

Plant Diversity

Ch 30

- From **Sea to Land**
- Origins, Relationships, Diversity
- Shared Derived Traits (**Synapomorphies**)
- **Nonvascular** to **Vascular** Plants
- **Seedless** to **Seeds**



Videos 28-3, 28-5



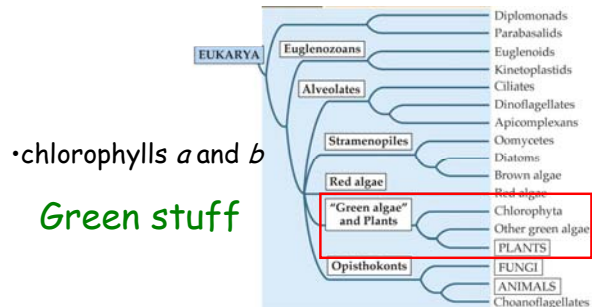
03 March 2009
ECOL 182R UofA
K. E. Bonine



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The Evolution of Land Plants

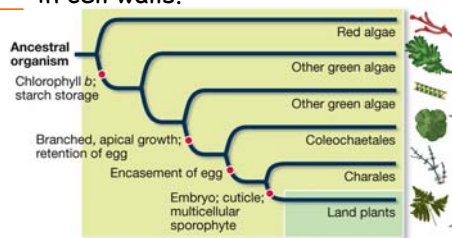
(from the edge of the swamp...)



Original Land Plants Related to Algae

Land plants retain derived features they share with **green algae (Charales)** and

as a storage product in cell walls.



Land Plants are Monophyletic

Land plants are **monophyletic**, all descend from a single common ancestor.

One **synapomorphy**: development from an **embryo protected** by tissues of the parent plant. Therefore, also called **embryophytes**.

(*phyton* = plant)

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Land Plants Comprise ~Ten Clades

Nonvascular (3 clades)

- paraphyletic** group
- liverworts,
- hornworts
- mosses



Vascular plants, or *tracheophytes*

(7 clades)—all have conducting cells called **-tracheids**.

-**monophyletic** group

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Moving to Land

Plants first appeared on land between **400-500 million years ago**.

Environmental Challenges:

- 1.
2. transport to all parts
3. (fight gravity)
4. disperse

Some challenges met immediately, others took millions of years

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Biological history

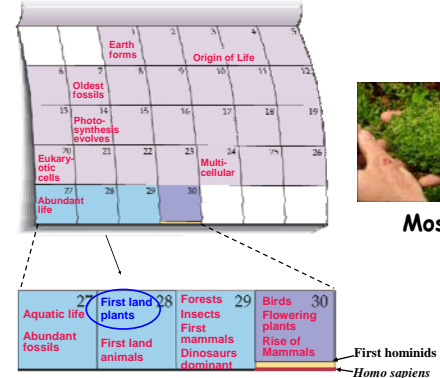
22.1 Earth's Geological History (Part 2)

RELATIVE TIME SPAN	ERA	PERIOD	ONSET	MAJOR EVENTS IN THE HISTORY OF LIFE
Cenozoic	Quaternary	1.8 mya*	Humans evolve; many large mammals become extinct	
		65 mya	Diversification of birds, mammals, flowering plants, and insects	
	Cretaceous	144 mya	Dinosaurs continue to diversify; flowering plants and mammals diversify; Mass Extinction at end of period (~70% of species disappear)	
Mesozoic	Jurassic	206 mya	Diverse dinosaurs; radiation of ray-finned fishes	
	Triassic	248 mya	Early dinosaurs; first mammals; marine invertebrates diversify; first flowering plants; Mass Extinction at end of period (~95% of species disappear)	
Paleozoic	Permian	290 mya	Reptiles diversify; amphibians decline; Mass Extinction at end of period (90% of species disappear)	
	Carboniferous	354 mya	Extensive "fern" forests; first reptiles; insects diversify	
	Devonian	417 mya	Fishes diversify; first insects and amphibians; Mass Extinction at end of period (~70% of species disappear)	
Paleozoic	Silurian	443 mya	Jawless fishes diversify; first ray-finned fishes; plants and animals colonize land	
	Ordovician	490 mya	Mass Extinction at end of period (~85% of species disappear)	
Cambrian	543 mya	Most animal phyla present; diverse algae		
	600 mya	Ediacaran fauna		
Precambrian	1.5 bya*	Eukaryotes evolve; several animal phyla appear		
	3.8 bya	Origin of life; prokaryotes flourish		
	4.5 bya			

*mya, million years ago; bya, billion years ago.

