

# Poaceae - the grasses



- the second large independent shift to reduced flowers and spikelets for wind pollination
- 4th largest family - 620 genera, 10,000 species
- most important family (ethnobotanically)



# grasses you collected!



*Setaria* spp. –  
foxtail



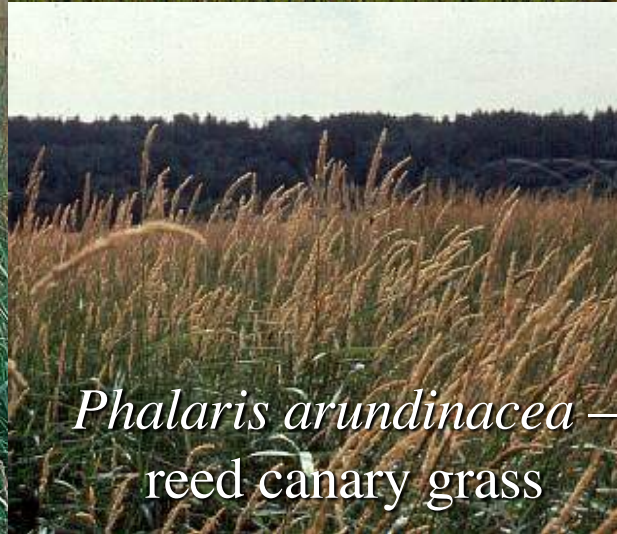
*Andropogon gerardii* –  
big bluestem



*Schizachyrium scoparium* –  
little bluestem



*Sorghastrum nutans* –  
Indian grass



*Phalaris arundinacea* –  
reed canary grass



*Bromus inermis* –  
smooth brome

# Picture key to grasses!



*Setaria* spp. –  
foxtail



*Andropogon gerardii* –  
big bluestem

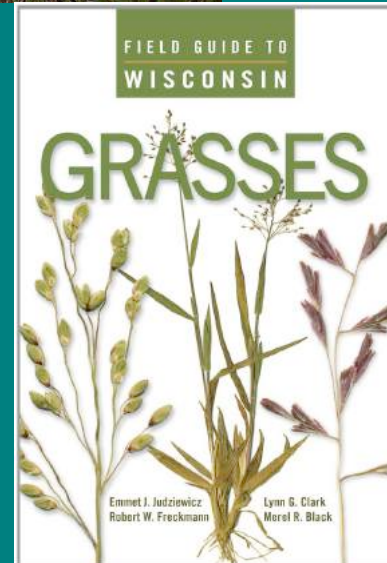


*Schizachyrium scoparium* –  
little bluestem

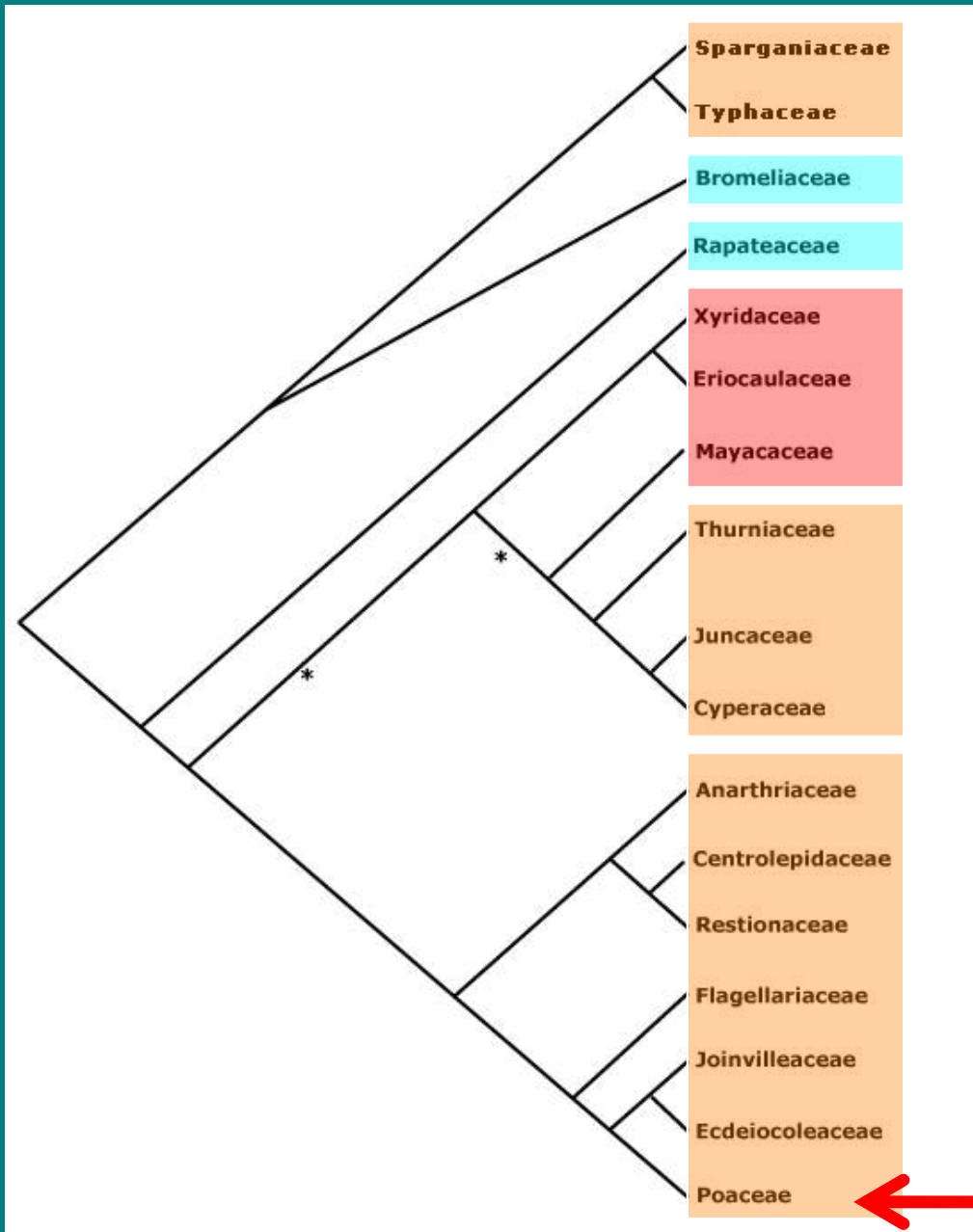
Grasses of Iowa

[www.eeob.iastate.edu/research/iowagrasses](http://www.eeob.iastate.edu/research/iowagrasses)

Field Guide to Wisconsin Grasses – book in lab



# Poales III: wind pollinated families



- showy flowers, insect or bird pollinated



- +/- reduced flowers, insect or wind pollinated



- reduced flowers, wind pollinated



# Poales III: wind pollinated families

Evolutionary trends:

- nectar to pollen gathering to **wind pollination**
- **reduced flowers** - loss of perianth
- **unisexuality** sometimes
- **bracts** become important
- flowers to **florets in spikelets**

- **showy flowers, insect or bird pollinated**



- **+/- reduced flowers, insect or wind pollinated**

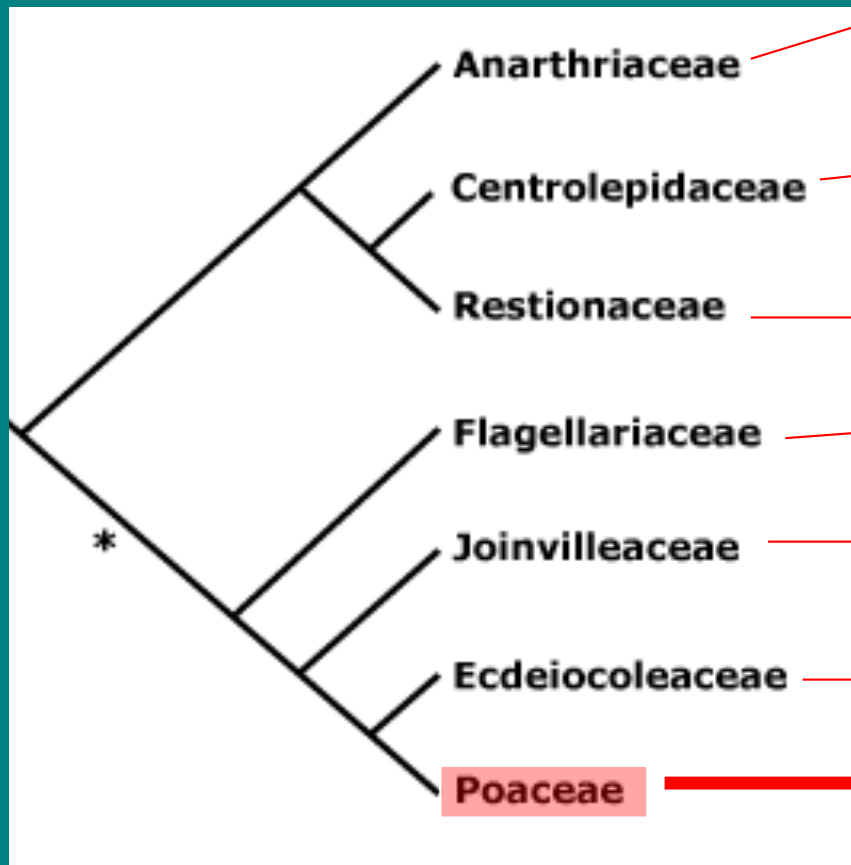


- **reduced flowers, wind pollinated**



# Poaceae - grasses

Poaceae related to more typical, although reduced, flowered graminoid monocots with 6 tepals – **Southern Hemisphere!**



