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Agrostology; An Introduction to the Systematics of Grasses

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A G R O S T O L O G Y

An Introduction to the Systematics of Grasses

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T A B L E O F C O N T E N T S

[Illustrations in this section have been omitted.]

SECTION 1 - INTRODUCTION

1.01 - GRASSES: AN OVERVIEW

"Of all things that live and grow upon this earth, grass is the most important." (Donald Culross Peattie. A Prairie Grove. 1938.)

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The first word on the title page of this syllabus is an uncommon one. **Agrostology** [Greek, a kind of grass + body of knowledge] is the branch of systematic botany that deals with grasses, especially their identification, classification, and evolution. **Agriculture**, on the other hand, is the applied science that deals with cultivating land, and the raising and breeding of crops and livestock. **Agronomy** is the science of soil management and of crop production. Both terms are derived from the Greek root for fields, soils, and crops.

WHAT ARE GRASSES?

All true grasses belong to a single family of flowering plants, Gramineae or Poaceae. I use the phrase "true grasses" because there are many plants that have "grass" as part of their common name that are not, in fact, grasses. Many, but not all, have grass-like leaves that fool the uninitiated.

"GRASSES" THAT ARE NOT GRASSES

Alkali-grass	*Zigadenus elegans*
Arrow-grass	*Triglochin maritima*
Bayonet-grass	*Scirpus maritimus*
Bear-grass	*Xerophyllum tenax*
Bear-grass	*Nolina microcarpa*
Bear-grass	*Yucca filamentosa*
Beavertail-grass	*Calochortus coeruleus*
Blue-eyed-grass	*Sisyrinchium* spp.
Cotton-grass	*Eriophorum* spp.
Eel-grass	*Zostera marina*
Fish-grass	*Cabomba caroliniana*
Gallow-grass	*Cannabis sativa*
Golden-eyed-grass	*Sisyrinchium* spp.
Goose-grass	*Potentilla anserina*
Grass	*Cannabis sativa*
Grass-of-Parnassus	*Parnassia* spp.
Grass-tree	*Xanthorrhea* spp.
Grass-wrack	*Zostera marina*
Indian basket-grass	*Xerophyllum tenax*
Iron-grass	*Carex caryophyllea*
Mat-grass	*Phyla nodiflora*
Merlin-grass	*Isoëtes* spp.
Milk-grass	*Valerianella locusta*
Mondo-grass	*Ophiopogon japonicum*
Nut-grass	*Cyperus esculentus*
Orange-grass	*Hypericum gentianoides*
Palm-grass	*Curculigo* spp.
Penny-grass	*Thlaspi* spp.
Pepper-grass	*Lepidium* spp.
Pigeon-grass	*Verbena officinalis*
Pineapple-grass	*Astelia* spp.
Pudding-grass	*Mentha pulegium*
Pudding-grass	*Hedeoma pulegoides*
Purple-eyed-grass	*Sisyrinchium* spp.
Ripple-grass	*Plantago lanceolata*
Saw-grass	*Cladium jamaicense*
Scorpion-grass	*Myosotis arvensis*
Sedge-grass	*Carex pendula*
Serpent-grass	*Polygonum viviparum*
Snake-grass	Equisetum arvense
Star-grass	*Aletris farinosa*
Surf-grass	*Phyllospadix* spp.
Tape-grass	*Vallisneria* spp.
Viper's-grass	*Scorzonera hispanica*
Whitlow-grass	*Draba verna*
Widgeon-grass	*Ruppia maritima*
Wire-grass	*Juncus* spp.
Yellow-eyed-grass	*Sisyrinchium* spp.
Yellow-eyed-grass	*Xyris* spp.

HOW BIG IS THE FAMILY?

Grasses, although they do not constitute the largest family of flowering plants, are economically the most important to us and ecologically they are the most dominant form of higher plants. Estimates of the size of the family vary, but ranges of 600-700 genera and about 10,000 species seem reasonable. The family ranks third in number of genera (behind the orchids and sunflowers) and fifth in number of species (after orchids, sunflowers, legumes, and members of the madder family).

NUMBER OF GENERA & SPECIES

Source	# Genera	# Species
Linnaeus (1771)	43	285
Trinius (1822)		2457
Hackel (1887)	313	3500
Bews (1929)	483	5871
Pilger (1954)	700	8,000
Prat (1960)	403	6250
Dahlgren (1985)	750	10,000

Clayton & Renvoize (1986)	651	10,000
Tzvelev (1989)	898	10,300
Watson & Dallwitz (1992)	793	9,890
Takhtajan (1997)	850	11,000
Thorne (1999)	656	9,976

A GLOBAL SUMMARY BY SUBFAMILY

Subfamily	Genera	Species
Anomalochlooideae	2 (0.3%)	4 (0.1%)
Pharoideae	3 (0.5%)	12 (0.1%)
Bambusoideae	65 (9.9%)	965 (9.7%)
Ehrhartoideae	18 (2.7%)	150 (1.5%)
Poöideae	154 (23.4%)	3275 (32.8%)
Arundinoideae	49 (7.4%)	605 (6.1%)
Danthonioideae	19 (2.9%)	275 (2.8%)
Aristidoideae	1 (0.1%)	250 (2.5%)
Centothecoideae	10 (1.5%)	25 (0.2%)
Panicoideae	207 (31.5%)	3290 (33.0%)
Totals	*658 (100%)*	*9976 (100%)*

[Number of taxa from Thorne, 1999]

THE TWENTY LARGEST GRASS GENERA

North America	World-wide
Panicum (113)	*Panicum* (590)
Poa (96)	*Poa* (500)
Elymus (80)	*Festuca* (472)
Muhlenbergia (77)	*Eragrostis* (350)
Festuca (63)	*Paspalum* (330)
Eragrostis (60)	*Stipa* (300)
Bromus (58)	*Aristida* (290)
Paspalum (54)	*Calamagrostis* (230)
Aristida (51)	*Digitaria* (230)
Agrostis (48)	*Agrostis* (220)
Calamagrostis (47)	*Elymus* (221)
Stipa (43)	*Muhlenbergia* (160)
Sporobolus (35)	*Sporobolus* (160)
Digitaria (32)	*Bromus* (150)
Setaria (28)	*Bambusa* (150)
Bouteloua (25)	*Axonopus* (110)
Melica (24)	*Setaria* (110)
Andropogon (23)	*Andropogon* (100)
Glyceria (21)	*Brachiaria* (100)
Hordeum (20)	*Isachne* (100)

DISTRIBUTION

Grasses are the most cosmopolitan of all higher plants, occurring on all continents, including Antarctica. They are also the most frequently encountered vascular plants. There may well be more individual grass plants than there are all other vascular plants combined! They are found from the polar regions to the equator, from mountain tops to seashores. They occur in brackish and freshwater marshes, ponds, streams, rain forests, deserts, tundra, and arid slopes. About one-fourth of the earth's plant cover is grasslands. They are dominant in the vast expanses of the world's prairies, steppes, pampas, paramos, and veldt. A major part of our agricultural lands is devoted to them. Grasses are with us in our cities, either as ornamentals or as weeds along sidewalks and in vacant lots. Grasses are never far away.

ECONOMIC IMPORTANCE

No other plant family, with the possible exception of the legumes and palms, can approach the grasses in direct economic importance to us. Major products include the cereal grains (wheat, rice, maize, barley, rye, sorghum, oats, and millets), hay, pasture, turf grasses, thatching material, timber, paper pulp, sugar (from sugar cane and sorghum), aromatic compounds (e. g., lemon grass and oil of vetiver), brooms, fishing poles, musical instruments, ornamentals, soil binders, starches, edible oils, alcohol, beverages, and food for most of the world's wild and domesticated animals.

We derive a major portion of our calories from cereals. Much of our agricultural land is devoted to the raising of cereals, especially wheat. Still more of the earth's surface is used for pastures for a variety of domesticated animals.

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1.02 - VEGETATIVE STRUCTURE

"I believe a leaf of grass is no less than the journey-work of the stars." (Walt Whitman)

ROOTS

Most mature grasses have a root system that is **fibrous** -- finely divided and lacking a dominant one, as in a taproot system. It is also **adventitious**, in that the primary root system is short-lived and it is soon replaced by roots that are derived from some other node along the embryo axis, rather than developing from the branches of the primary root. The extent and penetration of the grass root system is variable. *Aristida pungens* of North Africa has roots more than 20 m long.

The cells that give rise to root hairs may be equal in length or alternately long and short. There is also a difference in the point of attachment and the angle of insertion of root hairs relative to the basal part of the cell.

The roots are of little direct economic importance to us, although they do retard erosion through the structuring of the soil. Some roots contain aromatic principles, as in oil of vetiver.

STEMS

The erect aerial stem of a grass plant is called a **culm**. The stem is generally soft and herbaceous in our temperate grasses. Some of the reeds and canes have much tougher culms. Typical bamboos appear to be quite woody, but plant anatomists will argue that what we are seeing is not actually woody tissue. A grass stem may be only a centimeter or so tall to as much as 40 m or so in some of the tropical bamboos. The stem is divided into **nodes** and **internodes**. The nodes are regions where leaves are attached; they are typically rather easy to located in grasses because they are swollen. The region between two successive nodes is the internode. It is typically hollow, but we do have several exceptions in some commonly encountered grasses. Some studies suggest that about half of the grasses may have solid internodes. These plants also have a specialized spikelet structure and tend to inhabit arid regions.

Branches of stems arise most commonly from buds at the base of a parent shoot. These basal branches are called **innovations**. In some crop plants, the innovations are called **tillers** or **suckers**. A secondary stem may elongate within a leaf sheath or it may break through it as it develops. We call the former situation **intravaginal branching** and the latter **extravaginal branching**. Intravaginal is the more common situation.

Grasses also commonly produce horizontal or **repent** stems. The two most frequently encountered types are the **rhizome** and the **stolon**. A rhizome is a horizontal stem at or below the surface of the ground. It bears reduced, scale-like leaves. Stolons, on the other hand, are horizontal stems running along the surface of the ground and they often bear ordinary foliage leaves. Both serve as a means of vegetative reproduction. While these definitions sound precise, the distinction between the two is sometimes subtle. Bermuda grass (*Cynodon dactylon*) produces both rhizomes and stolons, depending upon environmental conditions.

Some grasses produce small onion-like **bulbs** (but without the odor), while others have **corms**, swollen hard stems surrounded by dry, papery, scale-like leaves, similar to the "bulb" of the gladiola.

The presence of rhizomes, stolons, bulbs, and corms is of taxonomic significance. All grass keys will, sooner or later, ask you whether these structures are present or absent. Make certain that you collect any underground parts of a grass plant when you are doing any serious collecting of grasses for identification or documentation.

Grass stems are very important as sources of building material, hay, forage, and packing material.

LEAVES

Grass leaves are **alternate** and **two-ranked**. They are alternate because only one leaf arises from a node. They are two-ranked because if the leaf borne at the first node comes off the left side of the culm, then the leaf at the second node will arise from the right side. Looking down on the stem and leaf system, the points of insertion or attachment are 180° opposite one another.

The leaves are typically composed of a **blade** or **lamina**, a **sheath**, and a **ligule**. The blade is usually linear -- most grass leaves, after all, do look like grass leaves! -- but it may be thread-like, needle-like, oval, or even arrowhead-shaped. In some of the tropical grasses, the leaf blades closely resemble those of some dicots. The venation is typically **parallel**, with all of the veins being more or less the same size or with one of them forming a more prominent midrib. Some tropical grasses have pinnate venation.

Some bamboos appear to have petioles, but I suspect they are best considered **pseudopetioles**. They appear to be nothing more than constrictions of the blade or sheath.

The grass sheath is usually interpreted as a flattened petiole. It is most often rounded, but in some grasses the sheath may be conspicuously flattened. Typically it is **open** -- the edges of the sheath come together and touch one another or they overlap slightly; but, they are not fused into a cylinder about the nodes. This is a useful character for separating most grasses from most sedges. But beware! Some very common grasses (orchard grass, onion grasses, and bromes) have **closed** sheaths, in which the two edges are joined. Wind action and careless use of a dissecting needle can convert closed sheaths to open ones.

The **ligule** is a membranous flap of tissue or a series of hairs (or both) at the junction of the blade and sheath. Its function may be to prevent water from entering the sheath or to hold the leaf tightly to the

culm. Not all grasses have ligules.

The first leaf of a culm branch or lateral shoot is the **prophyllum**. It is an unusual leaf, in that it lacks a blade. It protects the immature lateral stem axis and it provides mechanical support. The prophyllum has two prominent strands of vascular tissue running its length.

Grass leaves, especially those of the wheat or barley tribe (Triticeae) have ear- or claw-shaped appendages called **auricles**. These paired structures arise at the base of the blade in some grasses, but laterally at the sheath apex in others.

The leaf epidermis is an important source of taxonomic information. Typically the upper (adaxial) surface is different from the lower (abaxial) one. Both have cells arranged in columns over the vascular bundles (**costal region**) or in the zone between adjacent vascular bundles (**intercostal zone**). The cells are distinguished as **long**- or **short-cells**, depending upon their length-width ratio. Long-cells vary in wall thickness and appearance, being sinuous, papillate, or pitted. Those with sinuous walls are called **ripple-wall cells**.

Short cells occur singly or in pairs. There are two common types, **silica cells** and **cork cells**. The former have a silica-body in their lumen. The shape of this deposit determines the type of silica cell -- linear, rounded, irregular, saddle-shaped, dumbbell-shaped, cross-shaped, or double-axhead-shaped. Cork cells have cork in them.

Stomates are arranged in precise columns in the intercostal zone. Each is composed of two guard cells and two subsidiary cells.

An examination of the epidermis may also reveal **bulliform cells** -- large, colorless cells that are typically present in the intercostal zone of the adaxial surface. They are sometimes called mechanical cells, because they function in the rolling and unrolling (or folding and unfolding) of the leaf blade.

The blade, when seen in cross-section (also referred to as a transverse-section) yields the following features:

mesophyll: thin-walled parenchyma and chlorenchyma cells

vascular bundles: composed to xylem and phloem tissue, surrounded by one or two bundle sheaths; the inner one (when present) is termed an **endodermis** or **mesostome sheath** by various authors

sclerenchyma fibers: typically present in clusters in the region between the epidermis and the outer bundle sheath

TEXTURES

cartilaginous - resembling cartilage; hard and tough, but flexible
chartaceous - with the texture of writing paper
coriaceous - with the texture of leather
crustaceous - with a brittle texture
hyaline - thin and translucent or transparent
indurate - hard or hardened
membranous - thin, soft, and flexible
pellucid - transparent, clear
scarious - thin, dry, membranous; not green

COLORS

cinereous - light gray; ash-colored
ferruginous - rust-colored
fuscous - brownish, dusky
rufous - reddish-brown
stramineous - pale yellow; straw-colored
tawny - pale brown to dirty yellow

FEATURES OF THE SURFACES OF GRASSES*

☼ *Surface itself (exclusive of hairs, barbs, etc.)*

glabrous - without hairs
glaucous - with a whitish, waxy bloom
lustrous - shining
papillae - warty outgrowths of epidermal cells.
pitted - with small depressions, pits, pin-holes, or cavities
pruinose - with a waxy, powdery secretion on the surface
punctate - dotted with pin-point impressions or translucent dots
pustulose - with irregularly raised pimples
reticulate - netted with regular, slightly elevated lines
rugose - wrinkled
scurfy - covered with minute scales
smooth - not rough to the touch; not synonymous with glabrous
striated - marked with longitudinal lines
sulcate - furrowed with longitudinal channels
tessellate - marked by square to oblong depressions
tuberculate - with small projections; warty
verrucose - another way of spelling tuberculate
viscid - sticky

☼ *Projections and depressions from surfaces, margins, and apices*

☼ *Hairs branched or forked*
stellate - with few- to several branched sessile or stalked hairs

malpighiaceous (dolabriform) - with forked hairs attached at middle

☼ *Hairs simple, unbranched*

☼ *Hooked or barbed*
antrorsely - with forward or upward directed barbs
retrorsely - with backward or downward directed barbs
uncinate - hooked, as in a fish hook

☼ *Not hooked nor barbed*

☼ *Restricted to apex, base or margins*
ciliate - with hairs along margins only
fimbriate - as in ciliate, but hairs coarser and longer
comose - with a tuft of hairs at apex or base

☼ *On surfaces*

☼ *Curled, interwoven or entangled*
arachnoid - with slender, white, loosely tangled hairs
floccose - with tufts of soft hairs that rub off easily
lanate - with woolly or cottony hairs
tomentose - with densely and softly matted hairs

☼ *Not curled. interwoven, nor entangled*
bristle - a stiff slender hair-like appendage
canescent - with a dense mat of grayish-white hairs
echinate - with straight, ± large, prickle-like hairs
glabrate - initially hairy, but becoming glabrous
glandular - with swollen-tipped hairs; gland-bearing
hirsute - with rough or coarse, ± erect hairs
hoary - see canescent
hirsute - with straight, ± stiff hairs
hirtellous - minutely hirsute
hispid - with long, rigid, bristly hairs
hispidulous - minutely hispid
microhairs - typically bicellular [rarely multicellular] hairs usually requiring magnification of a compound microscope
macrohairs: typically one-celled hairs visible within the range of the ordinary dissecting microscope or good handlens;
papillate - with pimple-like hairs
papillose - see papillate
pilose - with sparse, slender, soft hairs
puberulent - minutely canescent
pubescent - with short, soft, erect hairs; downy
scabrous - with coarse, stiff, ascending hairs; rough
sericeous - with long, fine, appressed hairs; silky
setaceous - with bristly hairs
setose - see setaceous
strigose - with sharp, appressed, rigid, hairs that are often swollen at base
velutinous - with dense, firm, straight hairs; velvety
villous - with long, slender, soft (not matted) hairs; shaggy

*[Modified from Smith, J. P. 1977. Vascular plant families]

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1.03 - THE FLOWER, FRUIT, & SEED

FLOWERS

Most of us have never seen grass flowers and we are perhaps not even aware that grasses are flowering plants. The reasons are understandable. Grass flowers are small and hidden away from easy view by a system of reduced leaves (**bracts**). The brightly-colored sepals and petals that make the somewhat distantly-related lilies and orchids so attractive were lost through the gradual processes of evolutionary reduction. This is another way of saying that grass flowers do not strike most people as being terribly pretty. But, come closer!

All that remains of the grass perianth is two or three microscopic structures called **lodicules**. They are **hygoscopic**, swelling in the early morning and thereby forcing apart the bracts that enclose the flower. This process helps to facilitate wind pollination (**anemophily**). Not all grasses have lodicules.

The reproductive components of the grass flower that have been retained are modified for anemophily. The male part of the flower (**androecium**) is made up of stamens, each one consisting of a delicate, thread-like supporting stalk called a **filament** and a sac-like region of pollen-producing tissue, the **anther**. Most grasses have three stamens; some have two or one; a few have six; bamboo flowers may have hundreds of stamens!

The female portion of the flower (**gynoecium**) consists of a seed-producing **ovary**, two **styles** that are separate to their bases, and a terminal pair of feathery **stigmas** that trap airborne pollen.

Grass flowers vary in the presence or absence of reproductive parts. A **bisexual** or **perfect** flower is one that has both an androecium and a gynoecium. A **pistillate flower** has only the gynoecium; while the **staminate flower** has only the complement of stamens. A **neuter** or **sterile** flower has no reproductive structures. All grass keys will require you to distinguish among perfect, staminate, pistillate, or neuter flowers. A friendly warning -- what appears so easily defined on this piece of paper is often very difficult to interpret under the dissecting microscope or handlens. Look at several flowers before reaching your decision. One of the more common causes of error arises when anthers develop early, shed their pollen, shrivel up, and fall from the plant. A quick glance can lead to the mistaken notion that the flower is pistillate. Look carefully for filaments as a clue to the presence of fallen anthers.

FRUIT, SEED, AND EMBRYO

The ovule has a single chamber (**locule**) and it is one-seeded. In the vast majority of grasses, it will mature into a fruit type known as the **caryopsis**, in which the seed coat is fused to the ovary wall, except at the funiculus. In a few grasses, the seed is more or less separate from the ovary wall, producing a fruit type called an **achene**. In some bamboos, the fruit is a large, fleshy, single-seeded **berry**.

The seed contains endosperm and the embryo itself. Endosperm results from the fusion of two polar nuclei and a sperm nucleus. It provides nourishment to the developing embryo and later to the young seedling. The endosperm is typically solid and starchy in most grasses; in a few it is in a liquid state.

The embryo consists of the embryo axis and its appendages. At the upper end is the shoot or **plumule**, enclosed in a protective sheath, the **coleoptile**. At the lower end of the embryo axis is the embryonic root or **radicle**, also covered by an enveloping cap, the **coleorhiza**.

The **scutellum** is the major lateral appendage of the embryo. It is embedded directly in the endosperm, where it enzymatically digests and absorbs the stored food material. This function appears to be unique in the flowering plants. The scutellum is often interpreted as a modified cotyledon. Some grasses have a second appendage, called an **epiblast**. Its origin is more controversial. It appears as a small outgrowth opposite the scutellum, at a node just above that of the coleorhiza. In some grasses, there is a distinct region, the **mesocotyl**, between the nodes where the scutellum and the coleoptile are inserted.

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1.04 - SPIKELET STRUCTURE

THE BASIC PLAN

Because of their small size, high degree of evolutionary reduction, and lack of easily observed features, grass flowers have not been used extensively as the basis for distinguishing genera and species within the family. Instead, the classification of grasses has been based heavily upon the structure of the bracts that enclose individual grass flowers and that subtend groupings of them.

Grass flowers, the minute stalks that support them, and the bract system associated with them make up the **spikelet**. Some spikelets, especially those containing a single flower, may be quite small. Others may be a few centimeters long and easily seen without magnification. The spikelet, although characteristic of Gramineae, is not its exclusive property. Sedges have spikelets, too. Because their spikelets are superficially similar, it is easy to confuse the two families. Refer back to Table 1 for a comparison of the features of the two families.

All grass spikelets are put together according to the same basic plan. The tiny flowers and bracts are attached either directly or indirectly to an unbranched central spikelet axis called a **rachilla**. At the base of the rachilla are two bracts that are empty or sterile, in that they do not flowers in their axils. Each of the two basal bracts is a **glume**. Careful inspection will show that one bract is inserted slightly below the other. The lower bract is the first glume; the one attached slightly above it is the second glume. The two bracts may be similar in length, width, shape, and texture or they may be significantly different from one another. While most grass spikelets have two glumes, a few have only one, and it appears that in a few species the glumes are completely suppressed.

In addition to glumes, a spikelet contains one or more **florets**, each inserted at its own point of attachment (**node**) on the rachilla. The etymology of floret would suggest to you that the term means "a small flower." Not so. A floret is not only an individual small flower, but two bracts that enclose it. A floret never has more than one flower in it. The number of florets in a spikelet is of great diagnostic importance. A spikelet with a single floret is said to be one-flowered; one with two florets is two-flowered; and so on.

The two bracts that enclose the flower are the **lemma** and the **palea**. The lemma is typically the more conspicuous bract -- larger and of firmer texture, its edges often partially obscuring the palea. The lemma typically has an odd number of **nerves** or **veins** of vascular tissue running its length. Occasionally it will appear veinless. The number of nerves on the lemma is of great importance in identifying an unknown grass. Counting their number can be a challenge. It is very easy to overlook submarginal veins, those that lie close to the edge of the lemma. In most instances, the nerves of the lemma will converge with one another towards its apex; but in some grasses, they remain parallel to one another. When viewed in cross-section, a lemma often appears to be a rounded bract. Sometimes it is conspicuously flattened or even V-shaped. It may also have a prominent rib (**keel**) running down its center, the term being derived from the structure found on the bottom of a ship or boat. The lemma is attached directly to the rachilla. Usually it has a flower in its axil, in which case it is a **fertile lemma**. If the flower is absent, then it is called a **sterile lemma**.

Unlike the glume or lemma, the palea is not the source of many taxonomic features. It tends to be a delicate, membranous, two-nerved bract. It may be as long as the lemma, but it is usually somewhat shorter. The palea is not inserted directly on the rachilla. You will have to take my word for it, because it is all but impossible to see this level of detail under the dissecting microscope. The palea subtends the flower itself and it is attached to the tiny flower stalk.

The apex of a glume or lemma may bear a short, sharp point called a **mucro**. These bracts may also have a more elongate, substantial, hair-like projection known as an **awn**. It may be a few millimeters to several centimeters long. Awns may be straight, bent (**geniculate**), or twisted. Some, as in oats, function in the self-planting of the seed-like fruits. Some awns are terminal, while others arise from the back of a glume or lemma at about their midpoints. Others come from at or near the base of the bract. While glumes and/or lemmas are commonly awned, it is unusual in temperate grasses to find an awned palea.

The hardened base of a lemma or of a floret is its **callus**. In some instances, the callus is a combination of lemma and rachilla tissue. It may be rounded or sharp-pointed, as in the needle grasses. The callus may lack hairs or it may be clothed in a conspicuous tuft of hairs.

Spikelet parts are homologous with the stems and leaves of a grass plant. The rachilla is the homolog of a stem, the glumes and lemmas are homologous with ordinary foliage leaves, and the palea with the specialized first leaf of a side branch, the prophyllum.

COMPRESSION

Spikelets are either round in cross-section (**terete**) or they are flattened (**compressed**). Terete spikelets are relatively uncommon, but they occur in such common plants as the Indian rice-grass. Compressed spikelets come in two models. If the bracts are flattened as though pressure were brought to bear from the sides of the bracts, then the spikelet is **laterally compressed**. If the spikelet is flattened as though pressure were brought to bear from the backs of the bracts, then it is **dorsally compressed**.

Perhaps this distinction between dorsal and lateral compres-sion may be made clearer by drawing on two familiar animals that are flattened. Turtles show dorsal compres-sion, while fish are laterally compressed.

DISARTICULATION

At maturity, most spikelets will break apart at predeter-mined points of separation. The process is

called **disarticulation** and it occurs in various ways:

- ☼ below the first glume, so that the entire spikelet falls from the plant;
- ☼ above the glumes and between the florets so that empty glumes are all that remains behind;
- ☼ florets may fall separately or in clusters, sometimes with a prominent segment of the rachilla remaining attached.
- ☼ between the first and second glume (an unusual situation); or
- ☼ above glumes, but lemmas persisting (an unusual situation).

It takes some practice to determine disarticulation. You can force it to occur with a dissection needle, but not necessarily where it would under natural conditions. I recommend that you always observe older inflorescences -- ones that may otherwise look uninviting -- to find bare pedicels or empty glumes.

There is a tendency -- and it is nothing more than that -- for spikelets that are laterally compressed to disarticulate above the glumes and for those that are dorsally compressed to disarticulate below the glumes.

SEXUALITY

An individual floret or grass plant may be:

- ☼ bisexual (perfect or hermaphroditic), if it has both stamens and carpels;
- ☼ staminate (male), if it has only male florets;
- ☼ pistillate (female), if it has only female florets;
- ☼ sterile (neuter or barren), if it lacks either functional carpels or stamens (or, especially in older literature, if a floret were staminate).

There is another level of complexity. In many grasses, the lower florets of a spikelet are typically bisexual, with the upper florets progressively smaller and sterile. Another com-mon situation is the spikelet of panicoid grasses, in which the upper floret is bisexual and the lower is sterile. A less common possibility is the several-flowered spikelet that has both upper and lower florets that are sterile, while those in the middle are fertile.

Grass species, depending on the distribution of their stamens and carpels, may be described as:

- ☼ bisexual;
- ☼ monoecious, if an individual plant produces both staminate *and* pistillate spikelets;
- ☼ dioecious, if an individual plant produces either staminate *or* pistillate spikelets;
- ☼ various combinations of perfect and unisexual spikelets, on the same or different plants of a species.

VARIATION ON A THEME

To summarize, a typical grass spikelet consists of two glumes and one or more florets attached to a rachilla. It is laterally or dorsally compressed, or less often terete. The spikelet disarticulates above or below the glumes. The lemmas and/or the glumes may be awned.

While this is the basic plan, the spikelet is subject to a fascinating series of modifications. One of the most important of these is the reduction and loss of spikelet parts. One or both glumes may be missing. In spikelets with more than one floret, the upper one(s) are often smaller than the lower one(s) and they may be sterile. Sometimes the uppermost floret is well-developed and fertile, while the one or two florets below it are reduced. In a few grasses, the middle florets are best developed, while those above and below are reduced or sterile. The palea may be reduced or even absent, as in the bent grasses. This variation can be frustrating at first, but proper interpretation can be more easily assured if you take the time now to learn the basic positional relationships of the spikelet parts.

SPIKELET FORMULAE

A convenient system for summarizing the number of flower parts characteristic of various plant families is called a **floral formula**. In this system of notation, each of the four floral series is given an abbreviation, such as K (for calyx), C (for corolla), A (for androecium), and G (for gynoecium). Exponents or superscripts indicate the number of sepals, petals, stamens, and carpels. I developed the following little system for describing spikelets.

G = glume

G^0 = glumes absent

G^1 = one glume present

G^2 = two similar glumes present

G^{1+1} = two dissimilar glumes

F = fertile floret

F^{2-x} = 2 to several fertile florets

F^a = awned floret

L = sterile lemma (of a sterile floret)

L^x = 3 to several sterile lemmas

SOME SPIKELET MODELS

Agrostis	$G^2 + F$
Andropogon	$G^2 + L^1 + F^a$
Avena	$G^2 + F^{2-3}$
Panicum	$G^{1+1} + L + F$
Paspalum	$G^1 + L + F$
Phalaris	$G^2 + L^{1-2} + F$

Poa	$G^2 + F^{2-x}$
Uniola	$G^2 + L^x + F^x + L^x$
Zizaniopsis	$G^0 + F$

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1.05 - INFLORESCENCE TYPES

Grass stems, whether they are the primary culm or a lateral branch, may emerge from their sheaths and bear one to several hundred spikelets. This flowering portion of the grass plant is its **inflorescence**. A stem may bear only one inflorescence or it may have several of them. If it emerges from the uppermost sheath of a primary stem, it is a **terminal** inflorescence. If it arises from a lower sheath, it is an **axillary** or **lateral** inflorescence.

At first, it may be difficult for you to determine just how much of what you are looking at makes up a single inflorescence. A good rule of thumb is that there are never well-developed foliage leaves within an inflorescence. Whether terminal or axillary, the uppermost or outermost spikelet delimits the top of an inflorescence. The lowest typical foliage leaf marks its base.

The upper portion of the culm that supports the entire inflorescence is the **peduncle**, while the stalk that supports an individual spikelet is its **pedicel**. This terminology is not consistent with usage in other plant families. A pedicel is usually the stalk that supports a single flower. The true pedicel of a grass flower is, of course, within the spikelet. This error in terminology goes back about two hundred years to a time when attempts were made by Linnaeus and others to interpret the spikelet as a flower. The interpretation is incorrect, but unfortunately, the term persists.

