

Introduction to Botany

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Lectures 27–29

Outline

- 1 Plant diversity
 - Systematics
 - Kingdom Vegetabilia, land plants

- 2 Kingdom Vegetabilia, land plants
 - Mosses
 - Ferns
 - Classis Equisetopsida, horsetails
 - Heterospory
 - More “ferny” ferns

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Plant diversity

Systematics

Basics of systematics

Terms covered:

- Systematics = taxonomy
- Species, taxonomic hierarchy
- Taxon, rank = category, classification
- Kingdom, phylum, class, order, family, genus, species
- Subclass, subfamily and other intermediate ranks
- Subspecies and cultivars

Biological nomenclature

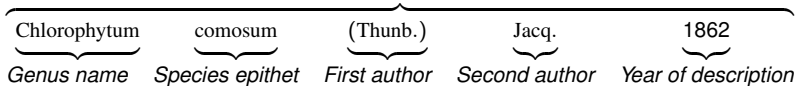
Terms covered:

- Binomial name, species epithet, reference = citation
- Synonyms, priority (older names have preference), starting dates (1753 for plants)

Examples

		Example 1	Example 2
Kingdom	Regnum	Vegetabilia	Animalia
Phylum	Phylum	Spermatophyta	Chordata
Class	Classis	Angiospermae (Magnoliopsida)	Mammalia
Order	Ordo	Liliales	Primates
Family	Familia	Asparagaceae	Hominidae
Genus	Genus	<i>Chlorophytum</i>	<i>Homo</i>
Species	Species	<i>Chlorophytum comosum</i> (Thunb.) Jacq. 1862	<i>Homo sapiens</i> L.

