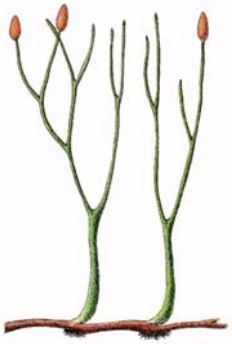
Luscious Lycophytes

Primitive Vascular Plants



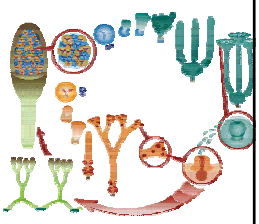
Aglaophyton

Primitive Vascular Plants

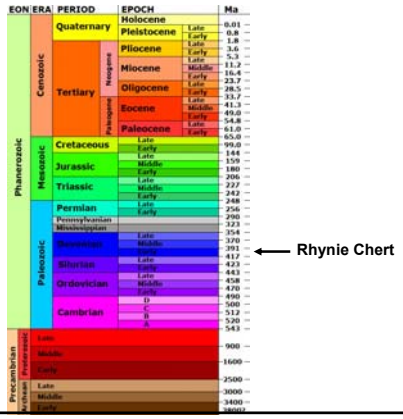
- Small & simple in structure
- Sporophyte a dichotomously branching stem
  - 1-2" high
  - Sporangia terminal
  - No leaves or roots
- Did not produce true tracheids in xylem
  - Used turgor pressure to remain upright
- Tracheids then evolved, giving rise to tracheophytes

Early Life Cycles

- Early vascular plants had alternation of more or less similar generations
  - Sporophyte & gametophyte (which was also branched) ~ same size
- Compared to bryophytes, both generations initially elaborate

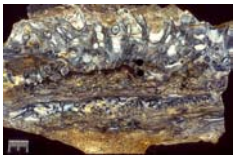


Geological Time Scale



The Rhynie Chert & Its Flora

- Found 1912, Rhynie, Scotland
- ~396 MYA
- Extremely important for our understanding of early plants, including vascular plants



http://www.uni-muenster.de/GeoPalaeontologie/Palaeo/Palbot/rhynie.html

Rhynie Chert Discoveries

Cyanobacteria:
- *Archaeothrix contexta*
- *Archaeothrix oscillatoriformis*
- *Kidstoniella fritschii*
- *Langiella scourfeldii*
- *Rhyniella vermiformis*
- *Rhyniococcus uniformis*

Fungi:
- *Allomyces* sp.
- *Glomites rhyniensis*
- *Krispiromyces discoides*
- *Milleromyces rhyniensis*
- *Palaeoblastocladia milleri*
- *Palaeomyces agglomerata*
- *Palaeomyces asteroxyli*
- *Palaeomyces gordonii*
- *Palaeomyces horneae*
- *Palaeomyces simpsonii*
- *Palaeomyces simpsonii*
- Several Chytridiomycetes
- Ascomycetes
  Various other undescribed fungi

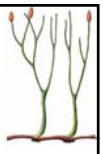
Lichens:
- *Winfrenatia reticulata*
- Nematophytes:
- *Nematophyton taitii*
- *Nematoplexus rhyniensis*

Algae *s.l.*:
- *Mackiella rotundata*
- *Palaeonitella cranii*
- *Rhynchertia punctata*

Tracheophytes (Sporophytes):
- *Aglaophyton major*
- *Asteroxylon mackiei*
- *Horneophyton lignieri*
- *Nothia aphylla*
- *Rhynia gwynne-vaughanii*
- *Trichopherophyton teuchansii*
- *Ventarura lyonii*

Tracheophytes (Gametophytes):
- *Langiophyton mackiei*
- *Lyonophyton rhyniensis*
- *Kidstonophyton discoides*
- Still undescribed female gametophyte of *Aglaophyton major*
- Still undescribed female and male gametophytes of *Rhynia gwynne-vaughanii*
- Still undescribed male gametophyte of *Horneophyton lignieri*

Aglaophyton



- Fossil taxon
- *Aglaophyton* best-known taxon from Rhynie Chert
  - New studies have shown that the conducting cells of *Aglaophyton major* are strongly reminiscent of those of certain mosses
  - Some authors, therefore, do not regard *Aglaophyton* as a real vascular plant

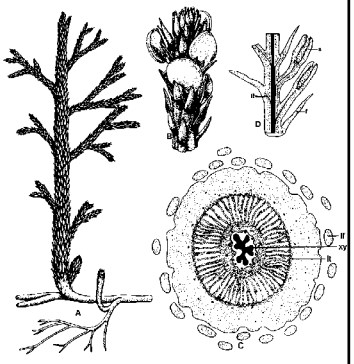
Rhynia

Asteroxylon

- ***Asteroxylon mackiei*, one of the earliest lycopods, is the only plant from the Rhynie Chert which had already small leaf-like structures**
  - **Lacked a vein**
- **Central stele = star-shaped xylem surrounded by phloem (actinostele)**
- **Resulted in a much greater plant stability**
- **Comparatively complex architecture**

