Tracheophyte Phylogeny Poster

VASCULAR PLANTS – SYSTEMATICS AND CHARACTERISTICS

Hornworts, Mosses, Liverworts see "Bryophyte" Phylogeny Poster

Lycophytes

lvs usu. with single central, unbranched vein
root dichotomous
sporangia reniform, dorsiventral and transversely dehiscent, 1 (adaxial) per leaf

homosporous
lvs eligulate
sporangia sometimes clustered in terminal strobili → **Lycopodiales** → Lycopodiaceae

cormose to rhizomatous
lvs spiral, in basal rosette
microspores monolete
megaspores 50–300 → **Isoëtales** → Isoëtaceae

heterosporous
lvs ligulate

sporangia on 4-sided strobili
lvs 4-ranked
microspores trilete
megaspores 4 → **Selaginellales** → Selaginellaceae

sporangiophores in terminal strobili
lvs whorled, fused into sheaths encircling base of internodes
stems ridged with internal hollow canals
spores with elaters 4–6, straplike → **Equisetales** → Equisetaceae

Ferns

each leaf with fertile (sporophore) & sterile (trophophore) parts
(latter inclined relative to former) → **Ophioglossales** → Ophioglossaceae

roots unbranched, root hairs absent
collateral leaf vascular bundles
gametophyte nonphotosynthetic, often subterranean, mycorrhizal

roots absent
lvs reduced, veins 1 or 0
sporangia 2–3, fused: synangium → **Psilotales** → Psilotaceae

Monilophytes

tropical, megaphyllous, stipules +
polycyclic siphonostele
often synangia, annulus –
sporangia open by longitudinal slit or pores → **Marattiales** → Marattiaceae

annulus lateral on sporangium
opening apically → **Osmundales** → Osmundaceae

sporangia in sori
sporangia primarily multi-layered:
eusporangial tapetum plasmodial
pseudoendospore +
siphonostele
stem protoxylem mesarch

sporangia
single-layered
with annulus:
leptosporangial

receptacle elongate
lvs thin, usually 1 cell layer
sori marginal → **Hymenophyllales** → Hymenophyllaceae

root steles with 3–5 protoxylem poles
rhizome with scales; veins anastomosing
sporangia maturation simultaneous → **Gleicheniales** → Gleicheniaceae Matoniaceae Dipteridaceae

annulus transverse, subapical
opening by longitudinal slit → **Schizaeales** → Anemiaceae Lygodiaceae Schizaeaceae

aquatic
aerenchyma +
leaf dimorphism
heterosporous; sporocarps; annulus – → **Salviniales** → Marsileaceae Salviniaceae

hairs

endospore
2-layered

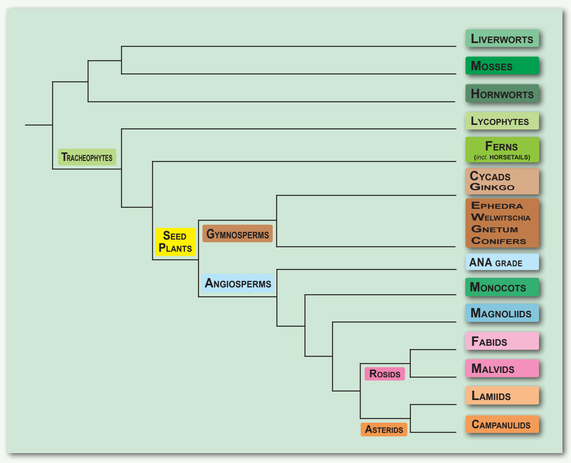
usually tree ferns
sori often terminal on veins → **Cyatheales** → Cyatheaceae; Cibotiaceae, Dicksoniaceae, Metaxyaceae, Thyrsopteridaceae, Loxsomataceae, Culcitaceae, Plagiogyriaceae

sporangial maturation mixed
annulus vertical on sporangium
interrupted by stalk and stomium → **Polypodiales** → Saccolomataceae, Lonchitidaceae, Pteridaceae, Cystodiaceae, Lindsaeaceae, Dennstaedtiaceae

Eupolypods I: Polypodiineae
(*incl.* Polypodiaceae, Davalliaceae, Didymochlaenaceae, Dryopteridaceae, Hypodematiaceae, Lomariopsidaceae, Oleandraceae, Tectariaceae)

Eupolypods II: Aspleniineae
(*incl.* Aspleniaceae, Athyriaceae, Blechnaceae, Cystopteridaceae, Desmophlebiaceae, Diplaziopsidaceae, Hemidictyaceae, Onocleaceae, Rhachidosoraceae, Thelypteridaceae, Woodsiaceae)

sporophyte dominant
vascular tissue:
tracheids + sieve cells
sporangia many
zygote:
1st division horizontal



Euphyllophytes

euphyll
leaf gaps
protoxylem exarch
roots monopodial
variously vessels
30-kb cp inversion