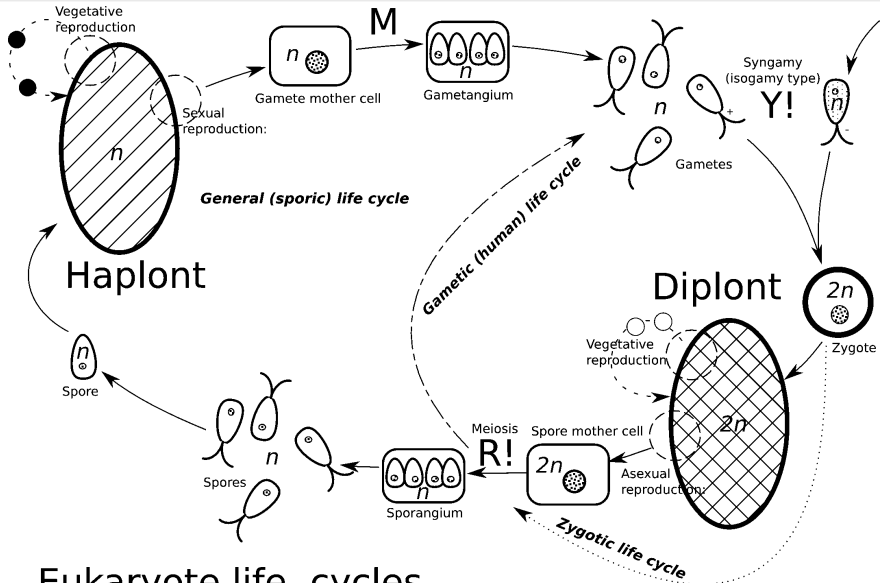
Species name



Plant diversity

Kingdom Vegetabilia, land plants

General life cycle



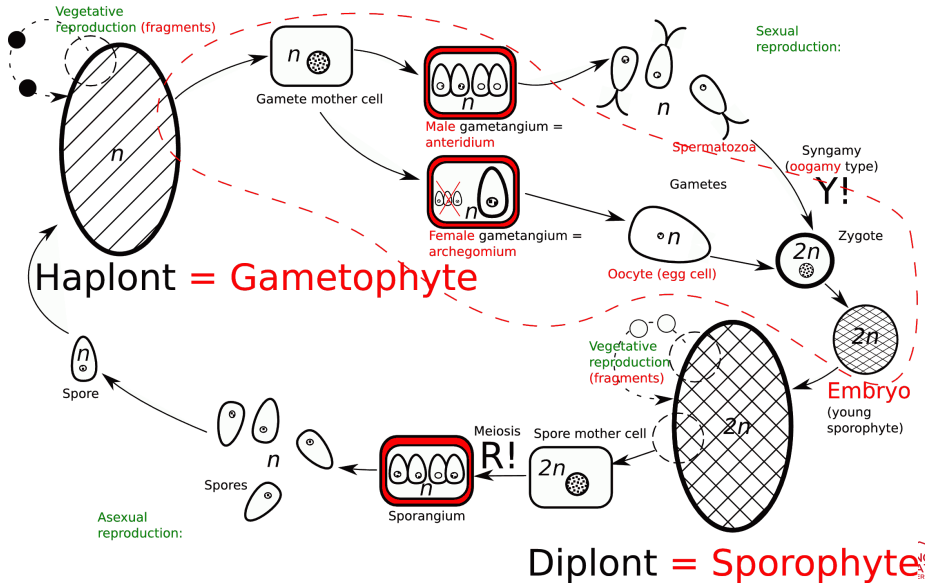
Eukaryote life cycles

Life cycle of land plants

Terms covered:

- Sporophyte and gametophyte
- Gametangia: archegonium and antheridium
- Spermatozoa and oocyte (egg cell)
- Embryo and parasitic sporophyte
- Predominance of sporophyte or gametophyte

Life cycle of land plants: differences



Kingdom Vegetabilia, land plants

Mosses

Three main phyla

- **Bryophyta**: gametophyte predominance
- **Pteridophyta**: sporophyte predominance, no seed
- **Spermatophyta**: sporophyte predominance, seed

Bryophyta

- $\approx 20,000$ species
- Sporic life cycle with gametophyte predominance
- Sporophyte reduced to sporogon (sporangium with seta), usually achlorophyllous, parasitic
- No roots, only rhizoid cells (long hairy dead cells capable for apoplastic transport)
- Poikilohydric plants
- Gametophyte starts development from protonema

Protonema



Life cycle of mosses

Covers: sporogon, biflagellate spermatozoa, the conflict between water cross-fertilization and wind distribution of spores which may be considered as “evolutionary dead end”.

Three main kinds (subphyla) of mosses

- **Hepaticae**—liverworts. Three classes, most primitive are Haplomitriopsida. Body leafy or thalloid, usually has dorsal and ventral parts, sporogon bag-like, without columella, spores with elaters.
- **Bryophytina**—true mosses. Six classes, most important are Sphagnopsida (peat mosses), Polytrichopsida (haircap mosses) and Bryopsida. Body radial, sporogon long, with columella, spores without elaters.
- **Anthocerotophytina**—hornworts. One class. Body flattened (thallus), sporogon long, green, sometimes branched, with columella and stomata, spores with elaters.

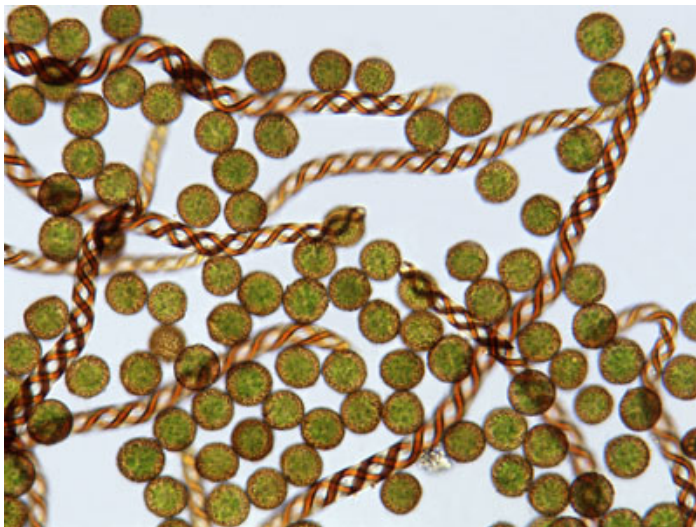
Mosses in the “evolutionary dead end”

- They resolved “skyscrapers problem” via gametophyte, not sporophyte
- Gametophyte needs water fertilization, which restricts the size and also requires the dense growing
- Also, root system is absent: this is an additional size restriction
- If sexual organs appear on the bottom of leafy shoot, sporogon (sporophyte) could not distribute spores with a wind
- The only way out is to “start over” from thallus and make sporophyte (which was highly specialized for the spore distribution) a main stage and reduce gametophyte

Haplomitrium gibbsiae, primitive liverwort



Elaters of liverworts (*Lepidozia* sp.)