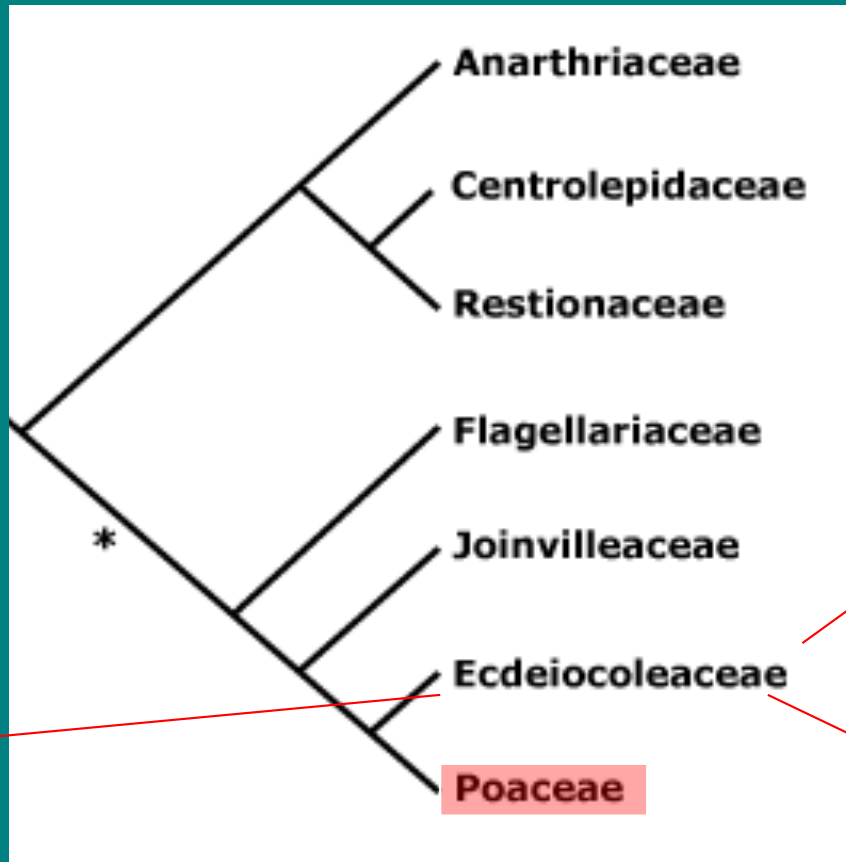




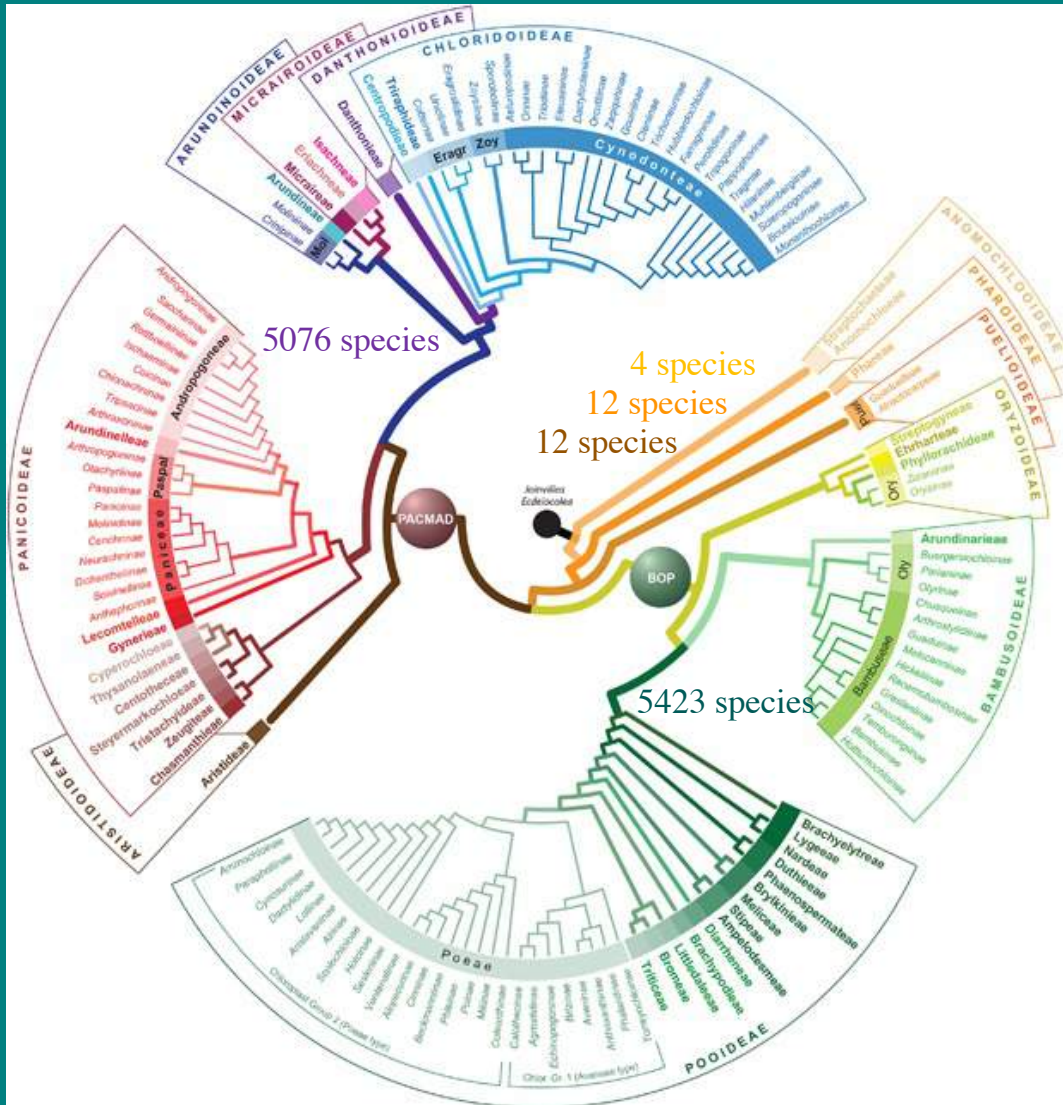
# Poaceae - grasses

Poaceae related to more typical, although reduced, flowered graminoid monocots with 6 tepals – **Southern Hemisphere!**

- bracted
- 6 tepals
- mixed male & female flowers
- achene



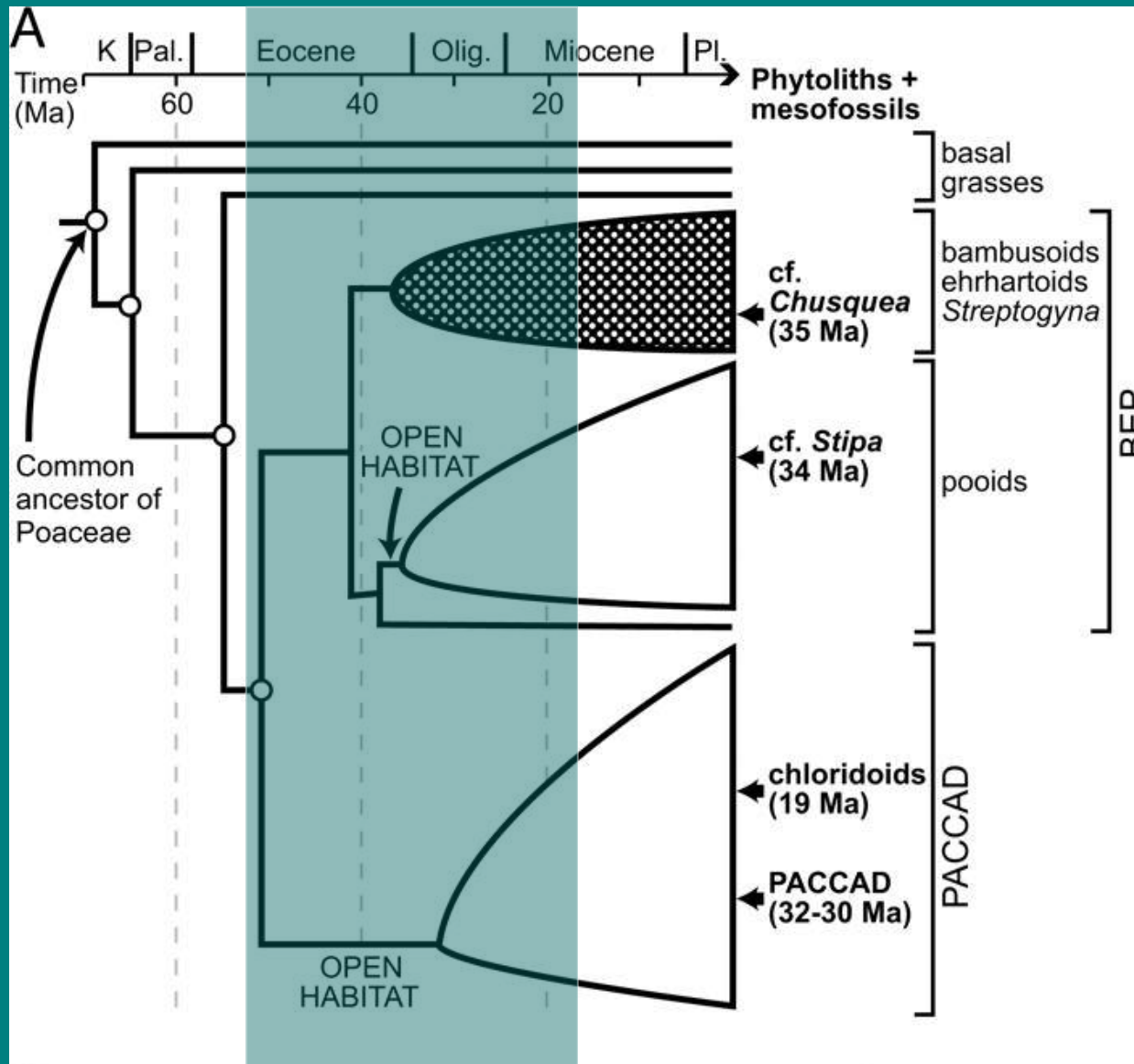
# Poaceae - grasses



What has driven this large and successful adaptive radiation?



# Poaceae - grasses



- first diversified ca. 70 mya in late Cretaceous – tropical forest understories
- major radiations during **formation of grasslands** in mid Tertiary
- shift to grasslands basis for adaptive radiation?

# Poaceae - grasses



blade  
ligule  
sheath

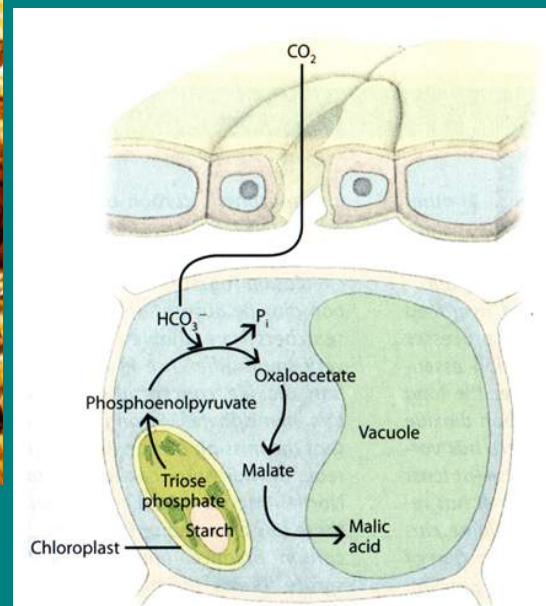
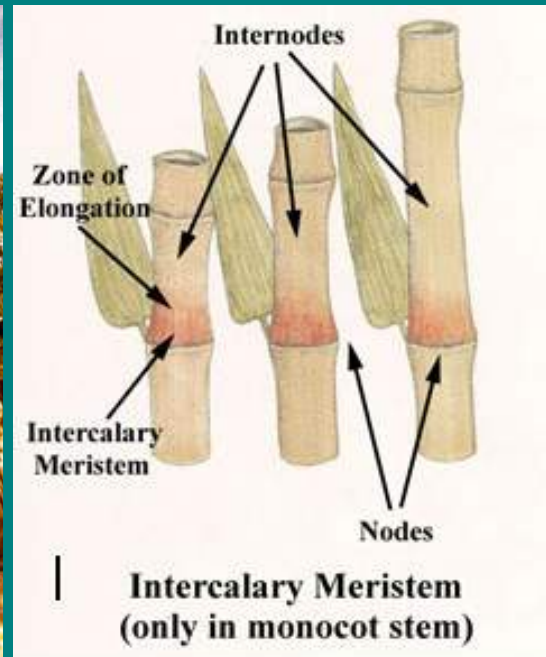
## Vegetative features

- jointed, hollow, circular stems (culms)
- leaves 2-ranked or spiralled
- blade, sheath, and ligule
- intercalary meristem above nodes

