertilization (like angiosperms). Only one embryo survives, other are eaten (endosperm<sub>2</sub>). Also have endosperm<sub>1</sub> (female gametophyte).
- *Welwitschia* is insect-pollinated, other are wind-pollinated like most non-angiosperms.
- Seeds are animal-dispersed (except *Welwitschia*).
- Amazingly, molecular data show relations with conifers, not with angiosperms!



# Gnetum

- Tropical shrubs, vines or small trees (30–35 species) with opposite leaves with pterodromous venation (like angiosperms again!). However, investigation of leaf development showed that initially leaf had dichotomous venation (like *Ginkgo* and some conifers).
- Dioecious plants, male and female structures (fructifications) are catkin-like
- Seeds big, colored



# *Gnetum* seeds



# *Gnetum* female fructifications



# *Gnetum* male fructifications



# Welwitschia

- One species occurring in Namibian desert (South Africa)
- Life form is completely unusual, the best description is “overgrown seedling”: small trunk with only two (constantly growing on the basement and degrading on top) wide leaves with parallelodromous venation. Secondary thickening anomalous (like in cycads). Wood with vessels.
- Insect-pollinated (!) dioecious plants
- Fructifications are cone-like; male one is similar to flower and contain sterile ovule (!)
- Seeds are wind-dispersed



# *Welwitschia*





# *Welwitschia*



# *Welwitschia* female cones



# *Welwitschia* male cones



# *Welwitschia* pollinators: *Odontopus sexpunctulatus* bug



# Ephedra

- $\approx$  35 species growing in dry places across all North Hemisphere and also in South America
- Shrubs or small trees, leaves are usually reduced to scales, stems are articulate (like horsetails). Wood is similar to conifers.
- Plants are monoecious or dioecious, male and female (bisexual also occur) fructifications are short, covered with thick scales
- Wind-pollinated, animal dispersed
- *Ephedra sinensis* is a source of pharmaceutically important **ephedrine**
- In all, *Ephedra* is more primitive than two other genera of Gnetopsida: wood does not contain vessels, ovule has large archegonia



# *Ephedra*



# *Ephedra nevadensis*, female fructification



# *Ephedra nevadensis*, male fructification





# *Ephedra* seeds



# For Further Reading



A. Shipunov.

*Introduction to Botany* [Electronic resource].

2015.

Mode of access:

[http://ashipunov.info/shipunov/school/biol\\_154](http://ashipunov.info/shipunov/school/biol_154)

