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)
Wisconsin flora “wordle”

Asteraceae

Plantaginaceae

Dryopteridaceae

Cyperaceae

Brassicaceae

Fabaceae

Orchidaceae

Rosaceae

Poaceae

Lamiaceae

Polygonaceae

Caryophyllaceae

Potamogetonaceae

Boraginaceae

Rubiaceae

Solanaceae

Amaranthaceae

Ranunculaceae

Apiaceae

Asteraceae

Brassicaceae

Lamiaceae
grasses you collected!

*Setaria* spp. – foxtail

*Andropogon gerardii* – *Schizachyrium scoparium* – big bluestem – little bluestem

*Sorghastrum nutans* – *Phalaris arundinacea* – *Bromus inermis* – Indian grass – reed canary grass – smooth brome
Picture key to grasses!

Grasses of Iowa

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

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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?

Strömberg et al. PNAS 2005;102:11980-11984
Poaceae - grasses

Vegetative features

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

Adaptive features

- intercalary meristem - grazing & fire response
- silica in stems
- C₄ photo-synthesis in arid “grasslands”

Nebraska grassland 25 mya
Evolution of $\text{C}_4$ photosynthesis across angiosperms

- $\text{C}_4$ photosynthesis evolved 62 times in angiosperms
Poaceae - grasses

- has C₄ photosynthesis driven speciation?

- C₄ 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
The main unit of the inflorescence is the **spikelet** which is composed of 2 **glumes** (spikelet bracts) and 1 or more **florets**.
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)

Dactylis glomerata
Orchard grass
This spikelet with two glumes has two florets each with two floret bracts - the outer lemma and the inner palea.
Although considerable variation occurs in florets (among species or within a spikelet), most of our species have the following floret structure:

- Perianth represented by 2 lodicules

**What is function of lodicules?**
Poaceae - grasses

What is function of lodicules?

*anthesis* – expose anthers & styles

*fungal endophytes* – preventing spores entering fruit?
Poaceae - grasses

- fungal endophytes (ascomycetes) produce physiologically active alkaloids

Nebraska grassland 25 mya
Poaceae - grasses

- fungal endophytes (ascomycetes) produce physiologically active alkaloids

- anti-herbivory defense against grazing mammals (defensive mutualism)?

Nebraska grassland 25 mya
Poaceae - grasses

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

Weiping Zhang, Jonathan F. Wendel, and Lynn G. Clark

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

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

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

- 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:

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What parts homologous to other flowers?
Poaceae - grasses

What parts homologous to other flowers?

- lodicules = petals
- palea/lemma = sepals
Grass phylogenetics

Basal grasses
Poaceae - grasses

Subfamily Anomochlooideae
(no spikelets, lodicules)

Streptochaete
Poaceae - grasses

*Anomochloa marantoidea*

4 stamens!
Poaceae - grasses

Subfamily Pharoideae
(herbaceous bamboos)

Pharus
Poaceae - grasses

Grass phylogenetics

Core grasses
Poaceae - grasses

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

Bambusa

Ochlandra
Poaceae - grasses

Subfamily Ehrhartoideae
(stamens 6, but 2 styles)

Oryza sativa - rice
2nd most important crop plant in the world
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* - bromegrass
Poaceae - grasses

_Elymus hystrix_

bottlebrush

_Avena sativa - oats_
Poaceae - grasses

Calamagrostis canadensis - bluejoint grass

Phalaris arundinacea
Reed canary grass
**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*
Prairie cord grass

*Bouteloua curtipendula*
Sideoats grass
Poaceae - grasses

Subfamily Panicoideae
(2 florets, bottom reduced, sterile)

Panicum virgatum - switchgrass
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