

**Tree of Life II:  
Eukaryotes (Protists and  
Plants)**

**Biology/Env S 304**

**Spring 2007**

# TOL: Eukaryotes

- 1) Protists (protistans, protoctists)
- 2) Plants
- 3) Fungi
- 4) Animals

# TOL: Protists

- Extremely diverse
- Most have some form of sexual reproduction
- Ecological roles include producers and consumers (pathogens, predators, symbionts) and some decomposers
- Plant-like (producers); fungus-like (decomposers); animal-like (predators, pathogens, parasites)

# TOL: Protists

Note that these three groups, based on feeding strategies, do not necessarily reflect evolutionary relationships as revealed by genetic data.

# Protistan diversity

See Fig. 1, Palmer et al. (2004)  
American Journal of Botany 91:  
1437-1445. (available on-line  
through the ISU library)

# TOL: Protists (animal-like)

- Animal-like protists are often called protozoans
- Include the flagellates, ciliates, apicomplexans, euglenas, and others
- Consumers by ingestion
- Ecologically very important in aquatic food webs but also as animal parasites

# TOL: Protists (animal-like)

- There are about 300-500 million cases of malaria a year, mostly in Africa
- About 1-3% are fatal (as many as 3 million deaths per year, maybe more)
- Main vector is mosquitoes
- Plasmodium is showing drug-resistance

# TOL: Protists (fungus-like)

- Fungal-like protists include the slime molds and the oomycetes
- Consumers by absorption
- Can be pathogens or decomposers

# TOL: Protists (fungus-like)

Oomycetes:  
potato blight,  
cause of the Irish  
potato famine

Also the cause of  
sudden oak death.

# TOL: Protists (plant-like)

- Plant-like protists are known as algae (very large ones are seaweeds)
- Includes those protists with non-green chloroplasts (e.g., dinoflagellates, golden-brown algae, brown algae, red algae)
- Extremely important as producers in aquatic ecosystems (both marine and fresh-water)

# TOL: Protists (plant-like)

dinoflagellate

red tides (PSP)  
bioluminescence

# TOL: Protists (plant-like)

diatoms

Diatomaceous earth

# TOL: Protists (plant-like)

brown algae (kelps)