Seed Plants

Gymnosperms

females: whorls of megasporophylls
at trunk apex alternate with trophophylls
(no seed cones) → **Cycadaceae** → *Cycas*

pachycaulous; pinnate megaphylls
males with pollen cones; pollen tube simple
roots with N_2-fixing cyanobacteria

seed cones with 2[3] seeds
per megasporophyll
lignins with syringaldehydes → **Zamiaceae** → *Bowenia, Ceratozamia, Chigua, Dioon, Encephalartos, Lepidozamia, Macrozamia, Microcycas, Stangeria, Zamia*

dioecious

zooidogamy

Cycadales

Ginkgoales

stout short shoots with
lvs flabelliform, dichotomously veined, deciduous
pollen tube branched
ovules 2 (basal collar); cotyledons 2 → **Ginkgoaceae** → *Ginkgo*

ovules/seeds not
enclosed by carpel
pollen tube haustorial
primarily
anemophilous
primary endosperm
no bisexual strobili

xeromorphic, lvs scale-like, sheathed, shed early
stems narrow, striate, photosynthetic
seed cones: 1–3 ovules; double fertilization → **Ephedraceae** → *Ephedra*

vessels
porose perforation plates
dioecious

striate pollen
binucleate sperm
cotyledons 2

caudex
lvs 2 (straplike) life-long basal continuous growth
venation parallel
♀ gametophyte tubes grow towards pollen tubes → **Welwitschiaceae** → *Welwitschia*

ectomycorrhizal
lvs opposite, simple, broad,
venation reticulate
(angiosperm-like "convergence")
laticifers → **Gnetaceae** → *Gnetum*

Gnetales

monoecious
resin canals; lvs linear (needles)
pollen mostly 2-saccate
ovules 2, inverted
seeds winged → **Pinaceae** → *Abies, Cathaya, Cedrus, Hesperopeuce, Keteleeria, Larix, Nothotsuga, Picea, Pseudolarix, Pseudotsuga, Pinus, Tsuga*

Pinales

Conifers I

loss of
spermatozoids
nucellar
siphonogamy

monoecious or dioecious
lvs broad to acicular
pollen not saccate
seed cones large, disintegrate
cotyledons 2–4 → **Araucariaceae** → *Agathis, Araucaria, Wollemia*

leaves
morphologically
diverse

dioecious; roots with nodules
1 ovule/scale, cone often one seeded
receptacle and/or
epimatium/carpidium fleshy
cotyledons 2 → **Podocarpaceae** → *Acmopyle, Afrocarpus, Dacrycarpus, Dacrydium, Falcatifolium, Halocarpus, Lagarostrobus, Lepidothamnus, Manoao, Microcachrys, Nageia, Parasitaxus, Pherosphaera, Phyllocladus, Podocarpus, Prumnopitys, Retrophyllum, Saxegothaea*

Cupressales

Conifers II

monoecious
"double needles" (cladodes)
ovules 7–9 → **Sciadopityaceae** → *Sciadopitys*

dioecious
evergreen; pollen cones tiny
peltate microsporangiophores
1 ovule, 1 seed/cone, arillate
cotyledons 2 → **Taxaceae** → *Amentotaxus, Austrotaxus, Cephalotaxus, Pseudotaxus, Taxus, Torreya*

cone scales
opposite

monoecious
(*Juniperus:* monoecious or dioecious)
lvs mostly scale-like
pollen not saccate
ovules 1–20/scale
cotyledons many
seed cones terminal → **Cupressaceae** → *Actinostrobus, Athrotaxis, Austrocedrus, Callitris, Calocedrus, Chamaecyparis, Cryptomeria, Cunninghamia, Cupressus, Diselma, Glyptostrobus, Fitzroya, Fokienia, Juniperus, Libocedrus, Metasequoia, Neocallitropsis, Papuacedrus, Pilgerodendron, Platycladus, Sequoia, Sequoiadendron, Taiwania, Taxodium, Tetraclinis, Thuja, Thujopsis, Widdringtonia, Xanthocyparis*

Spermatophytes

eustele
secondary growth
heterosporous
ovules
seeds
pollen
pollen tube with 2 gametes each

bisexual flower; fruit (ovules enclosed by carpel); loss of spermatozoids
pollen tube penetrating stigma/style/nucellus/synergid (complete siphonogamy)
vessels; pollenkitt; primarily zoophilous
double fertilization: triploid endosperm

Angiosperms see Angiosperm Phylogeny Poster

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Angiosperm Phylogeny Poster

Tracheophyte Phylogeny Poster

Bryophyte Phylogeny Poster

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• hypothetical tree based on molecular phylogenetic data (2020)
• branch lengths deliberate, not expressing actual time scale
• if a character is marked as being a potential synapomorphy at a node/for a clade, this does not mean that all members of that clade possess that character
• this poster is now available in 20 languages

References

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