Plants first appeared on land between 400-500 million years ago.

Biological history



Adaptations for Land

- Cuticle**
 - waxy covering that **retards water**
- Gametangia** enclosing gametes
- Embryos in a protective structure
- Pigments** that protect against UV radiation
- Spore walls containing **sporopollenin**
 - resists **desiccation** and
- Mutualistic relationships with **fungus**
 - to promote _____ from soil

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Plants Help Create Soil

Ancient plants contributed to **soil** formation.
Acids secreted by plants help break down rock.
Organic material from dead plants contributes to soil structure.
 Create **habitat** and pave way for **succession** of other species.

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Nonvascular Plants Are Similar to Ancestral Land Plants

Today's nonvascular plants are thought to be similar to the first land plants.

They grow in **moist environments** in dense mats

They are small, there is **no system to conduct water** from soil to plant body parts.



mosses

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Traits of Nonvascular Plants

Growth pattern of nonvascular plants allows water to move through mats by **capillary action**.

Minerals can be distributed through the small plants by **diffusion**.

Mutualistic relationship with fungi called **glomerozymetes** which promote absorption of water and minerals.



mosses

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Nonvascular Plant Reproduction

Base of **archegonium** grows to **protect** embryo during early development.

(land plants aka **embryophytes**)

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Nonvascular Diversity

Hornworts: Anthocerochyta—100 species.

Gametophytes are flat plates of cells.

Have **stomata**, which **do not close**.

Hornwort cells have a **single, large chloroplast**.

The sporophyte has no stalk; but has a basal region capable of infinite cell division. Sporophytes can grow **up to 20 cm**.

Hornworts have internal cavities filled with **nitrogen-fixing cyanobacteria**.



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Life cycle of a moss



Video 28-3

Mosses are group to plants

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Moss...

Sphagnum grows in swampy places.

The upper layers of moss compress lower layers that are beginning to decompose, forming **peat**.

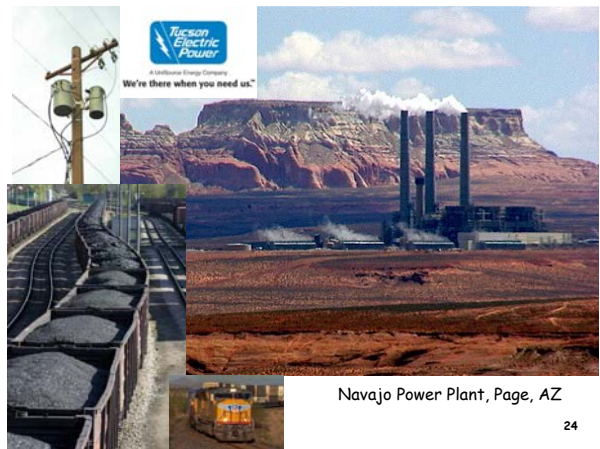
Long ago, continued compression led to the formation of .

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LIFE 8e, Figure 28.15

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Navajo Power Plant, Page, AZ

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Paleozoic: Carboniferous

- Large glaciers and swamp forests of treeferns and horsetails.

- Fossilized forests formed the **we now mine for**



Vascular Plants Arose from Nonvascular

Recently, fossilized fragments of ancient liverworts have been discovered.

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Vascular Plants Comprise Seven Clades

10 clades of land plants:

Nonvascular (3 clades)

- liverworts, hornworts, and mosses
- paraphyletic group

Vascular plants, or tracheophytes (7 clades)

- conducting cells called **tracheids**.
- monophyletic** group



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Seedless Vascular Plants

TABLE 28.1

Classification of Land Plants		
GROUP	COMMON NAME	CHARACTERISTICS
NONVASCULAR PLANTS		
1	Hepatophyta	Liverworts
2	Anthoceroophyta	Hornworts
3	Bryophyta	Mosses
VASCULAR PLANTS		
4	Lycophyta	Club mosses and allies
5	Pteridophyta	Horsetails, whisk ferns, ferns
SEED PLANTS		
6	Gymnosperms	Cycads
7	Ginkgophyta	Ginkgo
8	Gnetophyta	Gnetophytes
9	Coniferophyta	Conifers
10	Angiosperms	Flowering plants

Note: No extinct groups are included in this classification.