Sphagnum sp. (Bryophyta, Sphagnopsida) with sporogons



Dawsonia superba (Bryophyta, Polytrichopsida)—the largest moss with vascular system



Bryum capillare (Bryophyta, Bryopsida)



Leiosporoceros dussii (Bryophyta, Anthocerotopsida)—primitive hornwort



Kingdom Vegetabilia, land plants

Ferns

Pteridophyta: ferns and allies

- \approx 12,000 species and six classes
- Sporic life cycle with sporophyte predominance
- Gametophyte is often reduced to **prothallium** (small hornwort-like plant), some Pteridophyta have male and female gametophytes
- Have true roots (only whisk ferns, Psilotopsida are exception)
- Homoiohydric plants (same as seed plants)
- Sporophyte always starts development from embryo located on gametophyte
- Have true xylem and phloem, but do not have secondary thickening (exceptions: fossils and extant *Isoëtes* and *Botrychium*)

Pteridophyta classes

- Subphylum Lycopodiophytina (lycophytes)
 - Class **Lycopodiopsida**
- Subphylum Pteridophytina (monilophytes)
 - Class **Equisetopsida** (horsetails)
 - Class **Psilotopsida** (whisk ferns)
 - Class **Ophioglossopsida** (ophioglossalean ferns)
 - Class **Marattiopsida** (giant, or marattialean ferns)
 - Class **Pteridopsida** (“true” ferns)

Lycopodiopsida

- Four main genera (*Huperzia*, *Lycopodium*, *Selaginella* and *Isoëtes*) and ≈ 1000 species
- Separate, **microphyllous*** lineage of Pteridophyta (all other groups are **megaphyllous**)
- Sporangia associated with leaves and often form **strobilus***. Spermatozoon typically with two flagella (like in mosses). Homosporous genera have achlorophyllous, mycoparasitic underground gametophyte.
- In the past, were dominant trees of Carboniferous tropical swamp forests (lepidodendrids) and their remains became a coal
- Two genera, *Selaginella* (spike moss) and *Isoëtes* (quillwort) are heterosporous.

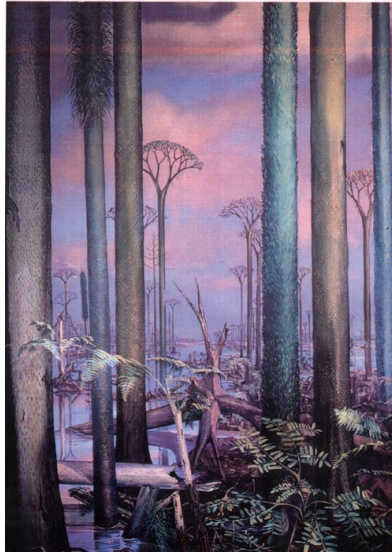
Tropical lycophyte, *Huperzia linifolia*



Phylloglossum drummondii, one of smallest lycophytes



Before: Chicago 300 Million Years Ago (lepidodendrids)



After: quillwort, aquatic lycophyte *Isoetes* sp.



Pteridophyta classes

- Subphylum Lycopodiophytina (lycophytes)
[Microphyllous]
 - Class **Lycopodiopsida**
- Subphylum Pteridophytina (monilophytes)
[Megaphyllous]
 - Class **Equisetopsida** (horsetails)
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Kingdom Vegetabilia, land plants

Classis Equisetopsida, horsetails

Equisetopsida

- Small group of one genus, *Equisetum* with ≈ 30 species
- Leaves are reduced into scales, stems are segmented, photosynthetic. Have specific stele—**artrostele** with specific central and peripheral canals (similar to stele of some grasses)
- Sporangia associated with specialized leaves—sporangiophores. Spores have attached **elaters**. Gametophyte minute, usually dioecious but plants are homosporous