# Poaceae - grasses



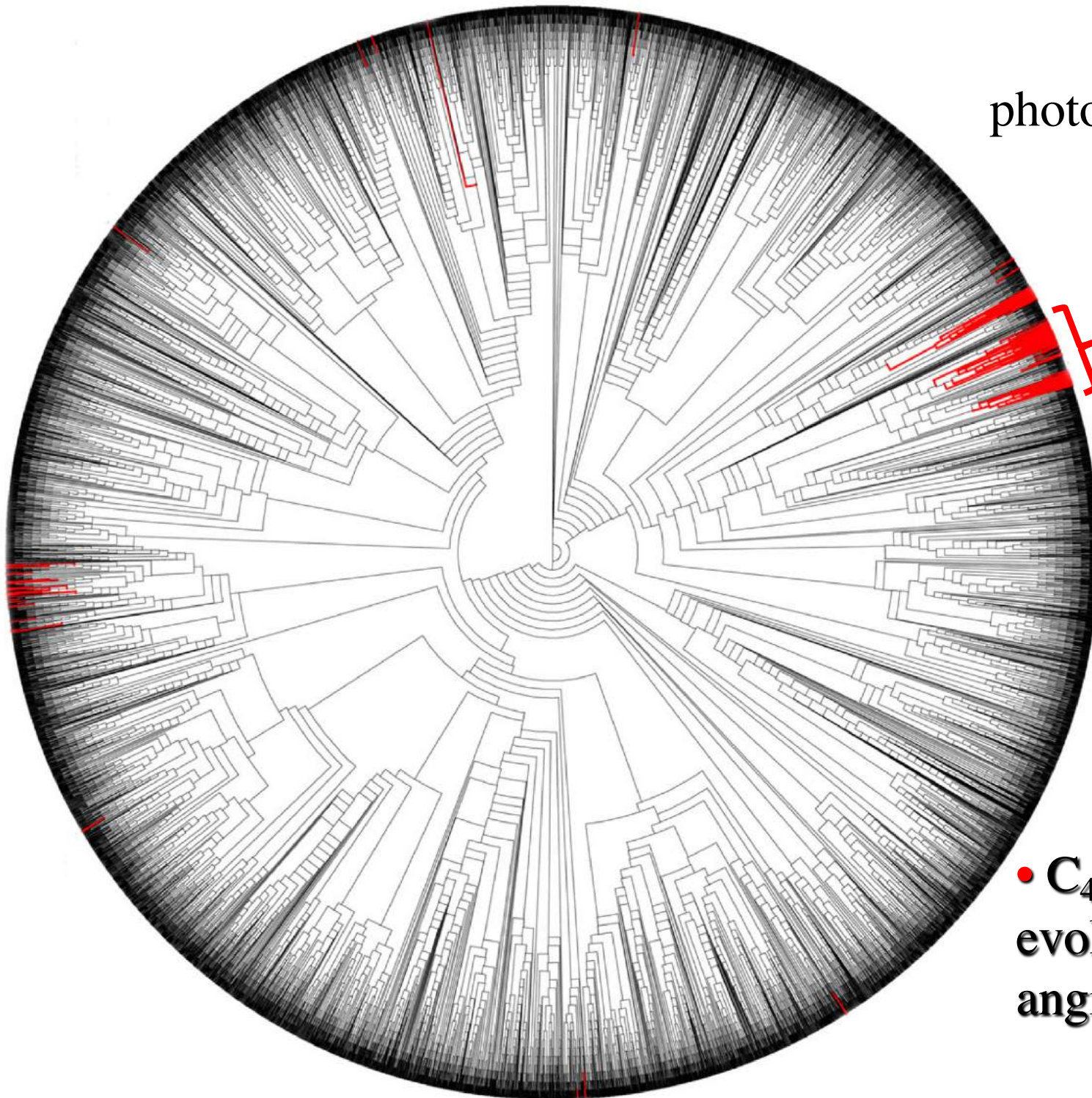
Nebraska grassland 25 mya



## Adaptive features

- intercalary meristem - grazing & fire response
- silica in stems
- C<sub>4</sub> photosynthesis in arid “grasslands”

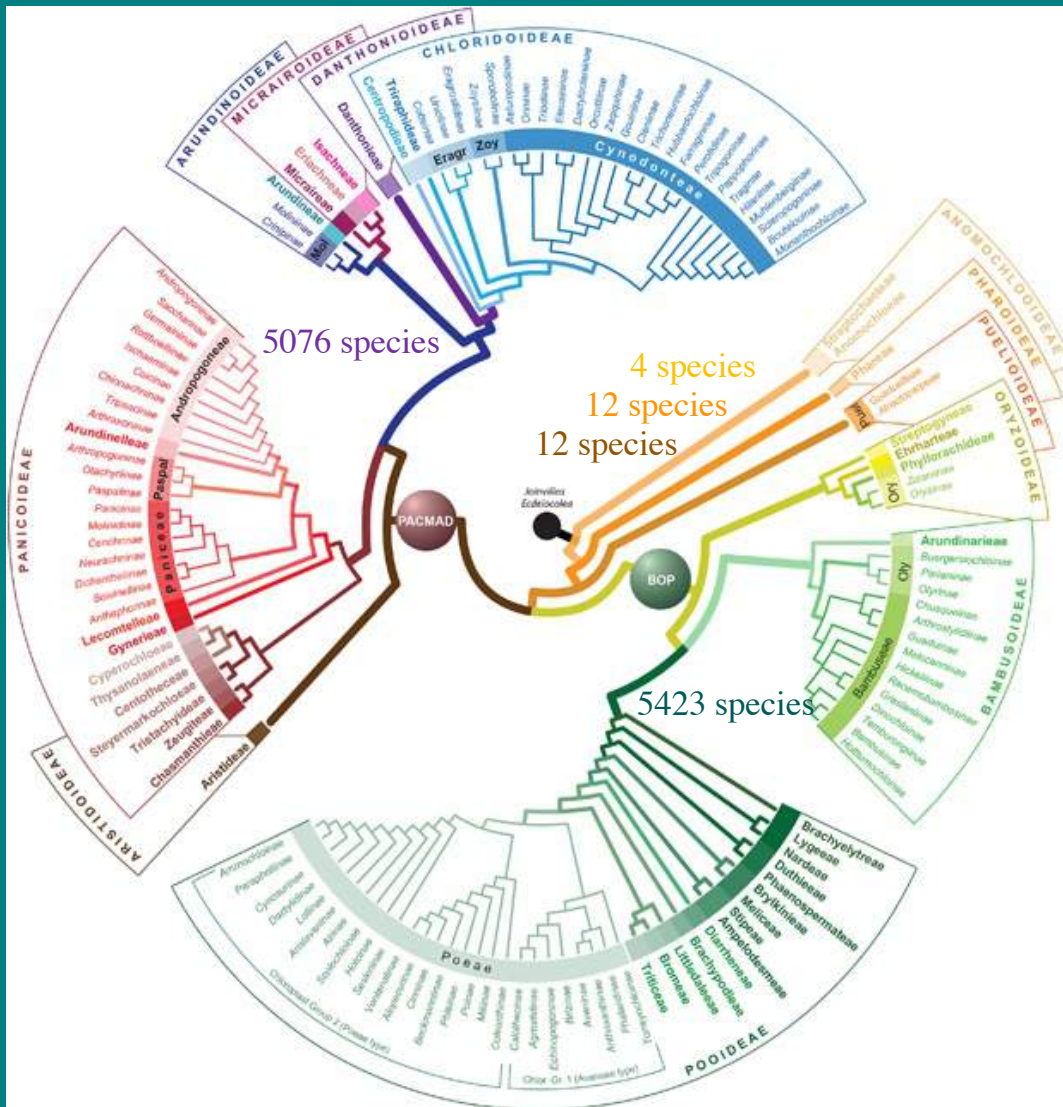
Evolution of C<sub>4</sub>  
photosynthesis across  
angiosperms



Poaceae

• C<sub>4</sub> photosynthesis  
evolved 62 times in  
angiosperms

# Poaceae - grasses



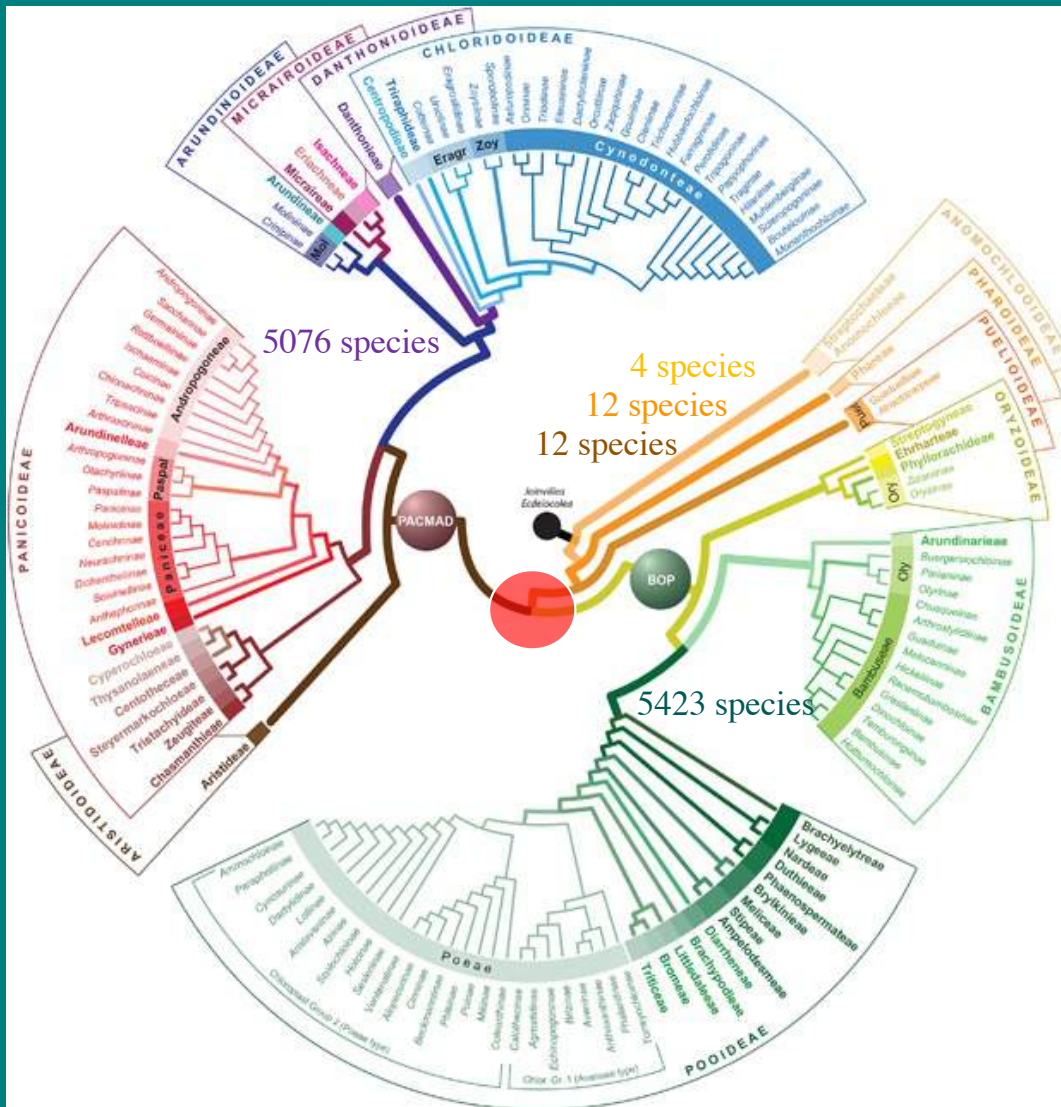
- has C<sub>4</sub> photo-synthesis driven speciation?

