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”

Grasses you collected!

- Setaria spp. - foxtail
- Andropogon gerardii - big bluestem
- Schizachyrium scoparium - little bluestem
- Sorghastrum nutans - Indian grass
- Phalaris arundinacea - reed canary grass
- Eragrostis cilianensis - stinkgrass

Picture key to grasses!

Grasses of Iowa
www.eeob.iastate.edu/research/iowagrasses

Field Guide to Wisconsin Grasses – book in lab
Poales II: wind pollinated families

- showy flowers, insect or bird pollinated
- +/- reduced flowers, insect or wind pollinated
- reduced flowers, wind pollinated

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

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

Male

Female

Anarthriaceae
Centrolepidaceae
Restionaceae
Flagellariaceae
Jointvilleaeae
Ecdeliocoleaceae

Poaceae

Whole genome duplications in Angiosperms
(Soltis et al. 2009, *Amer J Bot*)

Poaceae - grasses

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

Poaceae - grasses

Phylogeny & Origin of Grasses

<table>
<thead>
<tr>
<th>Node</th>
<th>Genera / spp</th>
</tr>
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<tbody>
<tr>
<td>BEP</td>
<td>658 / 11,000</td>
</tr>
<tr>
<td>PACCAD</td>
<td>2 / 4</td>
</tr>
<tr>
<td>2 / 12</td>
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Has whole genome doubling been a key innovation for grass diversification?

11,000 vs. 30 spp.

Likely occurrence of whole genome duplication in grasses
Poaceae - grasses

Adaptive features
- intercalary meristem - grazing & fire response
- silica in stems
- C₄ photosynthesis

Nebraska grassland 25 mya

Poaceae - grasses

Adaptive features
- first diversified ca. 70 mya in late Cretaceous - tropical forest understories
- major radiations during formation of grasslands in mid Tertiary
- is this set of features the key innovation?

Defining feature of grasses are the spikelet and its florets

Poaceae - grasses

Phylogeny & Origin of Grasses

- has C₄ photosynthesis driven speciation?
- C₄ photosynthesis evolved 62 times in angiosperms
- 24 times just in grasses
- all in PACCAD clade

5,423 spp.

5,706 spp.

Poaceae - grasses

Smithberg C A E PNAS 2005;102:11980-11984
The main unit of the inflorescence is the spikelet which is composed of 2 glumes (spikelet bracts) and 1 or more florets.

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

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
Poaceae - grasses

What is function of lodicules?

fungal endophytes – preventing spores entering fruit?

Poaceae - grasses

anthesis = expose anthers & styles

fungal endophytes (ascomycetes) produce physiologically active alkaloids

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

Poaceae - grasses

Nebraska grassland 25 mya

Poaceae - grasses

Lynn Clark

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

Poaceae - grasses

Jonathan Wendel

- panic grass from Yellowstone Natl Park
- geothermal tolerant >50°C
- requires fungus endophyte
- fungus requires a virus to confer this thermotolerance effect

Poaceae - grasses

• fungal endophytes (ascomycetes) produce physiologically active alkaloids

• fungal endophytes

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

From:

- Poaceae - grasses
- Toby Kellogg – Univ Missouri SL
- Whipple C J et al. PNAS 2007;104:1081-1086
Poaceae - grasses

Phylogeny & Origin of Grasses

South American origin!

Subfamily Anomochlooideae
(no spikelets, lodicules)

Anomochloa marantoides

4 stamens!
Poaceae - grasses

Subfamily Pharoideae
(herbaceous bamboos)

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

Pharus

Ochlandra

Subfamily Ehrhartoideae
(stamens 6, but 3 styles)

Oryza sativa - rice
2nd most important crop
plant in the world

Poaceae - grasses

Core grasses
Poaceae - grasses

Subfamily Ehrhartoideae
(stamens 6, but 2 styles)

Zizania aquatica - wild rice
Important native American food; unisexual spikelets

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

Poa annua - bluegrass

Poa pratensis - Kentucky bluegrass

Dactylis glomerata - orchard grass

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

Bromus inermis - bromegrass

Ammophila breviligulata - marram grass

Poaceae - grasses

Tribe Poaeae

Poaceae - grasses

Subfamily Pooideae
(Tribe Agrostideae
(awned lemma))

Ammophila breviligulata - marram grass
**Poaceae - grasses**

**Avena sativa** - oats

Subfamily Pooideae
Tribe Agrostideae
(awned lemma)

**Calamagrostis canadensis** - bluejoint grass

Reed canary grass

Invasive species of wetlands

**Elymus hystrix**
(Hystrix patula)
bottlebrush

**Triticum aestivum** - wheat

Hexaploid food crop

**Poaceae - grasses**

**Phalaris arundinacea**

Subfamily Pooideae
Tribe Agrostideae
(awned lemma)

**Elymus canadensis**
Wild rye

Subfamily Pooideae
Tribe Hordeae/Triticeae
(symmetrical spikes)
Poaceae - grasses

Subfamily Pooideae
Tribe Hordeae/Triticeae
(symmetrical spikes)

Agropyron repens
quackgrass

Elytrigia
wheatgrass

Poaceae - grasses

Subfamily Arundinoideae
(large inflorescences)

Phragmites australis - common reed
Circumboreal species; non-native populations have become invasive and displaced native populations.

Poaceae - grasses

Subfamily Arundinoideae
(large inflorescences)

Cortaderia - plume grasses from pampas

Aristida tuberculosa - 3-awned grass

Poaceae - grasses

Subfamily Aristidoideae
(Awns of lemma divided into 3 parts)
**Poaceae - grasses**

**Subfamily Chloridoideae**
(Spikelets arranged often one-sided)

*Bouteloua curtipendula*  
Sideoats grass

*Spartina pectinata*  
Prairie cord grass

*Sporolobus heterolepis*  
-Prairie dropseed

**Subfamily Panicoideae**
(2 florets, bottom reduced, sterile)

**Tribe Paniceae**

*Panicum virgatum*  
-switchgrass

*Dichanthelium* sp.  
-panic grass

*Digitaria*  
-crabgrass

*Setaria*  
-foxtail
Poaceae - grasses

Tripsacum - eastern gamagrass

Andropogon - bluestem

Tripsacum - eastern gamagrass

Andropogon - bluestem

Sorghastrum - Indian grass

Poaceae - grasses

Subfamily Panicoideae
(2 florets, bottom reduced, sterile)
Tribe Andropogoneae
(spikelets paired on linear inflorescence)

Saccharum - sugarcane

Sorghum - sorghum

Andropogon gerardii - big bluestem
Poaceae - grasses

Zea mays - maize

Subfamily Panicoideae
(2 florets, bottom reduced, sterile)
Tribe Andropogoneae
(spikelets paired on linear inflorescence)

Female spikelets solitary but condensed into cob or spike.

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

John Doebley

Tripsacum - teos