If there is a clearly defined axis within the inflorescence, it is called a **rachis**. Note that the rachis is the axis of an entire inflorescence of spikelets, while the rachilla is the central axis of an individual spikelet. The rachis may be delicate, wiry, or even thickened with spikelets partially embedded in its tissue.

The exact arrangement of spikelets determines the inflorescence type. You will find this terminology frustrating because it has not been standardized and authors of keys and descriptions vary shamefully in their usage. No scheme is without its problems, but I have found the following one useful.

SIMPLE INFLORESCENCES

In the **spike**, the spikelets are inserted directly on an unbranched rachis. Pedicels are, for all practical purposes, absent. The number of spikelets attached at a given node on the rachis is variable. One, two, three, and a cluster of several spikelets per node are common. Many grasses have this inflorescence type.

In the **raceme**, spikelets are borne on well-developed pedicels arising from an unbranched rachis. Typically spikelets occur in pairs or trios at a given node, infrequently only one spikelet per node, as in the semaphore grasses. It is much less common than the spike. The distinction between the raceme and spike is arbitrary, the degree of pedicel development marking the difference. I use 1 mm as the dividing line.

The **rame** is a specialized modification of the raceme in which pedicellate and sessile spikelets occur together in pairs or trios. The pedicels are of equal or unequal length. The rame is typical of the barley and bluestem tribes (Triticeae and Andropogoneae). Few authors recognize the rame as distinct from the raceme.

The **panicle** is probably the most common inflorescence type in the family. Here the spikelets are borne on pedicels that are themselves secondary or tertiary branches of a much-branched system. This means that the spikelets are not attached directly to a central axis as they are in the spike, raceme, or rame. Panicles may be large, open, and very conspicuously branched or it may be so contracted and dense that they appear to be some sort of spike.

An extreme form of the panicle is the **solitary spikelet**, in which the peduncle bears a single spikelet, as in the poverty oats. In such instances, we believe that the solitary spikelet is the result of evolutionary reduction of a more typical much-branched panicle with multiple spikelets.

In the spike, raceme, or rame, the spikelets may be more or less evenly attached on opposite sides of the rachis so that the inflorescence is **balanced**, or they may be obviously attached on just one side of the rachis, so that the inflorescence is **one-sided**. If the spikelets are tightly packed along one side, as in the teeth of a comb, the inflorescence is said to be **pectinate**. Examples may be seen in grama grass (*Bouteloua*) and in toothache grass (*Ctenium*).

COMPOUND INFLORESCENCES

In many grasses, we see inflorescences composed of unbranched or sparingly branched arms. If we look at any particular branch, it bears a spike of spikelets, a raceme of spikelets, or a rame of spikelets. We may refer to them as compound spikes, compound racemes, and compound rames, respectively. In older literature, these are also considered to be panicles because they are branched inflorescences. In these compound inflorescences, the branches may be clustered at the apex of a peduncle (**digitate**) or they may be attached at various points along a rachis and be **racemose**.

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1.06 - POLLINATION & REPRODUCTION

"... grasses break almost all of the rules that many other groups of animals and plants observe...."

INTRODUCTION

Pollination is the transfer of pollen from an anther to the surface of a stigma. The term is clearly not synonymous with fertilization, which involves the union of egg and sperm nuclei. In most flowering plants, the two structures are in different flowers and we speak of **cross-pollination**. It offers the selective advantage of yielding new genetic combinations from two different plants. On the other hand, cross-pollination requires a pollinator – insects, birds, water, wind, moths, etc.

In many instances, the stigma of a particular flower is receptive to its own pollen grains or to other flowers on the same plant and **self-pollination** occurs. No pollinator is required. This mechanism obviously is not found in dioecious species, but it may occur in monoecious species, such as maize. Most plants have developed mechanisms that prevent or retard self-pollination.

WIND POLLINATION

Grasses are heavily adapted for wind pollination and cross-fertilization. The syndrome of adaptation that we find in the family includes:

- ☼ lodicules sensitive to weather;
- ☼ elongation of stamen filament;
- ☼ new orientation of anthers;
- ☼ quick shedding of pollen;
- ☼ pollen released with high temperatures and lowered humidity;
- ☼ pollen that is light, abundant, easily dispersed;
- ☼ light pollen has lowered terminal velocities;
- ☼ lower probability of entrapment;
- ☼ large, easily exserted stigma;
- ☼ inflorescences well-elevated above vegetative plant parts; and
- ☼ lack of nectaries.

INSECT POLLINATION

Not all grasses are wind pollinated (**anemophilous**). A number of visits by insects have been recorded in the literature. They appear to be looking for food, in the form of pollen grains or various sweet liquids made by the *Claviceps* fungi. Grasses are commonly visited when they are in flower. Insects move from one flower to another and thereby transfer pollen. Examples may be found in our temperate grasses, but it is perhaps more common in tropical rain forests where there is little, if any, wind to effect wind pollination.

INCOMPATIBILITY

I have already mentioned that most plants have developed mechanisms that favor cross-pollination, or to put it differently they are self-sterile or self-incompatible. Several possibilities come easily to mind: pollen is produced at a time when the stigmatic surface of that same flower is not receptive; stamens may have short filaments and the styles of the same flower may be very long, thereby physically making self-pollination more difficult. Less obvious are those that may involve genetic incompatibility.

The incompatibility mechanism found in Gramineae is unique. It is referred to as the "SZ incompatibility system." Here are the basic elements:

- √ Compatibility or incompatibility rests on the interaction of two genes, S and Z.
- √ Both S and Z occur in multi-allelic series, S1, S2, S3, etc.
- √ In a diploid grass, a haploid pollen grain would contain one S allele and one Z allele. The diploid stigma and style tissue would have nuclei with two of each of them.
- √ Incompatibility is determined by whether the pollen grain and stigma/style share alleles. If they share none, they are compatible. If they share one, they are compatible. If they share both, they are incompatible.
- √ Prevents fertilization between genotypes identical in incompatibility alleles.
- √ Greater the allelic differences –> greater chance that pollen will function.

Stigma/Style	Pollen Grain	Outcome
S1S2Z1Z2	S1Z1	Fails
S1S2Z1Z2	S1Z2	Fails
S1S2Z1Z2	S2Z1	Fails
S1S2Z1Z2	S2Z2	Fails
S1S2Z1Z2	S1Z1	Fails
S1S2Z1Z2	S1Z3	OK
S1S2Z1Z2	S2Z1	Fails
S1S2Z1Z2	S2Z3	OK

S1S2Z1Z2	S1Z1	Fails
S1S2Z1Z2	S1Z3	OK
S1S2Z1Z2	S3Z1	OK
S1S2Z1Z2	S2Z3	OK
S1S2Z1Z2	S3Z3	OK
S1S2Z1Z2	S3Z4	OK
S1S2Z1Z2	S4Z3	OK
S1S2Z1Z2	S4Z4	OK

[After Chapman & Peat, 1992]

BREEDING SYSTEMS

Grasses may be predominantly or exclusively outcrossing or cross-fertilized (**allogamous**) or they are predominantly self-fertile (**autogamous**) or they may be outcrossing for some period of time and then switch to selfing at another stage. The taxonomic consequences of crossing and selfing can be both amazing and very frustrating, especially to those who adhere to the classical version of the biological species concept.

DISTRIBUTION OF REPRODUCTIVE STRUCTURES

The terms **fertile** and **sterile** (**barren, neuter,** or **neutral**) have different meanings, depending on the author. In the broad sense, a flower, spikelet, or grass plant is fertile if it bears stamens and/or carpels. In H & C, they are fertile only if they bear functional carpels.

Similarly, a flower, spikelet, or grass plant is sterile if it lacks functional carpels, even if the stamens are func-tional! In other words, fertility and sterility are defined by the presence or absence of female reproductive structures.

A flower, a spikelet, or a grass plant that has both stamens and carpels is **perfect** or **bisexual**. If it has either stamens or carpels, but not both, it is **imperfect** or **unisexual**, and a flower, spikelet, or plant is either male (**staminate**) or female (**pistillate**).

A plant that bears both staminate and pistillate flowers or spikelets is **monoecious**. If male and female flowers or spikelets occur on separate plants, then we have the **dioecious** condition. These terms do not apply to flowers or spikelets – only to plants or species.

Plants that bear both perfect and imperfect flowers or spikelets are said to be **polygamous**. Four flavors are recognized:

♂ + bisexual on same plant = andromonoecious
♂ + bisexual on different plants = androgynoecious
♀ + bisexual on same plant = gynomonoecious
♀ + bisexual on different plants = gynodioecious

TYPES OF REPRODUCTION

"Grasses, like old men, have found a substitute for sex."

[Richard W. Pohl, a personal revelation]

There are basically two kinds of reproduction -- **sexual** and **asexual**. Sexual reproduction involves the union of egg and sperm nuclei. Grasses have developed a series of mechanisms that favor outcrossing, so that the gametes that unite come from different plants. These include:

- imperfect flowers and spikelets;
- self-sterility;
- **chasmagamous** flowers (ones that are open pollinated); and
- protandrous flowers, in which the stamens shed their pollen before the stigmas are receptive.

On the other hand, mechanisms that favor inbreeding or selfing include:

- perfect flowers or spikelets;
- self-fertility; and
- **cleistogamous** flowers, those that are closed and self-pollinated.

Apomixis is the general term used for all types of asexual reproduction, where there is no union of egg and sperm. The simplest form of apomixis is vegetative reproduction by means of rhizomes, bulbs, corms, bulblets or bulbils (vegetative proliferations that replace flowers), and fragmentation of stems. New plants arise vegetatively because these various structures contain buds that will produce new stems, roots, leaves, and spikelets if suitable moisture and nutrients are available. Many of our most successful weedy grasses have exploited asexual reproduction. Each of those chopped up rhizome segments or bulbs is fully capable of yielding a new, independent plant that is a genetic carbon copy of its mother.

Grasses can be much more subtle about their asexual reproduction. In **agamospermy**, seeds are produced, but they are not the product of the union of egg and sperm. In **adventitious embryony**, the embryo develops directly from the diploid tissue of the nucellus or ovule integment. The gametophytic generation has been completely bypassed.

In **gametophytic apomixis**, alternation of generation occurs, but the gametophytes arise without meiosis having occurred. Five versions are recognized:

- **apospory**, in which a diploid embryo sac is formed directly from a cell of the nucellus or of the inner integument;
- **diplospory**, in which a diploid embryo sac is formed from a cell of the archegonium
- **parthenogenesis**, in which the embryo forms from a diploid egg cell;
- **apogamy**, in which the embryo forms from some cell in the embryo sac other than the egg cell; and
- **pseudogamy**, in which pollination is required to stimulate seed set.

KEY TO STRATEGIES

1. Reproduction by means of the union of egg and sperm nuclei (sexual reproduction) –> **2**
1. Reproduction by means of vegetative tissue only or by means of seeds formed without the union of egg and sperm (asexual reproduction or apomixis)

–> **3**

2. Plants self- or closed pollinated –> **Cleistogamy**
2. Plants cross- or open-pollinated –> **Chasmogamy**

3. Reproduction by means of rhizomes, tillers, stolons, bulbs, corms, or aerial stem fragments (node + bud) –> **Vegetative reproduction**
3. Reproduction by means of modified spikelet parts or by means of seeds formed without union of egg and sperm –> **4**

4. Palea and/or lemma modified into bulblets –> –> **Vivipary (proliferation)**
4. Neither palea nor lemma so modified; fertile seed formed through partial use of sexual life cycle (agamospermy or apomixis s. s.) –> **5**

5. Embryo sac not formed; embryo developing from somatic cells –> **Adventitious embryony**
5. Embryo sac formed –> **6**

6. Embryony sac derived from somatic cell of the ovary –> **Apospory**
6. Embryo sac derived from a megaspore mother cell –> **Diplospory**

SOME EXAMPLES

Inbreeding: *Aira, Avena, Bouteloua, Brachypodium, Briza, Bromus, Chloris, Cortaderia, Danthonia, Deschampsia, Digitaria, Echinochloa, Eleusine, Elymus, Eragrostis, Festuca, Glyceria, Hordeum, Hyparrhenia, Koeleria, Lagurus, Lolium, Oryza, Panicum, Paspalum, Phalaris, Phleum, Poa, Polypogon, Puccinellia, Rottboellia, Secale, Setaria, Sieglingia, Sorghum, Sporobolus, Stipa, Trisetum, Triticum, Vulpia, Zizania.*

Cleistogamy: *Agrostis, Amphicarpum, Arctagrostis, Aristida, Avena, Bothriochloa, Bouteloua, Briza, Bromus, Calamagrostis, Chasmanthium, Chloris, Cottea, Dactyloctenium, Danthonia, Deschampsia, Dichanthelium, Dichanthium, Digitaria, Echinochloa, Eleusine, Enneapogon, Eragrostis, Erianthus, Festuca, Gymnopogon, Helictotrichon, Hemarthria, Hordeum, Leersia, Leptochloa, Melica, Microchloa, Microstegium, Muhlenbergia, Oryza, Oryzopsis, Panicum, Pappophorum, Paspalum, Phippsia, Piptochaetium, Poa, Schizachyrium, Secale, Setaria, Sieglingia, Sorghum, Spartina, Sporobolus, Stipa, Tridens, Triplasis, Trisetum, Uniola, Vulpia, Willkommia.*

Apomixis: *Anthephora, Bothriochloa, Brachiaria, Calamagrostis, Cenchrus, Chloris, Coix, Cortaderia, Dichanthelium, Elymus, Eragrostis, Eriochloa, Heteropogon, Hierochloe, Hilaria, Hyparrhenia, Nardus, Panicum, Paspalum, Pennisetum, Poa, Saccharum, Setaria, Sorghum, Themeda, Tripsacum, Urochloa.*

Hidden Cleistogenes: *Amphicarpum, Andropogon, Aristida, Chloris, Cottea, Danthonia, Dichanthelium, Digitaria, Diplachne, Enneapogon, Leersia, Muhlenbergia, Pappophorum, Paspalum, Pennisetum, Phippsia, Sieglingia, Stipa, Triplasis.*

Subterranean Cleistogenes: *Amphicarpum, Chloris, Paspalum*

Only Unisexual Florets: *Allolepis, Arrhenatherum, Buchloe, Cathestecum, Coix, Cortaderia, Distichlis, Gynerium, Heteropogon, Luziola, Monanthochloe, Olyra, Opizia, Pharus, Poa, Scleropogon, Tripsacum, Zea, Zizania, Zizaniopsis.*

Monoecious: *Buchloe, Coix, Distichlis, Luziola, Olyra, Pharus, Scleropogon, Tripsacum, Zea, Zizania, Zizaniopsis.*

Dioecious: *Allolepis, Buchloe, Cortaderia, Distichlis, Gynerium, Monanthochloe, Opizia, Poa, Scleropogon.*

*After Watson, L. 1990. In, Chapman, G. P. Reproductive versatility in the grasses. Cambridge Univ. Press. Pp. 14, 15.

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1.07 - GENOMES, HYBRIDS, & POLYPLOIDS

GENOMES

A **genome** is a complete set of chromosomes. In a diploid, it is either of the two sets of chromosomes derived from the parents. In a polyploid, a genome is any of the sets derived from its ancestors. Genomes are usually designated by a single capital letter, as in the B genome of wheat. The number of chromosomes in a genome is often designated by a small letter **x**, as in **x = 7**.

In a **euploid**, the individual, cell, or nucleus contains an exact multiple of x. If x = 10, then 10, 20, 30, 40, etc. would constitute a euploid series. In **aneuploids**, we have chromosome numbers that are not exact multiples of the base chromosome number. Individual chromosomes have been added or lost. Several kinds of aneuploids are recognized. In the **nullisomic**, both members of a chromosome pair are missing. In a **monosomic**, only one member is missing. In a **trisomic**, one member of a pair is in triplicate. In a **tetrasomic**, both members of the chromosome pair are duplicated.

We use the small letter **n** to designate the number of chromosomes found in a sex cell or gamete. The number of chromosomes found in a vegetative cell is shown as **2n**, as in 2n = 10. These two conditions are also called the gametic and somatic chromosome numbers, respectively.

A convention has been adopted in plant genetics that tells the chromosome number and ploidy level. According to this scheme the "genetic formula" for bread wheat is 2n = 6x = 42. This means that the vegetative cells contain 42 chromosomes (the 2n indicating a somatic number, rather than a gametic one), and that the plant is a hexploid (6x). If 6x = 42, then x = 7.

POLYPLOIDY

An individual, a cell, or a nucleus that contains one and only one complete sets of chromosomes is **haploid**. If it contains two complete sets, it is a **diploid**. An individual, a cell, or a nucleus that contains three or more complete sets of chromosomes is a **polyploid**. The combination of the prefixes tri-, tetra-, penta-, hexa-, octa-, etc., and the suffix -ploid, indicates the particular number of complete sets. A hexaploid has six sets.

A polyploid in which all of the chromosome sets are derived from the same genetic lineage, so that a chromosome in one set is capable of pairing with its corresponding number in another set, is an **autoploid** or **autopolyploid**. If, on the other hand, we are dealing with a polyploid in which the chromosome sets are derived from different species, subspecies, or varieties, then we have an **allopolyploid**. Here the chromosome sets are different enough that pairing of chromosomes is impaired -- slightly to completely. In a **segmental allopolyploid**, the polyploid appears to be of both auto- and allopolyploid origin. A series of interrelated polyploids, often demonstrating morphological similarities to one another constitute a **polyploid complex**.

HYBRIDIZATION

C. D. Darlington (1937) defined a hybrid as "a zygote produced by the union of dissimilar gametes." While theoretically acceptable, this definition is too broad for general use. Essentially all sexually reproducing plants and animals would be hybrids. Your classes are filled with hybrid students. We will use the term in a more restricted sense -- the offspring of interbreeding (crossing) between two or more taxa. The process itself is called hybridization. There are hundreds (probably thousands) of crosses between grass species (**interspecific hybrids**) and a long list of crosses between grass genera (**intergeneric hybrids**). Here is a long, but incomplete list of the latter.

Aegilops X *Elymus*
Aegilops X *Secale*
Aegilops X *Triticum*
Agropyron X *Elymus*
Agropyron X *Hordeum*
Agropyron X *Secale*
Agropyron X *Triticum*
Agrostis X *Calamagrostis*
Agrostis X *Polypogon*
Ammophila X *Calamagrostis*
Arctophila X *Dupontia*
Arrhenatherum X *Avena*
Avena X *Arrhenatherum*
Bothriochloa X *Dichanthium*
Bromus X *Festuca*
Calamagrostis X *Agrostis*
Chloris X *Cynodon*
Colpodium X *Phippsia*
Cynodon X *Chloris*
Danthonia X *Sieglingia*
Dichanthium X *Bothriochloa*
Dupontia X *Arctophila*

Elymus X *Aegilops*
Elymus X *Hordeum*
Erianthus X *Saccharum*
Festuca X *Bromus*
Festuca X *Lolium*
Festuca X *Vulpia*
Hordeum X *Elymus*
Hordeum X *Secale*
Hordeum X *Triticum*
Imperata X *Saccharum*
Koeleria X *Trisetum*
Leptochloa X *Oryza*
Lolium X *Festuca*
Miscanthus X *Saccharum*
Oryza X *Leptochloa*
Oryza X *Pennisetum*
Oryza X *Sorghum*
Oryza X *Triticum*
Oryzopsis X *Stipa*
Pennisetum X *Oryza*
Pennisetum X *Zea*
Phippsia X *Colpodium*
Phippsia X *Puccinellia*
Polypogon X *Agrostis*
Puccinellia X *Phippsia*
Saccharum X *Erianthus*
Saccharum X *Imperata*
Saccharum X *Miscanthus*
Saccharum X *Sorghum*
Saccharum X *Zea*
Secale X *Aegilops*
Secale X *Elymus*
Secale X *Triticum*
Sieglingia X *Danthonia*
Sorghum X *Oryza*
Sorghum X *Saccharum*
Sphenopholis X *Trisetum*
Stipa X *Oryzopsis*
Tripsacum X *Zea*
Trisetum X *Koeleria*
Trisetum X *Sphenopholis*
Triticum X *Aegilops*
Triticum X *Elymus*
Triticum X *Secale*
Vulpia X *Festuca*
Zea X *Saccharum*
Zea X *Tripsacum*

NAMED INTERGENERIC HYBRIDS

Sometimes the offspring of crossing between plants in closely related genera are stable enough to warrant naming, even though they are partially to completely sterile. The following intergeneric hybrids have been named. Not all of them are legal according to the ICBN. It is drawn primarily after Clayton & Renvoize (1986) and Watson & Dallwitz (1992).

Aegilosecale	*Aegilops x Secale*
Aegilotriticum	*Aegilops x Triticum*
Agrocalamagrostis	*Agrostis x Calamagrostis*
Agroelymus	*Agropyron x Elymus*
Agrohordeum	*Agropyron x Hordeum*
Agropogon	*Agrostis x Polypogon*
Agrositanion	*Agropyron x Sitanion*
Agrotrisecale	*Agropyron x Triticum x Secale*
Agrotriticum	*Agropyron x Triticum*
Ammocalamagrostis	*Ammophila x Calamagrostis*
Arctodupontia	*Arctophila x Dupontia*
Bromofestuca	*Bromus x Festuca*
Calammophila	*Calamagrostis x Ammophila*
Cynochloris	*Cynodon x Chloris*
Danthosieglingia	*Danthonia x Sieglingia*
Dupoa	*Dupontia x Poa*
Dupontopoa	*Dupontia x Poa*
Elyhordeum	*Elymus x Hordeum*
Elyleymus	*Elymus x Leymus*
Elymostachys	*Elymus x Psathyrostachys*
Elymotrigia	*Elymus x Elytrigia*
Elymotriticum	*Elymus x Triticum*
Elysitanion	*Elymus x Sitanion*
Euchlaezea	*Euchlaena x Zea*
Festulolium	*Festuca x Lolium*
Festulpia	*Festuca x Vulpia*
Hordale	*Hordeum x Secale*
Leymopyron	*Leymus x Agropyron*
Oryzticum	*Oryza x Triticum*
Pucciphippsia	*Puccinellia x Phippsia*
Sitordeum	*Sitanion x Hordeum*
Stiporyzopsis	*Stipa x Oryzopsis*
Trisetobromus	*Trisetum x Bromus*
Trisetokoeleria	*Trisetum x Koeleria*
Triticale	*Triticum x Secale*
Triticosecale	*Triticum x Secale*
Tritordeum	*Triticum x Hordeum*

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SECTION 2 – SYSTEMATICS OF THE GRASSES

2.01 - GRASSES & THEIR RELATIVES

The grass family belongs to a major subgroup of flowering plants called Liliopsida (Monocotyledoneae of earlier systems). Informally called "monocots," these plants have a single cotyledon, scattered vascular bundles in the stem, a circular pattern of vascular tissue in the roots, parallel venation in the leaf blade, and floral parts in 3's or multiples of 3. All of these features are usually seen in most grasses, except for the characters of the flower. They are highly reduced and are not easily interpreted. More about them later.

The closest relatives of the grasses belong to little-known tropical and subtropical plant families, such as Flagellariaceae, Centrolepidaceae, and Restionaceae. None of them is represented in the flora of North America. There are, however, two other families whose plants resemble grasses, at least superficially. The rushes (Juncaceae) and sedges (Cyperaceae) occur widely in North America. Rushes are rather easily distinguished from grasses by their 3-parted calyx and corolla and by their fruit, a many-seeded capsule. Sedges require closer inspection. Table 1 presents a comparison of typical members of the two families.

TECHNICAL FAMILY DESCRIPTIONS

GRAMINEAE (THE GRASS FAMILY)

Annual or perennial herbs, sometimes $\pm$ woody in the canes, reeds, and ornamental bamboos. Roots generally fibrous and adventitious at maturity; rhizomes and stolons frequent, some with bulbs. Stems generally round, sometimes flattened, erect to prostrate; nodes swollen, solid; internodes generally hollow. Leaves alternate, 2-ranked, simple, generally elongate and differentiated into a blade with parallel veins, a sheath (typically open with its edges meeting or overlapping slightly) that encircles the stem, and ligule (a membranous flap or series of hairs at inner apex of sheath). Inflorescence complex, consisting generally of numerous basic units, the spikelets, which are themselves tiny spikes. Spikelets round or flattened (dorsally or laterally) in cross-section; generally consisting of 2 sterile, overlapping, basal bracts (the first and second glume) and one or more florets (flowers and subtending bracts, the palea and lemma), these 2-ranked on an internal axis (the rachilla); glumes equal or unequal in size and shape, awned or awnless; 0 to many-nerved; lemmas similar to glumes in appearance and texture or quite dissimilar, awned or awnless, 0 to many-nerved; palea generally thin, transparent, awnless, 2-nerved, and $\pm$ enclosed by the lemma; floret base sometimes forming a sharp-pointed and/or hairy callus; breaking apart at maturity either below or above the glumes. Spikelets borne in secondary inflorescences (spikes, spike-like panicles, panicles, etc.), rarely solitary. Flowers generally bisexual, minute, wind-pollinated, the perianth reduced to 2 or 3 microscopic structures (lodicules); stamens [1] 3 [6], anthers generally comparatively large; stigmas generally 2, typically dissected and feather-like; ovary 1-chambered. Fruit a caryopsis (or grain), with the fruit wall $\pm$ completely fused with the seed coat of the single seed inside. 651 genera; $\pm$ 10,000 species; cosmopolitan, probably the most frequently encountered flowering plants, found in a wide variety of habitats and on all continents, including Antarctica.

CYPERACEAE (THE SEDGE FAMILY)

Perennial [rarely annual] herbs of wet and marshy sites. Plants often with creeping rhizomes. Stems generally with solid internodes and often 3-sided. Leaves from basal tufts or cauline and 3-ranked; sheaths usually closed; ligule generally absent. Flowers minute, bisexual or unisexual (the species generally monoecious), spirally or distichously arranged in tiny spikes. Each flower is subtended by a small bract (often called a glume). The spike of reduced flowers and subtending bracts form the spikelet, which are themselves arranged in panicles, umbels, or spike-like inflorescences. Perianth of bristles, hairs, scales, or absent. Stamens 3 [rarely 1 or 6]. Carpels 2 or 3, united, 1-ovuled, with as many style-branches as carpels; ovary superior. Fruit an achene or nutlet, lenticular or 3-sided, sometimes enclosed in a membranous sac (perigynium). 90 genera; 4000 species; widespread, particularly in the cool temperate and subarctic regions. Of little economic importance; a few are edible and some are grown as ornamentals.

JUNCACEAE (THE RUSH FAMILY)

Perennial or annual herbs, from erect or horizontal rhizomes. Leaves generally basal, linear, sheathing at base, sheaths generally open; blades sometimes absent. Flowers small, green, actinomorphic, bisexual or unisexual (species diocecious); in heads, panicles, or corymbs. Tepals 6 (in two sets of 3), sepaloid. Stamens 6 [rarely 3]. Carpels 3, united, unilocular; placentation axillary or parietal; style 1; stigmas 3, brush-like; ovary superior. Fruit a capsule. 9 genera; 400 species; largely cool temperate and subarctic damp and wet sites. Of no direct economic importance; a few are grown as ornamentals.

CENTROLEPIDACEAE

Annual or perennial grass-like, rush-like, or moss-like herbs. Leaves linear, bristle-like, cauline or in basal rosettes. Flowers tiny, unisexual, in cymose false inflorescences (pseudanthia) of 1 or 2 male flowers and 2-many female flowers. Pseudanthia terminal, spikelike, and subtended by 2-several glume-like bracts. Male flowers reduced to 1 stamen. Female flowers reduced to 1 carpel, the ovary unilocular. Fruit dehiscent or indehiscent, 1-seeded. 5 genera; 30 species; found primarily in New Zealand, Australia, and the southern tip of South America. None occur in North America.

RESTIONACEAE

Perennial, rhizomatous herbs. Stem internodes solid or hollow. Leaves reduced to open sheaths, blades and ligules generally absent. Flowers small, regular, unisexual (species dioecious). Perianth absent or scale-like. Stamens 3 [rarely 1 or 4]. Carpels 1 or 3, united, the ovary superior. Fruit an achene, nut, or capsule. 38 genera; 400 species; found primary in the southern hemisphere [1 sp. in Viet Nam], especially well-represented in the Cape region of South Africa where 180 ssp. are endemic! Of little economic importance; a few are used for thatch and to make brooms. None occur in North America.

FLAGELLARIACEAE

Glabrous vines. Leaves spirally arranged, blades parallel-veined and terminating in a tendril; ligule absent. Flowers small, regular, bisexual, 3-merous, wind-pollinated, in terminal bracteate panicles. Tepals 3 + 3. Stamens 6. Carpels 3, united; ovary trilocular, superior. Fruit a drupe. 1 genus; 4 species; found primarily in the Old World tropics and islands of the South Pacific. Of little economic importance; one species is used in basket-making in Asia. None occur in North America.

JOINVILLEACEAE

Erect, perennial, rhizomatous herbs. Stem internodes hollow. Leaves grass-like, spirally arranged; ligulate and auriculate. Flowers bisexual, 3-merous, in terminal bracteate panicles. Tepals 3 + 3. Stamens 6. Carpels 3, united; ovary 3-locular, superior. Fruit a drupe. 1 genus; 2 species; restricted to Malaysia and the islands of the Pacifc. The family was only recently separated out of Flagellariaceae. Of no economic importance.

A COMPARISON OF GRASSES AND SEDGES

Feature	Grasses	Sedges
Stems:		
Shape in x-section	Round [flat]*	Triangular [round]
Internodes	Hollow [solid]	Solid
Leaves:		
# of Ranks	2	3
Sheaths		Open [closed]Closed
Ligule	Present	Absent
Spikelets:		
Bract insertion	Distichous	Distichous, spiral
Bracts per flower	2	1
Flowers:		
Perianth	2 [3] lodicules	0-6 bristles
Stamen number	3 [6, 1, many]	1-3
Anthers		VersatileBasifixed
Stigmas		23
Carpels		2 [3]3 [2]
Pollen shed as	Monads	Pseudomonads
Fruit and Seed:		
Fruit type	Caryopsis	Achene
Embryo position	Lateral	Central
Chromosomes:		
Centromeres	Monocentric	Diffuse

* Character states in brackets indicate the less typical situation.