- C<sub>4</sub> photosynthesis evolved 62 times in angiosperms

- 24 times just in grasses

- all in PACMAD clade

# Poaceae - grasses



- has whole genome doubling been a **key innovation** for grass diversification?
- WGD at base of PACMAD and BOP clades
- 11,000 vs. 28 spp.



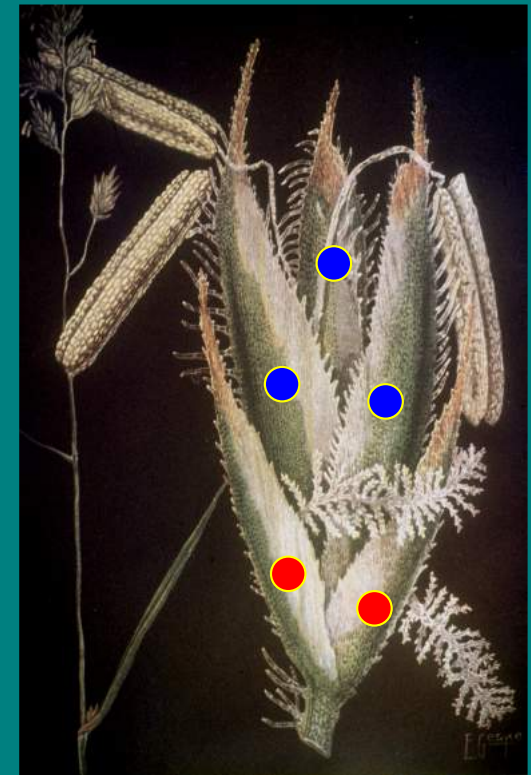
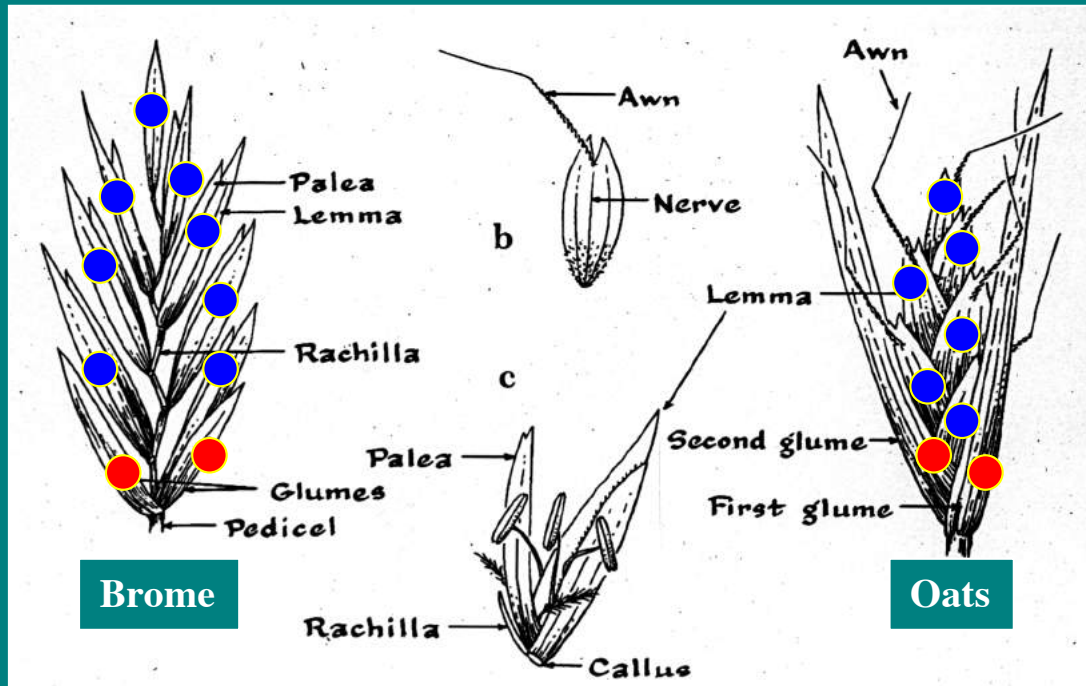
# Poaceae - grasses



Defining feature of grasses are the **spikelet** and its **florets**

# Poaceae - grasses

The main unit of the inflorescence is the **spikelet** which is composed of 2 **glumes** (spikelet bracts) and 1 or more **florets**



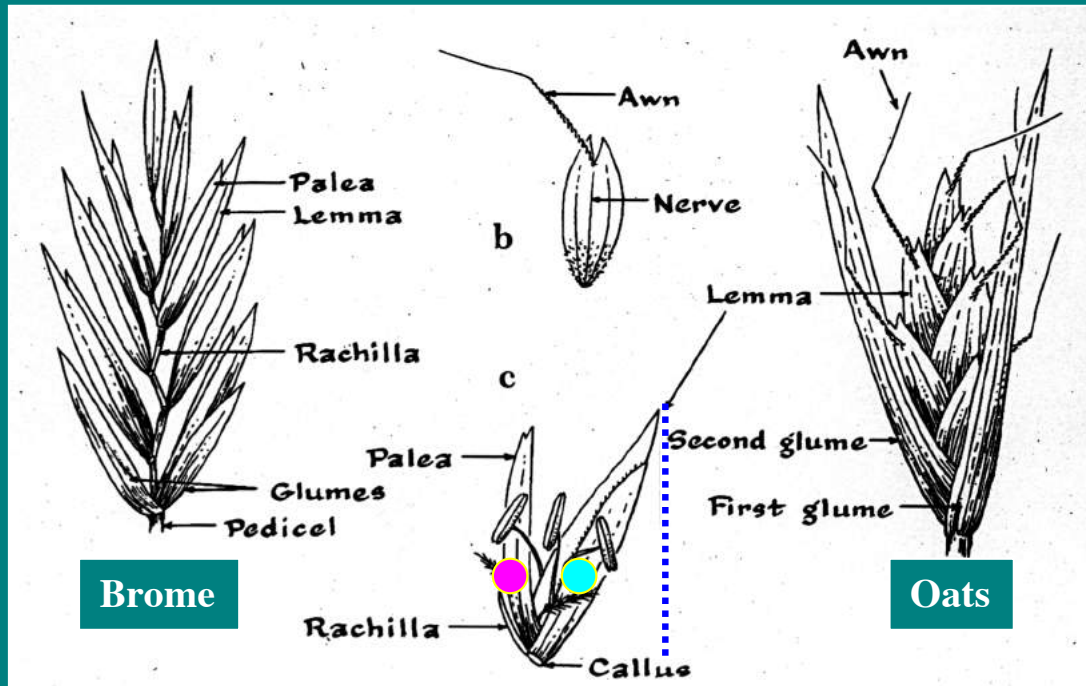
spikelet

glumes

florets

*Dactylis glomerata*  
Orchard grass

# Poaceae - grasses



Each **floret** is surrounded by two floret bracts - the outer **lemma** and the inner **palea** (usually not seen until anthesis - when florets open)



lemma

palea

*Dactylis glomerata*  
Orchard grass

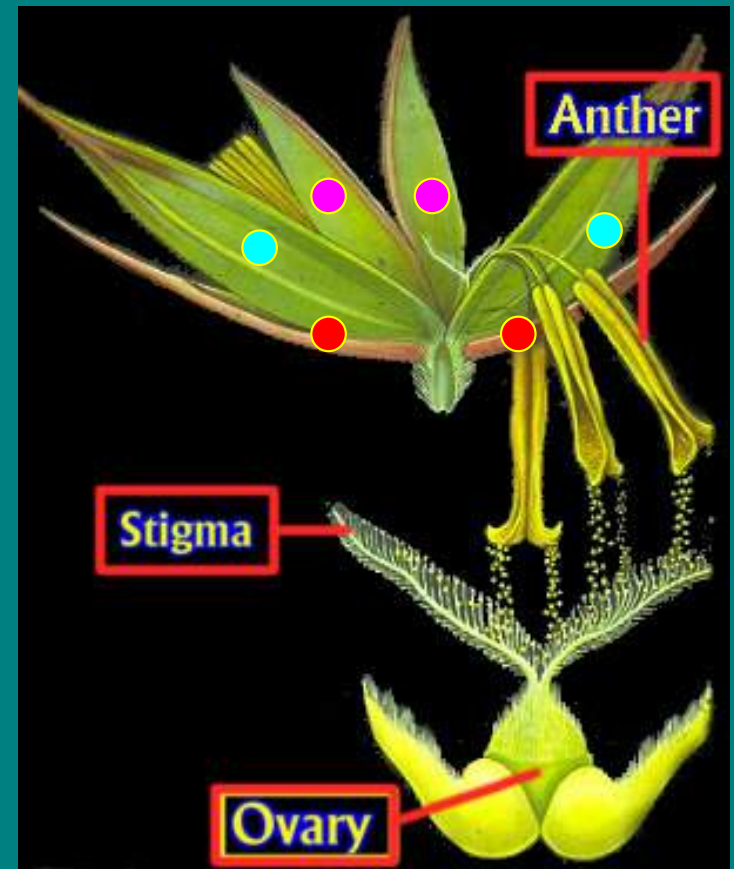
# Poaceae - grasses

This spikelet with two **glumes** has two florets each with two floret bracts - the outer **lemma** and the inner **palea**