Strobili and sporangiophores of *Equisetum arvense*



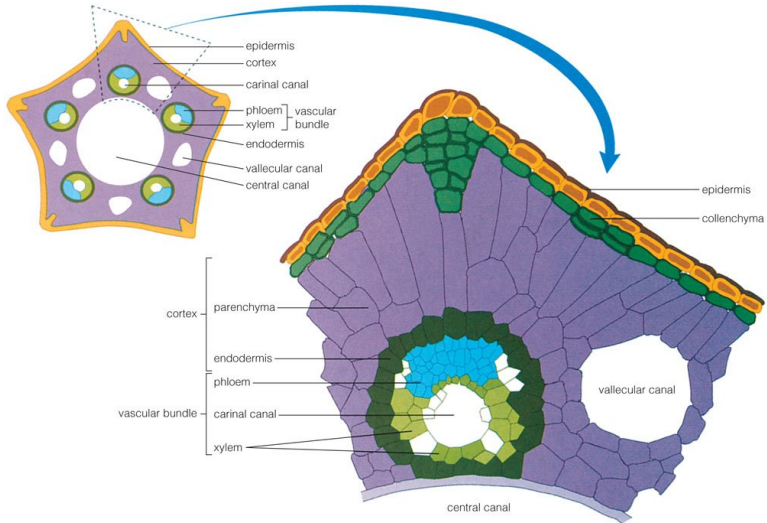
Equisetum giganteum



Equisetum sp. elaters



Artrostele



(please ignore labels)