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2.02 - SYSTEMS OF CLASSIFICATION [Historical Survey]

"The Grasses are dreadfully difficult and systematically a chaos of imperfect descriptions, erroneous identifications, confused synonymy and imbecile attempts. We have upwards of a century of collections and not an attempt at a classification. Each Botanist in his own country has worked at his sweet will in ignorance of his predecessors' and contemporaries' work, with imperfect materials and often no books -- 'Hinc illae lachrymae.' (Sir Joseph Dalton Hooker)

****

The purpose of this section is to outline the major attempts in the last four hundred years to classify grasses. While there have been important conceptual advances since Burbidge made his comment of thirty years ago, it still has a ring of truth about it.

Jacob Theodore (Tabernaemontanus) (1590) wrote thirty-five chapters on grasses, including rushes, arrow-grasses, plantains, horsetails, and some caryophylls. His classification was based upon general plant form and a plant's habitat.

Caspari Bauhin (1623) recognized twenty-four groups based upon form of the grass plant. His was an unnatural assemblages of plants, lumping together grasses and cattails.

Joseph Pitton de Tournefort (1694) was the first to present an index to technical and common names. His Class 15 included grasses, chenopods, nettles, smartweeds, sedges, etc. Section 3 was devoted to grasses and it contained 9 "genera" (1-7, cereals; 9, reed grasses; 8, others).

John Ray (1703) urged simplification in classification and the use of easier features. He also encouraged the use of dichotomous keys.

Pier Antonio Micheli (1728) developed a system based upon the completeness of flower and spikelet. He found the "lost petals" of the grass flower (lodicules).

Carolus Linnaeus (1753) recognized thirty-eight genera of grasses (one of them actually a sedge!). They were put into six of his artificial groups.

Robert Brown (1814) was one of England's most influential botanists. He was the first to distinguish the two great groups of grasses: Panicoideae and Pooideae.

Palisot de Beauvois (1812) recognized two "families," divided into tribes and then into sections. He recognized 210 genera based upon glume arrangement and disarticulation. His name appears frequently as the author of numerous genera and species of grasses.

Carl Bernard von Trinius (1822) prepared a summary of grass classification and synonymy, in which he listed 2457 species, along with their author and place of publication.

George Bentham (1881) was one of Victorian England's most famous botanists. He often collaborated with Joseph Dalton Hooker. Bentham's system was used by A. S. Hitchcock and others until mid-20th century.

Series A: Paniceae
- Tribe: Paniceae
- Tribe: Maydeae
- Tribe: Oryzeae
- Tribe: Tristegineae
- Tribe: Zoysieae
- Tribe: Andropogoneae

Series B: Poaceae
- Tribe: Phalarideae
- Tribe: Agrostideae
- Tribe: Aveneae
- Tribe: Chlorideae
- Tribe: Festuceae
- Tribe: Hordeae
- Tribe: Bambuseae

Eduard Hackel (1887) developed a system much like that of Bentham. He recognized 13 tribes and 313 genera.

George Valentine Nash (1909) wrote major portions of the treatment of Gramineae for the "North American Flora." He recognized 13 tribes, but did not place them in subfamilies.

- Tribe: Maydeae
- Tribe: Andropogoneae
- Tribe: Zoysieae
- Tribe: Tristegineae
- Tribe: Paniceae
- Tribe: Oryzeae
- Tribe: Phalarideae
- Tribe: Agrostideae
- Tribe: Aveneae
- Tribe: Festuceae
- Tribe: Chlorideae

John Bews was the author of "The World's Grasses: Their Differentiation, Distribution, and Ecology." Although quite dated, it remains a useful reference. In it, he recognized two subfamilies, 15 tribes, 481 genera, and 5871 species.

Subfamily: Pooideae
- Tribe: Bambuseae
- Tribe: Phareae
- Tribe: Festuceae
- Tribe: Aveneae
- Tribe: Chlorideae
- Tribe: Hordeae
- Tribe: Agrostideae
- Tribe: Zoysieae
- Tribe: Phalarideae
- Tribe: Arundinelleae
- Tribe: Oryzeae

Subfamily: Panicoideae

Tribe: Melinideae
Tribe: Paniceae
Tribe: Andropogoneae
Tribe: Maydeae

Nikolai Pavlovic Avdulov was a famous Russian botanist. His 1931 cytological examination of Gramineae is considered by many the foundation of the "new agrostology." In it, he listed two series and 13 tribes.

Series A
Tribe: Maydeae
Tribe: Andropogoneae
Tribe: Zoysieae
Tribe: Tristagineae
Tribe: Paniceae
Tribe: Oryzeae

Series B
Tribe: Phalarideae
Tribe: Agrostideae
Tribe: Aveneae
Tribe: Chlorideae
Tribe: Festuceae
Tribe: Hordeae
Tribe: Bambuseae

Romain Roschevicza, another Soviet botanist, in 1937 recognized two subfamilies (Poatae and Sacchariferae), 5 series, and 28 tribes.

Subfamily: Poatae
Series: Bambusiformes
Tribe: Bambuseae
Tribe: Phareae
Series: Phragmitiformes
Tribe: Centotheceae
Tribe: Arundineae
Tribe: Oryzeae
Tribe: Stipeae
Tribe: Brachypodieae
Tribe: Unioleae
Series: Festuciformes
Tribe: Festuceae
Tribe: Nardeae
Tribe: Aveneae
Tribe: Phalarideae
Tribe: Agrostideae

Subfamily: Sacchariferae
Series: Eragrostiformes
Tribe: Eragrosteae
Tribe: Pappophoreae
Tribe: Chlorideae
Tribe: Sporoboleae
Series: Paniciformes
Tribe: Paniceae
Tribe: Melinideae
Tribe: Zoysieae
Tribe: Andropogoneae
Tribe: Maydeae

Albert Spear Hitchcock, Curator of Grasses at the Smithsonian Institution, was the most influential American agrostologist of the early 20th century. The system he used in "The Manual" (1935, 1951) has two subfamilies and 14 tribes and it closely follows the thinking of George Bentham. This is the scheme that I learned when I took agrostology.

Subfamily: Festucoideae
Tribe: Bambuseae
Tribe: Festuceae
Tribe: Hordeae
Tribe: Aveneae
Tribe: Agrostideae
Tribe: Zoysieae
Tribe: Chlorideae
Tribe: Phalarideae
Tribe: Oryzeae
Tribe: Zizanieae

Subfamily: Panicoideae
Tribe: Melinideae
Tribe: Paniceae
Tribe: Andropogoneae
Tribe: Tripsaceae

Robert Pilger and **Eva Potzal**, two eminent German botanists, prepared portions of a world wide treatment of grasses. They recognized nine subfamilies, 34 tribes, and 555 genera. Although the individual generic treatments are still useful, their system is not widely accepted.

Alan Beetle, an American botanist, was one of the first to support more than two subfamilies for our North American material. He recognized:

Subfamily: Bambusoideae
Subfamily: Pharoideae
Subfamily: Festucoideae
Subfamily: Panicoideae

Tsugo Tateoka is one of Japan's most influential botanists. His system, published in 1957, recognized five subfamilies:

Subfamily: Pharoideae
Subfamily: Pooideae
Subfamily: Eragrostoideae
Subfamily: Panicoideae
Subfamily: Arundinoideae

Henri Prat (1960), in his world-wide survey of grasses, recognized six subfamilies, 26 tribes, 403 genera, and 6250 species.

G. Ledyard Stebbins and **Beecher Crampton** were both professors at the University of California at Davis. In 1961, they published a provisional scheme for North American grasses. It turned out to be very influential.

Subfamily: Bambusoideae
Tribe: Arundinarieae

Subfamily: Oryzoideae
Tribe: Phareae
Tribe: Olyreae
Tribe: Ehrharteae
Tribe: Oryzeae
Tribe: Zizanieae

Subfamily: Arundinoideae
Tribe: Arundineae
Tribe: Danthonieae
Tribe: Unioleae
Tribe: Aristideae

Subfamily: Festucoideae
Tribe: Ampelodesmeae
Tribe: Stipeae
Tribe: Brachyelytreae
Tribe: Nardeae
Tribe: Monermeae
Tribe: Meliceae
Tribe: Diarrheneae
Tribe: Festuceae
Tribe: Hordeae
Tribe: Aveneae

Subfamily: Eragrostoideae
Tribe: Aeluropideae
Tribe: Spartineae

Tribe: Pappophoreae
Tribe: Eragrosteae
Tribe: Chlorideae
Tribe: Zoysieae
Subfamily: Panicoideae
Tribe: Paniceae
Tribe: Andropogoneae

Henri Jacques-Felix, in his 1962 survey of tropical African grasses, recognized twelve subfamilies and 35 tribes. His names employ the endings of his native French.

Subfamily: Olyroide
Subfamily: Bambusoide
Subfamily: Streptogynoide
Subfamily: Stipoide
Subfamily: Oryzoide
Subfamily: Ehrhartoide
Subfamily: Zizanioide
Subfamily: Centothecoide
Subfamily: Arundinoide
Subfamily: Festucoide
Subfamily: Chloridoide
Subfamily: Panicoide

Frank Gould, in the 1968 edition of his textbook "Grass Systematics," recognized six subfamilies, 23 tribes, 122 genera, and 1083 native species in the United States. Gould, a faculty member at Texas A & M University, was one of the most productive agrostologists in this country.

Subfamily: Festucoideae
Subfamily: Panicoideae
Subfamily: Eragrostoideae
Subfamily: Bambusoideae
Subfamily: Oryzoideae
Subfamily: Arundinoideae

Charles Edward Hubbard, of the Royal Botanic Garden at Kew, was the dean of the British agrostologists, with an encyclopedic knowledge of the world's grasses. He did not follow the increasingly popular view of recognizing four to six subfamilies by listing only two (Festucoideae and Panicoideae) and 27 tribes.

W. Derek Clayton and **Stephen Andrew Renvoize** are the authors of one of the two major world-wide surveys to be published in the past few years. The descriptions of genera are relatively brief. The taxa are arranged systematically and keys to tribes and genera are provided.

Subfamily: Bambusoideae
Tribe: Bambuseae
Tribe: Anomochloeae
Tribe: Streptochaeteae
Tribe: Olyreae
Tribe: Parianeae
Tribe: Phareae
Tribe: Phaenospermateae
Tribe: Streptogyneae
Tribe: Oryzeae
Tribe: Phyllorachideae
Tribe: Ehrharteae
Tribe: Diarrheneae
Tribe: Brachyelytreae
Subfamily: Pooideae
Tribe: Nardeae
Tribe: Lygeae
Tribe: Stipeae
Tribe: Poeae
Tribe: Hainardieae
Tribe: Meliceae
Tribe: Aveneae
Tribe: Bromeae
Tribe: Triticeae
Subfamily: Centothecoideae
Tribe: Centotheceae
Subfamily: Arundinoideae
Tribe: Arundineae
Tribe: Thysanolaeneae
Tribe: Micraireae
Tribe: Aristideae
Subfamily: Chloridoideae
Tribe: Pappophoreae
Tribe: Orcuttieae
Tribe: Eragrostideae
Tribe: Leptureae
Tribe: Cynodonteae
Subfamily: Panicoideae
Tribe: Paniceae
Tribe: Isachneae
Tribe: Hubbardieae
Tribe: Eriachneae
Tribe: Steyermarkochloeae
Tribe: Arundinelleae
Tribe: Andropogoneae

N. N. Tzvelev is Russia's most prominent agrostologist. In 1989, he published a comprehensive review of the family in which he recognized only two subfamilies and 28 tribes. Note that he is the only recent author who goes back to the once common two subfamily view.

Subfamily: Bambusoideae
Tribe: Arundineae
Tribe: Bambuseae
Tribe: Dendrocalameae
Subfamily: Pooideae
Tribe: Brachypodieae
Tribe: Triticeae
Tribe: Bromeae
Tribe: Poeae
Tribe: Phleeae
Tribe: Meliceae
Tribe: Diarrheneae
Tribe: Brachyelytreae
Tribe: Ampelodesmeae
Tribe: Stipeae
Tribe: Nardeae
Tribe: Oryzeae
Tribe: Ehrharteae
Tribe: Centosteceae
Tribe: Arundineae
Tribe: Thysanolaeneae
Tribe: Aristideae
Tribe: Cynodonteae
Tribe: Paniceae
Tribe: Andropogoneae

Leslie Watson and **Michael J. Dallwitz** in 1992 published "The Grass Genera of the World," a compendium that provides very detailed descriptions. The genera are arranged alphabetically and there are no keys. Their system of classification appears below:

Subfamily: Stipoideae
Tribe: Nardeae
Tribe: Ampelodesmeae
Tribe: Stipeae
Tribe: Brachyelytreae
Subfamily: Pooideae
Tribe: Triticeae

Tribe: Brachypodieae
Tribe: Bromeae
Tribe: Aveneae
Tribe: Poeae
Tribe: Meliceae

Subfamily: Bambusoideae
Tribe: Oryzeae
Tribe: Diarrheneae
Tribe: Phareae
Tribe: Bambuseae

Subfamily: Centothecoideae
Tribe: Centotheceae

Subfamily: Arundinoideae
Tribe: Arundineae
Tribe: Danthonieae
Tribe: Aristideae

Subfamily: Chloridoideae
Tribe: Pappophoreae
Tribe: Orcuttieae
Main Chloridoid Assemblage

Subfamily: Panicoideae
Tribe: Paniceae
Tribe: Andropogoneae
Tribe: Maydeae

Grass Phylogeny Working Group. The GPWG is composed of eight individuals located here in the United States, and in South Africa and Switzerland. The system is based on a cladistic analysis of six molecular sequence data sites, chloroplast restriction site data, and more traditional morphological data.

Subfamily: Bambusoideae
Tribe: Bambuseae
Tribe: Olyreae

Subfamily: Anomochlooideae
Tribe: Streptochaeteae

Subfamily: Pharioideae
Tribe: Phareae

Subfamily: Ehrhartoideae
Tribe: Oryzeae
Tribe: Ehrharteae

Subfamily: Centothecoideae
Tribe: Centotheceae
Tribe: Thysanolaeneae

Subfamily: Pooideae
Tribe: Triticeae
Tribe: Brachypodieae
Tribe: Bromeae
Tribe: Poeae
Tribe: Ampelodesmeae
Tribe: Meliceae
Tribe: Stipeae
Tribe: Nardeae
Tribe: Brachyelytreae
Tribe: Diarrheneae

Subfamily: Arundinoideae
Tribe: Arundineae

Subfamily: Danthonioideae
Tribe: Danthonieae

Subfamily: Aristidoideae
Tribe: Aristideae

Subfamily: Chloridoideae
Tribe: Pappophoreae
Tribe: Orcuttieae
Tribe: Cynodonteae
Tribe: Eragrostideae
Tribe: Leptureae

Subfamily: Panicoideae
Tribe: Paniceae
Tribe: Andropogoneae

Flora of North America. 'The Manual of Grasses' will soon be replaced by two volumes in the 'Flora of North America' series. One volume has been published; the second is to appear in 2006. Mary Barkworth, an agrostologist at Utah State Univ., is the senior editor. The unpublished scheme that will be used appears below.

Subfamily: Bambusoideae
Tribe: Bambuseae
Tribe: Phareae

Subfamily: Oryzoideae
Tribe: Oryzeae

Subfamily: Pooideae
Tribe: Ehrharteae
Tribe: Diarrheneae
Tribe: Brachyelytreae
Tribe: Nardeae
Tribe: Stipeae
Tribe: Poeae
Tribe: Hainardieae
Tribe: Meliceae
Tribe: Aveneae
Tribe: Bromeae
Tribe: Brachypodieae
Tribe: Triticeae

Subfamily: Centothecoideae
Tribe: Centotheceae

Subfamily: Arundinoideae
Tribe: Arundineae
Tribe: Danthonieae
Tribe: Aristideae

Subfamily: Chloridoideae
Tribe: Pappophoreae
Tribe: Orcuttieae
Tribe: Cynodonteae

Subfamily: Panicoideae
Tribe: Paniceae
Tribe: Andropogoneae

THE SYSTEM-BUILDERS

1880 C. O. Hartz (Germany)
1881 George Bentham (England)
1887 Eduard Hackel (Germany)
1929 John Bews (England)
1931 Nikolai P. Avdulov (Russia)
1934 Charles E. Hubbard (England)
1936 Henri Prat (France)
1946 Romain Roshevitz (Russia)
1954 Robert Pilger (Germany)
1955 Alan Bettle (United States)
1957 Tsugo Tateoka (Japan)
1961 G. Ledyard Stebbins & Beecher Crampton (United States)
1986 W. Derek Clayton & Stephen A. Renvoize (England)
1988 Leslie Watson & Michael J. Dallwitz (Australia)
1989 Nikolai Tzvelev (Russia)
2001 Grass Phylogeny Working Group

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2.03 - THE BASIS OF MODERN SYSTEMS

The great agrostologists of the past were limited by the instruments and the technology of their period, just as we are today. For the most part, botanists had to rely upon the features that were seen under the light microscope. At first, these devices were relatively crude. You can still see Linnaeus's microscope if you visit his home in Sweden. Workers of the 19th century and the early part of the 20th based their systems of classification primarily on features that could be seen with increasingly better instruments, especially the dissecting microscope. They focused their attention on the morphological details of stems, leaves, the inflorescence, and the spikelet.

By the time A. S. Hitchcock had completed the first edition of "The Manual" in 1935, botanists in various countries around the world had begun using new techniques to understand the relationships in the family and to suggest new systems of subfamilies and tribes. These more modern systems of classification relied heavily upon a series of what we might call **microcharacters** -- anatomical, cytological, genetic, and chemical traits of grasses. The result is a system of subfamilies, tribes, and genera that is strikingly different from the ones produced by the great figures of the 19th and early 20th centuries. General reviews of these new features upon which the modern classification of the family rests are found in Auquier (1963), Avdulov (1931), Clifford (1969), and Gould & Shaw (1983).

A CHRONOLOGY

1892 Embryo structure
1926 Chromosome complements
1931 Chromosome karotypes
1932 Leaf epidermis
1953 Root hair development
1957 Persistent nucleoli
1957 Shoot apex and meristem activity
1957 Embryo structure
1958 Germination responses to IPC
1958 Leaf anatomy
1959 Nodal pulvini and internode structure
1960 Culm anatomy
1961 Seedling leaf
1961 Antigen/antibody reactions
1962 Starch grains
1968 Starch versus fructosan accumulation
1969 Underground seedling organs
1974 Photosynthetic pathways/leaf anatomy
1976 Flavonoid patterns
1978 Stomatal insertion
1983 Pollen antigens
1987 Photosynthetic pathways
1991 Chloroplast DNA analysis
2000 Phytochrome B

UNDERGROUND SEEDLING FEATURES

Hoshikawa (1969) recognized six patterns of underground organs of the grass seedling based upon:

- the presence or absence of transitory node roots (TNR);
- whether or not the mesocotyl elongates, and
- the presence or absence of mesocotyl roots (MR).

He also discovered seven patterns of seedling establishment based upon features of the TNR, MR, and crown node roots (CNR). He then used the six patterns of organs and the seven of establishment to characterize various subfamilies and tribes.

FIRST LEAF

Kuwabara (1960, 1961) investigated the shape, position, and length/width ratio of the first leaf of the grass seedling. He found that in festucoids the leaf blade was linear, perpendicular, and had a L/W ratio = 10.3-106. In panicoids, the blade was oval to lanceolate, horizontal to ascendent, and L/W = 1.3-12. In eragrostoids, the blade was heterogeneous and L/W = 15.5-25.9.

ROOT HAIRS

Row & Reeder 1957) and Reeder & von Maltzalen (1953) found two kinds of root hairs in grasses:

Type A, the hairs were made up of alternating long and short cells and the hairs themselves arose from apical end at a 45 angle. Typical of pooid grasses.

Type B, the hairs were composed of cells of equal length and arose from the midpoint at 90° angles. Found more commonly in chloridoid and panicoid taxa.

LEAF IN TRANSVERSE SECTION

Based upon the studies of Avdulov (1931), Prat (1936), and Brown (1958), we have been able to recognize six different patterns: festucoid, bambusoid, arundinoid, panicoid, aristidoid, and chloridoid. The characters used to distinguish the six types include those of the vascular bundles, the endodermis, the mestome sheath, the kind and location of plastids, and the pattern of chlorenchyma cells. In leaves of grasses that employ the C_4 photosynthetic pathway, there are specialized cells around the vascular bundles.

CULM IN TRANSVERSE SECTION

Brown, Harris, & Graham (1959) found that while almost all of the pooid grasses that they examined had hollow internodes, that 49-100% of the chloridoid and panicoids had ± solid internodes. They concluded that there was a positive correlation between the latter condition and hot, arid habitats.

CULM NODE AND SHEATH PULVINI

Brown et al. (1959) investigated the presence of leaf sheath pulvini and its correlation with hollow vs. solid culm internodes. Pulvini are meristematic swellings at the base of a leaf sheath. They are sometimes called "motor organs" because they make it possible for a stem that has been trampled or blown down to right itself. They discovered that pooid grasses have pulvini, while most panicoid and chloridoids do not. Therefore, pulvini are correlated with hollow internodes.

LEAF EPIDERMIS

Prat (1932, 1936) found that the leaf epidermis was a rich source of useful characters. Based upon the appearance of long cells, short cells, silica bodies, cork cells, stomata, microhairs, macrohairs, prickle-hairs, and papillae, it is possible to recognize four groups: bambusoids, pooids, chloridoids, and panicoids.

Tateoka et al. (1959) and Johnston & Watson (1976) have carried out extensive investigations of bicellular microhairs on grass leaf epidermises. Their findings are summarized as follows:

- ☼ width of hair/length of hair
  panicoids: 0.694
  eragrostoids: 2.265

- ☼ ratio of upper cell to lower cell length
  panicoids: 1.731
  eragrostoids: 2.681

- ☼ angle between axis of hair and shortest line
  panicoids: 2.014
  eragrostoids: 0.890

- ☼ cell wall thickness in upper and lower cells
  Type A: about same thickness (eragrostoids)
  Type B: intermediate
  Type C: upper thinner than lower (panicoids)

TUNICA LAYERS IN SHOOT APEX

At the apex of a grass shoot is a one- or two-layered tunica layer that covers the main body of cells. Brown et al. (1957) found that grasses always appear to have a two-layered tunica; while Barnard (1964) found that chloridoid and panicoid grasses have only a 1-layered tunica. This is the sort of major controversy that will cause you to toss and turn all night long.

LODICULES

Lodicules are small green or whitish flaps of tissue at the base of the grass flower. Most grasses have two; bamboos have three. Lodicules are usually interpreted as perianth remnants. Studies by Stebbins (1956), Jirásek & Jozífová (1968), and Guédès & Dupuy (1976) studied variation in lodicule structure at the subfamily and tribal levels. Their findings suggest the following patterns:

- ☼ Panicoids: short, truncate, thick, and heavily vasculated;

- ☼ Pooids: elongate, pointed, thick base and membranous above with little or no vasculature;

- ☼ Bambusoids: similar to festucoids, but heavily vasculated;

- ☼ Chloridoids: similar to panicoids, but little vasculature

LODICULE MICROHAIRS

Tateoka (1967) found that microhairs on lodicules are frequent in bambusoids, rare in most subfamilies, and absent in festucoids.

EMBRYO STRUCTURE

The grass embryo has been studied intensively for over a century, beginning with Bruns (1892), and continuing with Van Tieghem (1897), Yakovlev (1950), Reeder (1957, 1962), and Kinges (1961). John Reeder's 1957 paper is especially important. He examined four characters:

- ☼ whether the vascular trace to the scutellum and coleoptile diverged at the same point [F] or were separated by an internode [P];

- ☼ whether the epiblast was present [+] or absent [-];

- ☼ whether the scutellum was free from the coleorhiza [P] or fused with it [F]; and

- ☼ whether the embryonic leaf margins over-lapped [P] or merely met [F].

Based upon combinations of these character states, Reeder recognized seven embryo types:

Festucoid:	F + F F
Panicoid:	P - P P
Chloridoid-Eragrostoid:	P + P F
Bambusoid:	F + P P
Oryzoid-Olyroid:	F - P P, F + P P, F + F P
Arundinoid-Danthonioid:	P - P F
Centothecoid:	P + P P

STARCH GRAINS

For over a century, agrostologists have been studying the starch grains in the grass endosperm, hoping that the variation that they had discovered had some systematic significance. Tateoka (1962) investigated almost 800 taxa and found appreciable variation even within a single species. Although he could not find correlations that held with any subfamilies, he did recognize four different types of starch grains:

Type 1: Triticum-type. Simple grains, broadly elliptic, rounded

Type 2: Panicum-type. Simple grains, angular

Type 3: Miscanthus-type. Simple or of 2-4 granules

Type 4: Festuca-Eragrostis type. Compound grains only.

BASE CHROMOSOME NUMBER

The research carried out by Avdulov (1931) and Carnahan & Hill (1961) provided the breadth of chromosome numbers needed to survey variation in grasses. The range, by the way, is impressive: 2n = 4 to 220. In addition to the numbers reported below, base chromosome numbers of 4, 6, 8, 11, 13, 17, 19, and 23 have been cited.

Bambusoideae	x = 12
Pooideae	x = 7
Arundinoideae	x = 6 or 12
Ehrhartoideae	x = 12
Chloridoideae	x = 9 or 10
Panicoideae	x = 5, 9, or 10

PERSISTENT NUCLEOLI

When the nuclei of somatic cells divide, the nucleolus typically disappears before metaphase. The nucleoli are then reconstituted in the nuclei of daughter cells. Frew & Bowen (1927) and Brown & Emory (1957) found that in certain grasses the nucleolus persists after metaphase. Their studies showed that pooid grasses do not have persistent nucleoli, whereas they do persist in chloridoid and panicoids.

EFFECT OF IPC

Al-Aish & Brown (1958) studied the effect of IPC (isopropyl-n-phenyl carbamate) on grass seed germination. Festucoid seeds are very sensitive to IPC and did not germinate in its presence. Panicoid seeds are able to tolerate it; all seeds germinated.

LOW OXYGEN TENSION

The same authors also investigated the ability of grass seeds to germinate in low oxygen atmospheres. The panicoids tested did germinate; the pooids did not do well. Rice seeds were most successful.

CARBOHYDRATE STORAGE

Grasses are either sacchifers (storing carbohydrates only in the form of starch or sucrose) or laevulifers (storing them not only as starch or sucrose, but also as fructose polymers).

Pooids:	laevulifers
Chloridoids:	sacchifers
Panicoids:	sacchifers

HEAT PRODUCTION OF CARYOPSES

Pooids:	weakly exothermic
Chloridoids:	strongly exothermic
Panicoids:	strongly exothermic

PHOTOSYNTHETIC PATHWAYS

Grasses are just like all other higher plants in having a two-phase photosynthetic process. The **light reaction** is a photochemical process (photophosphorylation) that occurs in the chloroplasts and chlorenchyma cells of the mesophyll. Adenosine diphosphate (ADP) is converted to adenosine triphosphate (ATP). NADP is also reduced to NADPH. During the **dark reaction**, CO_2 enters through the stomates and combines with ribulose diphosphate to form a 6-carbon intermediary molecule. It quickly divides into two 3-carbon units, PGA (3-phosphoglyceric acid). These processes occur within the chlorenchyma cells in the mesophyll of the leaf.

About thirty years ago, another version of the dark reaction was discovered that involved 4-carbon units. This alternate pathway is variously known as the Hatch-Slack pathway (after its discoverers) or the kranz-type pathway (from the German word for "ring," an anatomical reference to the arrangement of some specialized leaf cells when seen in cross-section. This second photosynthetic pathway is found in many grasses. Not only are the intermediary compounds different, but the C_4 pathway takes place not only within the chlorenchyma cells of the mesophyll, but also in parenchyma sheath cells (often called kranz cells). Three subtypes of this pathway, based upon the decarboxy-lating enzymes found in the kranz cells, have been recognized. Smith & Brown (1973), Brown (1975, 1977), and Waller & Lewis (1979) investigated the systematic significance of the two pathways and found the following:

Bambusoideae	C3
Ehrhartoideae	C3
Pooideae	C3
Arundinoideae	C3 (mostly) and C4
Chloridoideae	C4 (mostly) and C3
Panicoideae	C3 and C4

IMMUNOLOGY AND SEROLOGY

Almost a century ago, two workers in Germany and in England discovered that the combination of antigens and antibodies yielded a visible precipitate and that this phenomenon could be used to investigate how closely related to organisms might be by testing how similar their proteins are to one another. Fairbrothers & Johnson (1961) employed this technique in the grasses and they discovered, for instance, that the Festuceae of George Bentham and later workers was a hodgepodge of unrelated taxa. Their work supported carving out a number of genera and placing them in an entirely different subfamily -- the Chloridoideae. Similar studies of amino acids in various grasses have also been carried out.

Another kind of protein interaction occurs when grass pollen encounters the tissues lining the nasal passages in humans. The taxonomic significance of allergic reactions to grasses has been explored by Watson (1983), and Watson & Knox (1976). Correspondence with Dr. Watson revealed that he and I were both amazed to see that we were allergic to some tribes of grasses, but not to others.

FLAVONOIDS

Flavonoids are secondary metabolites in plants. More specifically, they are kinds of phenolic compounds -- a loose assemblage of chemicals based upon a phenol nucleus. A number of the more unusual plant

pigments are flavonoids. Harborne & Williams (1976, 1987) have studied these pigments in grasses.

DNA & RNA STUDIES

When I was a graduate student, chromosomes were the Messiah. Yes, chromosomes had been invented that long ago! Their number, morphology, and behavior during meiosis would provide an objective index for determining whether two plants or two populations of plants belonged to a single species. What a disappointment it was to discover that grasses were not that simple.

More recent techniques focus on genetic information at an even more fundamental level. If chromosomes do not tell us what we need to know, then certainly examining the sequence of base pairs in the genetic material itself ought to do the trick. The earliest attempts to examine nucleic acid sequences involved extracting the total DNA of one plant and comparing it with the total DNA from another. The degree to which the two DNA samples annealed or reassociated was taken as a measure of how closely related the two entities were.

This methodology worked well in microorganisms, but less so in higher plants. Long stretches of repeated DNA sequences and the fact that DNA occurred in chromosomes, mitochondria, and plastids made analysis of these life forms more difficult. Today investigators use only specific sections of DNA that are separated by enzymes (restriction endonucleases) into well defined restriction fragments. These fragments can be separated from one another by gel electrophoresis. These studies rest on the assumption that examination of comparable restriction site fragments of DNA will yield more useful data. One of the more elegant papers on this subject is the work of Jones & Flavell (1982) on rye.