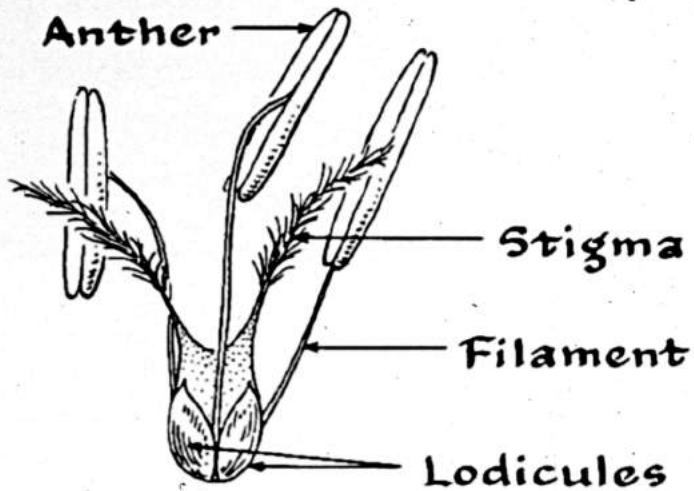
glumes

lemma

palea



# Poaceae - grasses

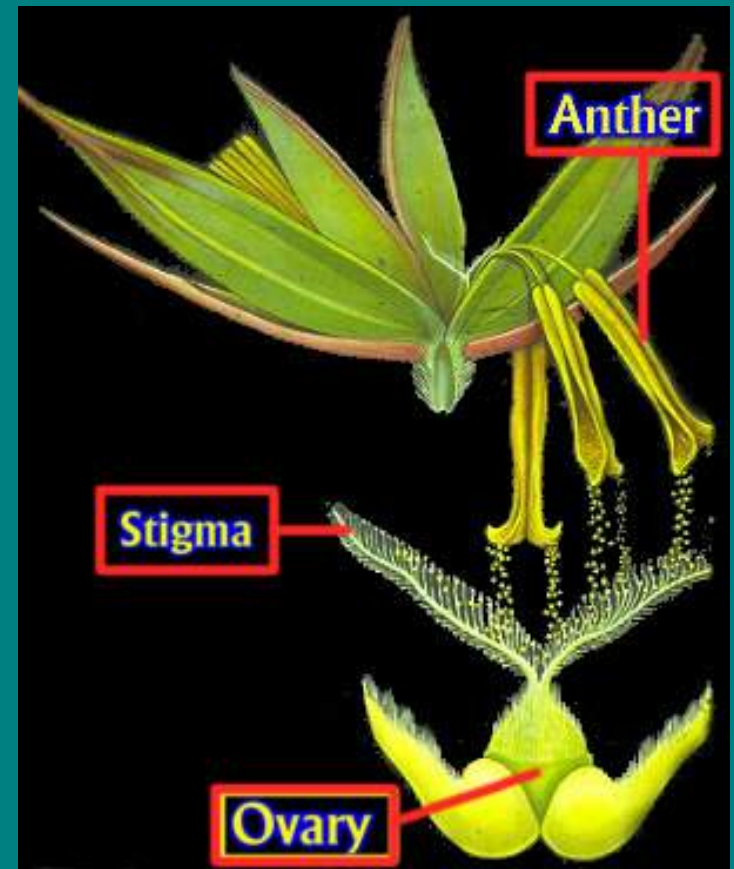


119 Reproductive parts of a grass floret.

- Perianth represented by 2 lodicules

*What is function of lodicules?*

Although considerable variation occurs in florets (among species or within a spikelet), most of our species have the following floret structure:



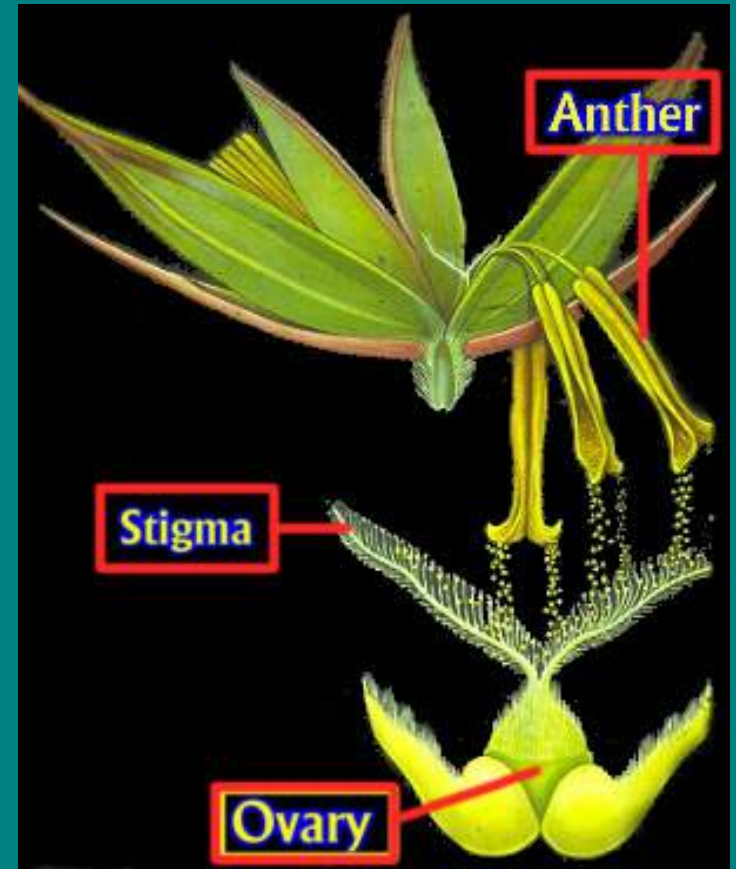
# Poaceae - grasses



*anthesis* – expose  
anthers & styles

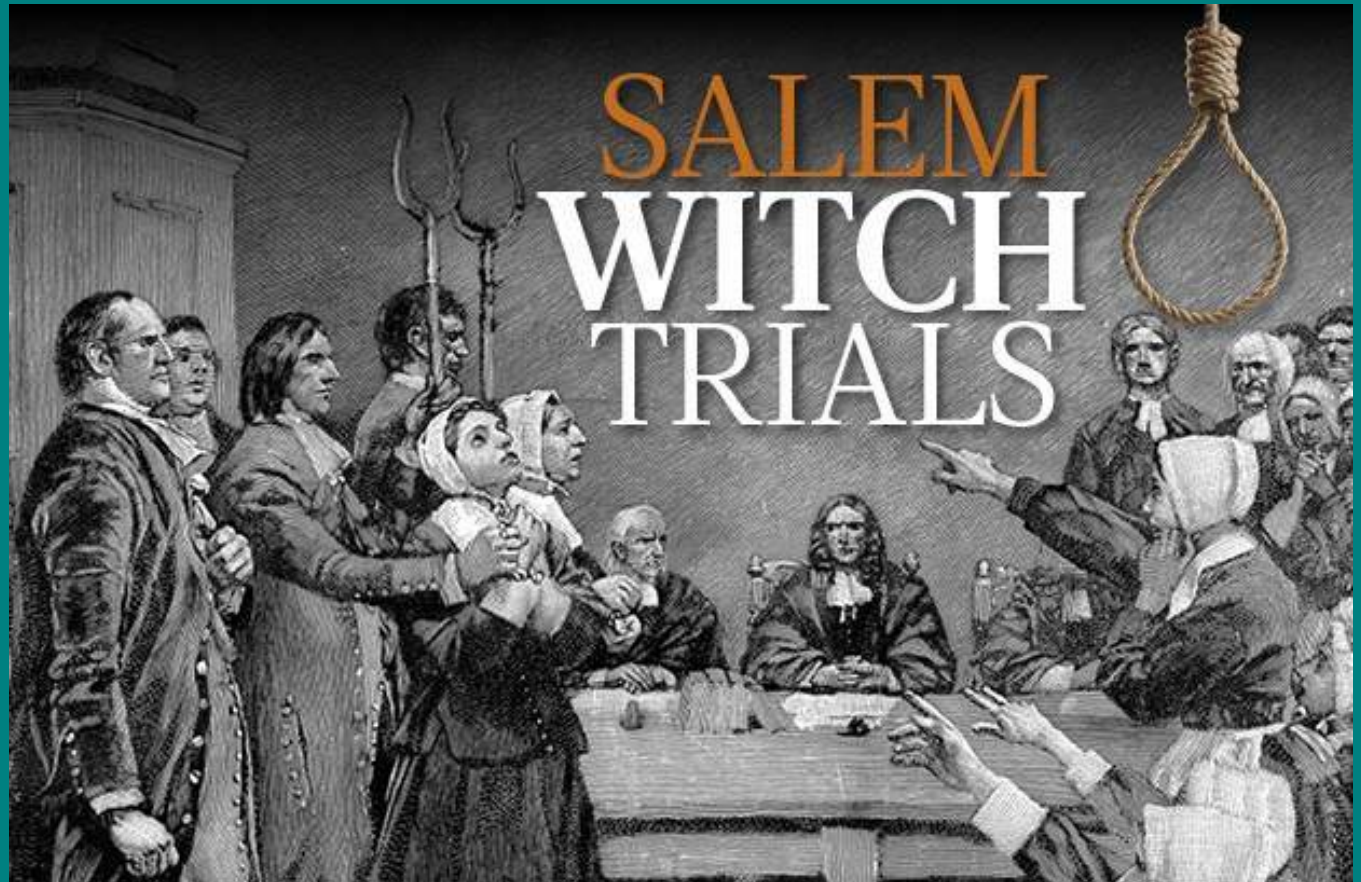
*fungal  
endophytes* –  
preventing  
spores  
entering fruit?

*What is function of lodicules?*



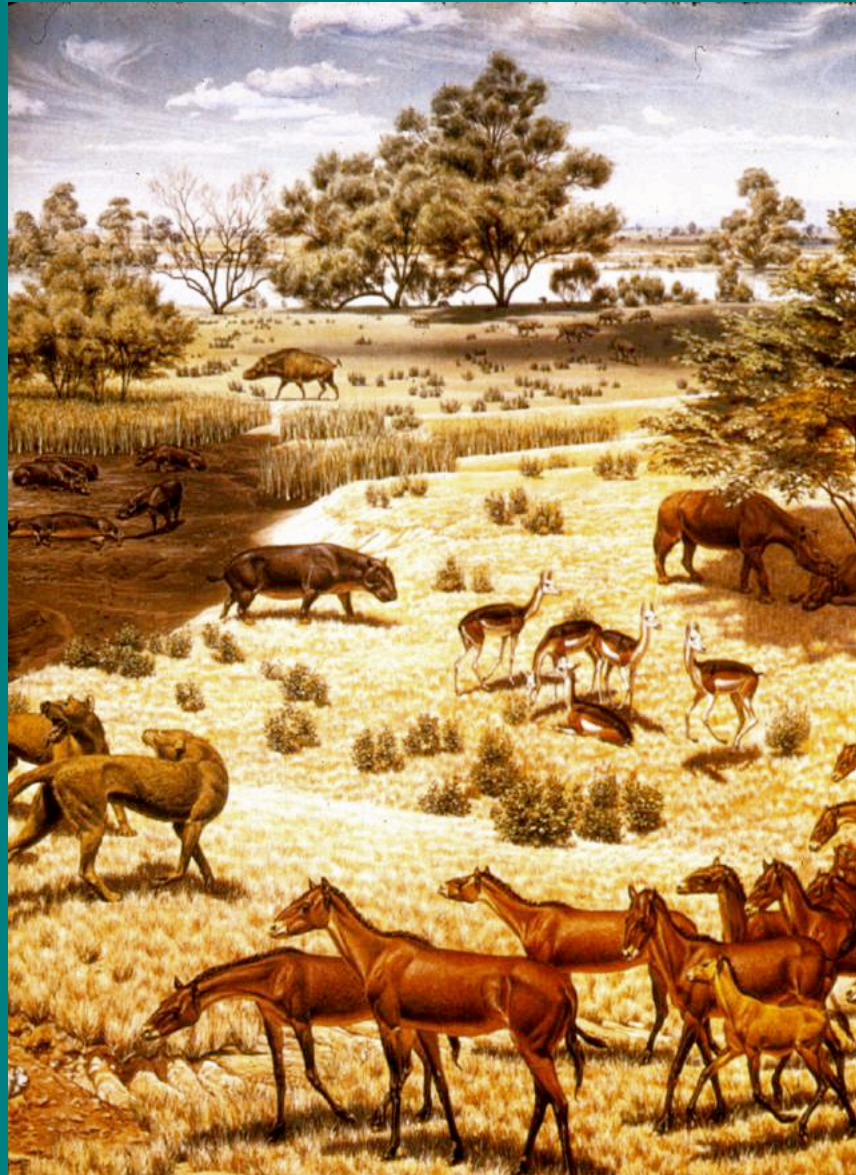
# Poaceae - grasses

- fungal endophytes (ascomycetes) produce physiologically active alkaloids



# Poaceae - grasses

- fungal endophytes (ascomycetes) produce physiologically active alkaloids
- anti-herbivory defense against grazing mammals (defensive mutualism)?