Traits of Vascular Plants

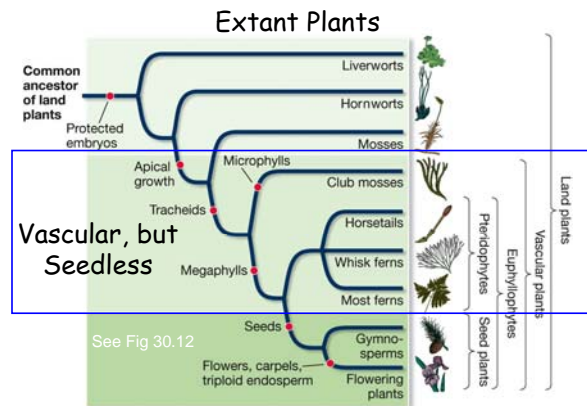
The **vascular system** consists of tissue specialized for the transport of materials.

_____ conducts water and minerals from soil up to aerial parts of plant. Some cells have **lignin**—provides **support**.

Tracheids are the main water-conducting element in xylem. Angiosperms have tracheids plus a more efficient system of vessels and fibers.

_____ conducts products of photosynthesis through plant.

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LIFE 8e, Figure 28.7

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Evolution of Vascular Plants

Vascular plants have a branching,

Mature sporophyte is **nutritionally independent** from the gametophyte.

Still must have water for part of the life cycle—for the flagellated, swimming sperm.

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Evolution of Vascular Plants

Earliest vascular plants (now extinct):

Rhyniophytes (Silurian) had dichotomous branching, but lacked leaves and roots.

They were anchored by **rhizomes** (horizontal portions of stem) and **rhizoids** (water-absorbing filaments).



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Earliest vascular plants

Evolution of Vascular Plants

Lycophytes appeared in the Silurian.

Pteridophytes appeared in the Devonian.

These groups had true roots and leaves, and two types of spores.

Overtopping evolved --new branches grow beyond the others—an advantage in the competition for light

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Evolution of Vascular Plants

Leaf: a flattened photosynthetic structure arising from a stem or branch; has true vascular tissue.

Two types: microphylls and megaphylls.

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Evolution of Leaves

Small megaphylls first appeared in the Devonian. Large megaphylls did not appear until the Carboniferous.

One theory: **high CO₂** concentrations in the Devonian prevented development of *stomata*.

Stomata allow heat to be lost by the evaporation of water. Large leaves with no stomata would have resulted in

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Evolution of Vascular Plants

Horsetails: Fifteen species in one genus—*Equisetum*.

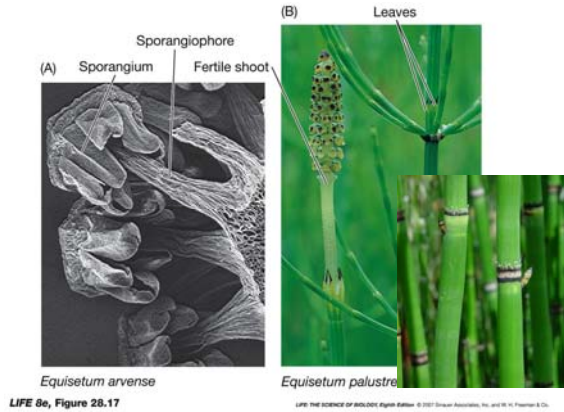
Silica in cell walls—"scouring rushes."

Have **true roots**



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Figure 28.17 Horsetails



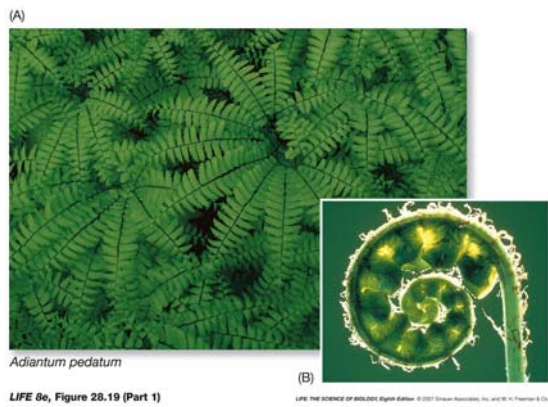
Evolution of Vascular Plants

Ferns: 12,000 species. About 97 percent are in a clade—leptosporangiate ferns—sporangia walls only one cell thick, borne on a stalk.

