

# Systematic Botany. Lecture 32

Alexey Shipunov

Minot State University

November 18, 2011

# Outline

## Questions and answers

### Spermatophyta, seed plants

Classes of seed plants

Conifers

Gnetophytes

# Outline

Questions and answers

Spermatophyta, seed plants

Classes of seed plants

Conifers

Gnetophytes

## Previous final question: the answer

Why peatmosses are important?

## Previous final question: the answer

Why peatmosses are important?

- ▶ They form specific communities: sterile, acidic, oligotrophic *Sphagnum* bogs

# Spermatophyta, seed plants

## Classes of seed plants

Phylum 42. SPERMATOPHYTA [ <sup>6</sup>*Magnolia* ] s.a.Classis 1(204). *Ginkgoopsida* [ <sup>5</sup>*Ginkgo* ]2(205). *Pinopsida* [ <sup>5</sup>*Pinus* ]<sup>125</sup>3(206). *Gnetopsida* [ <sup>5</sup>*Gnetum* ] stat.m.4(207). *Cycadopsida* [ <sup>5</sup>*Cycas* ]5(208). *Angiospermae* [ <sup>5</sup>*Magnolia* ]

## Spermatophyta: seed plants

- ▶  $\approx 600$  species of non-angiosperms and  $\approx 250,000$  species of angiosperms
- ▶ Sporic life cycle with sporophyte predominance and **seed**
- ▶ Gametophyte is reduced to cells inside ovule or inside pollen grain. Minimum number of cells is 3 for male gametophyte (pollen grain) and 4 for female gametophyte (embryo sac of angiosperms). Anteridia are reduced. In angiosperms and Gnetales, archegonia are also reduced.
- ▶ Sporophyte always starts development from embryo located inside nutrition tissue, endosperm<sub>1</sub> (female gametophyte) or endosperm<sub>2</sub> (second embryo)
- ▶ Have axillary buds
- ▶ Homiohydric plants (same as ferns)
- ▶ Have secondary thickening



## Spermatophyta classes

- ▶ **Ginkgoopsida**, ginkgo class
- ▶ **Cycadopsida**, cycads
- ▶ **Pinopsida**, conifers
- ▶ **Gnetopsida**, gnetophytes or chlamydosperms
- ▶ **Angiospermae**, or Magnoliopsida, flowering plants

## Ginkgoopsida

- ▶ Smallest class, only one species (!), Chinese tree *Ginkgo biloba* which became extinct several thousand years ago but saved as a "church tree".
- ▶ Distinctive triangle-shaped leaves with dichotomous venation
- ▶ Ovules are solitary or paired; microsporangia are in catkin-like structures; has sexual chromosomes (!)
- ▶ Pollen grains produce two mutli-flagellate spermatozoa which swim to large oocyte
- ▶ Seeds are fruit-like (generally edible), become ripe laying on a ground for a long time
- ▶ Almost no phytophagous insects damage *Ginkgo* leaves; the fungal symbiont of *Ginkgo* also belongs to separate class inside basidiomycetes, Bartheletiomycetes.

## *Ginkgo biloba* ovules



## *Ginkgo biloba* male organs



- └ Spermatophyta, seed plants
- └ Classes of seed plants

## *Ginkgo biloba* seeds



## Cycadopsida

- ▶ Two families, dozen genera and  $\approx 300$  species distributed mostly in tropics
- ▶ Palm-like plants, with large (and usually very rigid) pinnate leaves
- ▶ Stem structure is not similar to conifers and *Ginkgo*; cycads have large pith and anomalous secondary thickening via multiple cambium rings
- ▶ Ovules are attached to modified leaves (sporophylls) and usually gathered in large upright cones; microsporangia are always in cones
- ▶ Also have multi-flagellate spermatozoa, archegonia and large oocyte
- ▶ Large seeds are animal-distributed; life cycle is extremely slow (several years from initiation of cone to germination of seed).

## Cycadopsida families

- ▶ Two families, sometimes even placed in different orders:
  - ▶ **Cycadaceae**, with only genus *Cycas*. They do not have female cones, ovules are attached to leaves which are not radically modified. Leaves have fiddleheads (same in ferns!).
  - ▶ **Zamiaceae**, with all other genera (*Zamia integrifolia* is native to USA). Have female cones.

## *Cycas* sp.: young leaflets form fiddleheads





## Male *Cycas* sp. in dry season



## *Cycas* sp. seeds



## *Encephalartos gratus* (Zamiaceae)



## *Zamia integrifolia* (Zamiaceae)



# Spermatophyta, seed plants

## Conifers

## Pinopsida

- ▶ Three orders, several families and  $\approx 600$  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 (spermata), 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

## 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



# Spermatophyta, 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* 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 Gnetales: wood does not contain vessels, ovule has large archegonia

# *Ephedra*



## *Ephedra nevadensis*, female fructification



## *Ephedra nevadensis*, male fructification



- └ Spermatophyta, seed plants
- └ Gnetophytes

## *Ephedra* seeds



## Spermatophyta classes (and genera)

	1	2	3	4	5	6	7	8	9	10	11	12	13
Ginkgoopsida	0	0	1	0	0	0	1	1	0	1	0	0	0
Cycadopsida	1	0	0	0	1	0	1	1	0	1	0	1	0
Pinopsida	0	1	1	0	1	0	0	1	0	1	0	0	1
<i>Gnetum</i>	1	0	1	1	0	0	0	0	0	1	1	0	0
<i>Welwitschia</i>	1	0	0	1	1	1	0	0	0	1	1	1	1
<i>Ephedra</i>	0	1	1	0	0	1	0	1	1	1	1	0	0
Angiospermae	1	0	0	1	0	1	0	0	1	0	1	1	1

1 Tropical; 2 Leaves needle- or scale-like; 3 Coniferous wood; 4 Vessels; 5 Cones; 6 Bisexual fructifications; 7 Flagellate sperm (and micropylar chamber, and no pollen tube); 8 Archegonia; 9 Double fertilization; 10 Endosperm<sub>1</sub>; 11 Endosperm<sub>2</sub>; 12 Insect pollination; 13 Wind seed dispersion.

Characters are not necessary relevant to all members of class. Angiosperms characters taken from most primitive members (Magnoliidae subclass).

## Final question (3 points)

## Final question (3 points)

Who is the most primitive seed plant? Why?



## For Further Reading



Margulis and Chapman. 2009.

*Kingdoms and domains: an illustrated guide to the phyla of life on Earth.* 4th edition.