Nebraska grassland 25 mya



# Poaceae - grasses

MOLECULAR PHYLOGENETICS AND EVOLUTION  
Vol. 8, No. 2, October, pp. 205-217, 1997  
ARTICLE NO. FY970422

## Bamboozled Again! Inadvertent Isolation of Fungal rDNA Sequences from Bamboos (Poaceae: Bambusoideae)

Weiping Zhang, Jonathan F. Wendel, and Lynn G. Clark<sup>1</sup>

*Department of Botany, Iowa State University, Ames, Iowa 50011*

- phylogenetic analysis of bamboos turned out to be phylogeny of endophytic fungi!

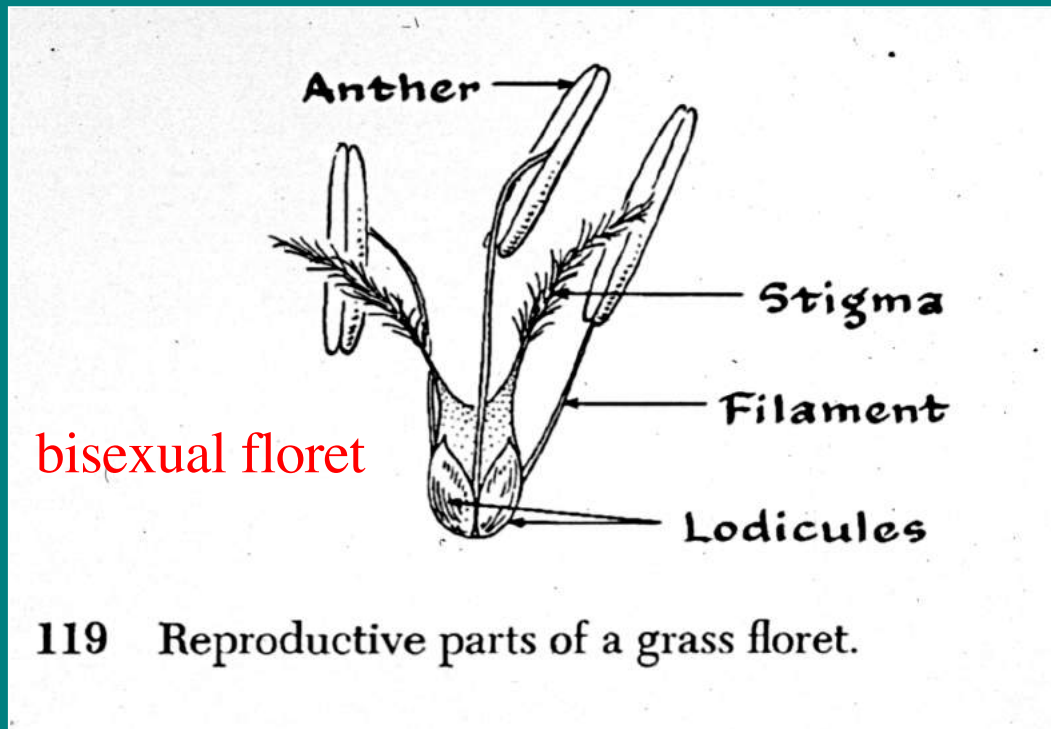


Lynn Clark



Jonathan Wendel

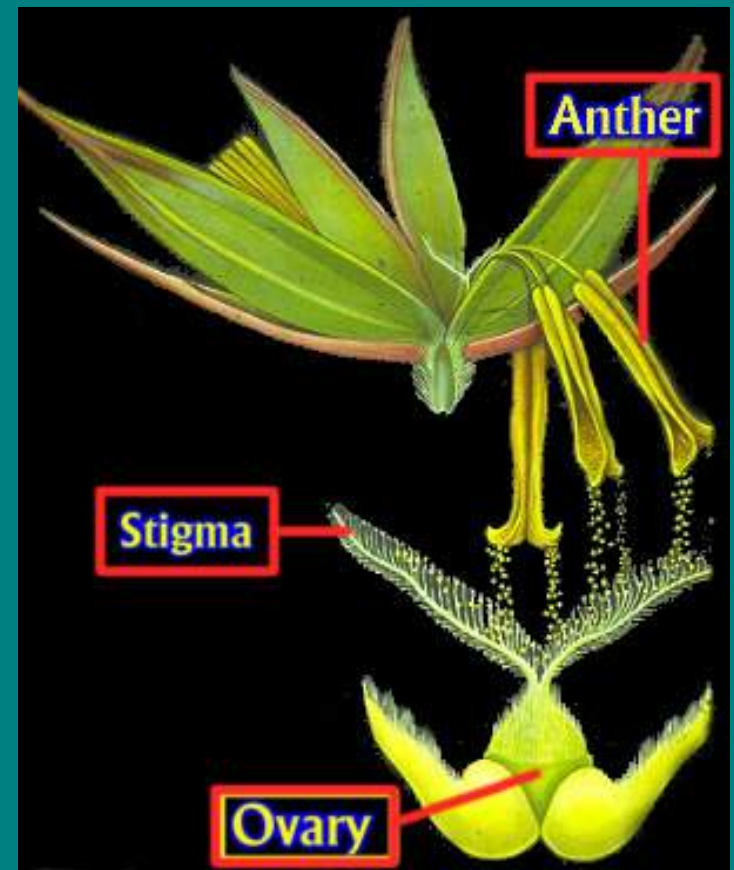
# Poaceae - grasses



- Perianth represented by 2 lodicules
- Stamens 3
- Superior gynoecium of 2 fused carpels
- One ovuled fruits called a grain or caryopsis = seed fused to ovary wall

*What parts homologous to other flowers?*

Although considerable variation occurs in florets (among species or within a spikelet), most of our species have the following floret structure:



# Poaceae - grasses

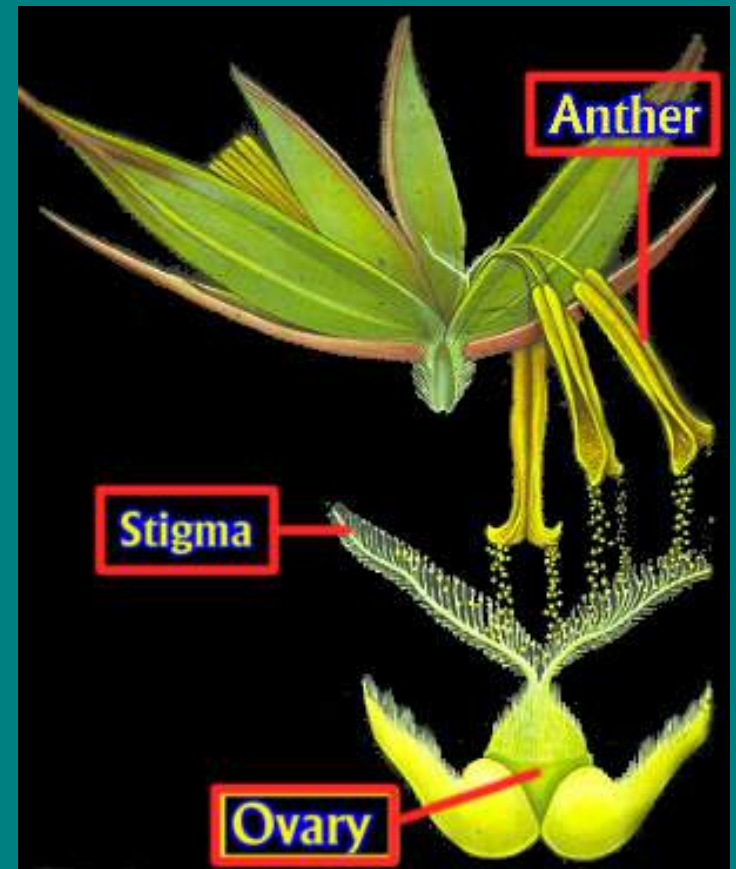


Toby Kellogg – Missouri Bot Gard

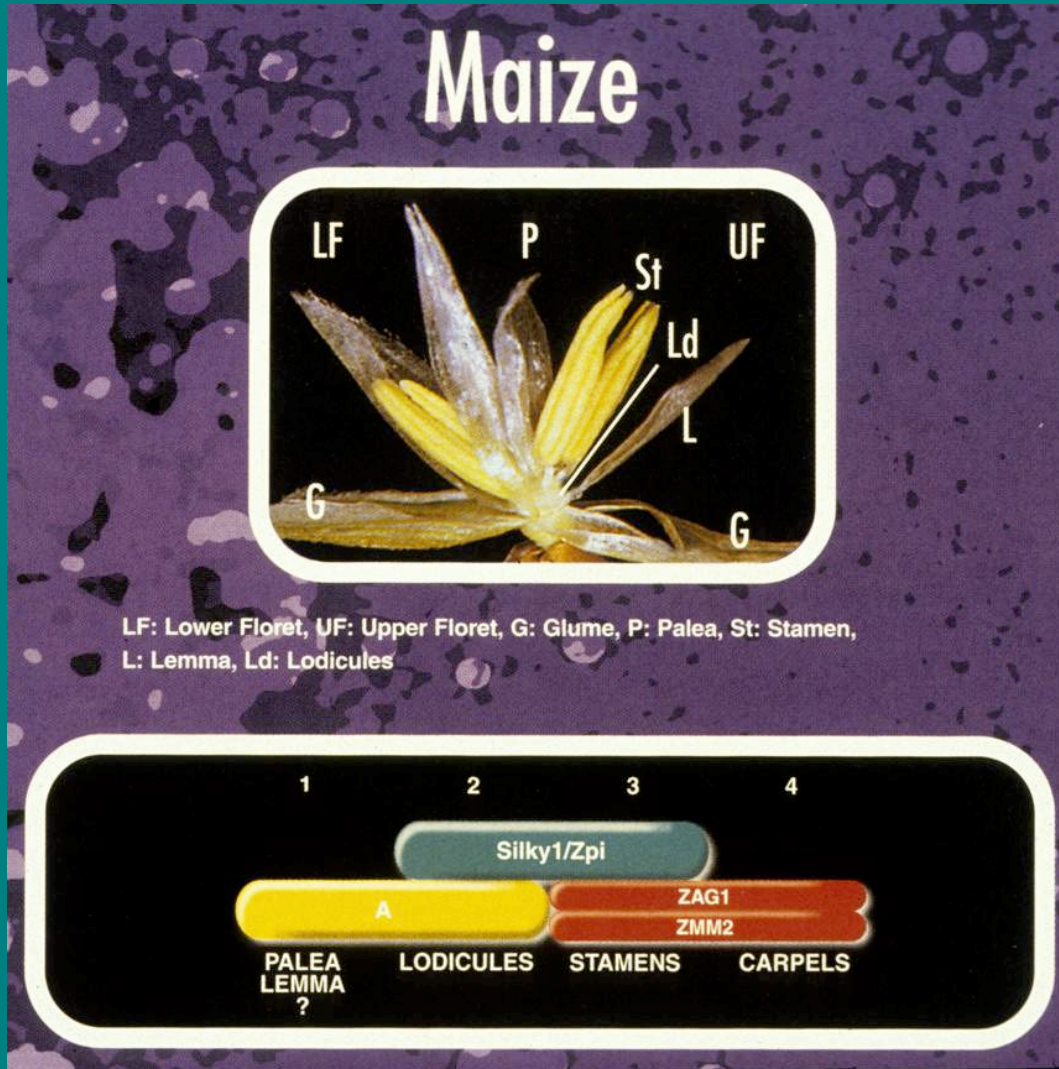
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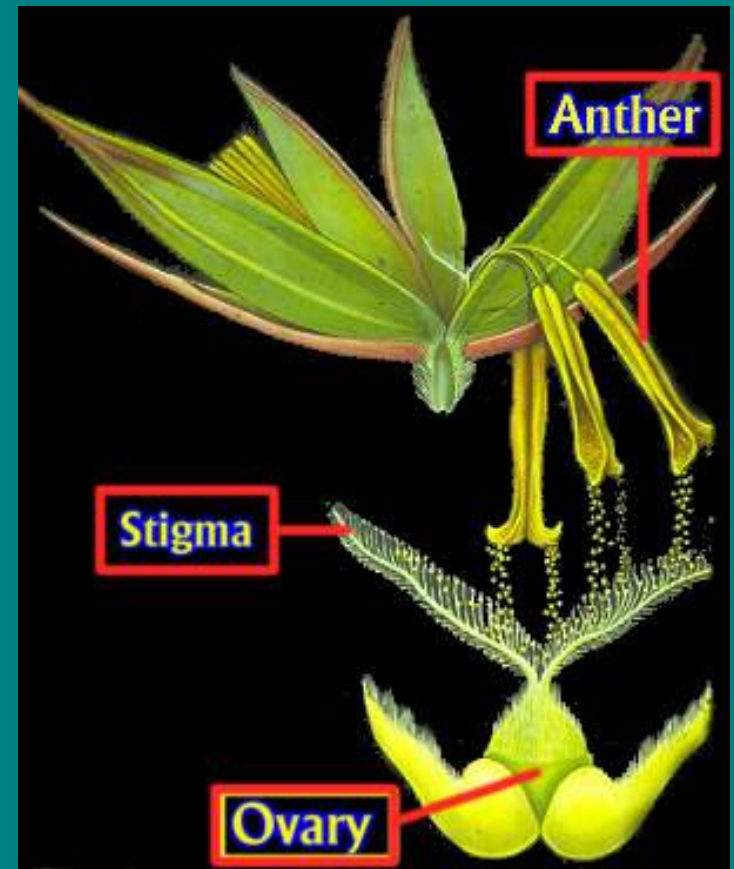
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# Poaceae - grasses