Sargasso sea kelp

# TOL: Protists (plant-like)

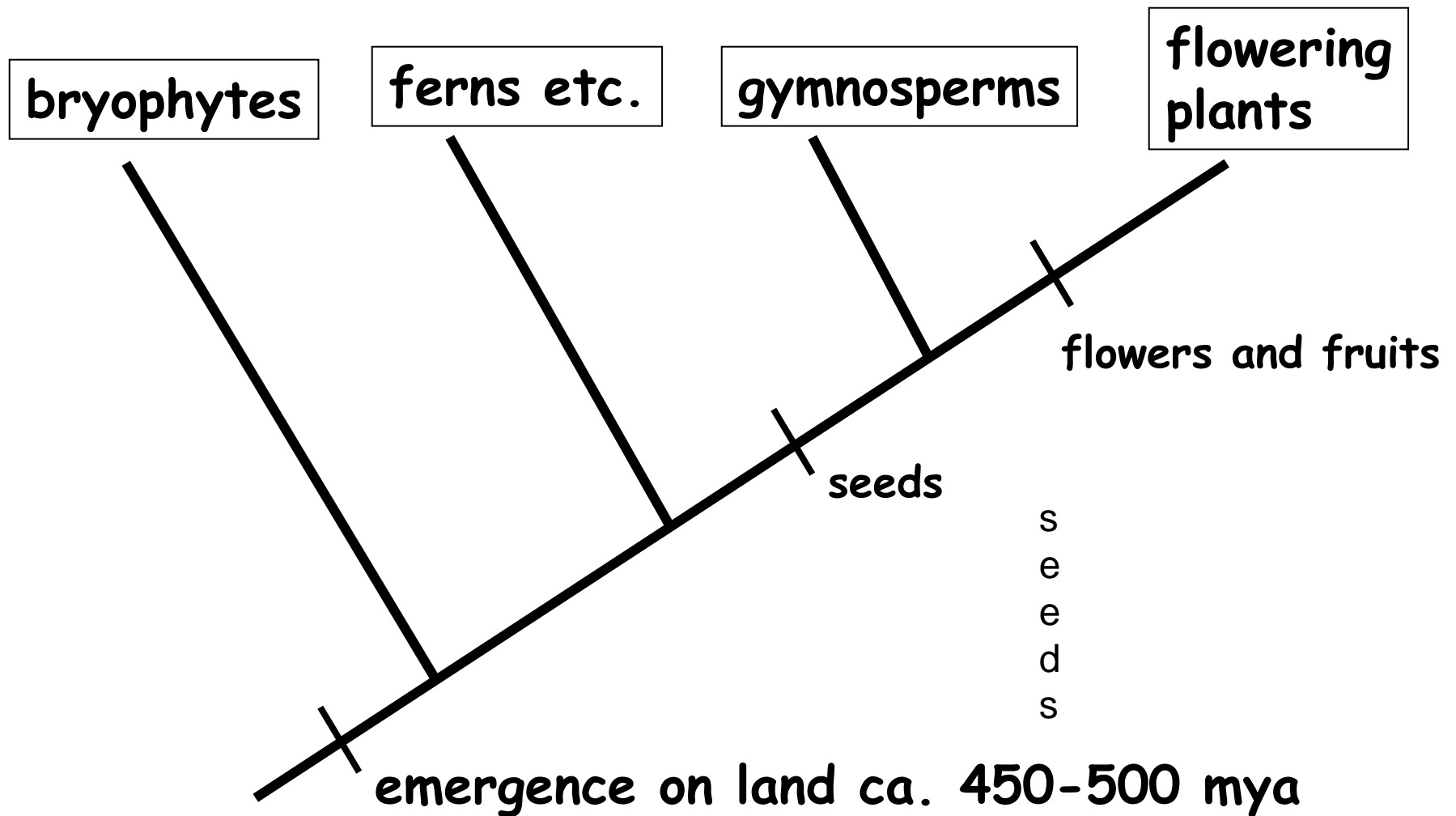
red algae

- coral reefs
- source of  
carrageenan,  
agar
- eaten  
directly (nori)

# TOL: Plants

- Photosynthesis using chlorophylls a and b (non-plant producers have some other combination of chlorophylls)
- Store starch in the chloroplasts
- Cell walls made of cellulose
- Green algae and terrestrial plants

# TOL II: Land plants



# TOL: Plants (green algae)

- Green algae include at least 7,000 species
- Ancestors of terrestrial plants
- Important primary producers, especially in fresh water systems
- Seaweeds are marine

Spirogyra

# TOL: Life on Land

About 500-600 million years ago, there was a teeming diversity of life in the oceans but no life on land.

But by 500 million years ago, life was emerging on land and by 400 million years ago, plants, animals and fungi were radiating into available habitats.

What happened?

# TOL: Life on Land



oxygen gas and  
free oxygen radicals

ozone  
in the  
ozone layer

# TOL: Life on Land

- By about 500 million years ago, enough ozone had accumulated to protect the land surface from ultraviolet (UV) radiation
- UV radiation causes what?
- Mutations
- Plants and fungi probably emerged first, then animals

# TOL: Problems of life on land

- 1) How to get male to female and maintain sexual outcrossing
- 2) How to capture more energy
- 3) How to disperse more offspring over greater distances
- 4) How to reproduce more efficiently (reduce matings with "wrong" species, improve survival of offspring)

# TOL: Plants on Land

Bryophytes were the first plants on land.

liverworts

hornworts

mosses

# TOL: Plants on Land

- Bryophyte solution:
  - Stay small, keep male and female plants close together (1)
  - Grow slowly, go dormant in bad times, grow on rocks and trees where competition is reduced (2)
  - Produce spore capsules on elongated stalk, tiny spores for wind dispersal, disperse from rocks and trees (3)
  - Not much progress on increasing efficiency (4)