Asteroxylon

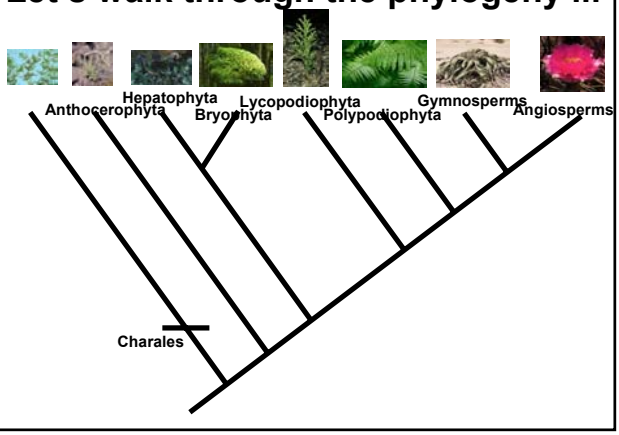
- **Up to 40 cm high**
- **Leaves up to 5 mm long**
- **Reniform sporangia on short stalks in leaf axils**



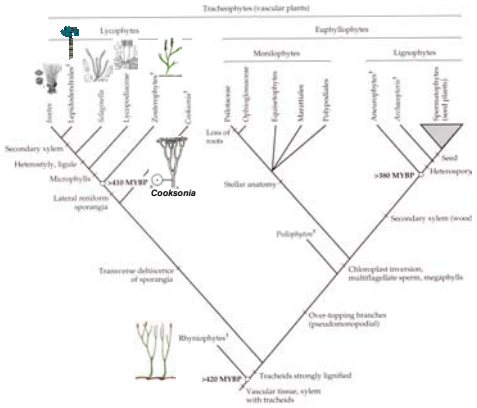
Asteroxylon

- **Rhizome formed repeatedly bifurcating root-like organs up to 20 cm deep**
  - **Not true roots, calyptra missing (cap-like structure on root tip)**
- **Leaves considerably increased photosynthetic surface**
- **Better able to regulate humidity**
  - **Keep dew drops between leaves**
  - **Better water regulation than other Rhynie Chert plants**
  - **Stomatal density of *Asteroxylon* is about 10X more than *Aglaophyton***
  - **Unlike other Rhynie Chert plants, could likely survive in temporarily drier environments**

Let's walk through the phylogeny ...



Phylogenetic Context



Lycophytes

Isoëtes
(Quillwort)

Selaginella
(Resurrection Plant)

Heterosporous

Lycopodium
(Club Mosses)

Homosporous

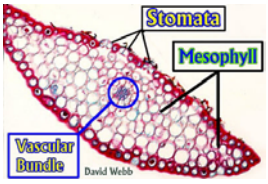
Sporophyte or Gametophyte?

- Bryophytes – dominant gametophyte generation
- Everything above them on the phylogeny – dominant sporophyte
- Gametophyte becomes successively reduced in size as we go along all the way up to angiosperms

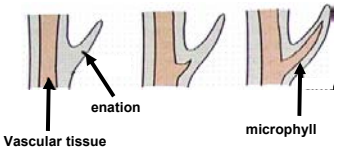
Shared Lycophyte Characters

- Contain true stems, roots & leaves
- Microphyll-type leaves
- Leaves densely spirally arranged
- Stems/ & roots often have dichotomous branching
- Sporangia borne on leaves
  - "Sporophylls"
- Sperm biflagellate

Microphylls



Enation Theory of Microphyll Origin



- Remember *Asteroxylon*?
  - Leaves without veins?
  - Enations!

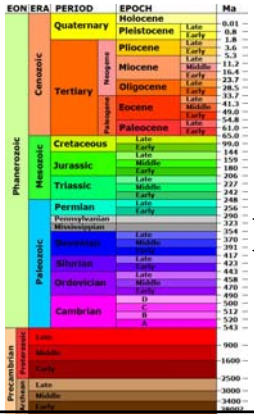
Extant Lycophyte Taxonomy

Lycopodiophyta
Lycopodiopsida
Lycopodiales
Lycopodiaceae
Selaginellaceae
Isoëtaceae

Lycopodiophyta

- An ancient group
- First fossils ~ 400 MYA (lower Devonian)
- Some extant genera known all the way back to ~300 MYA (Pennsylvanian epoch of Carboniferous)
- Today, a very small group, but once a dominant life form