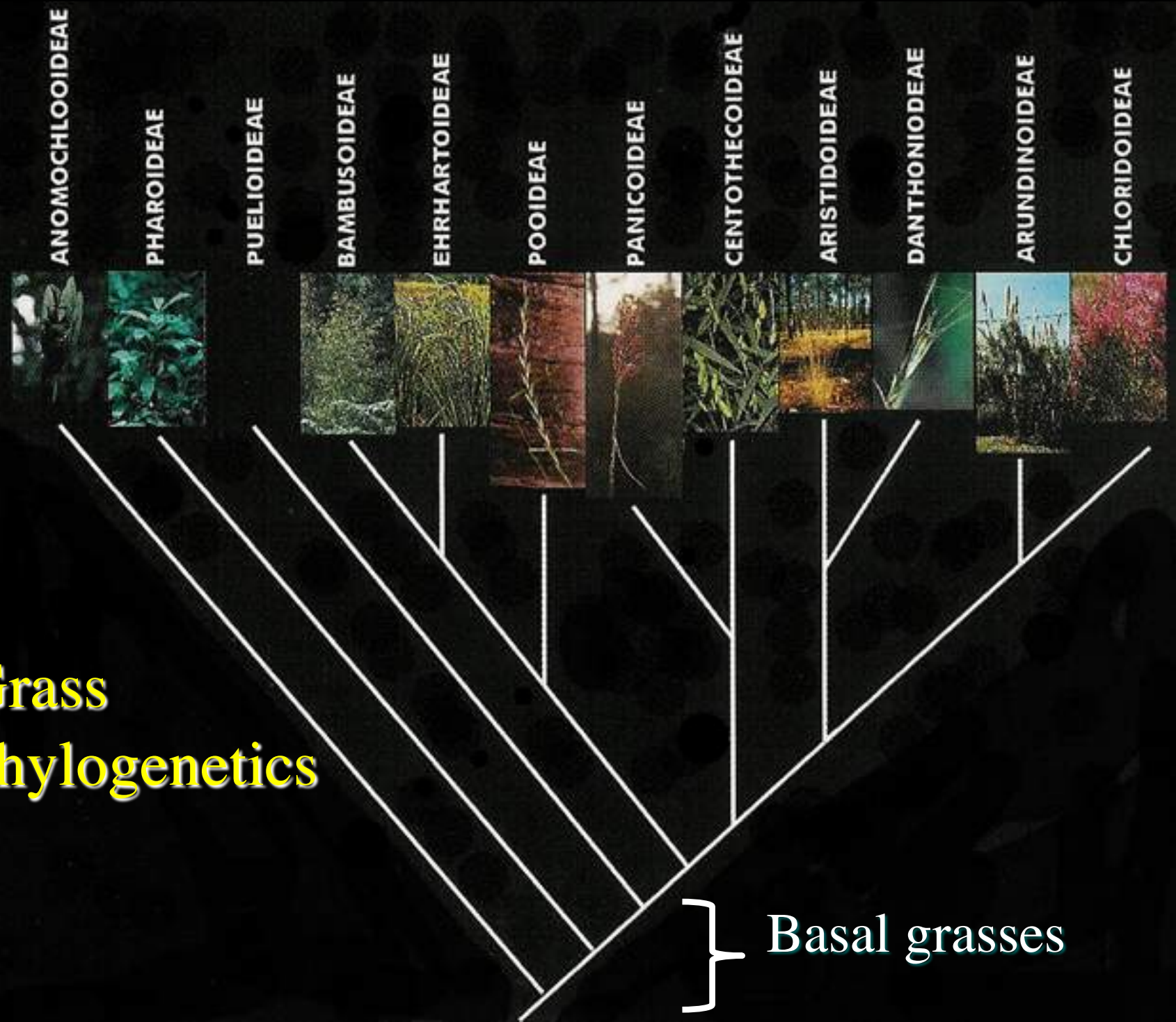


- lodicules = petals
- palea/lemma = sepals



*What parts homologous to other flowers?*

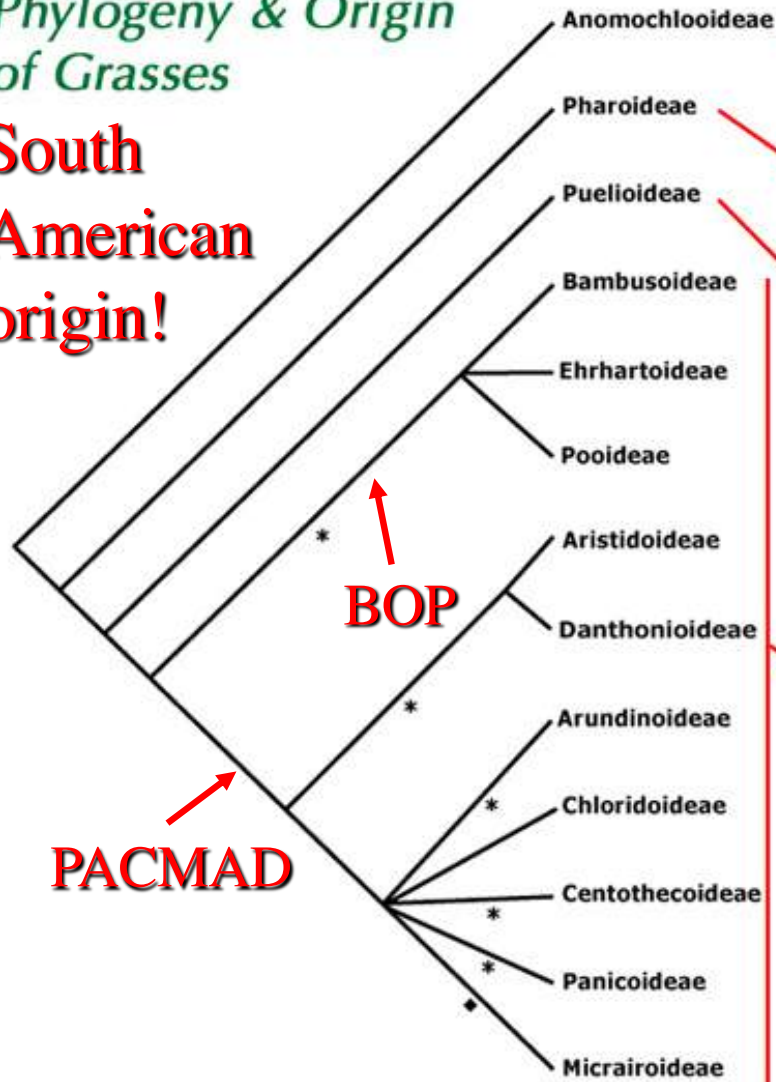
# Grass phylogenetics



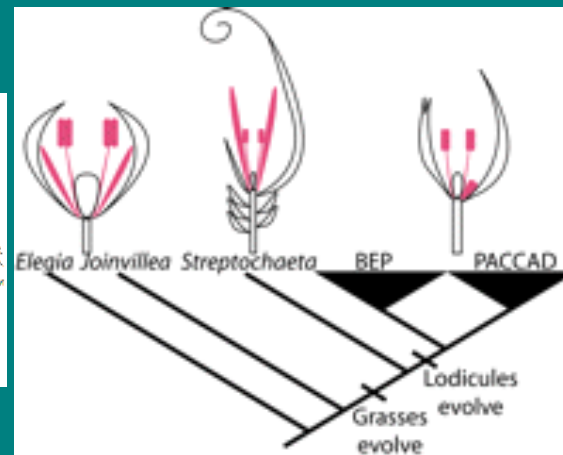
# Poaceae - grasses

## Phylogeny & Origin of Grasses

**South American origin!**



# Poaceae - grasses



**Subfamily Anomochlooideae**  
(no spikelets, lodicules)

# Poaceae - grasses



*Anomochloa marantoidea*

4 stamens!