# TOL: Plants on Land

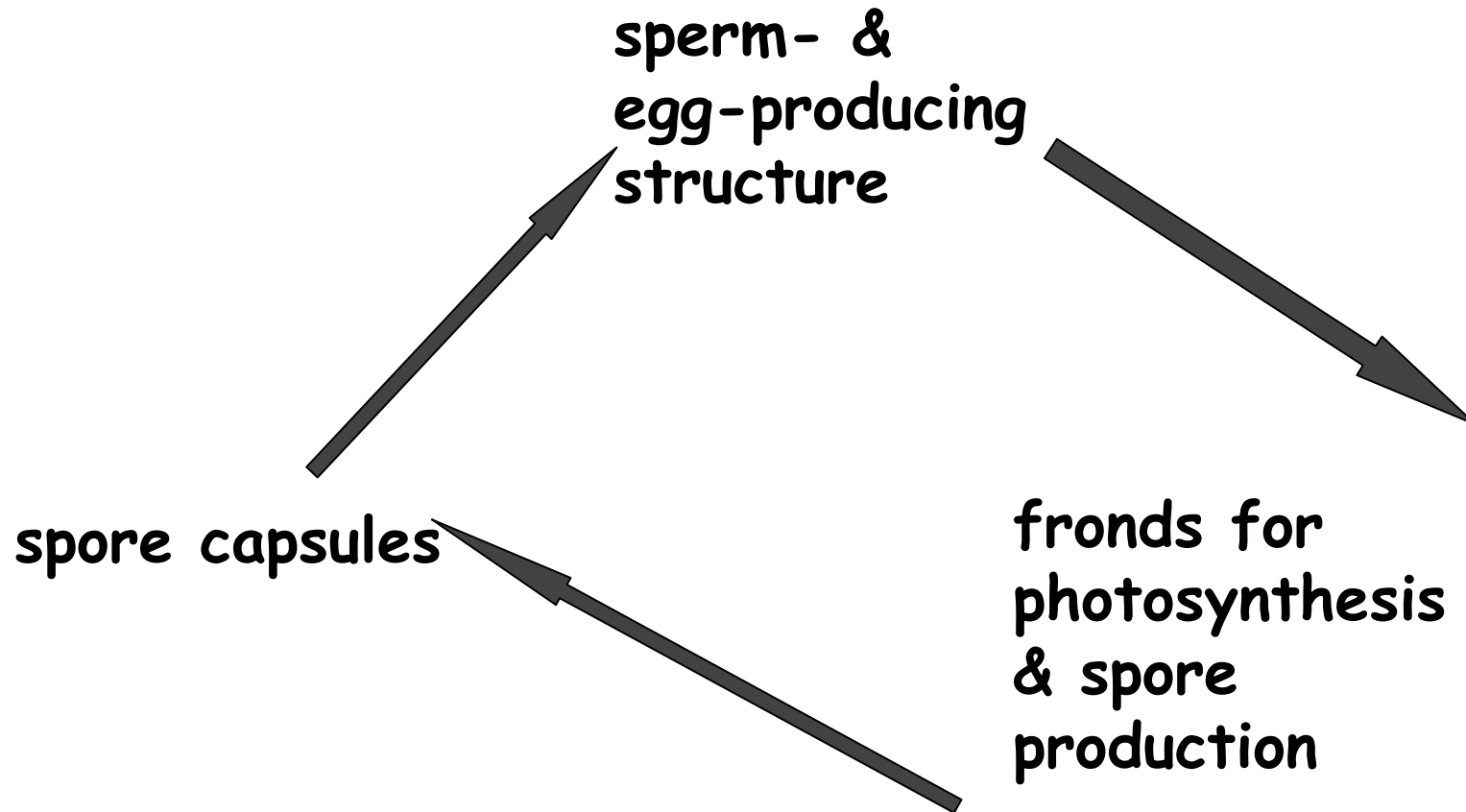
sperm-producing  
structures in a liverwort

egg-producing  
structures in a liverwort

# TOL: Plants on Land

- Pteridophyte (ferns and fern allies) solution to life on land:
  - Keep sexual stage small, males and females close together (1)
  - Allow spore-producing structure to become nutritionally independent (grow tall, produce leaves) (2)
  - Produce more capsules at a greater height (3)
  - Be glad you have improved on 2 while solving 1 and have become the dominant plants of your time