Geological Time Scale



Lycopodiophyta

- The major contributor to coal deposits of Carboniferous period ["Fossil Fuels"]
- They were largest during this period (345-290 MYA), dominating coastal swamps of tropical lowlands
- Some (e.g., Lepidodendrales) were > 40 m high & 2 m diam., & dominated forests
- Majority of fossils from this time period from this group

Lycopodiaceae

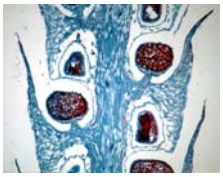
- Clubmoss, ground pine, running cedar
- Fossils date back to Pennsylvanian (300 MYA)
- Homosporous & leaves non-ligulate
  - Distinguish it from rest of order
- Strobilus = terminal cluster of sporophylls
  - Some spp. lack strobili; sporophylls elsewhere
- Sporangia kidney-shaped, opening by a transverse slit; solitary in leaf axils or borne on leaf bases

Lycopodium Sporangia

longitudinal slit

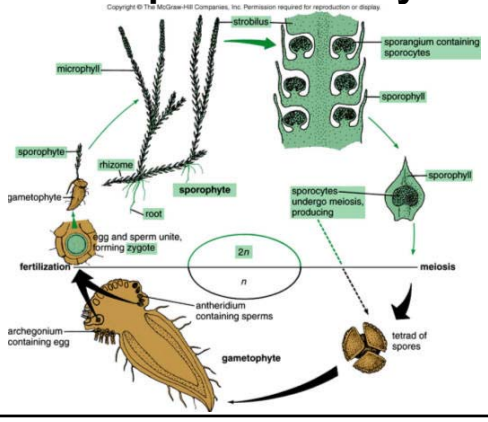
Lycopodium Strobilus

Homosporous



- Note all spores are the same size
- Contrast this with heterosporous plants

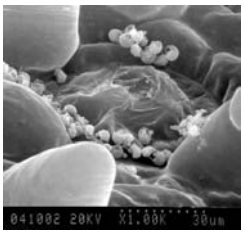
Homosporous Life Cycle



Gametophyte

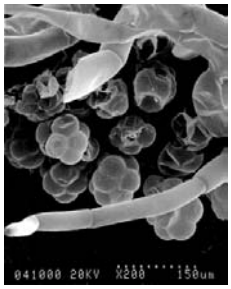
- Epiterrestrial or subterranean
- ~0.5” long
- Bisexual

antheridia

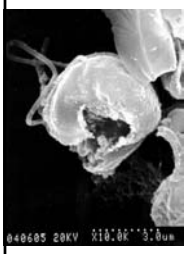


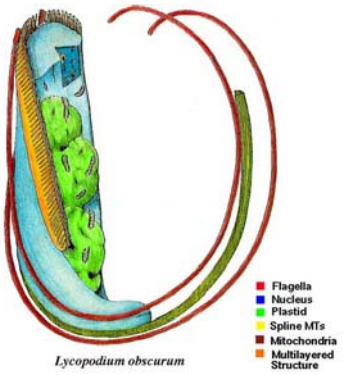
archegonia

Archegonia



Spermatozoids





Lycopodium obscurum

Economics

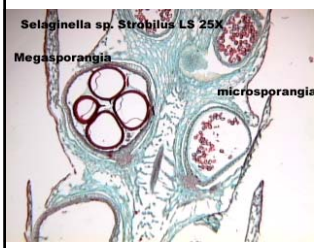
- Christmas garlands/wreaths
- Oily, highly flammable compounds in spore wall
  - Magicians/sorcerers in Middle Ages (flash of light)
  - The 'flash' of old-time photography
  - Early (experimental) photocopiers
  - Industrial lubricants
  - Formerly prevention of rubber cohesion in condoms & surgical gloves
- Used to count Avogadro's Number in chemistry lab

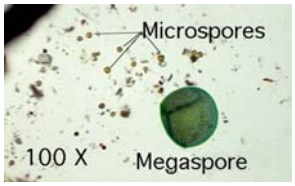
Heterosporous Lycophytes

- Selaginellaceae & Isoëtaceae
- Produce 2 types of spores
  - Microspores ("male")
  - Megaspores ("female")
- Microspores develop into microgametophytes
  - Produce antheridia & sperm
- Megaspores develop into megagametophytes
  - Produce archegonia & eggs

Heterospory

- Note the 2 different spore sizes
- Microspores are much smaller than megaspores