# Poaceae - grasses

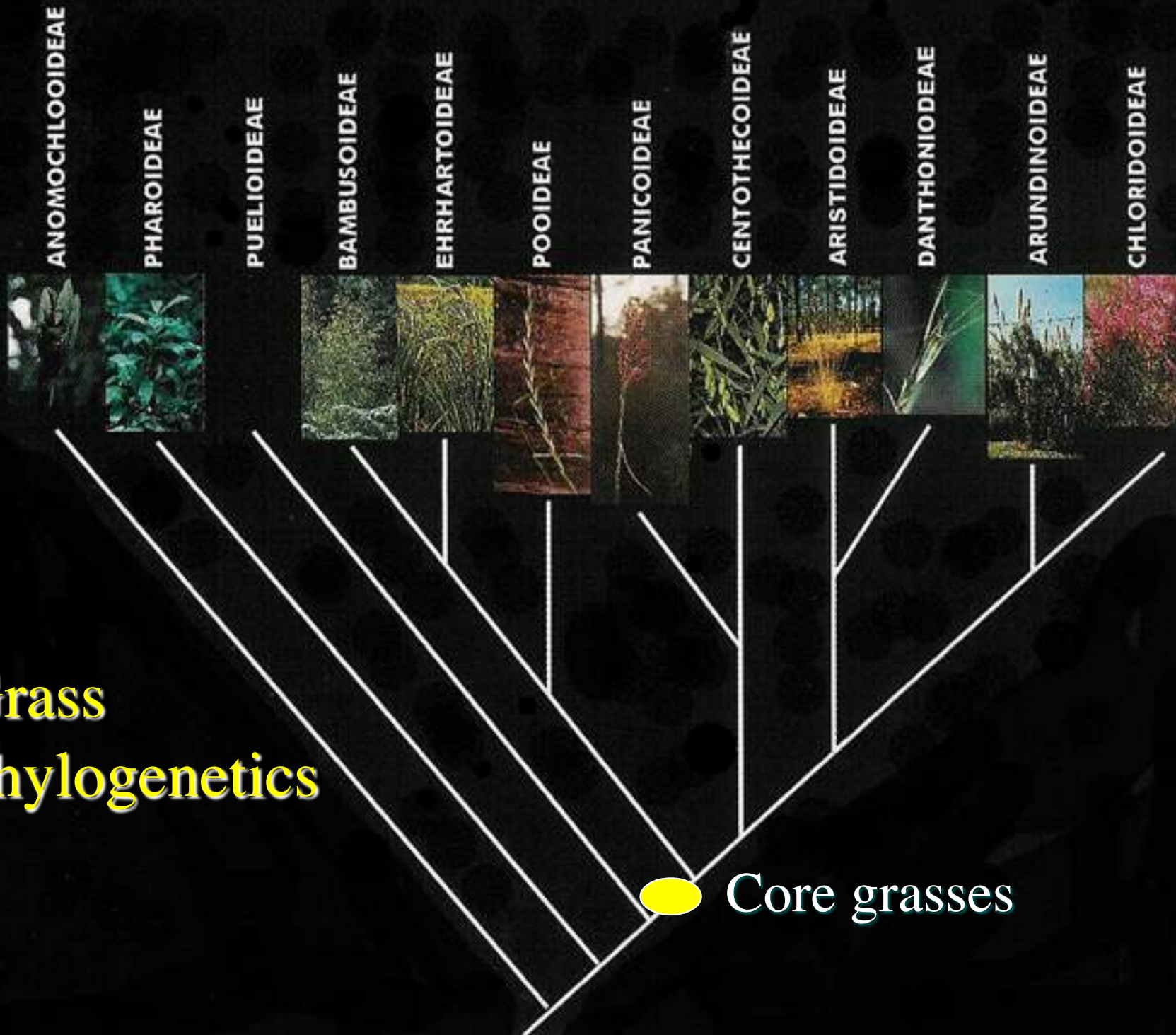
## Subfamily Pharoideae (herbaceous bamboos)



*Pharus*

pseudopetiole

# Grass phylogenetics



# Poaceae - grasses

*Bambusa*



*Ochlandra*



**Subfamily Bambusoideae**  
(6 stamens, 3 lodicules, 3 stigmas)

# Poaceae - grasses

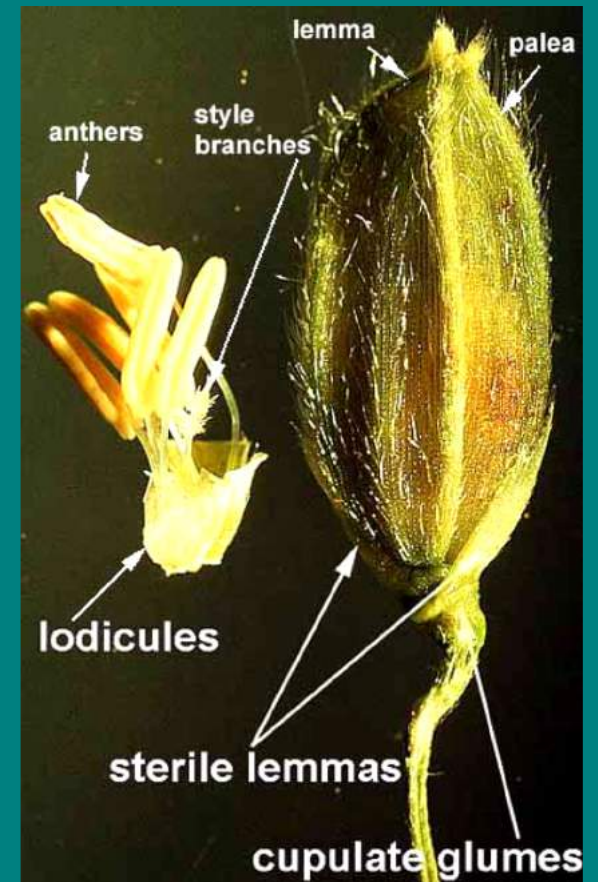


## Subfamily Ehrhartoideae

(stamens 6, but 2 styles)

### *Oryza sativa* - rice

2nd most important crop  
plant in the world



# Poaceae - grasses



**Subfamily Ehrhartoideae**  
(stamens 6, but 2 styles)

*Ziziana aquatica* - wild rice

Important native American food;  
unisexual spikelets



# Poaceae - grasses



*Poa annua* - bluegrass

## Subfamily Pooideae

(Spikelets with more than one grain  
forming floret;  
Lemma with 5 nerves)



*Poa pratensis* - Kentucky bluegrass

# Poaceae - grasses

*Dactylis glomerata* - orchard grass



*Bromus inermis* - brome grass

# Poaceae - grasses



*Elymus hystrix*  
bottlebrush



*Avena sativa* - oats



# Poaceae - grasses



*Calamagrostis canadensis* -  
bluejoint grass

*Phalaris arundinacea*  
Reed canary grass



# Poaceae - grasses

## Subfamily Arundinoideae (large inflorescences)



hairs from rachilla  
render the cotton-like  
appearance



*Phragmites australis* - common reed

Circumboreal species; non-native populations have become invasive and displaced native populations

# Poaceae - grasses



*Cortaderia* - plume grasses from pampas

# Poaceae - grasses

## Subfamily Chloridoideae

(Spikelets arranged often one-sided)



*Spartina pectinata*

*Spartina pectinata*  
Prairie cord grass

*Bouteloua curtipendula*  
Sideoats grass



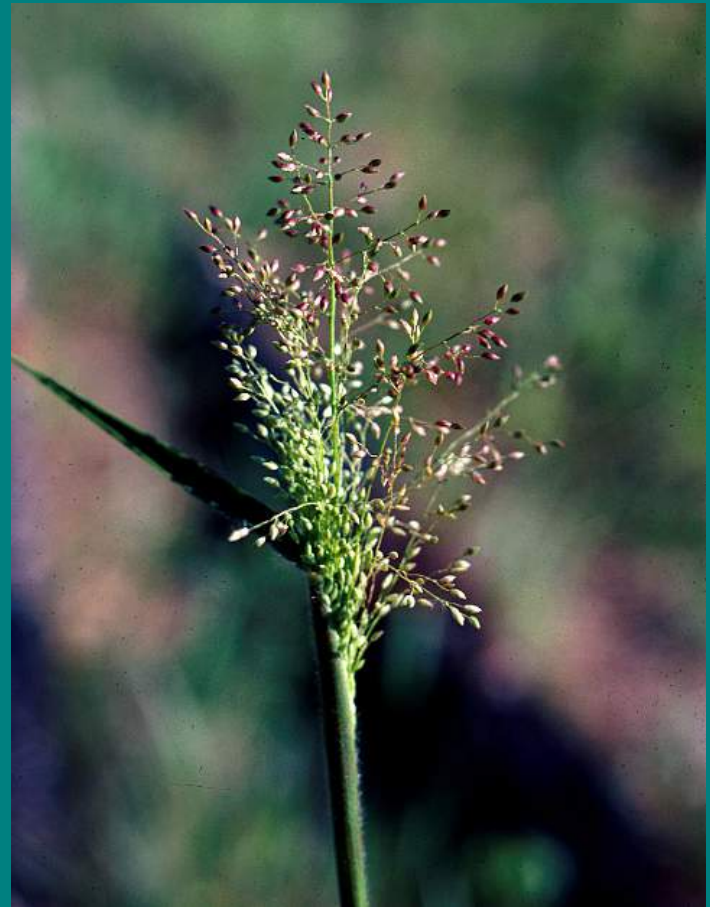
# Poaceae - grasses



*Panicum virgatum* - switchgrass

## Subfamily Panicoideae

(2 florets, bottom reduced, sterile)



*Dichanthelium* sp. - panic grass

# Poaceae - grasses



*Setaria* - foxtail



*Digitaria* - crabgrass

# Poaceae - grasses



*Andropogon gerardii* - big bluestem



# Poaceae - grasses



*Saccharum* -  
sugarcane



*Sorghum* -  
sorghum



# Poaceae - grasses



Female spikelets condensed into  
cob or spike

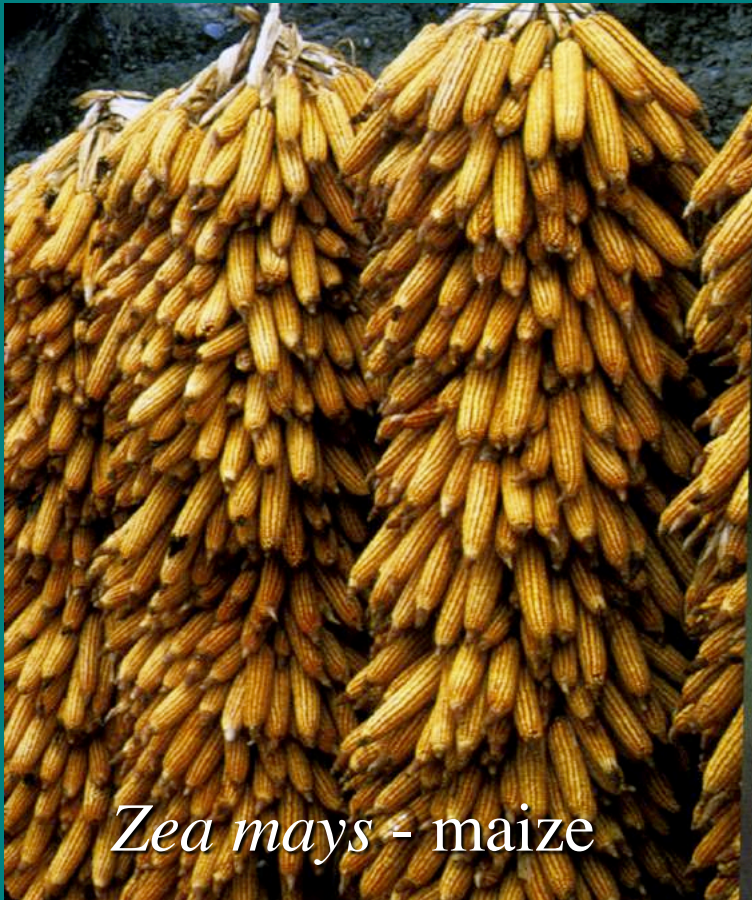


Male spikelets in  
panicle or tassel

*Zea mays* - maize

# Poaceae - grasses

The origin of maize from  
teosinte wild relatives in  
Mexico involved few genes



*Zea mays* - maize



*Tripsacum* - teosinte



John Doebley