# TOL: Plants on Land



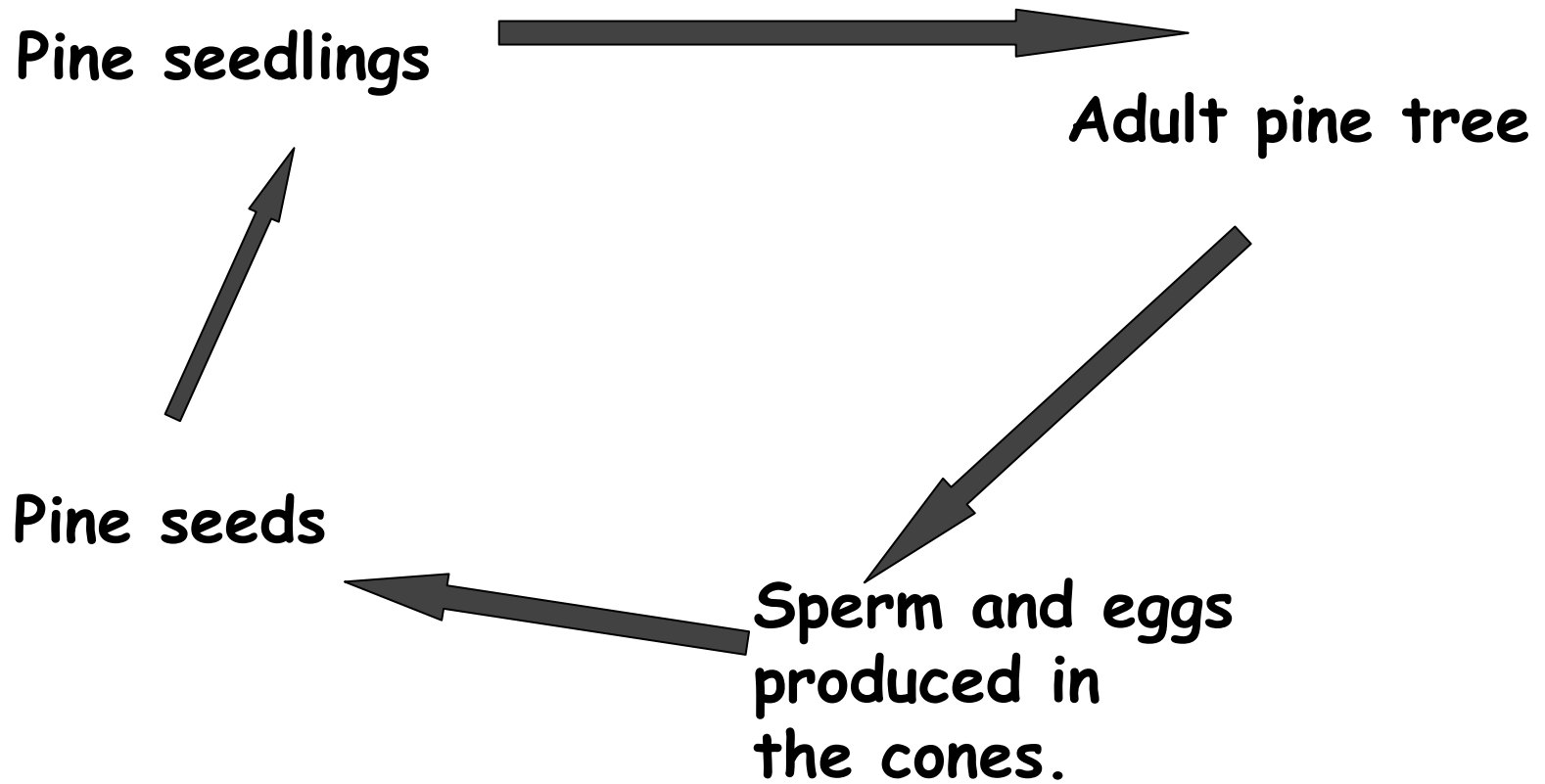
# TOL: Plants on Land

Ferns and fern allies of the Carboniferous produced the deposits of oil, coal and natural gas that we use today ("fossil fuels").

# TOL: Plants on Land

- The gymnosperm (seed plant) solution to life on land:
  - Protect sperm- and egg-producing structures, make pollen to carry the sperm by wind (1)
  - Become the tallest plants (2)
  - Become the tallest plants (3)
  - Produce seeds with stored energy to better nourish seedlings (4)
  - Simultaneously solved problems 1, 2 and 3, become dominant in their turn

# TOL: Plants on Land



# TOL: Plants on Land

- The flowering plant (angiosperm) solution to life on land:
  - As in gymnosperms, but pollen has to travel further (1)
  - Adopt gymnosperm or fern (or occasionally bryophyte) solution (2)
  - Adapt seeds and fruits to particular dispersal agents (3)

# TOL: Plants on Land

- The flowering plant (angiosperm) solution to life on land:
  - Use animals for “special delivery” of pollen to the right species and continue to make seeds (4) (includes inhibitors to prevent growth of “wrong” pollen, lots of seed and fruit adaptations for transport, burial, dormancy, nourishment)

# TOL: Plants on Land

- Flowering plants are the most dominant plants on land—are the most efficient in terms of reproduction
- Ca. 16,000 species of bryophytes, ca. 12,000 species of ferns and fern allies, ca. 970 species of gymnosperms, and ca. 300,000 species of flowering plants

# TOL: Plants on Land

Flowering plant seeds are  
the basis for human  
civilization.

cereal grains

beans

# TOL: Plants on Land

willow

Secondary chemicals  
provide many  
medicines.

*Catharanthus roseus*

# TOL: Plants on Land

ragweed

**Have you thanked  
a plant today?**