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SECTION 3 - SURVEY OF SUBFAMILIES, TRIBES, & GENERA

3.01 - SUBFAMILY BAMBUSOIDEAE

TECHNICAL DESCRIPTION

Habit: Mostly perennial; culms woody or herbaceous; leaf blades often pseudopetiolate

Root Hairs: Unequal, arising from the middle of the cell

Leaf Epidermis: Bicellular microhairs; short cells paired or in rows; silica-cells cross-, saddle-, or dumbbell-shaped; stomata with dome-shaped subsidiary cells

Leaf in Cross-section: Double vascular bundle sheath, the inner with thicker cell walls; large fusoid cells and arm cells present; non-kranz anatomy

Inflorescence: Typically paniculate; often subtended by a spathe

Spikelets: Bisexual or unisexual; 1- to many-flowered; glumes 2-5; awned or awnless, disarticulation above the glumes and between the florets.

Flowers: Lodicules [1] 3 [10]; stamens 3, 6, or more; gynoecium with 1, 2, 3 or more stigmas, tricarpellate

Fruit: Caryopsis, nut, berry, or utricle

Embryo Formula: F + P P

Cytology: x = 10, 11, or 12

Photosynthetic Pathway: C_3

Distribution: Asia, Africa, the Americas, and the islands of the Pacific and Indian oceans; abundant in the tropics; absent from Europe; mostly in forests, woodlands, and wet places.

SYSTEMATICS

Unfortunately, the delimitation of our first subfamily remains controversial. One hint that there is a problem is that these grasses may be treated as one, two or three distinct subfamilies. The most liberal interpretation places the woody and herbaceous bamboos in Bambusoideae, the oryzoid grasses (rice and its relatives) in Ehrhartoideae, and the pharoid grasses (only one species of which is in North America) in Pharoideae. Note how various authors have disposed of our North American bamboos:

Bentham (1881): Bambuseae
Roshevits (1937): Bambuseae, Phareae
Stebbins & Crampton (1961): Bambuseae
Potztal (1964): Bambuseae, Arundinariae
Tzvelev (1989): Bambuseae, Arundinariae
Clayton & Renvoize (1992): Bambuseae, Olyreae, Phareae, Oryzeae, Ehrharteae, Diarrheneae, Brachyelytreae
Watson & Dallwitz (1998): Bambuseae, Oryzeae, Phareae, Diarrheneae
Grass Phylogeny Working Wroup (2001): Bambuseae, Olyreae

A common error is to assume that any really large grass with what appears to be woody stems must be a bamboo. Look also in Arundinoideae for large bamboo-like grasses, such as the giant reed grass (*Arundo donax*).

TRIBE: BAMBUSEAE

Woody perennials from extensive rhizomes. Culms 2-10+ m tall, freely-branched; internodes hollow to solid. Leaves of axillary branches pseudopetiolate, while those of the culm itself typically without blades or those that fall early. Inflorescence usually a large, many-flowered panicle; sometimes reduced to 1 spikelet. Spikelets typically large, several-flowered, bisexual, and disarticulating above the glumes and between the florets. Glumes 2 (the first often reduced), shorter than the lemmas. Lemmas similar to glumes, 5- to many-nerved, usually awnless. Palea often 2-keeled. Lodicules typically 3; stamens usually 6; stigmas usually 3. [= Arundinarieae in older literature].

Bamboos, the tree grasses, are variable in habit. They range from a few centimeters to more than 40 m tall. The culms may be solid or have hollow internodes. Larger bamboos are almost 25 cm in diameter with internodes of up to 1.5 m. Not all bamboos are woody; plants in two of the three tribes represented in the flora of North America are herbaceous. One bamboo is a vine 30 m long.

Rhizome development is extensive. Two types of rhizome systems are recognized. The **pachymorph** rhizome is short and thick, with the lateral buds producing only rhizomes. New culms arise from the apex of the rhizome system. Bamboos of this sort typically have a "clump" growth form. The **leptomorph** rhizome system is long and slender, with many nodes capable of producing a new culm and adventitious roots. This is the rhizome system

characteristic of the "running bamboos."

Leaves on the main culm axis are typically bladeless or with blades that fall early. The leaves of lateral branches appear to be petiolate, but they are probably best considered **pseudopetiolate**. Sheaths and scale leaves have played an important role in the traditional taxonomy of the group.

The inflorescence of many bamboos is a panicle or is reduced to a single spikelet, subtended by a few to several bracts, this combination known as a **pseudospikelet**. It may be simple or compound.

The flowers are the most monocot-like found in the family. They are composed of three lodicules, 3 or 6 stamens (rarely as many as 120!), and three united carpels. Blooming is erratic. There seems to be three basic patterns. Some bamboos flower gregariously, in regular cycles during which they set tremendous quantities of seeds, and then die within a year or so. Other bamboos are characterized by irregular flowering, during which vegetative growth of the plant is stunted; but, the plants do not die. Still other species flower annually.

It now appears that most of the woody bamboos are probably wind pollinated, but that at least some of the herbaceous bambusoids are insect pollinated. Some bear their spikelets beneath the litter of the forest floor; others produce underground fruits, as in the peanut.

The economic uses of bamboos are almost endless -- "*No growing things on earth have so many and so varied uses as ... bamboos*" (Soderstrom, 1979). They include ornamentals building materials for houses, furniture, ships, aqueducts, carts, umbrella frames, bird cages, tiger cages, chop sticks, musical instruments, springs for carts, food, fibers, cordage, oars, masts, baskets, mats, spear shafts, bows, arrows, knives, ladders, rafts, pails, churns, curtains, tiles for roofs, beehives, fans, fishing poles, medicine ... and several hundred more!

ARUNDINARIA. Cane, canebrake, giant cane, switch cane. Rhizomatous perennial. Culms woody, 2-8 m tall. Leaves pseudopetiolate, the blades disarticulating from sheaths. Inflorescence spicate to paniculate; pseudospikelets absent. Spikelets bisexual, large, several-flowered, laterally compressed, disarticulating above the glumes and between the florets. *A. gigantea* is the only truly woody grass native to N. America and the only commonly occurring native bamboo here. The plants often form dense colonies. The species occurs from Ohio and Illinois into the Southeast. Three subspecies are now recognized.

PHYLLOSTACHYS. Fishpole bamboo, madake, timber bamboo, black bamboo, moso bamboo. Shrubby to arborescent perennials. Culms woody, 3-20+ m tall. Leaves pseudopetiolate. Inflorescence spicate-paniculate, often subtended by a spathe. Spikelets large (to 8 cm!), several- to many-flowered, bisexual, disarticulating above the glumes and between the florets. A genus of about 50 eastern Asian species. Of considerable economic importance as a source of handsome ornamentals, fishing rods, walking sticks, furniture, and edible young shoots.

BAMBUSA. Giant bamboo, hedge bamboo, timber bamboo, Oldham's bamboo. Shrubby to arborescent, rhizomatous perennials. Culms 2-35+ m tall. Leaves pseudopetiolate. Inflorescence in panicles or fascicles; pseudospikelets present. Spikelets terete to laterally compressed, large (to 8 cm!), several-flowered, bisexual, disarticulating above the glumes and between the florets. A large genus of about 120 species native to tropical and subtropical areas of the Old and New World. Of considerable economic importance as a source of rods, poles, scaffolding for construction, furniture, fibers for weaving, paper pulp, and edible shoots.

PSEUDOSASA. Metake, arrow bamboo. Shrubby, rhizomatous perennial. Culms woody, 2-5 m tall. Leaves pseudopetiolate with auriculate setae. Inflorescence a terminal panicle of bisexual spikelets. A genus of 8 species native to eastern Asia. *P. japonica* is commonly cultivated.

TRIBE: OLYREAE

Caespitose perennials. Culms woody, to 3 m. Leaves broad, with asymmetric blades and cordate to sagittate bases. Inflorescence paniculate, the spikelet-bearing branches persisting. Spikelets unisexual (species monoecious), several-flowered, disarticulating above the glumes and between the florets. A tribe of about 18 genera. *Olyra latifolia* occurs in Florida.

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3.02 - SUBFAMILY PHAROIDEAE

TECHNICAL DESCRIPTION

Habit: Rhizomatous perennial herbs; leaves distichous, pinnately-veined, pseudopetiolate, twisted, the blade resupinate; culms typically solid

Root Hairs:

Leaf Epidermis: Bicellular microhairs and papillae absent; silica bodies dumbbell-shaped; bulliform cells absent or poorly developed

Leaf in Cross-section: Fusoid cells prominent and well-developed; arm cells weakly to moderately well-developed

Inflorescence: Open, terminal panicle

Spikelets: Unisexual, 1-flowered, the male and female spikelets mostly paired on short branchlets; terete (♀) or laterally compressed (♂); female spikelets covered with uncinate microhairs

Flowers: Lodicules 0 or 3 (♂); stamens 6; stigmas 3

Fruit: Caryopsis

Embryo Formula:

Cytology: X= 12

Photosynthetic Pathway: C_3

Distribution: Pantropical; in New World from Florida southward to Argentina and Uruguay.

SYSTEMATICS

This subfamily was first defined in 1955 by Alan Beetle. It was formally described and published by Clark & Judziewicz in 1996. The subfamily consists of a single tribe of three genera and eleven species. The pharoid grasses are known in North America from a single species collected in Florida.

TRIBE: PHAREAE

Herbaceous perennials. Culms decumbent and rooting at the nodes, the internodes solid. Leaves with broad blades and a twisted, petiole-like constriction above the sheath. Inflorescence a panicle. Spikelets unisexual (species monoecious), 1-flowered, the pistillate sessile and the staminate pedicellate. Glumes 2, shorter than floret, 5- or 7-nerved. Lemmas 5- to 7-nerved, membranous (♂) or indurate (♀). Palea narrow, 2-keeled, 2-nerved.

A tribe of 3 genera. *Pharus lappulaceus* occurs in Florida, based on historic collections. It has probably been extirpated there.

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3.03 - SUBFAMILY EHRHARTOIDEAE

TECHNICAL DESCRIPTION

Habit: Herbaceous annuals and perennials

Root Hairs: No studies have been made.

Leaf Epidermis: Bicellular microhairs present; silica cells often broader than long, silica bodies mostly dumbbell-shaped; long cells with rows of papillae, as in the bambusoids

Leaf Anatomy: Arms cells and fusoid cells present, as in the bambusoids; vascular bundles with double sheath, the inner with thicker cell walls; non-kranz

Spikelets: Spikelets 1- or 3-flowered, perfect or unisexual, laterally compressed or terete; glumes reduced or absent; lemma 5- to several-nerved; palea 2- to 3+-nerved

Flowers: Stamens 6, 3, or rarely 1; stigmas 1 or 2

Embryo: F + P F or F + P P

Cytology: x = 12 for most species; x = 15 in *Zizania*

Photosynthetic Pathway: C_3

Distribution: Marshy and aquatic sites of the tropics and subtropics.

SYSTEMATICS

Hitchcock and Chase placed the members of this subfamily in three different tribes of their Festucoideae. Until the mid-1990's, the core of this group was rice and its relatives and the subfamily was called Oryzoideae. More recent studies suggest the appropriateness of including Ehrharteae here, which requires a name change.

The ehrhartoid, oryzoid, pharoid, and bambusoid grasses share many features, to the point where many agrostologists combine them into a single subfamily. I have followed that practice for a number of years. However, a number of recent studies, particularly at the molecular level, recognize them as distinct. For nomenclatural reasons that we need not explore, the transfer of *Ehrharta* into the Oryzoideae (rice subfamily) requires that its name be changed to Ehrhartoideae.

TRIBE: EHRHARTEAE

A small tribe of 4 genera, none of them with native to North America. Our only representative is *Ehrharta*.

EHRHARTA. Veldt grass. Annual or perennial herbs. Culms (ours) herbaceous, to 1 m tall. Inflorescence racemose to paniculate. Spikelets laterally compressed or terete, 3-flowered (the lower 2 reduced to sterile lemmas), bisexual, disarticulation above the glumes, but not between the florets. Glumes 2, 5-nerved, shorter or much longer than florets; sterile lemmas often transversely wrinkled; fertile lemma 5- to 7-nerved; palea 2-keeled. Lodicules 2; stamens 3, 4, or 6; stigmas 2. A genus of 27 species native to the Old World. *E. calycina*, *E. erecta*, and *E. longiflora* are weedy in California.

TRIBE: ORYZEAE

Annual or perennial herbs. Inflorescence a panicle. Spikelets laterally compressed, bisexual or unisexual, disarticulating above the glumes. Glumes reduced or absent, represented by a cup-like pedicel apex, their place seemingly occupied by sterile lemmas; fertile floret one. A tribe of about 13 genera.

ORYZA. Rice. Annual or perennial herbs. Inflorescence and open to contracted panicle. Spikelets laterally compressed, appearing 1-flowered, bisexual, disarticulating above the glumes. Glumes reduced to a 2-lobed cupule; lemmas 5-nerved, awned or awnless; palea 2-nerved. Lodicules 2; stamens 6; stigmas 2. A genus of about 25 species native to moist, wet, shady regions of the Old and New World; none native to North American. Rice, *O. sativa*, is one of the principal cereal crops that we consume. It is widely cultivated in flooded fields or on dry land. Another species, *O. rufipogon*, an Old World weedy species, has recently been found in the U. S.

THE SPECIES OF *ORYZA*

Species	Genome	Native
Diploids [2n= 2x = 24]		
O. australiensis	EE	Australia
O. barthii	AA	West Africa
O. brachyantha	FF	West & central Africa
O. eichingeri	CC	East & central Africa
O. glaberrima	AA	West Africa
O. granulata	–	South & Southeast Asia
O. longisminata	AA	Africa
O. meyeriana	--	Southeast Asia, China
O. nivara	AA	Asia, China, Australia
O. officinalis	CC	Asia, China, New Guinea
O. punctata	BB	Africa
O. rufipogon	AA	Asia and China
O. sativa	AA	Asia
O. schlechteri	--	New Guinea
Tetraploids [2n = 4x = 48]		
O. alta	CCDD	C. & S. America
O. eichingeri	BBCC	East & central Africa
O. grandiglumis	CCDD	South America
O. latifolia	CCDD	C. & S. America
O. longiglumis	----	New Guinea
O. minuta	BBCC	Southeast Asia

O. punctata	BBCC	Africa
O. ridleyi	----	Southeast Asia

[After Simmonds, 1976]

LEERSIA. Cutgrass, rice cutgrass, white grass. Mostly rhizomatous perennials. Inflorescence a panicle. Spikelets laterally compressed, bisexual, 1-flowered, disarticulating below the glumes. Glumes 0; lemmas 5-nerved, usually awnless. Lodicules 2; stamens 1-6; stigmas 2. A genus of about 18 species, mostly of moist to wooded sites in the Old and New World; 5 occur in North America. *Leersia oryzoides* is our only California species.

ZIZANIA. Wild-rice. Tall, reed-like annuals or perennials. Culms herbaceous, 1-3 m tall. Inflorescence a conspicuous, terminal panicle. Spikelets 1-flowered, unisexual; female spikelets on stiff, erect branches; male spikelets on lower spreading branches. Glumes 0; pistillate lemma 3-nerved, awned; staminate lemma 5-nerved, awn-tipped; pistillate palea 2-nerved; staminate palea 3-nerved. Stamens 6. A genus of 3 species native to North America and Eurasia. *Z. aquatica*, the wild rice of commerce, is native to the eastern half of the United States. A second species, *Z. texana*, occurs only in Texas. The third species (*Z. latifolia*) is cultivated for its edible shoots.

ZIZANIOPSIS. Marsh millet, southern wildrice. Coarse, rhizomatous perennials. Inflorescence a conspicuous, terminal panicle. Spikelets 1-flowered, unisexual (male and female spikelets on the same branches), disarticulation below the glumes. Staminate spikelet: glumes 0; lemma 5-nerved, awnless; palea 3-nerved; stamens 6. Pistillate spikelet: glumes 0; lemma 7-nerved, acuminate to awned; palea 3-nerved; stigmas 2. A genus of 3-5 species native to North and South America. *Z. miliacea*, the only species found in North America, grows in wet freshwater and brackish sites from Maryland through the southern states to Texas.

LUZIOLA. Southern water grass. Low growing perennials in ponds, marshy sites, and along stream banks. Inflorescences unisexual (♂ terminal and the ♀ axillary). Stamens 6-16. Fruit an achene. As treated here, the genus includes *Hydrochloa*. Three species are found in North America, mostly in the Southeast.

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3.04 - SUBFAMILY CENTOTHECOIDEAE

TECHNICAL DESCRIPTION

Habit: Perennial herbs

Root Hairs: No studies have been made.

Leaf Epidermis: Bicellular microhairs rodlike to linear; silica cells mostly dumbbell-shaped, confined to the costal region

Leaf Anatomy: Vascular bundles with a double sheath, the outer with large, thin-walled parenchyma cells; arm cells present in some species; mesophyll with large intercellular spaces; bulliform cells large, occupying a major portion of the blade in transverse section.

Spikelets: Spikelets 2- to many-flowered, with reduction above or below the fertile florets; perfect or unisexual

Flowers: Lodicules 2 or 0, many-nerved; stamens 2 or 3; stigmas 2

Embryo: P + P P

Cytology: x = 12

Photosynthetic Pathway: C_3

Distribution: Mostly grasses of shaded, warm woodlands and tropical forests of the Americas, Africa, and Asia

SYSTEMATICS

The subfamily consists of about 13 genera and only 30 or so species. It is represented in North America by a single tribe containing a single genus, *Chasmanthium*. The subfamily is clearly bambusoid in its affinities and it is merged with Bambusoideae in some modern treat-ments. Others place the genera in Arundinoideae.

In recent literature, the subfamily and tribe names were sometimes incorrectly spelled Centostecoideae.

TRIBE: CENTOTHECEAE

The characters are those of the single genus below.

CHASMANTHIUM. Wild oats, spangle grass, broad-leaved uniola. Broad-leaved perennials, often rhizomatous. Culms herbaceous, to 1.5 m tall. Leaf blades broad, flat. Inflorescence an open to contracted panicle. Spikelets 2- to many-flowered (the lower 1-6 sterile), bisexual, laterally compressed, disarticulating above the glumes and between the florets. Glumes 2, 3- to 7-nerved; lemmas 5- to many-nerved, awnless; palea 2-keeled, winged. Lodicules 2; stamens 1 [3]; stigmas 2, red. A genus of 5 or 6 species, of the southeastern and southwestern United States and adjacent Mexico. H & C treated it as part of *Uniola* and placed the genus in their tribe Festuceae. *C. latifolium* is probably the most conspicuous species; it is increasingly popular as an ornamental. Other species may be confused with plants of the genus *Diarrhena*.

CHASMANTHIUM* AND *UNIOLA

Feature	*Chasmanthium*	*Uniola*
Habitat	Mesic forests	Coastal sand dunes
Stamen Number	One	Three
Spikelet Color	Greenish	Straw-colored
Disarticulation	Above glumes	Below glumes
Embryo Type	P + P P	P - P F
Leaf Anatomy	Bambusoid	Chloridoid
Chromosomes	x = 12, 24	x = 20

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3.05 - SUBFAMILY POÖIDEAE

TECHNICAL DESCRIPTION

Habit: Annual or perennial herbs

Root Hairs: Equal

Leaf Epidermis: Relatively simple; bicellular microhairs absent (except in some Stipeae); silica cells round, elliptical, solitary or paired with cork cells; stomata low, dome-shaped or with parallel-sided subsidiary cells

Leaf Anatomy: Vascular bundle sheath usually double; chlorenchyma irregular; non-kranz anatomy

Inflorescence: Typically a panicle, rarely a spike or raceme

Spikelets: Spikelets 1- to many-flowered, laterally compressed or terete; florets 1 to many, the upper usually reduced or aborted; disarticulation usually above the glumes and between the florets; lemmas 5- to many-nerved; palea typically 2-keeled

Flowers: Lodicules 2; stamens usually 3; stigmas 2

Embryo: F + F F

Cytology: x = 7, often relatively large (x = 8, 9 or 10 in Meliceae; x = 7 and 11 in Stipeae); no persistent nucleoli

Photosynthetic Pathway: C_3

Distribution: Herbaceous grasses, primarily of the cool and temperate regions of the world or of the alpine areas of the tropics and subtropics.

SYSTEMATICS

This subfamily, called Festucoideae by Hitchcock and Chase, was recognized by all of the classical workers, but in a much broader sense than we see it now defined. The other genera included by H & C now reside in every other subfamily, except Panicoideae.

FATE OF H & C'S SUBFAMILY?

I. Tribes moved to other subfamilies:

Bambuseae ➙	Bambusoideae
Chlorideae ➙	Chloridoideae
Oryzeae ➙	Oryzoideae
Zizanieae ➙	Oryzoideae
Zoysieae ➙	Chloridoideae

II. Portions of tribes moved:

Agrostideae ➙	Arundinoideae
Agrostideae ➙	Chloridoideae
Agrostideae ➙	Aristidoideae
Aveneae ➙	Arundinoideae
Aveneae ➙	Danthoniodeae
Festuceae ➙	Arundinoideae
Festuceae ➙	Chloridoideae

III. Tribes remain more or less intact:

Agrostideae	= Aveneae: Alopecurinae
Aveneae	= Aveneae: Aveninae
Hordeae	= Triticeae
Phalarideae	= Aveneae: Phalarinae

IV. New tribes carved out of old ones:

Aristideae	out of Agrostideae
Bromeae	out of Festuceae
Danthonieae	out of Aveneae
Hainardieae	out of Hordeae
Meliceae	out of Festuceae
Nardeae	out of Hordeae
Stipeae	out of Agrostideae

TRIBE: DIARRHENEAE

The tribe consists of the single genus described below.

DIARRHENA. Perennial herbs. Inflorescence a few-flowered panicle, its branches often drooping. Spikelets 3- to 5-flowered, bisexual, disarticulating above the glumes and between the florets. Glumes 2, the first 1-nerved, the second 3-nerved; lemmas 3-nerved, awnless; palea 2-nerved. Lodicules 2; stamens [1] 2 or 3; stigmas 2; fruit a shiny, turgid, beaked achene. The tribe consists of the 5 Old World and New World species of this genus. In North America, we see *Diarrhena americana*, a grass of rich or moist woods in the central and eastern states.

TRIBE: BRACHYELYTREAE

This tribe consists of the single genus described below.

BRACHYELYTRUM. Perennial, rhizomatous herbs. Culms herbaceous, to 1 m; internodes solid. Inflorescence a few-flowered panicle. Spikelets terete to dorsally compressed, 1-flowered, disarticulating above the glumes. First glume minute to absent; second glume short, awned or awnless. Lemma 5-nerved, awned. Lodicules 2; stamens 3; stigmas 2. This is the only genus in the tribe. It consists of 2 species, one in Japan and Korea; *B. erectum* is native to moist or rocky woods in eastern North America.

TRIBE: POEAE

Annual or perennial herbs. Inflorescence a panicle, rarely a raceme or spike. Spikelets 2- to many- [1-] flowered, laterally compressed, bisexual [rarely unisexual]. One or both glumes shorter than the lemmas; lemmas 5- to many-nerved, awned or

awnless, its apex variable.

FESTUCA. Fescue, fescue grass. Caespitose, rhizomatous, or stoloniferous perennial herbs. Culms to 2 m tall, internodes hollow or soild. Leaves mostly basal; sheaths open. Inflorescence an open to contracted panicle. Spikelets 2- to several-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, unequal, 1- to 3-nerved, shorter than the florets; lemmas similar to glumes in texture or much firmer, typically [3-] 5- to 7-nerved, awned from an entire to minutely bifid apex or awnless; palea relatively long, apically notched. Lodicules 2; stamens 3; stigmas 2; flowers open-pollinated.

A genus of about 360+ species of temperate and mountainous regions worldwide. Of economic importance as a source of fodder, lawn grasses, and major weedy species. Common species include *F. ovina* (sheep fescue), *F. arundinacea* (tall or alta fescue), *F. idahoensis* (Idaho fescue), *F. pratensis* (meadow fescue), and *F. rubra* (red fescue).

The annual fescues (*Festuca* sec. *Vulpia* in H & C) are now most often treated as belonging to the segregate genus *Vulpia*. The table below presents the name changes in the North American species. You will note that several species have disappeared into synonymy.

ANNUAL *FESTUCA* TO *VULPIA*

Festuca* Sect. *Vulpia	**Combination in *Vulpia***
F. arida ↣	*V. microstachys* var. *m*.
F. confusa ↣	*V. microstachys* var. *confusa*
F. dertonensis ↣	*V. bromoides*
F. eastwoodiae ↣	*V. microstachys* var. *ciliata*
F. grayi ↣	*V. microstachys* var. *ciliata*
F. megalura ↣	*V. myuros* var. *hirsuta*
F. microstachys ↣	*V. microstachys* var. *m*.
F. myuros ↣	*V. myuros* var. *m*.
F. octoflora var. *glauca* ↣	*V. octoflora* var. *g*.
F. octoflora var. *hirtella* ↣	*V. octoflora* var. *h*.
F. octoflora var. *octoflora* ↣	*V. octoflora* var. *o*.
F. octoflora var. *tenella* ↣	*V. octoflora* var. *t*.
F. pacifica var. *p*. ↣	*V. microstachys* var. *pauciflora*
F. pacifica var. *simulans* ↣	*V. m.* var. *pauciflora*
F. reflexa ↣	*V. microstachys* var. *pauciflora*
F. sciurea ↣	*V. sciurea*
F. tracyi ↣	*V. microstachys* var. *confusa*

VULPIA. Annual fescue. Tufted annuals [rarely perennial] herbs. Culms to 9 dm tall, the internodes solid or hollow. Inflorescence a contracted or open spike-like panicle. Spikelets 2- to many-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, very unequal, 1- to 3-nerved, shorter than the florets; lemmas tapered, firmer than the glumes, 3- to 5-nerved (often inconspicuously so), awned or acuminate; palea relatively long, apically notched. Lodicules 2; anthers 1 [3]; stigmas 2; flowers cleistogamous.

A genus of about 23 species widespread in the temperate regions of the world where they are often weedy. Included in *Festuca* by H & C. Common species include *V. octoflora* (sixweeks fescue), *V. myuros*, and *V. bromoides*. Some agrostologists, myself included, prefer to merge this genus with *Festuca*, but this is not a popular view.

COMPARISON OF *FESTUCA* AND *VULPIA*

Festuca	***Vulpia***
Perennial [annual]	Annual [perennial]
Stamens 3 [1]	1 [3]
Pollination open [closed]	closed [open]

LOLIUM. Rye grass. Caespitose annuals or perennial from rhizomes or stolons. Culms herbaceous, to 1+ m tall, the internodes hollow. Inflorescence a single spike (spikelets attached edgewise to rachis). Spikelets several-flowered, laterally compressed, bisexual, disarticulating above the glume and between the florets. Glume 1 (lower missing), except in the uppermost spikelets; lemmas 5- to 9-nerved, awned or awnless; palea relatively long, often ciliate. Lodicules 2, stamens 3; stigmas 2.

A genus of 8-10 Old World species, especially African and Eurasian. Of economic significance because of fodder, lawn grasses, and common weeds. Formerly placed in Triticeae because of its inflorescence type; *Lolium* now treated as a close relative of *Festuca* because of its interfertility. Recent research suggests it should be merged with that genus. *Lolium perenne* is an important pasture grass; *L. temulentum* (darnel) is commonly toxic because of a fungal infection.

PUCCINELLIA. Alkali grass. Annuals or perennials herbs. Culms herbaceous, to 1 m tall. Leaves sheaths open [rarely closed]. Inflorescence an open or congested panicle. Spikelets small, several-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, very unequal, shorter than the florets, first 1-nerved and the second 3-nerved; lemmas with 5 weak or strong, parallel nerves; palea equalling or exceeding the lemma. Lodicules 2; stamens 3; stigmas 2.

A genus of about 80 species native to the north temperate zone of the Old and New World, especially North America; often of wet or marshy, especially alkaline sites. A few species listed in H & C have been transferred to *Glyceria* and *Torreyochloa* by some workers. *P. airoides* (Nuttall's alkali grass) is an important forage grass in some areas; otherwise, the genus is of little direct economic importance.

TORREYOCHLOA. Stoloniferous or caespitose perennials. Culms herbaceous, to 5 dm tall. Leaf sheaths open. Inflorescence a panicle. Spikelets 3- to 7-flowered, bisexual, laterally compressed, and disarticulating above the glumes and between the florets. Glumes 2, very unequal, 1- or 3-nerved; lemmas 5- to 7-nerved, awnless; palea relatively long. Lodicules 2; stamens 3; stigmas 2.

A genus of 4 species native to northern Asia and North America, often found in wet meadows and aquatic sites. The genus is doubtfully distinct from *Glyceria*.

POA. Blue grass, mutton grass. Annuals or perennials, many rhizomatous. Culms herbaceous, to 1.5m tall, the internodes hollow. Leaf blade with a bow-shaped tip. Inflorescence an open to congested panicle, sometimes reduced to a raceme. Spikelets small, [1-]

2- to 10-flowered, laterally compressed, bisexual or infrequently unisexual (species dioecious), and disarticulating above the glumes and between the florets. Glumes 2, ± equal, 1- or 3-nerved; lemmas typically 5-nerved, keeled, awnless, its base glabrous or with a web of fine, cottony hairs; palea 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A large and notoriously difficult cosmopolitan genus of about 500 species, found typically in grasslands and meadows, but in a variety of other habitats as well; many are weedy. Recent treatments have often resulted in reducing the number of taxa, certainly a step in the right direction. *P. pratensis* (Kentucky bluegrass) may well be the most important perennial pasture grass in North America; *P. fendleriana* (mutton grass) is a very important pasture grass in the Rocky Mountain region; *P. compressa* (Canada bluegrass) is often used as a lawngrass.

BRIZA. Quaking grass, rattlesnake grass. Tufted annuals or perennials. Culms herbaceous, ours to 0.5 m tall. Inflorescence an open panicles, the pedicels slender and often drooping. Spikelets several-flowered (florets crowded and spreading at right angles to the rachilla), bisexual, laterally compressed, and disarticulating above the glumes and between the florets. Glumes 2, ± equal, thin and papery, rounded, 3- to 15-nerved; lemmas similar to glumes in texture, 7- to 15-nerved, awnless; palea 2-nerved. Lodicules 2, stamens 3; stigmas 2.

A genus of about 16-20 species native to Europe, Mexico, and principally South America. Three European species are adventive in North America. They come in three sizes, *B. maxima*, *B. media*, and *B. minor*. The first species is often found as a roadside weed and it is gathered up for dried arrangements.

DACTYLIS. Orchard grass. Tall, densely caespitose perennials. Culms herbaceous, to 2 m tall. Leaf sheaths keeled and closed. Inflorescence a panicle, with secund spikelets clumped at ends of panicle branches. Spikelets 2- to 5-flowered, bisexual, laterally compressed, and disarticulating above the glumes and between the florets. Glumes 2, shorter than or equaling the florets, 1- or 3-nerved; lemmas 5-nerved, awned or awnless; palea 2-nerved and 2-keeled. Lodicules 2; stamens 3; stigmas 2.