Sporophytes have **true roots, stems, and leaves.**

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Figure 28.19 Fern Leaves Take Many Forms



Ferns...

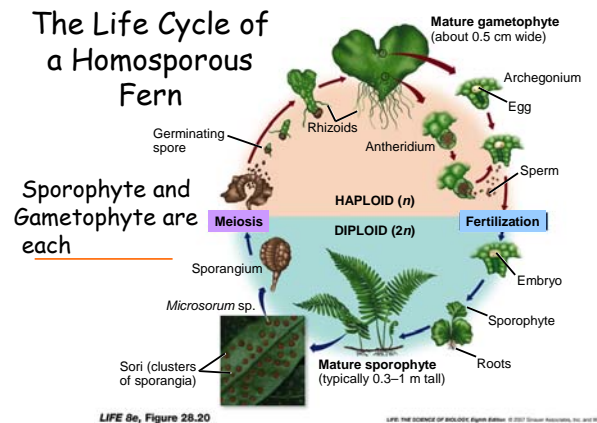
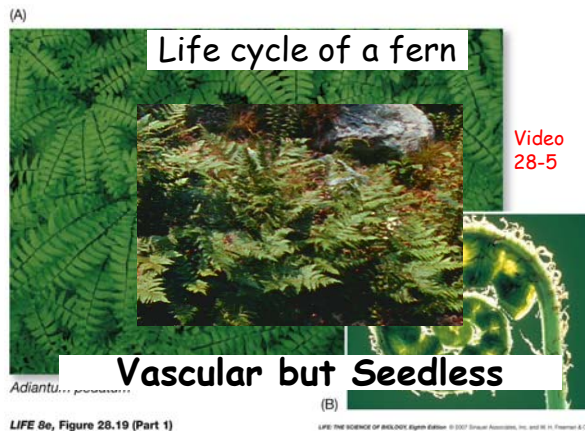
Most ferns are in **shaded, moist** environments.

Tree ferns can reach heights of 20 m.

Sporangia occur on undersides of leaves in clusters called **sori**.

Some genera have a tuberous gametophyte that depends on a **mutualistic fungus** for nutrition.

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Ferns...

DNA research suggests that diversification of modern ferns is fairly recent.

Ferns may have taken advantage of **shady environments created by angiosperm trees.**

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Early Vascular Plants

During the Permian, the continents came together to form Pangaea.

Extensive glaciation occurred late in the Permian.

Lycophyte-fern forests were replaced by **gymnosperms.**



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Bristlecone Pine



If you could imagine a living tree as old as the pyramids of Egypt, what do you think it would look like? It would look like a bristlecone pine, *Pinus longaeva*, the known tree species in the world.

The bristlecone pine only lives in scattered, arid mountain regions of six western states of America, but the oldest are found in the Ancient Bristlecone Pine Forest in the **White Mountains of California.** There the pines exist in an exposed, windswept, harsh environment, free of competition from other plants and the ravages of insects and disease. The oldest bristlecones usually grow at elevations of **10,000 to 11,000 feet.**

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Bristlecone Pine



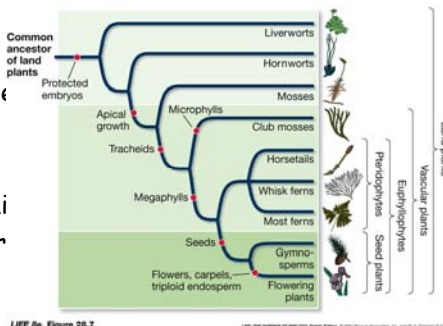
The year is not clear, but the tree is estimated to be over 4,800 years old. It is the oldest living tree on Earth, and its age is determined by the growth rings in its trunk. The tree is a member of the Pinus genus, and it is found in the White Mountains of California. It is a member of the Pinus longaeva species, which is the oldest living tree species in the world.

Laboratory of Tree-Ring Research
<http://www.ltrr.arizona.edu/>

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Which of the following are vascular plants?

- a Juniper
- b Sunflower
- c Fern
- d Moss
- e Horsetail
- f Liverwort
- g Lily



LIFE 8e, Figure 26.7

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