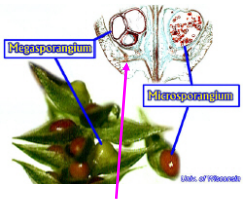




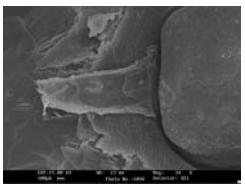
***Selaginella* strobilus**

Heterosporous Lycophytes

- Ligulate leaves
  - Leaves with a small flap of tissue at base



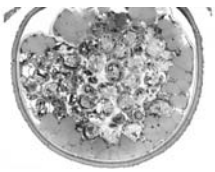
Selaginella ligule



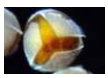
Isoëtes ligule

Endosporic Gametophytes

- **Mega- and microspores produce endosporic gametophytes in the heterosporous lycophytes**
- Gametophyte produces wholly within spore wall (until mature)



Selaginella microgametophyte



Isoëtes megagametophyte

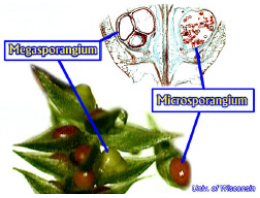
Selaginellaceae: *Selaginella*

Selaginellaceae

- 1 genus (*Selaginella*)
  - c. 750 spp. (38 in FNA)
- Most moist tropics
  - But many adapted to xeric habitats
- Leaves small (< 2 cm long)
- Sporangia usually in strobili
- Vegetatively similar to *Lycopodium*

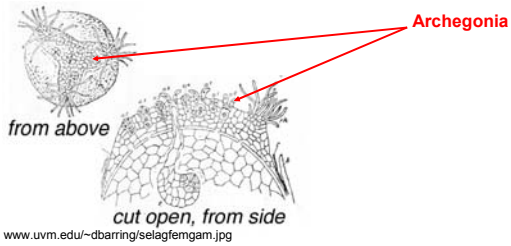
Selaginella Sporangia

- Both sporophyll-types still *microphylls* anatomically
- Megaspores produced in megasporaniga (megasporophyll)
- Microspores produced in microsporangia (microsporophyll)



Megagametophyte

- Endosporic
  - Bursting out when mature
- Anchored by rhizoids



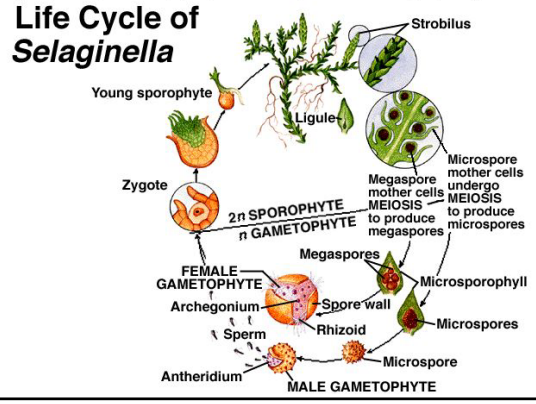
www.uvm.edu/~dbarring/selagfemgam.jpg

Resurrection Plant

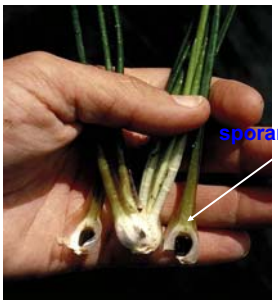
- Adaptation to xeric environments
  - Dormancy
  - Come back when conditions favorable

Selaginella lepydophylla

Heterosporous Life Cycle



Isoëtaceae: *Isoëtes*

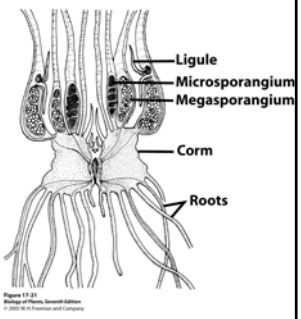


Isoëtes: Quillworts

- 2 genera in family, but we'll look at *Isoëtes* (150 spp.; 24 spp. in FNA)
- Cosmopolitan, except for Pacific islands
- Fossils similar to *Isoëtes* as far back as the Triassic (213-248 MYA)
  - Some with leaves 1 m long! NB. Still microphylls
- Usually aquatic or marshy-areas
- Similar looking to grasses & rushes
  - Often overlooked
- Leaves - elongated microphylls (up to 1 ft [30 cm], but can be as small as several centimeters)

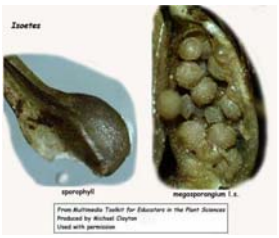
Isoëtes

- Stem – short, corm-like, 2(-4) lobed
- Shoot & root apices sunken
- Dichotomously branched



Sporangia

- Microsporangia produce ~ 150,000-1,000,000 microspores
- Megasporangia produce ~ 50-300 megaspores



As Aquarium Plants?

- Several species of *Isoëtes* can be used as aquarium plants

Isoëtes kirkii

Isoëtes Life Cycle