A monotypic genus (or 3-5 species if you are a splitter), native to temperate Eurasia. *D. glomerata* is used as a pasture and fodder grass. It is also a major weed.

CYNOSURUS. Dogtail. Caespitose annuals or perennials. Culms herbaceous, to 1 m tall. Inflorescence a head-like or cylindric, spike-like panicle of two very heteromorphic fertile and sterile spikelets. Fertile spikelets sessile, 1- to 5-flowered, bisexual, laterally compressed, and dis-articulating above the glumes and between the florets. Glumes 2, ± equal; lemmas 5-nerved, awned; palea relatively long; 2-nerved. Lodicules 2; stamens 3; stigmas 2. Sterile spikelets pedicellate, its awns and lemmas rigid, lanceolate, 1-nerved, and ± concealing the fertile ones.

A genus of 4-8 species native to Eurasia and Africa. Two species are adventive in North America. *C. echinatus* is an annual weed of disturbed, open ground. *C. cristatus*, also weedy, has been used as a pasture grass.

LAMARCKIA. Goldentop. Caespitose annual. Culms herbaceous, to 2 dm tall. Leaf sheaths keeled and closed for 2/3 their length. Inflorescence a contracted panicle of drooping fascicles of two very heteromorphic fertile and sterile spikelets. Terminal spikelets in each fascicle bisexual (with a single fertile floret and a stipitate rudimentary one), laterally compressed, and disarticulating below the glumes. Glumes 2, ± equal, 1-nerved; lemmas papery, 2-lobed, awned; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2. Staminate or sterile spikelets with 3- to 6-flowered, the lemmas awnless.

A monotypic Mediterranean and Asian genus. *L. aurea* is adventive in Texas, Arizona, and California. It is attractive enough to be an ornamental, but I have never seen it offered in nurseries.

TRIBE: BROMEAE

This tribe, traditionally included in Poeae (= Festuceae of older systems), is separated from it on the basis of microcharacters, such as starch grain type and features of the gynoecium. The ovary is hairy, with a con-spicuous apical appendage. Our only representative in North America is the genus below.

BROMUS. Brome grass, rescue grass, chess, ripgut. Annuals or rhizomatous or stoloniferous perennials. Culms herbaceous, to 2 m tall, the internodes hollow [rarely solid]. Leaf sheaths closed. Inflorescence an open to contracted panicle, sometimes reduced to a raceme or even 1- to a few spikelets. Spikelets several-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, typically very unequal, 1- to 5-nerved, usually awnless; lemmas 5- to several-nerved, usually awned from a bifid apex; palea 2-nerved, often adnate to the caryopsis. Lodicules 2; stamens 1-3; stigmas 2; ovary hairy, with an apical appendage and lateral styles.

A large and complex genus of about 150 species native to a variety of habitats in temperate regions of the Old World and New World, and in cooler, mountainous regions of the tropics and subtropics. It is of economic significance as a source of fodder, hay, and major weedy species. Five sections are recognized. They are sometimes treated as separate genera.

The Sections of *Bromus*

***Ceratochloa*.** Native annuals, biennials, and perennials of the Pacific and mountain states; spikelets large, distinctly laterally compressed; glumes and lemmas keeled. *B. carinatus* (California brome), *B. marginatus*, and *B. unioloides* (= *B. catharticus* in H & C) (rescue grass).

***Bromopsis*.** Native perennials of woodlands and grass-lands; panicles mostly open, lemmas rounded. *B. inermis* (smooth brome).

***Bromium*.** Annual Mediterranean weeds of the grain-fields; glumes and lemmas comparatively broad. *B. mollis* (soft chess), *B. brizaeformis* (rattlesnake chess), *B. secalinus* (chess), *B. commutatus* (hairy chess), and *B. japonicus* (Japanese brome).

Bromus (= ***Eubromus*** in H & C). Annual

Mediterranean weeds of disturbed sites; glumes and lemmas narrow, long-awned; callus sharp; the ripgut grasses are mechanically injurious to cattle. *B. rubens* (foxtail chess), *B. tectorum* (downy chess), and *B. diandrus* (= *B. rigidus* in H & C) (ripgut).

***Neobromus*.** Introduced South American annual; lemmas lanceolate, deeply bifid, the awn twisted and geniculate. *B. berterianus* (Chilean chess) occurs in Oregon, California, and the Southwest.

EVOLUTION IN BROMUS*

	Bromposis	*Ceratochloa*	*Neobromus*
14	LL *B. ciliatus* *B. anomalus*	A_1A_1 X B_2B_2	B_3B_3 X B_4B_4
28	LLLL	$A_1A_1B_2B_2$	$B_3B_3B_4B_4$
42	LLLLLL	$A_1A_1B_2B_2B_2B_2$ *B. catharticus*	$A_2A_2B_3B_3B_4B_4$ *B. berterianus*
56		$A_1A_1B_2B_2B_2B_2LL$ *B. carinatus* *B. marginatus*	
84		$A_1A_1A_2A_2B_2B_2B_2B_2B_3B_3$ B_4B_4 *B. arizonicus*	

*After Stebbins (1981)

TRIBE: AVENEAE

This group is conceptually difficult. Hitchcock and Chase recognized a relatively large assemblage of grasses characterized by a paniculate inflorescence and spikelets with elongate glumes, at least the second one being as long as the lowest lemma. All of the florets were typically fertile, except for the uppermost. The lemmas were usually awned from the base, back, or from a bifid apex. The genera seemed especially arbitrary. Other workers have argued that the group is nothing more than a segment of a larger reduction series involving *Phalaris* and its relatives with reduced florets below the single fertile one above and *Agrostis* and its relatives with a single fertile floret.

I have tended to accept the more recent views of the group and to recognize a single large tribe (Aveneae) that included the Aveneae, Phalarideae, and Agrostideae of Hitchcock and Chase. However, recent cluster analysis studies suggest that there is some justification for the view that there are three tribes, but not as described by H & C. The summary below is a compromise, recognizing the three major "lumps" at the subtribal level.

SUBTRIBE: AVENINAE

The subtribe contains most of the genera of H & C's Aveneae. Typical features include open to contracted panicles of spikelets with 2-several florets whose glumes are as long as or longer than the first floret, often all of them. The lemmas usually have a twisted, geniculate awn arising from the back or apex. The rachilla is often prolonged beyond the upper floret as a slender stalk, sometimes bearing a rudimentary floret.

AVENA. Oats, wild oats. Caespitose annuals. Culms herbaceous, to 1 m tall. Inflorescence an open panicle, the branches capillary and pendulous, sometimes reduced to a raceme or even a solitary spikelet in depauperate material. Spikelets large, typically 2- or 3-flowered, bisexual, laterally compressed, disarticulating above the glumes and between the florets (except in cultivated oats). Glumes 2, ± equal, 3- to 11-nerved, as long as or longer than the florets, awnless; lemmas rounded, 5- to 7-nerved, with a stout, geniculate awn (reduced or absent in cultivated oats); palea 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of 15-30 species native to the Old World. *A. fatua* var. *sativa* is cultivated oats; *A. fatua* var. *fatua* is one of several important weeds called wild oats.

SUMMARY OF *AVENA* SPECIES

Ploidy: Species	Comment
Diploids [2n = 2x = 14]	
A. strigosa (sand oat)	Fodder plant; now weedy
A. brevis (short oats)	Grown in s. Europe for fodder
Tetraploids [2n = 4x = 28]	
A. barbata (slender oat)	Weedy
A. abyssinica (Abyssinian oat)	Wild/cultivated forms
Hexaploids [2n = 6x = 42]	
A. byzantina (red oat)	Eaten by livestock and us
A. fatua (wild oats)	Pernicious weed
A. nuda (naked oat)	Grain crop in China
A. sativa (cultivated oat)	Widely cultivated
A. sterilis (animated oat)	Fodder and ornamental

ARRHENATHERUM. Tall oat grass. Caespitose perennials. Culms herbaceous, to 2 m tall; corms sometimes present. Inflorescence a narrow panicle. Spikelets typically 2-flowered (upper perfect, the lower larger and staminate), laterally compressed, bisexual, disarticulating above the glumes (2 florets falling together); rachilla extended as bristle beyond uppermost floret. Glumes 2, very unequal, the first 1-nerved and the second 3-nerved, awnless; lemmas 5- to 9-nerved, awnless or with a dorsal awn; palea relatively long. Lodicules 2; stamens 3; stigmas 2.

A genus of 4-6 species native to Europe and the Mediterranean. *A. elatius* (tall oat grass) is planted for pasture and has escaped in many areas of North America.

HELICTOTRICHON. Spike-oat, alpine-oat. Caespitose perennials. Culms herbaceous, to 1.5 m tall. Inflorescence a contracted panicle. Spikelets large, 2- to 7-flowered, bisexual, laterally compressed, disarticulating above the glumes and between the florets. Glumes 2, equal to or shorter than the florets, 1- to 5-nerved; lemmas 5- to 7-nerved, apex toothed, with a stout, twisted, geniculate dorsal awn; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of about 90 species native to the Old and New World. Two are native to North America (*H. hookeri* and *H. mortonianum*); one is introduced from Europe (*H. pubescens*).

AIRA. Silver hair grass. Delicate, caespitose annuals. Culms herbaceous, to 0.25 m tall. Inflorescence an open or panicle. Spikelets 2-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, ± equal, as long as or longer than the florets, 1- or 3-nerved; lemmas 5-nerved, a geniculate, hair-like awn arising from below the middle, apex with 2 slender teeth or setae; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of 8-10 species native to the northern and southern temperate regions of the Old World. *A. caryophyllea*, *A. elegans*, and *A. praecox* are adventive in North America.

DESCHAMPSIA. Hair grass. Mostly caespitose perennials; a few are annuals. Culms herbaceous, to 1 m tall. Inflorescence an open or congested panicle, often with capillary branches. Spikelets small, 2-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets, the rachilla hairy and prolonged above the upper floret (sometimes with a rudiment at its apex). Glumes 2, ± equal, the first 1-nerved and the second 3-nerved, as long as or longer than the lower floret; lemmas 5- to 7-nerved (often obscurely so), its apex several toothed or cleft, and with a geniculate awn from or below the middle; palea relatively long. Lodicules 2; stamens 3; stigmas 2.

A genus of about 40 species native to the temperate and cooler portions of the Old and New World. *D. danthonioides*, the only annual species in North America, is common in the West; *D. caespitosa* (tufted hair grass) occurs in mountain meadows in the same region.

TRISETUM. Trisetum. Mostly caespitose perennials. Culms herbaceous, to 1.5 m. Inflorescence a contracted panicle. Spikelets 2-flowered [rarely 3- or 4-flowered], laterally compressed, bisexual, disarticulation above or below the glumes, or not disarticulating, the rachilla prolonged above the uppermost floret. Glumes 2, equal or unequal, the first 1- to 3-nerved and the second 1- to 5-nerved; lemmas 5- to 7-nerved, its apex bifid, the teeth awned, with a straight or bent awn from the base of the cleft; palea relatively long, with two apical setae. Lodicules 2; stamens 3; stigmas 2.

A genus of about 75-85 species of the temperate and cooler regions of the Old and New World. Of economic importance as a source of pasture and fodder grasses. *T. spicatum* (spike trisetum) occurs in the Rocky Mountains and in the West.

SPHENOPHOLIS. Wedgescale. Caespitose annuals and perennials. Culms herbaceous, to 1+ m tall. Inflorescence a contracted panicle. Spikelets 2- or 3-flowered, laterally compressed, bisexual, disarticulating below the glumes. Glumes 2, dimorphic (first narrow and 1- [3-] nerved and the second broad and 3- to 5-nerved); lemmas faintly 5-nerved, awnless or less often awned; palea relatively long. Lodicules 2; stamens 3; stigmas 2.

A genus of 4 or 5 species native to North America and the West Indies. *S. obtusata* (prairie wedgescale) is widespread in North America.

KOELERIA. June grass. Caespitose annuals or perennials. Culms herbaceous, to 1+ m tall. Inflorescence a spike-like panicle. Spikelets 2- to 4-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets, rachilla extended as a bristle beyond the uppermost floret. Glumes 2, ± equal, as long as or shorter than the florets, dimorphic (first acute, 1-nerved and the second broader, longer, obscurely 3- to 5-nerved); lemmas 3- to 5-nerved, awnless or awned from a bifid apex; palea relatively long, apically notched, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of about 60 species native to the temperate regions of the Old and New World. The annual species have been treated as the genus *Lophochloa*. *K. macrantha* (= *K. cristata* in H & C) is native to prairies and wooded areas over much of North America. *K. phleoides* is a small, introduced annual.

HOLCUS. Velvet grass. Caespitose perennials. Culms herbaceous, weak, succulent, to 1 m tall. Leaves velvety-pubescent, especially the sheaths. Inflorescence a contracted panicle. Spikelets 2-flowered (lower perfect, the upper staminate or neuter), laterally compressed, bisexual, rachilla prolonged above the uppermost fertile floret, disarticulating below the glumes. Glumes 2, as long as or longer than the florets, the first 1-nerved and the second 3-nerved; lemmas faintly 3- to 5-nerved, the upper one with a short, hooked awn from near its apex; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2. A genus of 6-8 species native to Eurasia and Africa. *H. lanatus* and *H. mollis* are adventive in North America.

BECKMANNIA. Slough grass. Annuals with thick culms. Inflorescence a panicle of appressed or ascending spikes. Spikelets 1- or 2-flowered, ± orbicular, laterally com-pressed, sessile, disarticulating below the glumes, the rachilla often prolonged. Glumes 2, equal, broad, inflated, 3-nerved, keeled, and apiculate at apex. Lemma ± equal to glumes, narrow, 5-nerved, tapering to a slender tip. Palea narrow, shorter than lemma. Lodicules 2; stamens 3; stigmas 2.

A genus of two species native to Eurasia and North America. *Beckmannia syzigachne*, American slough grass, is native to marhes and wet sites over much of the northern and western U. S. It is sometimes frequent enough to use for hay or forage.

SUBTRIBE: PHALARIDINAE

As here defined, the subtribe is equivalent to the Phalarideae of H & C. The group is defined by its spikelets with a single fertile floret with 1 or 2 staminate or sterile florets below it, these sometimes reduced to inconspicuous, scale-like rudiments.

ANTHOXANTHUM. Sweet vernal grass. Annuals or perennials, pleasantly fragrant because of coumarin. Culms herbaceous, to 1 m tall. Inflorescence a contracted to spike-like panicle. Spikelets with a single fertile floret subtended by two sterile ones, laterally compressed, bisexual, disarticulating above the glumes (the three florets falling as a group). Glumes 2, very unequal, the first 1-nerved, the second 3-nerved, longer than the florets; sterile lemmas 3-nerved, hairy, awned from a notched apex; fertile lemma 3- to 5-nerved, glabrous except at apex, awnless; palea 1- or 3-nerved. Lodicules 0; stamens 2; stigmas 2.

A small genus of about 4 species native to the Old World. Two species, *A. odoratum* (sweet vernal grass) and *A. aristatum* are adventive in North America. The genus is doubtfully distinct from *Hierochloë.*

HIEROCHLOË. Holy grass, sweet grass. Caespitose or rhizomatous perennials, pleasantly fragrant because of coumarin. Culms herbaceous, to 1+ m tall. Inflorescence an open to contracted panicle. Spikelets with a single fertile floret subtended by two staminate ones, laterally compressed, bisexual, disarticulating above the glumes (the three florets falling as a group). Glumes 2, equal, the first 1- to 5-nerved and the second 3- to 5-nerved, as long as or slightly shorter than the florets; lemmas of staminate florets awnless or with a short awn from a notched apex, 5-nerved; lemma of fertile floret 3- to 5-nerved, awnless; palea 1- or 3-nerved. Lodicules 2; stamens 2 (bisexual florets) or 3 (staminate florets).

A genus of 20-30 species native to the temperate and cooler regions of both hemispheres. Three species are found in North America. *H. alpina* occurs in from the New England states across Montana; *H. odorata* is found through much of the northern and western states; and *H. occidentale* coours along the Pacific Coast. Schouten & Veldkamp (1985) proposed merging this genus with *Anthoxanthum*, but their work seems to have gone largely unnoticed.

PHALARIS. Canary grass, reed canary grass.

Caespitose annuals or perennials, often from rhizomes. Culms herbaceous, to 2 m tall. Inflorescence typically a spike-like panicle. Spikelets with a single bisexual floret subtended by two reduced (sometimes very tiny!) scale-like florets, laterally compressed, disarticulating above or below the glumes or not disarticulating. Glumes 2, ± equal, as long as or longer than the florets, usually with a winged dorsal keel; sterile lemmas reduced to small scales; fertile lemma 5-nerved, awnless; palea relatively long, 1- or 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of 15 or 16 native to Eurasia, Africa, and the New World. Five are native to North America; four are adventive. *Ph. arundinacea* (reed canary grass) is an important pasture grass and weed; *Ph. canariensis* is one of the standard ingredients in commercial birdseed mixtures.

SUBTRIBE: ALOPECURINAE

This subtribe contains some, but by no means all, of the genera of H & C's Agrostideae. The plants are primarily of the temperate and Arctic regions. The inflorescence is typically a panicle. The spikelets are 1-flowered, small, and mostly laterally compressed. The glumes tend to be longer than the floret. The lemmas are thin, 3- to 5-nerved, and rarely awned.

AMMOPHILA. Beach grass, European beach grass. Coarse, rhizomatous perennials. Culms herbaceous, to 1.5 m tall. Inflorescence a dense, spike-like panicle. Spikelets large, 1-flowered, laterally compressed, bisexual, rachilla prolonged as a hairy bristle beyond the floret, disarticulat-ing above the glumes. Glumes 2, ± equal, the first 1-nerved and the second 1- to 3-nerved, as long as or longer than the floret; lemma 5-nerved, awnless, with long hairs at the base; palea relatively long, 4- to several-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of 2-4 species native to North America and Europe. *A. breviligulata* (American beach grass) is native to the East Coast and around the Great Lakes; *A. champlainensis* is native to the Northeast; *A. arenaria* (European beach grass) was introduced to stabilize sand dunes along the Pacific Coast.

CALAMAGROSTIS. Reed grass, bluejoint. Caespitose, rhizomatous, or stoloniferous perennials, often of wet and marshy sites. Culms herbaceous, sometimes reed-like, to 2 m tall. Inflorescence a panicle, typically contracted. Spikelets 1-flowered, laterally compressed, bisexual, disarticulating above the glumes, rachilla often extended beyond the single floret as a slender bristle. Glumes 2, ± equal, longer than the floret, the first 1-nerved and the second 3-nerved; lemma 3- or 5-nerved, its apex notched or toothed, bearing a slender, geniculate dorsal awn; callus long-hairy; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of over 230 species native to the temperate and cooler regions of the Old and Nedw World. A number of species reported for North America, all but one of them native. *C. canadensis* (bluejoint), which occurs over much of the northern part of the continent, is an important forage grass. *C. purpurascens* (purple reedgrass) is found over much of the western United States; *C. nutkaensis* (Pacific reedgrass) is native along the Pacific coast from Alaska to California; *C. inexpansa* (northern reedgrass) ranges from Greenland to California.

AGROSTIS. Bent grass, bent, redtop, tickle grass. Annuals and caespitose, rhizomatous, or stoloniferous perennials. Culms herbaceous, to 1 m tall. Inflorescence an open to contracted panicle. Spikelets small (sometimes distressingly so), 1-flowered, laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, ± equal, the first typically 1-nerved and the second 1- [3-] nerved, as long as or longer than the floret; lemma 3- or 5-nerved, glabrous or hairy at base, awned dorsally from or below the middle or awnless; palea typically small or even absent. Lodicules 2; stamens 3; stigmas 2.

A complex genus of over 200 species native to the temperate and cooler regions of both hemispheres. Several of our North American representatives are of considerable economic importance as forage grasses, lawn grasses, and as the substrate on which some humans use sticks to knock little white balls into small holes in the ground. A number of them are also weedy. *A. gigantea* (= *A. alba* in H & C) is redtop; *A. hiemalis* is winter bentgrass, and *A. palustris* is the creeping bent used at golf courses.

CINNA. Woodreed. Caespitose or rhizomatous perennials, often of wet, shady sites. Culms herbaceous, to 1.5 m tall. Inflorescence an open or congested panicle. Spikelets 1-flowered, laterally compressed, bisexual, disarticulating below the glumes, the rachilla prolonged above the floret as a stub or bristle. Glumes 2, equal or the first shorter, the lower 1-nerved and the upper 1- or 3-nerved; lemmas 3- to 5- nerved, the mid-nerve extended as a short, straight awn; palea about as long as the lemma, 1-nerved. Lodicules 2; stamen 1 or 2 [3]; stigmas 2.

A genus of 3-4 species native to the temperate regions of both hemispheres. *C. latifolia* (drooping woodreed) is widespread in moist, shaded areas; *C. arundinacea* (stout woodreed) is found in moist woods in the eastern and central portions of North America; *C. bolanderi* is endemic to California.

PHLEUM. Timothy. Caespitose annuals and perennials. Inflorescence an ovoid to cylindrical, spike-like panicle. Culms herbaceous, to 1.5 m tall, the bases sometimes tuberous. Spikelets 1-flowered, strongly laterally compressed, bisexual, disarticulating above or below the glumes. Glumes 2, ± equal, longer than the floret, abruptly narrowed to an awn or mucro, 3-nerved; lemma 5- to 7-nerved, blunt, awnless.

A genus of 10-15 species native to the temperate regions of Eurasia and North America. *Ph. alpinum* is native in mountainous areas; *Ph. pratense* (timothy) is perhaps the leading hay grass of the eastern states.

POLYPOGON. Rabbitfoot grass. Annuals or perennials. Culms herbaceous, often weak and decumbent and rooting at nodes, to 1+ m tall. Inflorescence a soft, dense, contracted panicle (hence the common name). Spikelets small, 1-flowered, ± laterally compressed, bisexual, disarticulating below the glumes. Glumes 2, ± equal, longer than the floret, 1-nerved, bearing a long awn from an entire or notched apex; lemma 5-nerved, its apex typically toothed, awned or awnless; palea relatively long, 2-nerved. Lodicules 2; stamens 1 or 3; stigmas 2.

A genus of 10-20 species native mostly to the

temperate regions of the Old World. Several Eurasian species have been introduced; *P. monospeliensis* (rabbitfoot grass) is a common weed in wet areas across North America. *P. elongatus* is native to Arizona and California.

Lagurus. Hare's tail. Plants annual. Inflorescence a dense, pale, ovoid to oblong capitate panicle. Sheaths and blades pubescent. Spikelets 1-flowered. Glumes thin, narrow, villous, 1-nerved, tapering to a plumose awn-point. Lemma shorter than glumes, thin, glabrous, bearing an awn form its back, its apex awn-tipped. Palea thin, narrow, the two keels ending in minute awns.

One species, *L. ovatus*, native to the Mediterranean. Cultivated as an ornamental, popular in dried arrangements. Sparingly escaped in California and elsewhere.

ALOPECURUS. Meadow foxtail. Annuals and caespitose or rhizomatous perennials. Culms herbaceous, to 1 m tall. Inflorescence a dense, spike-like panicle. Spikelets 1-flowered, laterally compressed, bisexual, disarticulating below the glumes. Glumes 2, their lower edges united, ciliate-keeled, equal, 3-nerved, equaling the floret; lemma 5-nerved, its lower margins joined, awned from below the middle; palea absent or much-reduced. Lodicules 0; stamens 3; stigmas 2.

A genus of 25-35 species native to the northern temperate regions of both hemispheres. Of economic significance as a source of fodder, pasture grasses, and weeds. *A. carolinianus*, a native annual, is widely distributed. *A. pratensis* (meadow foxtail), a European pasture grass, is grown in the northern states.

GASTRIDIUM. Nit grass. Caespitose annuals. Culms herbaceous, to 5 dm tall. Inflorescence a dense, spike-like panicle. Spikelets 1-flowered, laterally compressed, bisexual, disarticulating below the glumes, the rachilla prolonged above the floret as a bristle. Glumes 2, unequal, longer than the floret, 1-nerved; lemma 5-nerved, awnless or awned from below the toothed apex; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of only two species, both native to western Europe and the Mediterranean. *G. ventricosum* (nit grass) is adventive along the Pacific coast and scattered locations in Texas and the East.

TRIBE: TRITICEAE

"Abandon hope all ye who enter here." (Dante Alighieri, writing on an another distressing topic)

Annuals or perennials. Leaf blades usually auriculate. Inflorescence a balanced spike or rame, its axis continuous or breaking apart at maturity. Spikelets commonly 1-3 per node, sometimes as many as 6. Lemmas 5- to 9-nerved, awned from the tip or awnless. Caryopsis free from or adhering to the anthoecium. Hybridization rampant; polyploidy common. X = 7. The tribe is more or less equivalent to the Hordeae of H & C.

I am tempted to offer Dante's admonition about abandoning all hope to those who enter here. Generic delimitations within the tribe are exceedingly difficult, often appearing quite arbitrary, and they remain controversial. To give you some flavor of the difference of opinion as to how to treat this group, some workers recommend recognizing a single genus, *Triticum*. Others, including myself, believe that our North American material can be accommodated in about six genera. The most liberal disposition is that we ought to give generic recognition to each distinct genome or combination of genomes, which yields Avogadro's number of segregate (and to my way of thinking, useless) genera.

EVOLVING VIEWS OF TRITICEAE

Bentham (1882). *Agropyron, Elymus, Hordeum, Hystrix, Secale, Triticum*.

Nevski (1933). *Aegilops, Agropyron, Brachypodium*, *Critesion, Elymus, Elytrigia, Eremopyrum, Hordeum, Psathyrostachys, Secale, Sitanion, Taeniatherum, Triticum*,

Hitchcock (1951). *Aegilops, Agropyron, Elymus, Hordeum, Hystrix, Lolium*, *Monerma*, *Nardus*, *Parapholis*, *Scribneria*[2], *Secale, Sitanion, Triticum*.

Tzvelev (1976). *Aegilops, Agropyron, Elymus, Elytrigia, Eremopyrum, Hordeum, Hystrix, Leymus, Psathyrostachys, Secale, Taeniatherum, Triticum*.

Baum (1982): *Aegilops, Agropyron, Elymus, Elytrigia, Eremopyrum, Hordeum, Hystrix, Leymus, Psathyrostachys, Secale, Taeniatherum, Triticum*.

Estes & Tyrl (1982): *Agropyron, Elymus, Hordeum, Secale, Triticum.*

Gould (1983): *Agropyron, Elymus, Hordeum, Hystrix, Secale, Sitanion, Taeniatherum, Triticum*.

Löve (1984): *Aegilops*, *Aegilopodes, Agropyron, Critesion, Cylindropyrum, Elymus, Elytrigia, Eremopoa, Eremopyrum, Hordeum, Hystrix, Leymus, Lophopyrum, Pascopyrum, Psathyrostachys, Pseudoroegneria. Roegneria, Secale, Sitanion, Taeniatherum, Thinopyrum, Triticum*.

Barkworth (1983, 1985): *Aegilops, Agropyron, Critesion, Elymus, Elytrigia, Eremopyrum, Hordeum, Leymus, Pascopyrum, Psathyrostachys, Pseudoroegneria, Secale, Taeniatherum, Thinopyrum, Triticum*.

Clayton & Renvoize (1986): *Aegilops, Agropyron, Brachypodium, Crithopsis, Elymus, Eremopyrum, Hordeum, Hystrix, Leymus, Psathyrostachys, Secale, Sitanion, Taeniatherum, Triticum.*

Watson & Dallwitz (1992): *Aegilops, Agropyron, Elymus, Elytrigia, Eremopyrum, Hordeum, Hystrix, Leymus, Lophopyrum, Pascopyrum, Psathyrostachys, Pseudoroegneria, Secale, Sitanion, Taeniatherum, Thinopyrum, Triticum*.

Czerepanov (1995): *Aegilops, Agropyron, Elymus, Elytrigia, Eremopyrum, Hordeum, Hystrix, Leymus, Psathyrostachys, Secale, Taeniatherum, Triticum*.

GENOME-BASED GENERA

Askell Löve and others have argued that the genera of Triticeae should be based on genomes. Here is how that would look.

Genome	Genus
A	*Crithodium*
AB	*Gigachilon*
ABD	*Triticum*
B	*Sitopsis*
BU	*Aegilemma*
C	*Orrhopygium*
CD	*Cylindropyrum*
D	*Patropyrum*
DM	*Gastropyrum*
DMU	*Aegilonearum*
E	*Lophopyrum*
EJS	*Elytrigia*
F	*Eremopyrum*
G	*Festucopsis*
H	*Critesion*
HJNS	*Pascopyrum*
HS	*Elymus*
HT	*Hordelymus*
I	*Hordeum*
J	*Thinopyrum*
JN	*Leymus*
K	*Crithopsis*
L	*Chennapyrum*
M	*Comopyrum*
MU	*Aegilops*
N	*Psathyrostachys*
O	*Henrardia*
P	*Agropyron*
Q	*Heteranthelium*
R	*Secale*
S	*Pseudoroegneria*
T	*Taeniatherum*
U	*Kiharapyrum*
V	*Dasypyrum*
Z	*Amblyopyrum*

INTERGENERIC HYBRID

Given the promiscuous nature of the grasses in this group, you will not be surprised to learn that there are many intergeneric hybrids, as seen below.

X *Aegilosecale*
X *Aegilotriticum*
X *Agroelymus*
X *Agrohordeum*
X *Agrositanion*
X *Agrotrisecale*
X *Agrotriticum*
X *Elyhordeum*
X *Elymordeum*
X *Elymopyrum*
X *Elyleymus*
X *Elysitanion*
X *Elytesion*
X *Leytesion*
X *Pseudelymus*
X *Sitordeum*
X *Triticosecale*
X *Tritordeum*

FATE OF H & C's GENERA

The genera recognized by Hitchcock & Chase (1951) appear in the left column. Their current disposition as per various recent monographs is shown on the right. You will note that the concept of some genera, such as *Secale* and *Triticum*, has changed little. Some genera, such as *Hystrix*, have disappeared. In still other cases, H & C recognized a large genus, such as *Elymus*, and recent workers also recognize an entity called *Elymus*, but it is more narrowly defined because one or more species have been transferred to segregate genera.