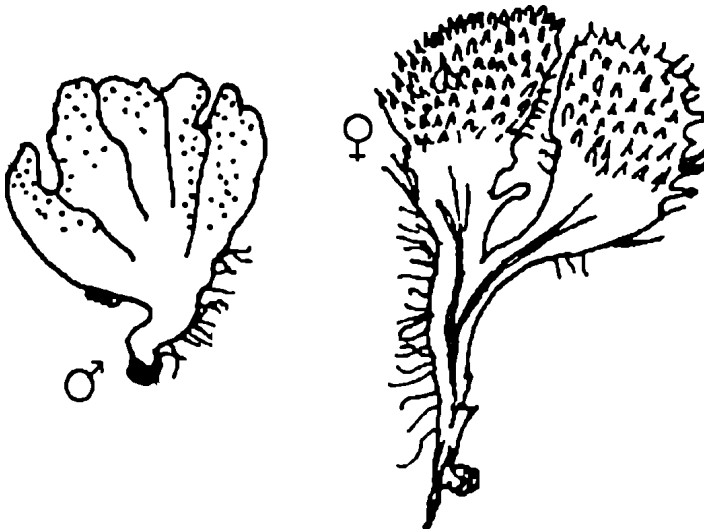
Horsetail gametophytes



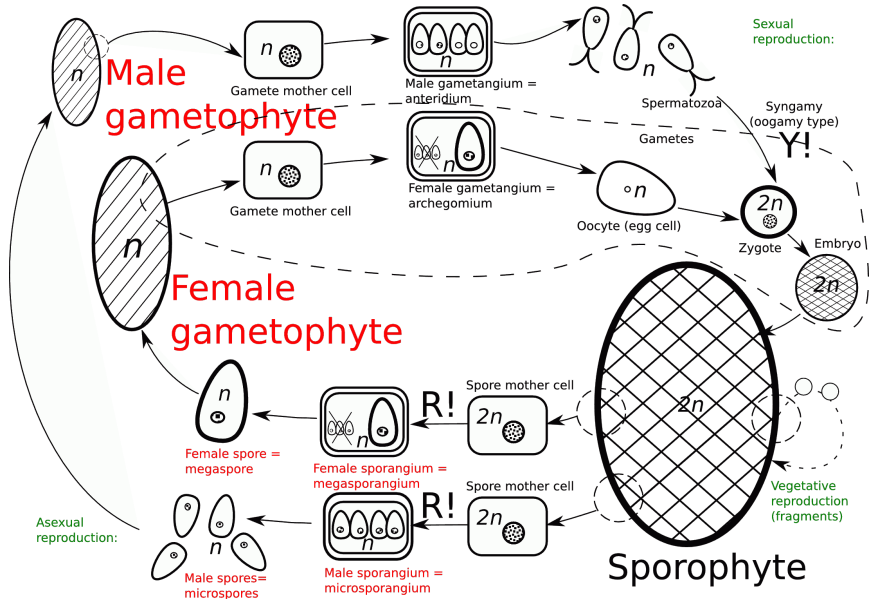
Kingdom Vegetabilia, land plants

Heterospory

Horsetails start it: spores same, gametophytes different



Heterosporic cycle: differences



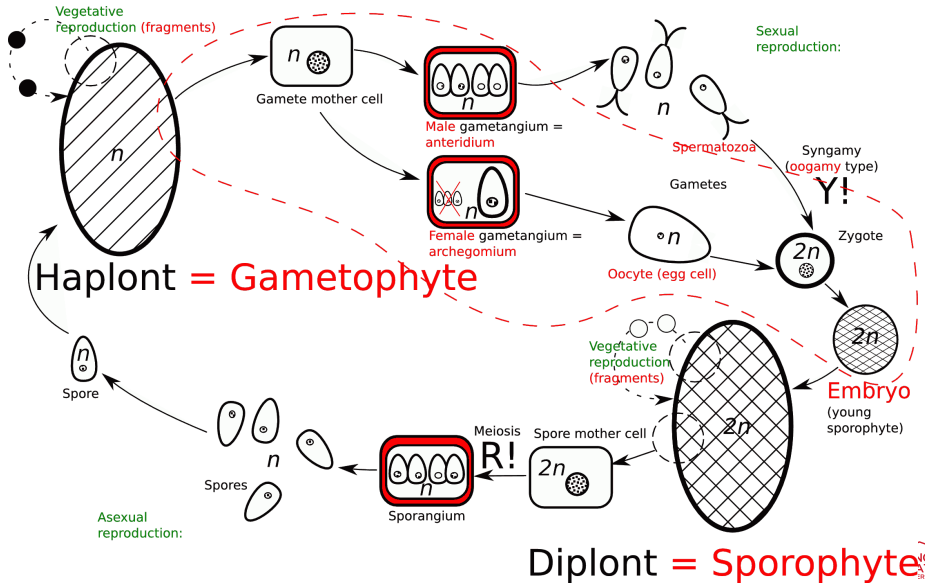
Heterosporry

Heterosporous ferns (lycophytes *Selaginella* and *Isoetes*, monilophytes *Salvinia*, *Marsilea*, *Pilularia*, *Regnellidium* and *Azolla*) went one step further and made their spores different too. It will allow the better allocation of resources and will restrict the self-fertilization.

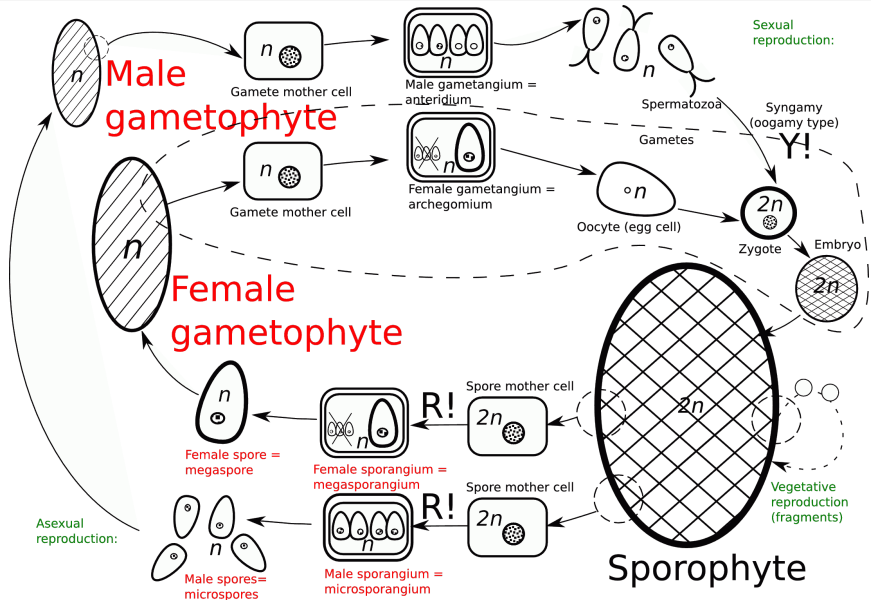
Terms covered:

- Male gametophyte, female gametophyte
- Microspores and microsporangium
- Megaspores and megasporangium

Life cycle of land plants



Heterosporic cycle: differences



Kingdom Vegetabilia, land plants

More “ferny” ferns

Psilotopsida

- Small tropical group of two genera, *Psilotum* and *Tmesipteris* and 7 species
- Have protostele (like lycophytes), underground long-lived gametophytes but multiflagellate spermatozoa (like horsetails and all “higher” ferns). Sporangia unite into **synangia**. Leaves may absent (*Psilotum*) and replaced with **enatia**.
- Externally remain fossil **rhyniophytes**, the oldest extinct Pteridophyta

Hawaiian *Psilotum complanatum*



New Zealand *Tmesipteris tannensis* with double synangium



Ophioglossopsida

- Small group (*Ophioglossum*, *Botrychium*, *Mankyua* and *Helminthostachys*) and ≈ 75 species
- Always have underground rhizome and aboveground bisected leaves: one half is the leaf blade and other half is **sporangiophore**. Gametophytes grow underground.
- Some (namely, *Botrychium*, grape fern) have **secondary thickening** of underground rhizome.
- *Ophioglossum vulgatum*, adder’s tongue fern, has $2n = 1360$, the largest chromosome number ever.

Ophiloglossum vulgatum, $2n = 1360$ hero



Helminthostachys zeylanicum (Ophioglossopsida)



Mankyua chejuense (Ophioglossopsida)



Marattiopsida

- Tropical ferns, several genera with ≈ 100 species
- Biggest ferns, one leaf (frond) could be 6 m length, but stems are smaller. Leaves with stipules.
- Sporangia (**eusporangia** like in all other Pteridophyta except “true” ferns) usually unite in **synangia**, gametophytes 1-2 cm in diameter, photosynthetic, terrestrial, usually long-lived.
- In a past, also were dominants of Carboniferous swamp forests.

Angiopteris sp. (Marattiopsida)



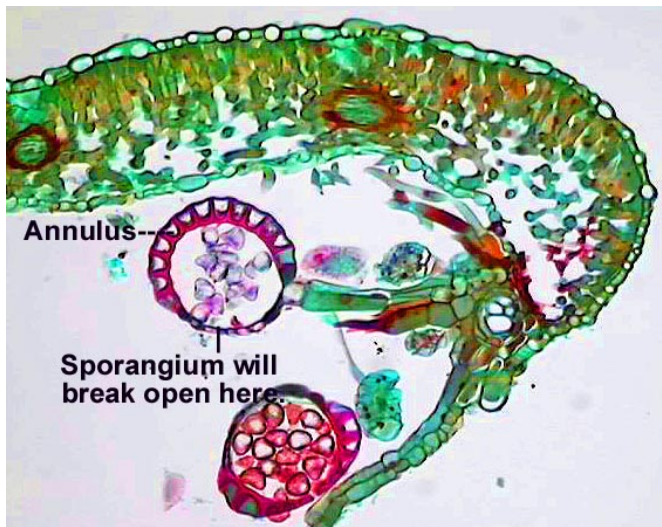
Synangia of *Danaea nodosa* (Marattiopsida)



Pteridopsida

- “True” ferns, about 10,000 species.
- Leaves are fronds, with apical growth. Young leaves are coiled in **fiddleheads**.
- Sporangia have one-celled wall (**leptosporangia**) and grouped in **sori** (often covered with indusium)
- Gametophyte minute, grow aboveground. Some genera of ferns are heterosporous.
- Bracken fern, *Pteridium aquilinum*, is the most widespread plant of the world.
- Many ferns have various vegetative reproduction.

Sorus, indusium, leptosporangium and annulus



Heterosporous fern *Marsilea quadrifolia*, the Shamrock. Well, almost...



Young leaves of bracken fern: Korean "gosari"



For Further Reading



A. Shipunov.

Introduction to Botany [Electronic resource].

Mode of access:

http://ashipunov.info/shipunov/school/biol_154