In a few instances, genera are now seen as members of tribes other than Triticeae. They

Aegilops	*Aegilops* *Cylindropyrum* *Triticum*
Agropyron	*Agropyron* *Elymus* *Eremopyrum* *Pascopyrum* *Pseudoroegneria* *Roegneria* *Thinopyrum*
Elymus	*Elymus* *Elytrigia* *Leymus* *Lophopyrum* *Psathyrostachys* *Taeniatherum*
Hordeum	*Hordeum* *Critesion*
Hystrix	*Elymus*
Lolium	*Lolium* (Poeae)
Monerma	*Hainardia* (Hainardieae)
Nardus	*Nardus* (Nardeae)
Parapholis	*Parapholis* (Hainardieae)
Scribneria	*Scribneria* (Hainardieae)
Secale	*Secale*
Sitanion	*Sitanion* *Elymus*
Triticum	*Triticum*

AGROPYRON. Crested wheatgrass. Caespitose or rhizomatous perennials. Culms herbaceous, to 1 m tall. Inflorescence a balanced spike, the rachis continuous or shattering at maturity, spikelets ± pectinate, 1 per node, inserted flatwise to axis. Spikelets 3- to 8-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, ± equal, shorter than the florets, broad or narrow, awned; lemmas 5- or 7-nerved, awned or awnless; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

As defined here, the genus consists of about 15 species native to the Mediterranean area and Asia. Our North American representatives are *A. cristatum* (crested wheatgrass) and *A. desertorum* (desert

wheatgrass). I follow Stebbins and Gould in placing the other species listed in H & C in the expanded version of *Elymus*. The increasingly popular disposition of these taxa is to place them in a series of segregate genera.

ELYMUS. Wild rye. Caespitose or rhizomatous perennials. Culms herbaceous, to 2 m tall. Inflorescence a balanced spike [compound in some species], the rachis continuous. Spikelets typically [1] 2 or 3 [6] per node; [2-] 3-7 [9-] flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, equal or unequal, 3- to 7-nerved, broad to quite narrow, almost awn-like in some; lemmas 5- to 7-nerved, tapering to an awn [rarely awnless]; palea relatively long, 2-nerved. Lodicules 2; stamens 3, stigmas 2.

A genus of about 150 species widespread in the temperate and cooler regions of both hemispheres. As treated here, the genus includes most of the taxa assigned to *Agropyron* in H & C. Some species are important forage grasses. *E. virginicus* (Virginia wild-rye), *E. canadensis* (Canada wild-rye), *E. glaucus* (blue wild-rye), *E. cinereus.*

Common species transferred from *Agropyron* include *E. smithii* (western wheatgrass), *E. repens* (quack grass), and *E. spicatus* (bluebunch wheatgrass). The genus also includes all of our North American species of *Sitanion* (squirreltail grasses) and *Hystrix* (bottlebrush grasses) that appear in H & C.

TAENIATHERUM. Medusa head. Annuals. Culms herbaceous, to 6 dm tall. Inflorescence a bristly, balanced spike, spikelets paired, the rachis continuous. Spikelets 2-flowered (the lower bisexual and the upper rudimentary), dorsally compressed, disarticulating above the glumes. Glumes 2, subulate, indurate, 1- or 3-nerved, joined at base, tapering to a stiff awn; lemma narrow, 5-nerved, with a long, flattened awn; palea about as long as lemma, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of 2-3 species, doubtfully distinct from *Elymus*, native to Eurasia. *T. caput-medusae* [= *Elymus c.-m.* in H & C] is a serious weed in several of the western states, including California.

HORDEUM. Barley, foxtail barley, little barley, squirreltail. Annuals or caespitose perennials. Culms herbaceous, to 1+ m tall. Inflorescence a dense, balanced, often bristly spike, continuous or shattering at maturity. Spikelets typically 3 per node, the central sessile and fertile, the laterals often pedicellate and sterile (all three fertile in *H. vulgare*). Central spikelet 1-flowered, the rachilla extended above it and bearing a rudiment, laterally or dorsally compressed, bisexual, disarticulating below the glumes or not disarticulating in cultivars. Glumes 2, narrow, rigid, 1-nerved, subulate or awned; lemma dorsally flattened, 5-nerved (often difficult to distinguish), acuminate to an awn or awn-point; palea about as long as lemma, often adnate to caryopsis. Lateral spikelets often reduced to awn-like glumes. Lodicules 2; stamens 3; stigmas 2.

A genus of 25-40 species native to the temperate regions of both hemispheres; a number of them are weedy. A dozen or so species are found in North America, most of them native. *H. jubatum* (foxtail barley) is native in the West; *H. brachyantherum* (meadow barley) provides good forage; *H. pusillum* (little barley) is a native annual found over much of North America; *H. vulgare* is cultivated barley, whose grains are eaten and sprouted to make malt for the brewing and distilling industries.

SUMMARY OF NORTH AMERICAN *HORDEUM*

Ploidy Level: Taxon	**Nativity (Duration)**
2n = 2x = 14	
H. bulbosum	Mediterranean (P)
H. californicum	Western United States (P)
H. euclaston	South America (A)
H. intercedens	Western United States (A)
H. marinum ssp. *marinum*	Mediterranean (A)
H. marinum ssp. *gussoneaum*	Mediterranean (A)
H. murinum ssp. *glaucum*	Mediterranean (A)
H. pusillum	North America (A)
H. vulgare ssp. *vulgare*	Cultivated (A)
2n = 4x = 28	
H. brachyantherum	West. N. America/East Asia (P)
H. bulbosum	Mediterranean (P)
H. depressum	Western United States (A)
H. jubatum	N. America/East Asia (P)
H. marinum ssp. *gussoneanum*	Mediterranean (A)
H. murinum ssp. *murinum*	Mediterranean (A)
H. murinum ssp. *leporinum*	Mediterranean (A)
H. vulgare ssp. *vulgare*	Cultivated (A)
2n = 6x = 42	
H. arizonicum	Southwest United States (A/P)
H. murinum ssp. *leporinum*	Mediterranean (A)

[After R. von Bothmer in Shewry, P. R. (1992)]

AEGILOPS. Goat grass. Caespitose or rhizomatous annuals. Culms herbaceous, to 8 dm tall. Inflorescence a single, balanced spike, the spikelets solitary at each node. Spikelets turgid or cylindrical, placed flatwise and fitting into the rachis, 2- to 5-flowered, rounded to ± laterally compressed, bisexual, disarticulating above or below the glumes, or not disarticulating. Glumes 2, several-nerved, 1- or 3-awned; lemmas usually 5- to 7-nerved, awnless, mucronate, or 1- or 2-awned; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

The genus is completely interfertile with *Triticum* and the two genera are often merged. A genus of 20+ species native to the Mediterranean and Asia. *Ae. cylindrica* (jointed goatgrass) is a widespread weed in the central and southern states; *Ae. ovata* and *Ae. triuncialis* are common weeds in California.

TRITICUM. Wheat, bread wheat. Caespitose annuals. Culms herbaceous, the internodes hollow or solid, to 1 m tall. Inflorescence a thick, balanced spike, the spikelets solitary at each node and attached flatwise to the rachis. Spikelets 2- to 5-flowered, laterally compressed or rounded, bisexual, disarticulating above or below the glumes, or not disarticulating in cultivars. Glumes 2, ± equal, shorter than the florets, 5- to 11-nerved, mucronate or with 1 or more awns at its apex; lemmas keeled or rounded, glabrous or pubescent, several-nerved, awnless or with 1 or 3 awns.

A genus of about 8 species native to Eurasia. *T. aestivum* (bread wheat) and *T. durum* (durum or macaroni wheat) are the principal economic species.

SUMMARY OF WHEAT SPECIES

Species (Common Name)	**Genome(s)**
Diploids [2n = 2x = 14]	
T. boeoticum (wild einkorn wheat)	AA
T. monococcum (einkorn wheat)	AA
Tetraploids [2n = 4x = 28]	
T. dicoccoides (wild emmer wheat)	AABB
T. dicoccum (emmer wheat)	AABB
T. durum (durum or macaroni wheat)	AABB
T. turgidum (poulard or rivet wheat)	AABB
T. polonicum (Polish wheat)	AABB
T. carthlicum (Persian wheat)	AABB
T. timopheevii	AAGG
T. araraticum	AAGG
Hexaploids [2n = 6x = 42]	
T. spelta (spelt wheat)	AABBDD
T. macha (macha wheat)	AABBDD
T. vavilovii (Vavilov's wheat)	AABBDD
T. compactum (club wheat)	AABBDD
T. sphaerococcum (shot wheat)	AABBDD
T. aestivum (bread or common wheat)	AABBDD

EVOLUTION OF MODERN HEXAPLOID WHEATS

Phase I: Diploid to Tetraploid

Triticum boeoticum (Wild einkorn wheat) [2n = 2x = 14] [Genome: AA]

X

Aegilops speltoides (Goat grass) [2n = 2x = 14] [Genome: BB]

▽
▽

Sterile F_1 Hybrid
[2n = 2x = 14]
[Genomes: AB]

▽
▽

Unreduced Gametes
("Chromosome Doubling")

▽
▽

Triticum dicoccoides
(Wild emmer wheat)
[2n = 4x = 28]
[Genomes: AABB]

▽
▽

Domestication

▽
▽

Triticum dicoccum
(Cultivated emmer wheat)
[2n = 4x = 28]
[Genomes: AABB]

Phase II: Tetraploid to Hexaploid

Triticum dicoccum (Cultivated emmer wheat) [2n = 4x = 28] [Genomes: AABB]

X

Aegilops squarrosa (Goat grass) [2n = 2x = 14] [Genomes: DD]

▽
▽

Sterile Hybrid
[2n = 3x = 21]
[Genomes: ABD]

▽
▽

Unreduced Gametes
("Chromosome Doubling")

▽
▽

Triticum aestivum
(Bread wheat)
[2n = 6x = 42]
[Genomes: AABBDD]

▽
▽

Domestication

▽
▽

Hulled/Free-threshing cultivars

▽
▽

Recent domestication

▽
▽

Genetic engineering

SECALE*.* Rye. Annuals, sometimes perennials. Culms herbaceous, to 1+ m tall. Inflorescence a balanced spike, the spikelets solitary at the node, and placed flatwise to the rachis. Spikelets typically 2-flowered, laterally compressed, bisexual, disarticulating below the glumes or not disarticulating in cultivars. Glumes 2, narrow, 1-nerved, subulate; lemmas sharply keeled, ciliate on the keels, 5-nerved, tapering to a long awn.

A genus of 5 species native to Eurasia. *S. cereale* (rye) escapes from cultivation.

X *TRITICOSECALE**.*** Triticale. The hybrid between wheat and rye, combining desirable features from both of these important crop plants. It is the source of triticale berries that you see in the health food markets.

TRIBE BRACHYPODIEAE

The characters of the tribe are those of the genus below.

BRACHYPODIUM. False brome, purple-brome. Mostly perennial herbs. Inflorescence a series of linear racemes on stiffly erect branches. Spikelets 1 per node, ± sessile, divergent. Spikelets 2- to 20-flowered, ± terete to slightly laterally compressed, disarticulating above the glumes. Glumes 2, 5- to 9-nerved; lemmas herbaceous to thickened at maturity, 7- to 9-nerved, extending into an awn. Lodicules 2; stamens 3; stigmas 2, white.

A genus of 16 species native to the temperate regions of Europe and Asia, especially of woodlands and open grasslands. Two are native to Mexico. *B. distachyon* is a weedy European introduction of scattered sites in the U. S. A.

TRIBE: MELICEAE

A small tribe of grasses often associated with wet sites. Leaf sheaths typically closed. Inflorescence a panicle or raceme. Spikelets several-flowered; disarticulation above or below the glumes. H & C included these genera in their Festuceae. See Section 4 for a key to genera.

MELICA. Onion grass, melic. Perennials. Culms herbaceous, to 1 m tall, bases often swollen into bulb-like corms. Leaf sheaths closed. Inflorescence an open to contracted panicle. Spikelets several-flowered, rounded to laterally compressed, bisexual, the upper florets sterile, over-lapping, and forming a knob-like cluster, disarticulating above the glumes and between the florets. Glumes 2, 1- to 7-nerved, the margins scarious; lemmas thin, 5- to several-nerved, scarious-margined, awnless; palea present, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of about 60-80 species native to the temperate regions of both hemispheres; about 20 of them are found in North America. *M. mutica* (two-flowered melic) is native to much of the eastern United States. *M. nitens* and *M. mutica* occur in the eastern states; *M. subulata* (Alaska onion grass) occurs from Alaska to California; *M. porteri* (Porter's melic) is found in the Southwest.

GLYCERIA. Manna grass. Rhizomatous, stoloniferous, or caespitose perennials of wet sites. Culms herbaceous, often decumbent and rooting at the nodes, to 1+ m tall. Inflorescence an open to contracted panicle, sometimes reduced to a raceme. Spikelets fragile, linear, awnless, laterally compressed or almost terete, several-flowered, bisexual, disarticulating above the glumes and between the florets. Glumes 2, unequal, 1- [3-] nerved, shorter than the florets; lemmas broad, with [5] 7 [9] conspicuous, parallel nerves, the apex acute, obtuse, or truncate; palea broad, slightly longer than lemma, 2-nerved. Lodicules 2; stamens 2 or 3; stigmas 2.

A genus of about 35-40 species native to the temperate regions of the Old and New World; about 15 of them are found in North America. Some species of the genus have been treated under *Puccinellia* and *Torreyochloa* by recent workers. Several species are important sources of food for humans and waterfowl. *G. striata* (fowl manna grass) is probably the most widespread representative of the genus in North America, ranging from Newfoundland to Mexico; *G. borealis* (northern manna grass) occurs from Newfoundland to Washington and south to California; *G. septentrionalis* (eastern manna grass) is found from Canada to Florida, west to Texas.

PLEUROPOGON. Semaphore grass. Caespitose perennials or annuals. Culms herbaceous, to 1+ m. Leaf sheaths closed. Inflorescence a single raceme, rarely a panicle. Spikelets large, linear, several-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, unequal, shorter than the florets, the first 1-nerved and the second 3-nerved; lemmas 7-nerved, apex entire or bifid, awned; palea 2-nerved, 2-keeled, keels winged on lower portion, awned in 2 species. Lodicules 2; stamens 3; stigmas 2.

A genus of 5 species endemic from Washington to California; three of them known only from relatively few sites in California. A sixth species (*P. sabinii*) is circumpolar. An alternative treatment is to place the American species in the genus *Lophochlaena*, with *P. sabinii* being the only taxon in *Pleuropogon*.

TRIBE: STIPEAE

Plants of this tribe were placed in the Agrostideae of H & C. They differ in details of spikelet morphology and chromosome number. This group is sometimes placed in the subfamily Arundinoideae; sometimes it is treated as the distinct subfamily Stipoideae. See Section 4 for a key to the North American genera of Stipeae.

STIPA. Needle grass, porcupine grass. Caespitose perennials. Culms herbaceous or woody, to 2 m tall. Leaves often in a basal clump; cleistogamous spikelets often present within sheaths. Inflorescence an open to contracted panicle. Spikelets 1-flowered, terete to laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, 1- to 6-nerved, longer than the floret; lemmas long, narrow, firm to indurate at maturity, often tightly wrapped around palea and caryopsis, terminating in a conspicuous awn; lemma base and rachilla forming a sharp-pointed callus, this usually clothed in stiff hairs; palea relatively long, 2-nerved. Lodicules 3 [2]; stamens 3; stigmas 2-4.

A large genus of about 300 species native to temperate and tropical regions of the Old and New World. Of economic significance as a source of pasture grasses, fibers for cordage and mats, and weeds. The sharp-pointed florets can cause mechanical injury to domesticated and wild animals. *S. spartea* (porcupine grass) occurs in the prairies; *S. pulchra* (purple needle grass) is found in the California Coast Ranges; *S. avenacea* (blackseed needle grass) is native to the eastern and southeastern states. *S. hymenoides* [= *Oryzopsis h.* in H & C] (Indian ricegrass) is an important forage grass in the drier regions of the West. *S. robusta* (sleepy grass) is toxic, especially to horses.

Barkworth (1993) has, for the most part, elevated the sections of *Stipa* (or their equivalent) to the generic level. Our North American material would then fall into the genera *Achnatherum, Hesperostipa,* and *Nassella*. If we accept this disposition, which I do not, the new combinations would be as follows:

STIPA RENT ASUNDER

***Stipa* (Traditional)**	***Stipa* (Sensu Barkworth)**
Stipa arida ➙	*Achnatherum aridum*
Stipa x bloomeri ➙	*Achnatherum X bloomeri*
Stipa brachychaeta ➙	*Achnatherum brachychaetum*
Stipa californica ➙	*Achnatherum occidentale* var. *c*.
Stipa cernua ➙	*Nassella cernua*
Stipa comata ➙	*Hesperostipa comata*
Stipa coronata ➙	*Achnatherum coronatum*
Stipa curtiseta ➙	*Hesperostipa curtiseta*
Stipa curvifolia ➙	*Achnatherum curvifolium*
Stipa diegoensis ➙	*Achnatherum diegoense*
Stipa eminens ➙	*Achnatherum eminens*
Stipa formicarum ➙	*Nassella formicarum*
Stipa hymenoides ➙	*Achnatherum hymenoides*
Stipa x latiglumis ➙	*Achnatherum X latiglume*
Stipa lemmonii ➙	*Achnatherum lemmonii*
Stipa lepida ➙	*Nassella lepida*
Stipa lettermanii ➙	*Achnatherum lettermanii*
Stipa leucotricha ➙	*Nassella leucotricha*
Stipa lobata ➙	*Achnatherum lobatum*
Stipa neesiana ➙	*Nassella neesiana*
Stipa nelsonii ➙	*Achnatherum nelsonii*
Stipa neomexicana ➙	*Hesperostipa neomexicana*
Stipa nevadensis ➙	*Achnatherum nevadense*
Stipa occidentalis ➙	*Achnatherum occidentale*
Stipa parishii ➙	*Achnatherum parishii*
Stipa pinetorum ➙	*Achnatherum pinetorum*
Stipa porteri ➙	*Ptilagrostis mongholica* ssp. *porteri*
Stipa pulchra ➙	*Nassella pulchra*
Stipa richardsonii ➙	*Achnatherum richardsonii*
Stipa robusta ➙	*Achnatherum robustum*
Stipa scribneri ➙	*Achnatherum scribneri*
Stipa spartea ➙	*Hesperostipa spartea*
Stipa speciosa ➙	*Achnatherum speciosum*
Stipa stillmanii ➙	*Achnatherum stillmanii*
Stipa tenuissima ➙	*Nassella tenuissima*
Stipa thruberiana ➙	*Achnatherum thurberianum*
Stipa viridula ➙	*Nassella viridula*
Stipa webberi ➙	*Achnatherum webberi*

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ORYZOPSIS. Ricegrass. Caespitose perennials. Culms herbaceous, the internodes solid or hollow, to 1+ m tall. Inflorescence an open or contracted panicle, the branches sometimes capillary. Spikelets 1-flowered, terete to dorsally compressed, bisexual, disarticulating above the glumes. Glumes 2, ± equal, as long or longer than the floret, 3- to 7-nerved, broad, acuminate to obtuse; lemma 3- to 5-nerved, firm to indurate, with a deciduous awn; callus short and blunt; palea relatively long, similar to lemma in texture and marginally or completely covered by it. Lodicules 2 or 3; stamens 3; stigmas 3.

A genus of 20-35 species native to temperate and subtropical regions of both hemispheres. Plants of this genus hybridize freely with *Stipa*. As treated here, *Oryzopsis* includes *Piptatherum*, the latter with an incurved callus, 3 lodicules, marginally covered palea, and free styles. The genus occurs widely in the United States, with species often being locally important as forage. *O. miliacea* (smilo grass) is a weedy Mediterranean grass established on both coasts; *O. micrantha* (little ricegrass) is native in the West from Canada to California; *O. hymenoides* (Indian ricegrass) has been transferred to *Stipa*.

PIPTOCHAETIUM. Pinyon ricegrass, blackseed needle grass. Caespitose perennials. Culms herbaceous, stiffly erect, to 1+ m tall. Leaves basal, the blades filiform, usually involute. Inflorescence an open panicle. Spikelets 1-flowered, turgid, ± terete, bisexual, disarticulating above the glumes. Glumes 2, ± equal, somewhat longer than the floret, 3- to 7-nerved; lemma 5-nerved, dark-pigmented, with a stout, twisted, geniculate awn; palea 2-nerved, 2-keeled, with a narrow sulcus between the keels. Lodicules 2 or 3; stamens 3; stigmas 2.

A genus of 20-30 species native to the New World, mostly in South America. *P. fimbriatum* (pinyon ricegrass) is an important forage grass in the Southwest; *P. avenaceum* [= *Stipa a.* in H & C] (blackseed needle grass) is native to the wooded areas of the eastern U. S. A few other adventive species have been reported in California.

TRIBE: HAINARDIEAE

Grasses of the sea coasts. With their spicate inflorescences, they are similar to *Aegilops*. The spikelets are 1-flowered, disarticulating along with a segment of the rachis. The two genera below were assigned to Hordeae in H & C. See Section 4 for a key to the North American taxa.

HAINARDIA. Thintail. Caespitose annuals. Culms herbaceous, the internodes solid, to 5 dm tall. Inflorescence a single spike, spikelets solitary at each node, ± embedded in notches in a thickened, cylindrical rachis. Spikelets 1-flowered, dorsally compressed, bisexual, disarticulating below the glume, with a rachis segment attached. Glume 1, the first absent and the second firm to indurate, acute, 3- to several-nerved, longer than the floret, closing over the cavity in the rachis; lemma 3-nerved, thin, awnless; palea relatively long, hyaline, 2-nerved. Lodicules 2; stamens 1-3; stigmas 2. A monotypic genus native to the Mediterranean area. *H. cylindrica* [= *Monerma c.* in H & C] is an introduction in California salt marshes.

PARAPHOLIS. Sickle grass. Caespitose annuals. Culms erect to ± spreading, the internodes hollow, to 2 dm tall. Inflorescence a single spike, curved or straight, the spikelets solitary at each node, ± embedded in a thickened rachis, disarticulating below the glumes with a rachis segment attached. Glumes 2, ± equal, longer than the floret, 3- or 5-nerved, leathery, their attachment displaced so that they appear side-by-side in front; lemma hyaline, 1-nerved; awnless; palea relatively long, tightly clasped by lemma, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of 4-6 species native to maritime soils and salt marshes of the Old World; commonly occupying the same habitats as adventives. *P. incurva* is weedy on mud flats and in salt marshes of the Atlantic, Gulf, and Pacific coasts. A second species (*P. strigosa*) is known only from around Humboldt Bay. Its spikes are not curved, as in the other species. It was discovered a few years ago by Thomas Worley, who was an HSU student at the time.

SCRIBNERIA. Low, tufted annual. Inflorescence a slender spike; spikelets 1 per node, inserted flatwise against the rachis. Spikelets 1-flowered, disarticulating above the glumes; rachilla extended as a tiny, hairy bristle. Glumes 2, ± equal, awnless; first 2-nerved and the second 4-nerved. Lemma membranous, minutely bidentate, the midnerve extended as a short, straight awn. Palea about as long as lemma. Stamen 1; stigmas 2. 2n = 36. A monotypic genus. *S. bolanderi* is native from British Columbia to California. H & C placed the genus in their Hordeae.

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3.06 - SUBFAMILY ARUNDINOIDEAE

TECHNICAL DESCRIPTION

Habit: Cane-like, reed-like, or bamboo-like; sometimes perennial herbs

Root Hairs: Equal

Leaf Epidermis: A combination of festucoid and panicoid features

Leaf Anatomy: A combination of festucoid and bambusoid (arm cells present), with a few panicoid features; fusoid cells lacking

Spikelet: 1- to several-flowered; upper florets often reduced; in a few lower ones imperfect

Flower: Lodicules 2; stamens 3 [rarely 6]; stigmas 2, often densely and minutely plumose; flowers perfect or unisexual

Embryo: P - P F

Cytology: x = 6, 10, 11, or 12; chromosomes small

Photosynthetic Pathway: C_3

Distribution: Cosmopolitan, especially southern hemisphere.

SYSTEMATICS

This subfamily is a mess! It was not recognized by Hitchcock and Chase. Instead, they placed these grasses in their tribes Festuceae and Aveneae. It appears to me that the more we learn from the newer molecular studies, the less tenable our various treatments of Arundinoideae become.

The placement of *Gynerium* remains unsettled. It has been placed in its own tribe; the Grass Phylogeny Working Group left it "incertae sedis," which translates roughly from the Latin as "we don't know where the hell it goes."

TRIBE: ARUNDINEAE

Tall, coarse, rhizomatous or densely clumped perennials, often of wet sites. Inflorescence a conspicuous terminal panicle. Spikelets few- to several-flowered, often long-hairy, bisexual or unisexual, laterally compressed, disarticulating above the glumes and between the florets. See Section 4 for a new to the genera found in North America.

ARUNDO. Giant reed. Rhizomatous perennials. Culms woody, 2-6 m tall. Leaf blades broad, not pseudopetiolate. Inflorescence a terminal, plumose panicle. Spikelets several-flowered, bisexual, laterally compressed, disarticulating above the glumes and between the florets. Glumes 2, ± equal, 3-nerved, tapering to a point, awnless. Lemmas 3-nerved, villous on its lower half, tapering to a point or awn. Palea 2-keeled and -nerved. Rachilla glabrous. Lodicules 2; stamens 3; stigmas 2. X = 12; 2n = 60, 72, 110, and 112.

A genus of 3-6 species. *A. donax* is weedy along waterways; it is also grown as an ornamental and its is used in erosion control. It is also one of the sources of material used to make the reeds for certain wind instruments.

PHRAGMITES. Reed, common reed. Robust rhizomatous or stoloniferous perennials. Culms herbaceous to woody, to 4 [10] m tall. Leaf blades broad, not pseudopetiolate. Inflorescence a terminal, plumose panicle. Spikelets several-flowered, bisexual, disarticulating above the glumes and between the florets. Glumes 2, pointed, awnless, the first 1-nerved and the second 3-nerved; lemmas 3-nerved, awned or awnless. Rachilla with long, silky hairs. Palea 2-nerved. Lodicules 2; stamens 3; stigmas 2. X = 12; 2n = 36, 44, 46, 48, 49, 50, 51, 52, 54, and 96.

A genus of 3 cosmopolitan species. Our only North American representative is *Ph. australis* (= *Ph. communis* in H & C), often considered the most widely occurring vascular plant. It is found around lakes and along waterways over much of the continent.

GYNERIUM. Uva grass, caña brava. Robust, rhizomatous perennials to 10 m tall. Leaf blades to 2 m long; sharply serrulate. Plants dioecious. Inflorescence a conspicuous panicle. Female spikelets with a hairy callus.

A genus of one species, *G. sagittatum*, which is native to streamsides and wet places from Mexico into South America. It has become established in Florida. Stems used for construction, arrow-shafts; leaves for thatch, weaving, and basketry; inflorescences often painted some really tacky color and sold for some outrageous price in "import" shops.

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3.07 - SUBFAMILY DANTHONIOIDEAE

TECHNICAL DESCRIPTION

Habit: Caespitose perennials; reed-like in *Cortaderia*

Root Hairs:

Leaf Epidermis: Panicoid microhairs present; stomates absent or rare; silica bodies various

Leaf in Cross-section: Mesophyll non-radiate

Inflorescence: Panicle, sometimes reduced to a raceme or solitary spikelet

Spikelets: 2- to many-flowered; laterally compressed; disarticulating above the glumes

Flowers: Lodicules 2; stamens 3 (0 in unisexual florets); stigmas 2

Embryo Formula: P - P F

Cytology: x = 9; diploids and tetraploids

Photosynthetic Pathway: C_3

Distribution: Temperate, especially southern hemi-sphere; only *Danthonia* is native to North America

SYSTEMATICS

Hitchcock & Chase placed these grasses in their Festucoideae. More recent workers segregated them out as arundinoids. Recent research has resulted in recognizing seven clades, including the *Cortaderia* clade and the *Danthonia* clade.

TRIBE: DANTHONIEAE

Annuals or perennials herbs. Inflorescence a panicle, raceme, or occasionally reduced to a single spikelet. Spikelets few- to several-flowered, bisexual, disarticulating above the glumes and between the florets. Glumes 2, longer than the florets; lemmas bifid or toothed, awned or mucronate.

This tribe of predominantly southern hemisphere grasses is not well represented in North America. Its circum-scription remains unsettled. When C. E. Hubbard originally described the group in 1948, he separated out genera of the traditional Aveneae. Agnes Chase retained our few representatives in the Aveneae. The microcharacters of this group combine pooid and panicoid features. See Section 4 for a key to the genera of North American Danthonieae.

CORTADERIA. Pampas grass. Robust, caespitose perennials. Culms to 4 m tall. Leaves mostly basal, the blades often with harsh, toothed margins. Inflorescence a terminal panicle (conspicuously plumose in female plants). Spikelets 2-3 [5-] flowered, unisexual (the species gynodioecious), laterally compressed, disarticulating above the glumes and between the florets, the rachilla extended beyond the uppermost floret. Glumes 2, ± equal, glabrous, 1- to 3-nerved, awnless; lemmas 3-nerved, awned or awnless, conspicuously hairy on back and base in pistillate spikelets; palea 2-nerved and keeled. Lodicules 2; stamens 0 or 3; stigmas 0 or 2. X= 9; 2n = 36, 72, 90, and 108.

A genus of 24 species, native to New Zealand and to South America. *C. selloana* is an attractive ornamental that sometimes turns weedy. *Cortaderia jubata* is a pernicious weed of coastal California. You should kill pampas grass where ever it occurs. This will not be easy. You may need a flame thrower or a small nuclear device.

DANTHONIA. Poverty-oats. Caespitose perennials. Culms to 1 m tall. Inflorescence a few-flowered panicle or raceme (sometimes reduced to a single spikelet); our North American plants also have cleistogamous spikelets hidden within the leaf sheaths. Spikelets several-flowered, bisexual, disarticulating above the glumes and between the florets. Glumes 2, 3- to 7-nerved, much longer than the florets; lemmas hairy, 7- to many-nerved (often indistinctly so), the apex 2-toothed or -cleft, with a flat, twisted, geniculate awn from its midnerve; palea 2-nerved and -keeled. Lodicules 2; stamens 3; stigmas 2.

A genus of about 20 species of mesophytic to xerophytic habitats. Several are important pasture species. *D. spicata* occurs in much of the U. S., except for the far Southwest. *D. californica* and *D. unispicata* are found over much of the West.

RYTIDOSPERMA. Hairy oat grass, hairy-danthonia, poverty grass. Plants perennial, caespitose, spreading, sometimes rhizomatous. Inflorescence a raceme or panicle. Spikelets 3- to several-flowered, bisexual, dis-articulating above the glumes and between the florets. Glumes 2, more or less equal. Lemmas 5- to 9-veined, with 2 more or less complete rows of tufts of hairs (the feature that distinguishes the genus from *Danthonia*). Lodicules 2; stamens 3; stigmas 2.

A genus of about 45 species native to Asia, Oceania, and South America. Three species have been introduced into the United States, all of them along the Pacific coast. Only *R. penicillatum* (= *Danthonia pilosa* in older literature) is well established, especially in northern California and southern Oregon.

SCHISMUS. Mediterranean grass. Annual or weak perennials, caespitose or decumbent. Inflorescence a contracted or loosely spicate panicle. Spikelets several-flowered, slightly laterally compressed, disarticulating above or below the glumes, rachilla prolonged beyond uppermost floret. Glumes 2, 3- to 7-nerved, ± equal, shorter than or equaling enclosed florets. Lemmas similar to glumes, apex bifid or emarginate, awnless, mucronate, or awned. Palea 2-nerved, rounded or acute. Lodicules 2; stamens 3; stigmas 2. X = 6.

A genus of 5 species native to Africa, and from the Mediterranean to India. *S. arabicus* (Arabian grass) and *S. barbatus* (Mediterranean grass) have become major weeds in parts of the Southwest and in the deserts of California.

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3.08 - SUBFAMILY ARISTIDOIDEAE

TECHNICAL DESCRIPTION

Habit: Annual or perennial herbs

Root Hairs:

Leaf Epidermis: 2-celled panicoid microhairs present; stomates with dome-shaped or triangular subsidiary cells; silica bodies of the festucoid, oryzoid, or panicoid type

Leaf in Cross-section: Mesophyll with radiate parenchyma

Inflorescence: An open to contracted panicle of few to many spikelets

Spikelets: 1-flowered, cylindric to laterally compressed; typically with a triple or trifid awn (the lateral branches sometimes reduced or absent)

Flowers: Lodicules 2 or 0; stamens 1-3; stigmas 2 (red or brown)

Embryo Formula:

Cytology: x = 11 or 12; diploids, tetraploids, and hexaploids

Photosynthetic Pathway: C_4

Distribution: Temperate, subtopical/tropical; often of drier sites; widespread

SYSTEMATICS

The genus *Aristida* has always been something of a problem child. Its 1-flowered spikelets led early workers to put it in Agrostideae. A host of microcharacters show that to be untenable. The Grass Phylogeny Working Group has segregated the genus into its own subfamily.

TRIBE: ARISTIDEAE

The characters of the tribe are those of the single genus that it contains.

ARISTIDA. Three-awn grass. Caespitose annuals or perennials. Culms herbaceous, the internodes hollow or solid, to 1 m tall. Inflorescence an open or contracted panicle. Spikelets 1-flowered, terete to laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, thin and narrow, 1-nerved, as long as or longer than the floret; lemmas tough, terete, 3-nerved, with a sharp-pointed callus, tapering gradually to an awn column that usually bears 3 awns (the lateral ones reduced or obsolete in section *Streptachne*); palea relatively short to reduced, 2-nerved. Lodicules 2 or 0; stamens 1-3; stigmas 2, red or brown pigmented. A genus of almost 300 species native to the temperate and warmer regions of both hemispheres. *A. oligantha* (old field three-awn) is found on open ground, mostly in the eastern half of the country; *A. purpurea* (purple three-awn) and *A. longiseta* (red three-awn) occur on plains and dry hills in the Southwest, especially after they have been disturbed.

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3.09 - SUBFAMILY CHLORIDOIDEAE

TECHNICAL DESCRIPTION

Habit: Herbaceous; culm internodes hollow or solid

Root Hairs: Equal

Leaf Epidermis: Complex; bicellular microhairs present; silica cells cross- or saddle-shaped; stomata with triangular or dome-shaped subsidiary cells

Leaf Anatomy: Vascular bundles with double parenchyma sheath, the outer often with conspicuously radiating cells

Inflorescence: Various, often 1-sided racemes or spikes

Spikelets: 1- to several-flowered; lemmas typically 3-nerved (1-nerved in *Sporobolus* and *Calamovilfa*; several-nerved in some grasses in minor tribes).

Flower: Lodicules 2; stamens 3; stigmas 2

Embryo: P + P F

Cytology: X = 9 or 10 (8 in *Erioneuron*); nucleoli persistent

Photosynthetic Pathway: C_4

Distribution: Tropical and subtropical regions, especially of the Old World; particularly in arid and semiarid situations where there is high light intensity; best represented on this continent in the American Southwest.

SYSTEMATICS

The subfamily has also been called Eragrostoideae in the recent literature, a name that must be rejected for technical reasons. The group was not recognized by Hitchcock and Chase. It is a portion of their Festucoideae. Many of the grasses included here resided in their Festuceae and Chlorideae. The plants are essentially festucoid in spikelet structure and panicoid in many of their microcharacters.

Often there is general agreement as to what makes up the core of a subfamily; the disagreement seems to be mainly about the smaller "fringe groups." In the chloridoids, most everyone is satisfied that several smaller tribes belong here. The arguments focus on the core. Several workers recognize two large tribes, Eragrostideae and Cynodonteae (= Chlorideae of H & C); Watson & Dallwitz merge them into a unit they call the "Main Chloridoid Assemblage."

Here are the various tribes of the subfamily, as viewed by recent authors:

Clayton & Renvoize (1986): Pappophoreae, Orcuttieae, Eragrostideae, Cynodonteae

Watson & Dallwitz (1992): Pappophoreae, Orcuttieae, "Main Assemblage"

"The Splitters:" Pappophoreae, Orcuttieae, Aeluropodieae, Unioleae, Eragrostideae, Sporoboleae, Spartineae, Cynodonteae, Zoysieae

Hilu & Esen (1993): Pappophoreae, Orcuttieae, Eragrostideae

Grass Phylogeny Working Group (2001): Pappophoreae, Orcuttieae, Eragrostideae, Cynodonteae

Flora North America (2003): Pappophoreae, Orcuttieae, Eragrosideae

We will use the four tribe model, and also recognize a series of subtribes, each of which has also been viewed as tribes by various agrostologists.

TRIBE: ERAGROSTIDEAE

Annuals or perennials. Inflorescence typically a panicle. Spikelets typically few- to many-flowered, the lower florets fertile.

SUBTRIBE: MONANTHOCHLOINAE

Mostly grasses of seashores and saline marshy sites. Plants stoloniferous and rhizomatous, mostly dioecious. Inflorescence a condensed panicle or raceme. Leaf epidermis with papillae and sunken bicellular microhairs. These grasses have also been placed in their own tribe, Aeluropodeae.

DISTICHLIS. Salt grass. Low, rhizomatous perennials. Culms erect, rigid, the internodes solid, to 2 dm tall. Leaves often distichous. Inflorescence a reduced panicle or racemes. Spikelets several-flowered, laterally compressed, unisexual (species usually dioecious), disarticulating above the glumes and between the florets. Glumes 2, unequal, the first 1- to 5-nerved and the second 4- to 9-nerved, shorter than the florets, awnless; lemmas 9- to 11-nerved, awnless (those of the staminate spikelet thinner in texture); palea relatively long, 2-nerved, 2-keeled, these ± winged. Lodicules 2; stamens 3 or 0; stigmas 2 or 0.

A genus of 1 to a few species native to North America, with one in Australia. Beetle (1955) recognized a number of taxa. I have always found them difficult to distinguish. The treatment put forth by McVaugh (1983) seems reasonable to me. Following this more conservative view, *D. spicata* occurs along the Atlantic and Pacific coasts and in interior salt flats and marshes. *D. texana* in H & C has been transferred to the genus *Allolepis*.

MONANTHOCHLOË. Shore grass. Mat-forming rhizomatous, stoloniferous perennial. Culms herbaceous, decumbent, much-branched, to 2 dm tall. Leaves tufted, acicular, less than 1 cm long. Inflorescence reduced to a single spikelet ± concealed by upper leaf sheaths. Spikelets few-flowered, laterally compressed to rounded, unisexual (species dioecious), disarticulating below florets. Glumes 0; lemmas several-nerved, awnless; palea relatively

long, 2-keeled. Lodicules 0; stamens 0 or 3; stigmas 2 or 0.

A genus of three species, one in North America and two in South America. *M. littoralis* (shore grass) is found mostly in maritime coastal flats in southern California and in similar habitats in Texas, Louisiana, and Florida.

SWALLENIA. Eureka dune grass. Coarse, rhizomatous, perennial. Culms herbaceous to woody, to 1 m tall. Inflorescence a contracted panicle. Spikelets 3- to 7-flowered, laterally compressed, bisexual, persistent on the rachis. Glumes 2, ± equal, the lower 5- to 7-nerved and the upper 7- to 11-nerved; lemmas 5- to 7-nerved, awnless, densely hairy on lower margins; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2. A monotypic genus, *S. alexandrae* is known only from sand dunes at two sites in Inyo Co., California. [= *Ectosperma a.* in H & C].

SUBTRIBE: ERAGROSTINAE

Annuals or perennials. Inflorescence a panicle, less often 1-sided spikes or racemes. Spikelets with several to many florets, 2 or more of them typically fertile. Glumes shorter than the florets. Lemmas 3-nerved (rarely 1-nerved), these usually conspicuous; awnless or with 1 long awn or 3 short ones. Plants of this subtribe were placed in Festuceae or Chlorideae by H & C.

ERAGROSTIS. Lovegrass, stink grass. Caespitose annuals or perennials [rarely stoloniferous]. Culms herbaceous, internodes hollow or solid, to 1 m tall. Inflorescence an open or contracted panicle. Spikelets, few- to many-flowered, the florets usually strongly overlapping, laterally compressed, bisexual [rarely unisexual and the species dioecious], disarticulating above the glumes and between the florets, the paleas persisting on the rachilla. Glumes 2, unequal, shorter than the florets, 1-nerved; lemmas 3-nerved, keeled or rounded, acute or acuminate, awnless; palea usually strongly 2-keeled, often ciliolate. Lodicules 2; stamens 1-3; stigmas 2.

A cosmopolitan genus of about 300 species, often of poorer, sandy sites. A number are weedy. *E. intermedia* (plains love grass) is a forage plant of some importance; *E. curvula* (weeping lovegrass) is an introduced forage grass in the southern states; *E. spectabilis* (purple lovegrass) occurs over much of the central and eastern sections of the United States; *E. cilianensis* (stink grass) is a widespread, malodorous weed. As treated here, the genus includes *Neeragrostis*, a small group of dioecious, mat-forming species.

TRIDENS. Purpletop, tridens. Erect, caespitose perennials. Culms herbaceous, to 1 m tall. Inflorescence an open or contracted panicle. Spikelets 3- to 12-flowered, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, ± equal, the first 1-nerved and the second 1- to 3-nerved, shorter than the florets; lemmas broad, 3-nerved, typically hairy below, the apex bidentate, the midnerve usually extending between the teeth as a muro or short awn; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2, often red pigmented.

A genus of 16-18 species native to the eastern and southern United States and to adjacent Mexico. In H & C, the genus included a few species that are now assigned to *Erioneuron*. *T. flavus* (purpletop) is common in old fields and in open woods in the eastern half of the country; *T. albescens* (white tridens) of the southwest and south-central states is unusual in having glabrous lemmas; *T.* x *oklahomensis* is an endemic known only from a wet meadow near Stillwater, OK.

LEPTOCHLOA. Sprangletop. Caespitose annuals or perennials, often of marshy or wet sites. Culms herbaceous, to 1+ m tall. Inflorescence variously described as a panicle of racemose, unbranched branches or a compound, race-mose inflorescence whose branches bear spikes or spike-like racemes. Spikelets 2- to several-flowered, often overlapping, rounded to laterally compressed, bisexual, disarticulation above the glumes and between the florets. Glumes 2, equal of unequal, 1-nerved, shorter than the florets; lemmas 3-nerved, often minutely pubescent on the nerves, awnless, mucronate, or awned; palea shorter than lemma, 2-nerved. Lodicules 2; stamens 2 or 3; stigmas 2.

A genus of about 70 species, native to the warmer regions of both hemispheres. As treated here, the genus includes *Diplachne*. See the table below for a comparison. *L. filiformis* (red sprangletop) is a common weed in the Southwest and in the Southeast. *L. dubia* (green sprangletop) is found on dry sites in the Southwest.

DIPLACHNE* VERSUS *LEPTOCHLOA

Feature	***Diplachne***	***Leptochloa***
Spikelets	4-12 mm long	1-4 mm long
Florets	5-12	2-5 (7)
Caryopses	elliptical in x-s not grooved	triangular in x-s grooved on one side
Lemma	rounded lateral nerves extending to upper margins	strongly keeled lateral nerves not extending to upper margins
Inflorescence	racemose 2.5-6 mm wide	spicate 0.5-4 mm wide

REDFIELDIA. Blowout grass. Rhizomatous perennial to 1 m. Leaf blade involute, with filiform tip. Inflorescence a large, open panicle, 1/3 to ½ length of culms, its branches flexuous. Spikelets [1-] 2- to 6-flowered, dis-articulating above glumes. Glumes 2, acuminate, 1-nerved; lemmas keeled, hairy on margins at base, 3-nerved; callus bearded. Lodicules 2; stamens 3; stigmas 2. One species, *R. flexuosa*, native to the interior sandy hills of the U. S., from SD and OK to CO, AZ.

SUBTRIBE: ELEUSININAE

ELEUSINE. Goose grass. Low, spreading, annuals. Culms herbaceous, weak, flattened, to 2 dm tall. Inflorescence a series of 2 to several ± digitate branches clumped at the culm apex. Spikelets sessile in 2 rows, 3- to several-flowered, laterally compressed, bisexual, disarticulation above the

glumes and between the florets (except in cultivars). Glumes 2, unequal, the first 1-nerved and the second 3- to 5-nerved, shorter than the florets; lemmas 3-nerved, acute, awnless to mucronate; palea shorter than lemma, apically notched. Lodicules 2; stamens 3; stigmas 2.

A genus of 6-9 species, all but one native to the Old World. *E. indica* (goose grass) is a common weed over much of the United States; *E. coracana* (finger millet, ragi) is an important grain crop in the Old World.

DACTYLOCTENIUM. Durban grass, crowfoot grass. Annual or perennial herbs, the culms often spreading and rooting at the nodes. Inflorescence a series of paired or digitate racemes; spikelets imbricate in two rows, inserted at right angles to rachis. Spikelets 2- to several-flowered, laterally compressed, disarticulating between the first and second glume. Glumes 2, 1-nerved, the upper with an oblique awn from just below its tip; lemmas 3-nerved, strongly keeled, acute or abruptly narrowed to a short recurved awn. Lodicules 2; stamens 3; stigmas 2.

A genus of about 13 species native to the Old World, especially of dry, sandy sites. *Dactyloctenium aegyptium* is a cosmopolitan weed and is also planted for lawns and playing fields. It occurs in North America from NC to FL and the Pacific coast.

SUBTRIBE: MUHLENBERGIINAE

Annuals or perennials with well-developed panicles of small, 1-flowered spikelets. Disarticulation above the glumes. Lemmas 1- or 3-nerved. Plants of this subtribe were placed in Agrostideae by H & C. The group is often recognized as a separate tribe, Sporoboleae.

SPOROBOLUS. Dropseed. Caespitose annuals or perennials, a few rhizomatous. Culms herbaceous, internodes usually solid, to 2 m tall. Ligules ciliate (a useful feature in distinguishing the genus from *Muhlenbergia*, with which it is easily confused). Inflorescence an open or contracted panicle. Spikelets small, 1- flowered, rounded to laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, unequal, 1-nerved, shorter than the floret; lemma 1-nerved, awnless; palea relatively long, sometimes splitting at maturity and thereby resembling an extra lemma; pericarp free from the seed (hence the common name). Lodicules 0 or 2; stamens 2 or 3; stigmas 2.

A genus of almost 200 species native to diverse habitats of the Old and New Worlds. *S. cryptandrus* (sand dropseed) occurs on sandy soils over much of the country; *S. heterolepis* (prairie dropseed) is found on prairies through the central portion of the United States; *S. airoides* (alkali sacaton) occurs in alkaline meadows and in valleys of the West; *S. junceus* (smut grass) [= *S. poiretii* in H & C and *S. indicus* in more recent literature] is a tropical-subtropical introduction in the Southeast; *S. virginicus* (seashore dropseed) is native to the sandy shores of the Texas Gulf coast.

MUHLENBERGIA. Muhly, nimblewill. Delicate, caespitose annuals to coarse, rhizomatous, stoloniferous perennials. Culms herbaceous, internodes solid or hollow, to 2 m tall. Ligule membranous. Inflorescence an open to contracted panicle [rarely spike-like]. Spikelets small, 1-flowered [rarely 2-flowered and rarely keying properly!], laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, equal or unequal, [0-] 1- [3-] nerved, awnless to short-awned; lemmas 3-nerved, typically with a single well-developed awn, occasionally mucronate or awn-less; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A large genus of 125-160 species native to diverse habitats of both hemispheres, especially the New World. *M. schreberi* (nimblewill) occurs in damp, shady places in the eastern half of the country; *M. emersleyi* (bull grass) is found in rocky woods and ravines of the Southwest; *M. sylvatica* (forest muhly) is a rhizomatous grass of wooded areas in the eastern and central U. S.; *M. rigens* (deer grass) of southern California was used by Native Americans in basket making.

CALAMOVILFA. Sand reedgrass. Coarse, rhizomatous perennials. Culms herbaceous, the internodes solid, to 2 m tall. Inflo-rescence an open or contracted panicle. Spikelets 1-flowered, laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, unequal, 1-nerved, as long as the floret, lemmas 1-nerved, awnless, the callus bearded; palea reduced, 2-nerved. Lodicules 2; stamens 3; stigmas 2; pericarp free from the seedcoat, as in *Sporobolus*.

This small genus of 4 species is a favorite of the conservative right because all of them are native to North America. *C. longifolia* and *C. gigantea* are found in sandy habitats in the central and southwestern regions of the country.

SUBTRIBE: MUNROINAE

ERIONEURON. Fluff grass. Low, tufted, stoloniferous perennials. Culms herbaceous, to 2 dm tall. Leaf blades with cartilaginous margins. Inflorescence a compact, head-like to more open panicle. Spikelets several-flowered spikelets, laterally compressed, bisexual, disarticulating above the glumes and between the florets. Glumes 2, ± equal, 1-nerved; lemmas broad, 3-nerved, with long hairs (at least below), apex bilobed, midnerve extended as a short awn, the lateral ones as a short mucro; palea about as long as lemma, ciliate on the keels, long-hairy below. Lodicules 2; stamens 1-3; stigmas 2, white.

A genus of 5 species native to drier, often rocky sites of the American Southwest and adjacent Mexico. These taxa were included in *Tridens* by H & C. As treated here, the genus includes *Dasyochloa*. *Erioneuron pulchellum* (fluff grass) occurs on mesas, sandy washes, and rocky hills in the Southwest; *E. pilosum* (hairy tridens) is found on plains of the South Central and Southwest regions.

ERIONEURON* VERSUS *TRIDENS

Feature	***Erioneuron***	***Tridens***
Embryo	oval; translucent	reniform; dark brown
Stigmas	+/- white	dark purple
Lemmas	2- (3-) lobed hairy near midrib/margins	bidentate; not lobed less pubescent
Palea long-hairy below	usually glabrous; ciliate on keel	never ciliate
Habit	low, stoloniferous	tall perennials
Leaf	white margins cartilaginous	green margins not cartilaginous
x =	8	10

CRYPSIS. Prickle grass, swamp timothy. Prostrate to ascending annuals. Internodes hollow or solid. Inflores-cences terminal or axillary, ovoid to capitate, spike-like panicles, often ± enclosed by bract-like sheaths. Spikelets 1-flowered, keeled, strongly laterally compressed, disarticulating above or below the glumes. Glumes 2, acute or short-awned, 0 or 1-nerved; lemma 1-nerved; palea 1- or 2-nerved. Lodicules 0; stamens 2 or 3; stigmas 2, white. Fruit an achene, the seed free from the pericarp, as in *Sporobolus*.

A genus of 8 species, mostly native to the Middle East and Mediterranean; often found on saline soils. Three species occur in the U. S., all of them introduced.

SUBTRIBE: UNIOLINAE

UNIOLA. Sea-oats. Rhizomatous or stoloniferous perennials. Culms to 2 m tall. Inflorescence a few- to many-flowered panicle. Spikelets several-flowered (the proximal and distal florets sterile), bisexual, laterally compressed, disarticulating below the glumes. Glumes 2, shorter than the florets, 3-nerved, awnless; lemmas 3- to 10-nerved, awnless or mucronate, serrulate-keeled; palea 2-keeled, winged, serrate to ciliate. Lodicules 2; stamens 3; stigmas 2.

A small genus of 2 species native to North and South America and the Caribbean. *U. paniculata* is found on coastal sand dunes of Alabama, Florida, and the Gulf Coast. Its large, drooping panicles are popular in dried arrangements, where they are often sprayed some hideous color. The other species, *U. pittieri* is found on the beaches from Mexico to northern South America. As treated by H & C, *Uniola* included several other species now transferred to *Chasmanthium* of the Centostecoideae.

TRIBE: CYNODONTEAE

Annuals or perennials. Inflorescence typically a compound spike or raceme, the spikelets often in two rows on one side of the branch. Spikelets 1-flowered or few- to several-flowered, but only one typically fertile. Unisexual spikelets occur in some genera. Disarticulation above the glumes. Lemmas 3-nerved.

SUBTRIBE: CHLORIDINAE

CYNODON. Bermuda grass. Low, mat-forming, stolon-iferous and/or rhizomatous perennials. Culms herbaceous, to 4 dm tall. Inflorescence a series of 2 to several digitate branches, spikelets sessile, in 2 rows on a ± triangular rachis. Spikelets 1-flowered, rachilla extended beyond floret and sometimes bearing a rudiment, laterally compressed, bisexual, disarticulating above the glumes. Glumes 2, ± equal, 1-nerved, the second about as long as the floret; lemmas 3-nerved, hairy on keel and lateral nerves, awnless; palea as long as lemma, 2-nerved. Lodicules 2; stamens 3; stigmas 2, red pigmented.

A genus of 10 species native to the Old World. *C. dactylon* (Bermuda grass) is an important pasture grass, lawn grass, and aggressive weed over most of the warmer parts of North America.

CHLORIS. Windmill grass, finger grass. Caespitose annuals or perennials from rhizomes or stolons. Culms herbaceous, internodes hollow or solid. Leaf sheaths keeled. Inflorescence a series of racemose or digitate branches, each bearing 2 rows of sessile spikelets. Spikelets with 1 fertile floret and 1 or more rudimentary ones above it, laterally compressed, disarticulating above the glumes. Glumes 2, equal or unequal, the lower 1-nerved and the upper 1- to 4-nerved; lemmas [1-] 3- [5-] nerved; palea relatively long, strongly 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of about 70 species native to the warmer regions of the Old and New Worlds. As treated here, the genus includes the 2 *Trichloris* species in H & C, but does not include *Chloris* section *Eustachys* in H & C, which is now generally recognized as a distinct genus. *C. gayana* (Rhodes grass) has escaped from cultivation in the southern states; *C. virgata* (feather finger grass) is a common weed; *C. verticillata* (windmill grass) is native to the plains states; *C. cucullata* (hooded windmill grass) is native to the Southwest.

GYMNOPOGON. Skeleton grass. Perennials, often rhizomatous. Culms herbaceous, to 1 m tall. Leaf blades stiff, distichous. Inflorescence a series of racemose branches, the spikelets in two rows.

Spikelets 1- to 3-flowered, laterally compressed, bisexual, the rachilla extending beyond the uppermost fertile floret as slender stalk bearing a rudimentary floret, disarticulation above the glumes. Glumes 2, ± equal, 1-nerved, the second longer than the florets; lemmas 3-nerved, usually awned; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of about 15 species, all but one of them native to the New World. There are four species in North America; *G. ambiguus* is the most commonly encountered species, growing from the Pine Barrens of New Jersey south to Florida and across to Texas and Oklahoma; *G. brevifolius* is native to the southeastern Coastal Plain; two species are endemic to Florida.

SPARTINA. Cord grass, marsh grass. Caespitose, stoloniferous/rhizomatous perennials. Culms herbaceous, internodes solid or hollow, to 2 m tall. Inflorescence a series of few to many short, often appressed, racemose branches. Spikelets 1-flowered, conspicuously laterally compressed, imbricate on one side of rachis, bisexual, disarticulation below the glumes. Glumes 2, unequal, the first 1-nerved and the second 1- to 3-nerved, the second as long or longer than the floret, awned or awnless; lemma 1- or 3-nerved, keeled, awnless; palea relatively long, 2-nerved, with membranous margins. Lodicules 0; stamens 3; stigmas 2.

A genus of 16 species, one native to Europe and the remainder to the New World. *S. pectinata* (prairie cord grass) is common in wet areas over much of the country; *S. foliosa* occurs in salt marshes along the California coast; *S. densiflora*, native to South America, occurs around Humboldt Bay, California; *S. alterniflora* (smooth cord grass) is found in saline marshes along the Atlantic and Gulf coasts.

ORIGIN OF SPARTINA X TOWNSENDII

Huskins (1931)

S. stricta (2n = 56) x *S. alterniflora* (2n = 70)

▽
▽

S. townsendii (2n = 126)*

Marchant (1966)

S. maritima	X	*S. alterniflora*
AABBCC		$AAB_1B_1B_2B_2$
2n = 60		2n = 62
4 long chromosomes		6 long chromosomes
European		American (ballast)
Low seed set		Low seed set
Good pollen		Poor pollen

▽
▽

S. X *townsendii*
AAB_1B_2BC
Sterile F1 hybrid
S. townsendii of 1881 description
2n = 62
10 long chromosomes
Rules out autotetraploidy
Back crosses to *S. a.*

▽
▽

Doubling of Chromosomes

▽
▽

S. x *townsendii*
$AAAABBB_1B_1B_2B_2CC$
2n = 120, 122, 124
Pollen good
Seed set good
20 long chromosomes

* "S. townsendii has evidently originated by chromosome doubling, following on interspecific hybridisation. It is an extremely successful new species, having spread widely from its point of origin, and has almost completely eliminated its parent species whereever it has come into competion with them. It seems to be an outstanding example of the significance of allopolyploidy in plant evolution." (C. L. Huskins, 1931)

SUBTRIBE: BOUTELOUINAE

BOUTELOUA. Grama grass. Annuals or caespitose, rhizomatous, or stoloniferous perennials. Culms herbaceous, internodes hollow or solid, to 1 m tall. Inflorescence of 1 to many short, spicate branches that are racemose along a common axis, each bearing sessile spikelets in 2 rows along a flattened or angular rachis. Spikelets with 1 fertile floret and 1-3 rudimentary ones above it, laterally compressed, disarticulation either above the glumes (subgenus *Chondrosum*) or at the base of a branch, the subunit of the inflorescence falling at maturity (subgenus *Bouteloua*). Glumes 2, equal or unequal, 1-nerved, awned or awnless; lemmas 3-nerved, the midnerve often extended as an awn, the lateral ones sometimes also awn-tipped; palea sometimes 2-awned. Lodicules 2; stamens 3; stigmas 2.

A genus of about 40-50 species native to the New World from Canada through South America; the American Southwest is a major center. *B. curtipendula* (sideoats grama) is a valuable forage grass; *B. hirsuta* (hairy grama) occurs on plains and in rocky places in the central United States; *B. gracilis* (blue grama) is found in the plains of the central and western states.

BUCHLOË. Buffalo grass. Low, stoloniferous, mat-forming perennials. Culms herbaceous, internodes solid, to 2 dm tall. Unisexual spikelets in separate inflorescences, typically on different plants, less frequently on the same plant; staminate inflorescence a series of 1-4 spicate branches, each bearing 2 rows of sessile, secund spikelets, well-elevated above the vegetative portion of the plants; pistillate inflorescence a bur-like head, partially hidden in ± inflated upper leaf sheaths, the outer covering of the bur a combination of thickened rachis and glumes. Staminate spikelets 2-flowered; pistillate spikelet 1-flowered. Glumes 2, the second indurate, with 3 rigid lobes, and enveloping the florets in the pistillate spikelet; lemmas 3-nerved and typically awnless; palea ± equal to lemma, 2-nerved. Lodicules 2 or 0; stamens 3 or 0; stigmas 2 or 0.

A monotypic genus native to open, drier plains of North America. *B. dactyloides*, is a very important

range grass of the short-grass prairie, where it can be a dominant.

HILARIA. Galleta, tobosa, curly-mesquite. Rhizomatous, stoloniferous, or caespitose perennials. Culms herbaceous, stiff, the internodes solid, to 1 m tall. Inflorescence a balanced spike of sessile spikelets inserted in trios within ciliate, cup-like depressions along a wavy or zig-zag rachis; disarticulation below the glumes, the trio of spikelets falling as a group. Spikelets of the trio dissimilar, the lateral ones 2- to 4-flowered, staminate; the central one 1-flowered and perfect. Glumes 2, firm, united to form a false involucre, awned on one side from about the middle; lemmas 3-nerved, awned or awnless; palea relatively long, 2-nerved. Lodicules 2 or 0; stamens 3; stigmas 2.

A genus of about 10 species native to the New World; five of them are found in North America; *H. belangeri* (curly-mesquite) occurs in the arid and semiarid sites in the Southwest; *H. swallenii* is endemic to western Texas and adjacent Mexico. *H. jamesii* (galleta) is native to dry plains and deserts in the West and Southwest; *H. rigida* (big galleta) is a coarse, ± woody desert grass with a felt-like covering on its culms; *H. mutica* (tobosa) is found on drier sites in the Southwest.

SUBTRIBE: ZOYSINAE

This is small tribe of introduced grasses. The inflorescence is a contracted raceme of 1-flowered spikelets on short pedicels. Disarticulation is below the glumes. The palea is often reduced or absent. X = 10.

ZOYSIA. Zoysia or zoisia. Rhizomatous/stoloniferous perennials. Inflorescence a spike, the spikelets solitary on a zig-zag rachis. Spikelets 1-flowered; disarticulation below the glume. Glume 1 absent; second glume 1-nerved, mucronate or short-awned. Lemma 1-nerved, shorter than second glume and enclosed by it. Palea present or absent. Lodicules 0; stamens 2 or 3; stigmas 2. A genus of about 10 species, native to Southeast Asia and New Zealand. Three species have been introduced into the warmer, southern portions of the United States where they are grown as popular lawn grasses.

TRAGUS. Weak-stemmed annuals. Inflorescence a spike-like raceme, the spikelets in bur-like clusters of 2 to 5. Spikelets 1-flowered; disarticulation at the base of a spikelet cluster. Glumes 2, the second one in some spikelets bearing stout, hooked spines. Lemmas 3-nerved, awnless. Lodicules 2; stamens 3; stigmas 2. A genus of 7 species, 6 of them native to Africa. *T. racemosus* and *T. berteronianus* are weedy introductions in the eastern and southwestern portions of the country.

TRIBE: PAPPOPHOREAE

This small tribe of warm, dry climate grasses was treated as part of Festuceae by H & C. The inflorescence is a panicle of 3- to several-flowered spikelets. The lower florets are perfect, the upper ones staminate or neuter. Disarticulation above the glumes, the florets separating as a group. Lemmas with 9 or more nerves, the apex divided into 3-many sharp lobes or awns. X = 10. See Section 4 for a key to our North American taxa.

PAPPOPHORUM. Pappus grass. Caespitose perennials. Inflorescence a contracted to spike-like panicle. Spikelets 3- to 6-flowered; lower 1 to 3 fertile. Glumes thin, ± equal, 1-nerved, awnless. Lemmas leathery, many-nerved, these extending into unequal awns. Palea about as long as lemma. Lodicules 2; stamens 3; stigmas 2. A genus of 8 species, native to the American Southwest and South America. *Pappophorum bicolor* (pink pappus grass) and *P. mucronulatum* (whiplash pappus grass) are native to North America.

ENNEAPOGON. Spike pappus grass. Tufted perennials. Inflorescence a spike-like panicle. Spikelets several-flowered; disarticulation above the glumes. Glumes ± equal, 5- to many-nerved, awnless. Lemmas much shorter than glumes, firm, 9-nerved, these extending into plumose awns. Lodicules 2; stamens 3; stigmas 2. A genus of about 30 species, mostly of Old World xerophytic sites. *E. desvauxii* (spike pappus grass) is our only New World species. It is found in the Southwest and extends into Mexico.

COTTEA. Cottea grass, pelucilla. Tufted perennial. Leaves often pilose. Inflorescence a ± open panicle. Spikes 6- to 10-flowered; disarticulation above the glumes and between the florets. Glumes ± equal, 7- to many-nerved, awned or awnless. Lemmas 9- to 13-nerved, these extending into unequal awns. Palea slightly longer than lemma. Lodicules 2; stamens 3; stigmas 2. A monotypic genus. *C. pappophoroides* is native to Arizona, New Mexico, and Texas. It also occurs in Central and South America.

TRIBE: ORCUTTIEAE

This small tribe of California endemics was treated as part of Festuceae by H & C. A peculiar feature of these grasses is that the leaf blade and sheath are not clearly differentiated from one another. The inflorescence is a spike, spike-like raceme, or a panicle. Grasses of this tribe are restricted to mud flats and vernal pools in California and Baja California. All of them are classed as rare and/or endangered. See Section 4 for a key to our North American taxa.

NEOSTAPFIA. Colusa grass. Tufted, spreading, aromatic annual. Culm internodes solid. Leaves glandular-viscid, not clearly differentiated into blade and sheath. Inflorescence a dense, cylindric spike-like raceme, often partially enclosed in dilated upper leaf sheaths. Spikelets several-flowered; disarticulation above the glumes. Glumes 0. Lemmas fan-shaped, prominently 7- to 11-veined, awnless. Palea about as long as lemma. Lodicules 2; stamens 3; stigmas 2. A monotypic genus. *N. colusana* is endemic to vernal pool margins in four counties in California.

ORCUTTIA. Orcutt grass. Tufted, semiaquatic annuals, erect to prostrate. Leaf blade and sheath not clearly differentiated. Inflorescence a spike-like raceme. Spikelets few- to many-flowered; disarticulation above the glumes and between the florets. Glumes 2, irregularly toothed. Lemmas prominently 5-toothed, awnless. Palea about as long as lemma. Lodicules 0; stamens 3; stigmas 2. A genus of 5 species, endemic to vernal pools in California and Baja California. All taxa are rare and endangered.

TUCTORIA. Tufted annuals. Stems ascending to erect, fragile at maturity. Leaf blade and sheath not differentiated. Inflorescence spike-like, often partially

enveloped by upper leaves. Spikelets 5- to many-flowered, spirally inserted; disarticulation above the glumes and between the florets. Glumes 2, ± equal, awnless. Lemmas 11- to 17-veined, the apex entire to minutely toothed. Palea about as long as the lemma. Lodicules 2; stamens 3; stigmas 2. A genus of 3 species, all of them endemic to vernal pools and grasslands in California and Baja California. *T. greenei* and *T. mucronata* are native to a few counties in California.

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3.10 - SUBFAMILY PANICOIDEAE

TECHNICAL DESCRIPTION

Habit: Mostly herbaceous grasses; internodes often solid

Root Hairs: Equal

Leaf Epidermis: Complex, needle-shaped bicellular micro-hairs present; silica cells usually dumbbell-shaped, x-shaped, or saddle-shaped; stomata rhombic

Leaf Anatomy: Single sheath of parenchyma around vascular bundles (except in plants with kranz syndrome); chlorenchyma may be more or less radiating

Inflorescence: Panicles, compound racemes, rames, and spikes

Spikelet: Dorsally compressed, disarticulating below the glumes; 1 terminal perfect floret and a staminate or neuter one below it; glumes 2, 1, or absent

Flower: Lodicules short, truncate, and heavily vasculated; stamens 3; stigmas 2

Embryo: P - P P

Cytology: X = 9, 10 (rarely 5 or 8); some with persistent nucleoli

Photosynthetic Pathways: C_3 and C_4

Distribution: Diverse habitats, abundant in the tropics and subtropics; absent from the Arctic.

SYSTEMATICS

This circumscription of this subfamily has changed little in recent years. The principal modifications at the tribal level consists of merging Melinidae with Paniceae. Tripsaceae (Maydeae), here recognized as a distinct tribe, is often merged with Andropogoneae. Many adjustments have occurred at the generic level.

TRIBE PANICEAE

Inflorescence a panicle or a series of racemose or spicate branches that bear racemes or spikes of spikelets. First glume short, sometimes missing; second glume and sterile lemma both membranous and soft; fertile floret indurate or leathery. Spikelets or clusters of them sometimes subtended by bristly or spiny involucres. See Section 4 for a key to our

SUBTRIBE SETARIINAE

The principal distinguishing feature of the subtribe is spikelets with a hard upper lemma. The surface may be granular, wrinkled or highly polished.

PANICUM. Panic grass, panicum. Caespitose, rhizomatous or stoloniferous annuals or perennials. Culms herbaceous or woody, the internodes hollow or solid, to 4 m tall. Inflorescence an open to contracted panicle, either terminal or axillary, rarely a raceme. Spikelets 2-flowered, dorsally compressed, bisexual, disarticulating below the glumes. Lower floret sterile or sometimes staminate, its lemma similar in size and texture to the second glume. Upper floret fertile, its lemma firm to indurate, awnless, and clasping the palea with its enrolled margins. Fertile lemma and palea of similar texture. Glumes 2, the first much shorter than the second, the first 1- to 7-nerved and the second 3- to 9-nerved; sterile lemma 5- to 9-nerved, awnless, similar to second glume in size and texture; fertile lemma 3- to 11-nerved, awnless, glabrous, firm to indurate at maturity; palea of fertile floret similar to lemma in texture, and tightly clasped by it. Lodicules 2; stamens 3; stigmas 2, red pigmented.

The largest genus of Gramineae with about 500 species, native just about everywhere. Of considerable economic importance as a source of grains, pasture grasses, and weeds. As treated by H & C, the genus consisted of three subgenera: *Eupanicum, Dichanthelium,* and *Paurochaetium*. Grasses of subgenus *Paurochaetium* have a point or bristle that subtends the uppermost spikelet and they are now often placed in the genus *Setaria*. Gould elevated the subgenus *Dichanthelium* to the generic level. That opinion, while followed early on, has been increasingly rejected.

The following key may be helpful in understanding the redefinition of *Panicum*. It is modified from H & C and Gould (1979).

1. Axis of branchlets extending beyond the base of the uppermost spikelet as a point or bristle –> ***Setaria*** **subgenus** ***Paurochaetium***
1. Axis of branchlets rarely flattened, but never pointed or bristle-like –> **2**
2. Plants annual or perennial, without a basal rosette of short, broad blades or a basal tuft of soft, linear blades; panicles open or contracted at maturity, the spikelets long- or short-pediceled (in some plants the spikelets subsessile and the primary branches spicate); lemma and palea of upper floret smooth or rugose; culms not becoming much-branched in age and with reduced branchlets and panicles; plants flowering from July to November –> ***Panicum*** **subgenus** ***Panicum***
2. Plants perennial, most species developing a basal rosette of short, broad basal blades in spring or with a tuft of soft, linear blades; panicles of main culms open, the spikelets loosely-spaced, at least some with pedicels much longer than spikelets; lemma and palea of upper floret smooth; culms of several species becoming much-branched in age to produce fascicles of reduced leafy branches and panicles; most species flowering first March to May and then throughout the growing season at irregular intervals ***Panicum subgenus Dichanthelium***

Important grasses of the subgenus *Panicum* include *P. virgatum* (switch grass), a rhizomatous perennial over much of the United States; *P. capillare* (witch grass), a common plant of open ground and waste places; *P. bulbosum* (bulb panicum), an important forage grass of the Southwest; *P. miliaceum* (proso millet, broomcorn millet), an escape from cultivation; and *P. maximum* (elephant grass, Guinea grass), one of the tropical forage grasses introduced into the southern states.

Hitchcock & Chase recognized over one hundred species in the subgenus *Dichanthelium*, many of them very difficult to distinguish from one another and known only from very localized occurrences. These grasses are especially common in the southeastern states. In their monograph, Gould and Clark performed the heroic and welcomed task of reducing the number of species to 26! *P. oligosanthes*, in the broad sense, is perhaps the most widespread species in the subgenus.

DICHANTHELIUM VERSUS *PANICUM*

SUBGENUS *DICHANTHELIUM*	**SUBGENUS *PANICUM***
Perennial	Annual or perennial
Leaf blades rarely ribbed/furrowed	Pronounced ribs/furrows on upper and lower surfaces
Autumn/winter rosettes present	Rosettes absent
Cleistogamous lateral inflorescences	
Chasmogamous terminal inflorescences	
Diploids (mostly)	Polyploids (mostly)
x = 9	x = 9 or 10
2n = 2x = 18	2n = 4x = 18, 20, 30, 36, 40, 72 + aneuploids
Embryo relatively small	Embryo relatively large
Non-kranz anatomy	Kranz anatomy
C_3 [phosphoglyceric acid]	C_4 [oxaloacetic acid, malic acid]
Chlorenchyma irregular	Chlorenchyma radial
Numerous air spaces	Few air spaces
Outer sheath without chloroplasts	Large, specialized chloroplasts
Palea tip with simple papillae	Papillae compound or clustered
Papillae in regular rows	Papillae irregular
Double tunica layer	Single tunica layer

Sources:

Clark, C. & F. Gould. 1978. American J. Bot. 62(7): 743-748.
Gould, F. & C. Clark. 1978. Annals Missouri Bot. Gard. 65(4): 1088-1132.

GENERA SEGREGATED FROM *PANICUM*

If we look in the "Species Plantarum" of Linnaeus, we will see that He recognized a genus *Panicum*. It included most everything that we now think of as a panicoid grass. Since then, botanists have carved out an impressive list of genera, most of which have stood the test of time.

Segregate Genus	Basionym in *Panicum*
Echinochloa (1812)	*Panicum crusgalli*
Setaria (1812)	*Panicum viride*
Stenotaphrum (1822)	*Panicum dimidiatum*
Steinchisma (1830)	*Panicum hians*
Brachiaria (1853)	*Panicum eruciforme*
Sacciolepis (1901)	*Panicum glabrum*
Phanopyrum (1903)	*Panicum gymnocarpum*
Leptoloma (1906)	*Panicum cognatum*
Lasiacis (1910)	*Panicum divaricatum*
Homolepis (1911)	*Panicum aturense*
Paspalidium (1920)	*Panicum geminatum*
Urochloa (1920)	*Panicum reptans*
Dichanthelium (1974)	*Panicum dichotomum*

ERIOCHLOA. Cup grass. Annuals or perennials, often of moist sites. Culms herbaceous, to 1 m tall. Inflorescence a sparingly branched, contracted panicle. Spikelets 2-flowered (the lower sterile and the upper bisexual), dorsally compressed, disarticulation below the glumes. Glumes 2, the first reduced to minute sheath or strip that is fused to the thickened ring- or cup-like callus; sterile lemma 5-nerved, similar to second glume, longer than fertile floret; fertile lemma 5-nerved, glabrous, indurate, mucronate to awned; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2, red pigmented.

A genus of 25-30 species native to warmer parts of both hemispheres. *E. contracta* (prairie cup grass) occurs in the central and southwestern portions of the U. S.; *E. sericea* (Texas cup grass) is native to the Great Plains.

PASPALUM. Dallis grass, knot grass, bahia grass. Caespitose, rhizomatous, or stoloniferous perennials; rarely annuals. Culms herbaceous, the internodes hollow or solid, to 3 m tall. Inflorescence a series of racemose [rarely paired] branches, bearing subsessile spikelets. Spikelets 2-flowered, dorsally compressed, solitary or paired along a narrow or broadly-winged rachis, bisexual, disarticulating below the glumes. Lower floret sterile or staminate; upper floret fertile. Glumes 1 (first usually absent) or rarely 2, 3- to 6-nerved, second glume and sterile lemma of lower floret similar in size and texture; sterile lemma 3- to 5-nerved, as long as the fertile lemma; fertile lemma 3- to 5-nerved, rounded on the back, firm to indurate, awnless, its back facing toward the rachis; palea broad, flat or slightly convex, its margins covered covered by the enrolled edges of the lemma. Lodicules 2; stamens 3; stigmas 2, red pigmented.

A genus of about 400 species native to warmer regions of both hemispheres. Of economic significance as a source of grains, pasture grasses, and weeds. *P. dilatatum* (Dallis grass), is an important forage grass that becomes infected by the ergot fungus; *P. distichum* (knot grass) is a plant of wet areas along both coasts and the southern half of the country.

STENOTAPHRUM. St. Augustine grass. Mat-forming, rhizomatous, stoloniferous perennials. Culms herbaceous, to 1 dm tall. Leaf sheaths compressed; blades flat, succulent. Inflorescence spike-like, the spikelets embedded in a thickened rachis. Spikelets 2-flowered (the lower staminate or sterile and the upper fertile), dorsally compressed, bisexual, disarticulation below the glumes and falling with a rachis joint. Glumes 2, unequal, the lower nerveless and the upper 5- to 9-nerved; sterile lemma 7- to 9-nerved, as long as the second glume; fertile lemma 3- to 5-nerved, chartaceous, firmer than the glumes; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2, red or white pigmented.

A genus of 6 or 7 species native to the subtropical and tropical regions of the Old and New Worlds. *S. secundatum* (St. Augustine grass) is native to the Southeastern United States. It is a popular lawn grass that also escapes and becomes weedy.

ECHINOCHLOA. Barnyard grass, jungle-rice. Coarse, caespitose annuals or perennials. Culms herbaceous, the internodes hollow or solid, often succulent. Leaf sheaths compressed. Inflorescence a contracted to more or less open panicle, the branches simple to rebranched. Spikelets subsessile, solitary, or in irregular clusters on one side of the branch, 2-flowered (the lower sterile and the upper fertile), plano-convex, bisexual, disarticulation below the glumes. Glumes 2, unequal, the lower 0- to 3-nerved and the upper 5- to 7-nerved; sterile lemma similar to second glume, 5-nerved, awned; fertile lemma plano-convex, 5-nerved, smooth and shining, pointed, its margins enrolled below (enclosing the palea at that point), the upper portion flat; palea similar to fertile lemma in texture, narrowing to a point that is free from the lemma margins, 2-nerved. Lodicules 2; stamens 3; stigmas 2, red pigmented.

A genus of 20-40 species native to the warmer regions of both hemispheres. Of economic significance as a source of minor cereals, grains, pasture grasses, and weeds. *E. crus-galli* (barnyard grass) and *E. colona* (jungle-rice) are weedy in the United States.

AXONOPUS. Carpet grass, mat grass. Ours stoloniferous or caespitose perennials. Inflorescence a series of 2 to many subdigitate racemes, sometimes inserted on a central axis. Spikelets oblong-elliptical, disarticulating below the glume. First glume absent; rounded back of fertile lemma indurate, turned away from rachis; palea indurate. Lodicules 2; stamens 3; stigmas 2, white.

A genus of about 100 species native to the warmer regions of the New World, especially South America. One species is native to Africa. They occur in savannas, in forest clearings, and can become weedy. Some species are used for pasture and for lawns. Three species are native to the United States; *A. affinis*, common carpet grass, is the most frequently encountered.

SACCIOLEPIS. Cup scale. Annual or perennial herbs. Inflorescence a contracted [open] panicle. Spikelets laterally compressed, disarticulating below the glumes. Glumes 2, prominently ribbed, the upper one gibbous and inflated; sterile lemma 3- or 5-nerved; upper lemma dorsally compressed; fertile floret smooth, indurate, rounded. Lodicules 2; stamens 3; stigmas 2.

A genus of about 30 species native to the tropics and

subtropics, especially of Africa. They are typically found in wet sites and shallow waters. Only *S. striata*, American cupscale, is native to the U. S., from TX and OK the SE portion of the country.

SETARIA. Foxtail, bristle grass, millet. Annuals or caespitose perennials; rhizomes and stolons common. Culms herbaceous, the internodes hollow or solid, to 3 m tall. Inflorescence a dense, spike-like panicle. Spikelets awnless, but subtended by 1 to several bristles (sterile branches), 2-flowered (the lower sterile and the upper fertile), dorsally compressed, bisexual, disarticulation below the glumes, but above the bristle(s). Glumes 2, the first broad, typically about half the length of the second, second glume and sterile lemma similar in size and texture; sterile lemma 5-nerved, as long as or longer than the fertile one; fertile lemma 1- to 5-nerved, indurate, rounded at its apex, with fine to coarse transverse wrinkles; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2, white or red pigmented.

A genus of 110-125 species native to the warmer regions of both hemispheres. Of economic importance as a source of grains, a minor cereal, pasture grasses, and weeds. Rominger recognizes three sub-genera in North America: *Setaria*, with non-plicate leaf blades and all spikelets subtended by bristles; *Ptychophyllum*, with plicate leave blades and all spikelets subtended by bristles; and *Paurochaetium* (formerly treated as a subgenus of *Panicum*), with only the uppermost spikelet of a branchlet bearing a bristle. Noteworthy species include *S. lutescens* (yellow foxtail), *S. viridis* (green foxtail), *S. faberi* (giant foxtail), and *S. verticillata* (bristly foxtail), often encountered in disturbed areas and as agricultural weeds. *S. italica* (foxtail millet, Hungarian millet, Italian millet) has been in cultivation as a food plant since prehistoric times.

SUBTRIBE: MELINIDINAE

Grasses of this subtribe have panicles of spikelets that have a reduced first glume.

MELINIS. Molasses grass, ruby grass, Natal grass. Annuals or perennials. Inflorescence an open to contracted panicle. Spikelets 2-flowered (the lower staminate or sterile and the upper fertile), rounded to dorsally compressed, disarticulation below the glumes. Glumes 2, the first a tiny scale or reduced to a rim; second glume 5- to 7-nerved, similar to sterile lemma in size and texture (silky-villous in *M. repens*), sterile lemma 3- to 5-nerved; fertile lemma 1- to 5-nerved, awned or awnless; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2.

A genus of about 26 species, all but one of them native to the Old World. As treated here, the genus includes *Rhynchelytrum*. *M. minutiflora* (molasses grass), an important tropical pasture grass, escapes in Florida. *M. repens* [= *Tricholaena rosea* in H & C and *Rhynchelytrum r.* in most recent grass floras] (ruby grass, Natal grass) is common in the tropics and is now weedy in California, Arizona, Texas, and Florida.

SUBTRIBE: DIGITARIINAE

Grasses of this subtribe usually have racemes of spikelets, with their first glumes reduced or even absent.

DIGITARIA. Crab grass, cotton top, fall witchgrass. Caespitose annuals or rhizomatous, stoloniferous perennials. Culms herbaceous, the internodes solid or hollow, to 2 m tall. Inflorescence a series of racemose or digitate branches bearing subsessile or short-pedicellate spikelets. Spiklets in pairs or trios (rarely solitary or in 5's), alternating in 2 rows on one side of a 3-angled winged or wingless rachis. Spikelets 2-flowered (the lower sterile and the upper fertile), plano-convex, bisexual, disarticulation below the glumes. Glumes 1 [rarely 2], the first minute or absent, the second resembling the sterile lemma in size and texture, 3- to 7-nerved, glabrous to long-ciliate; sterile lemma as long as fertile floret, 3- to 7-nerved, often hairy; fertile lemma more or less narrow, acute or acuminate, cartilaginous or leathery, its margins thin and flat, not clasping the palea as in other genera of the tribe; palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2, red pigmented.

A genus of about 300 species native to warmer regions of both hemispheres. Of economic importance as a source of grains, pasture and lawn grasses, and weeds. As treated here, the genus includes taxa assigned to *Leptoloma* and *Trichachne* in H & C. *D. sanguinalis* (hairy crab grass) and *D. ischaemum* (smooth crab grass) are major weeds around the country; *D. californica* (Arizona cottontop) [= *Trichachne c.* in H & C] is an important forage grass in the Southwest; *D. cognatum* (fall witchgrass) [= *Leptoloma c.* in H & C] is common in the East.

SUBTRIBE: CENCHRINAE

This subtribe is probably the most easily recognized because of the bristles or scales that subtend the spikelets.

PENNISETUM. Fountain grass, feathertop. Caespitose, rhizomatous, stoloniferous perennials; rarely annual. Culms herbaceous, the internodes hollow or solid, to 4 m tall. Inflorescence a dense, spike-like panicle. Spikelets 2-flowered (the lower sterile and the upper fertile), dorsally compressed, bisexual, solitary or in clusters of 2 or 3, subtended by an involucre of bristles (often plumose), these united at their bass and falling with the spikelet at disarticulation. Glumes 2, the first small or vestigial, second glume and sterile lemma similar in size and texture; sterile lemma 3- to 9-nerved, less firm than fertile lemma; fertile lemma 5- to 7-nerved, similar to or firmer than glumes in texture; palea relatively long, 2-nerved. Lodicules 2 or 0; stamens 3; stigma 2.

A genus of about 80 species native to the warmer regions of both hemispheres. Of economic importance as a source of grains, pasture and lawn grasses, ornamentals, and weeds. *P. glaucum* (pearl millet) is an important food plant in the tropics. *P. purpureum* (Napier grass, elephant grass) is an important forage plant; *P. clandestinum* (kikuyu grass) is an important pasture grass; *P. villosum* (feathertop) is grown as an ornamental, where it often escapes to become a major pest.

CENCHRUS. Sandbur. Annuals or perennials, caespitose, rhizomatous, or stoloniferous. Culms herbaceous, often weak, decumbent, internodes hollow or solid, to 1 m tall. Inflorescence a series of spike-like or racemose burs, these readily disarticulating. Spikelets 2-flowered (lower sterile and the upper fertile), dorsally com-pressed, bisexual,

hidden within burs (involucres of bristles or spines), the entire structure falling from the plant at maturity. Glumes 2, unequal, the first 1- to 5-nerved and the second 1- to 7-nerved, thin, membranous; sterile lemma 1- to 7-nerved, ± equal to fertile lemma, awnless; fertile lemma 3- to 7-nerved, thin, membranous, its apex acuminate; palea relatively long, 2-nerved. Lodicules 0; stamens 3; stigmas 2.

A genus of about 20 species native to the warmer regions of both hemispheres, but mostly American. *C. incertus* (including *C. pauciflorus* of H & C) is widespread in sandy places over much of the country; *C. myosuroides* (big sandbur) can reach 1.5 m in moist, sandy sites in the Southeast. Transitional species make the distinction between this genus and *Pennisetum* difficult.

TRIBE: ANDROPOGONEAE

Inflorescence a series of paired spikelets, evenly or unevenly pedicellate; pedicellate spikelet often reduced (sometimes missing, which can lead to misinter-pretation of the inflorescence). Spikelets 2-flowered, the lower sterile or staminate and the upper bisexual, awnless or awned from fertile lemma, the awn often easily disarticulating. Glumes thick, firm, equal in length. Fertile lemma and palea thin.

SUBTRIBE: SACCHARINAE

Inflorescence terminal, of solitary, digitate, or paniculate rames. Spikelets paired, similar; one sessile and the other pedicellate or both with pedicels. Clayton & Renvoize view this group as the most primitive because the grasses have unspecialized rachis internodes and both members of the spikelet pair are fertile.

SACCHARUM. Sugar cane, plume grass. Robust perennials. Inflorescence a conspicuous, plumose panicle to almost 1 m in length. Spikelets of the pair alike, fertile, awnless, and obscured by a tuft of long, silky hairs attached at the bases. Glumes large and firm. Sterile lemma, fertile lemma (sometimes absent), and palea membranous. *S. officinarum* (sugar cane), one of the earliest plants to be domesticated, is the source of about two-thirds of the sugar used in commerce.

As treated here, the genus includes *Erianthus*, which H & C recognized as a separate genus. These plants, which are found in the Southeast, differ from sugar cane in having a long awn arising from the fertile lemma.

MISCANTHUS. Miscanthus, eulalia. Caespitose or rhizomatous perennials, often cane- or reed-like. Culms herbaceous, the internodes solid, to 2 m tall. Inflorescence a fan-shaped panicle. Spikelets unequally pedicellate, silky hairy, 2- flowered, dorsally compressed, bisexual, disarticulation below the glumes. Glumes 2, ± equal, papery to membranous, the first 3- or 4-nerved and the second 1- to 5-nerved; sterile lemma membranous, longer than the fertile one, awnless; fertile lemma membranous, 0- to 3-nerved, with a geniculate and twisted awn or awnless; palea relatively short, nerveless. Lodicules 2; stamens 2 or 3; stigmas 2, red pigmented.

A genus of about 20 species native to the Old World, especially to Asia. *M. sinensis* is grown as an ornamental in this country.

SUBTRIBE: ANDROPOGONINAE

Inflorescence of single, paired [digitate] rames, these aggregated into terminal or axillary compound panicles. Spikelets of the pair dissimilar. Grasses of this subtribe have 2-keeled glumes and callus inserted into hollowed tip of the internode.

ANDROPOGON. Bluestem, beard grass. Coarse, caespitose or rhizomatous perennials; less frequently annuals. Culms herbaceous, the internodes solid, to 2 m tall. Inflorescence a series of 2-several rames, the flowering culms much-branched, subtended by a spathe-like sheath in some species. Spikelets 2-flowered (the lower floret sterile and the upper bisexual), dorsally compressed. Sessile spikelet well-developed and fertile, disarticulating with a section of rachis and pedicel; pedicellate spikelet well-developed, reduced, or absent. Glumes 2, ± equal, firm, the first keeled and 1- to several-nerved and the second 1- to 3-nerved, awnless; sterile lemma hyaline, 2-nerved, ± equalling the fertile lemma; fertile lemma hyaline, narrow, 1- to 3-nerved entire or bifid, usually bearing a bent and twisted awn; palea hyaline, reduced or absent, nerveless. Lodicules 2; stamens 1-3; stigmas 2.

A genus of about 100 species native to warmer regions of the Old and New Worlds. We have a number of them in North America, mostly in the southeastern United States. As treated by H & C, *Andropogon* consisted of three subgenera: *Arthrolophis, Amphilophis,* and *Schizachyrium*. Each is now recognized as a distinct genus. *Andropogon* [= subgenus *Arthrolophis*] includes such common species as *A. virginicus* (broomsedge), a plant of sandy, sterile soils in the Southeast; *A. gerardii* (big bluestem), a very important forage plant of the tall grass prairie; *A. hallii* (sand bluestem), a close relative of big bluestem that grows in sandy places; and *A. glomeratus* (bushy beard grass), which grows in moist places in the Southeast and Southwest.

SCHIZACHYRIUM. Little bluestem. Caespitose or rhizomatous perennials. Culms herbaceous, the internodes hollow or solid. Flowering culms much-branched, each terminating in a single narrow rame. Spikelets as in *Andropogon*, often closely-appressed to the rachis. Sessile spikelet fertile and awned; pedicellate spikelet rudimentary.

A genus of about 60 species native to the warmer regions of north hemispheres. *S. scoparium* (little bluestem) is an important forage plant of the tall grass prairie, where it is one of the dominants.

SUBTRIBE: ANTHISTIRIINAE

According to Clayton & Renvoize (1986: 354), this sub-tribe "... is distinguished from Andropogoniinae by a pointed callus applied obliquely to the internode tip, rather than blunt and sunk into it."

HYPARRHENIA. Thatching grass, jaraguá grass. Caespitose perennials, to 2.5 m tall. Inflorescence an elongate compound panicle, consisting of paired racemes subtended by ± conspicuous bracts. Spikelets paired, the lower pairs sterile and awnless; fertile spikelets 1 to a few on each rame, the lemma bearing a strong geniculate awn.

A genus of about 55 species native to the Old World, mainly to Africa, where they are common in savannas. Introduced in the American tropics, where it has been weedy. Two species, *H. hirta* and *H. rufa*, occur as roadside weeds in the Southwest and Southeast.

SUBTRIBE: SORGHINAE

Inflorescence terminal [axillary], of single, digitate, or paniculate rames, sometimes reduced to a trio of spike-lets or a single spikelet. Spikelets paired, dissimilar, the sessile bisexual; pedicellate spikelet male or barren, sometimes much reduced.

DICHANTHIUM. Bluestem. Caespitose, rhizomatous or stoloniferous perennials [rarely annual]. Culms herbaceous, internodes solid, to 2 m tall. Inflorescence similar to *Bothriochloa*, but lacking central groove or membranous area on its pedicels and internodes. The lower pairs of spikelets on each rame are typically sterile and awnless.

A genus of about 16 species native to the Old World tropics. The genus is not included in H & C. *D. annulatum* (Kleberg bluestem), *D. aristatum* (Angleton bluestem), and *D. sericeum* (silky bluestem) have been introduced in this country as pasture grasses and have become naturalized in Texas and Louisiana.

BOTHRIOCHLOA. Bluestem. Caespitose, rhizomatous, or stoloniferous perennials. Culms herbaceous, the internodes solid, to 2 m tall. Inflorescence a series of a few to several rames, as in *Andropogon*. Pedicels and upper rachis branches with a central groove or membranous area. Sessile spikelet fertile and awned, some with a pit (depressed glandular area) on the middle or upper portion of the first glume of the sessile spikelet. Pedicellate spikelet usually well-developed, but staminate or neuter. Spikelets disarticulating with a section of rachis.

A genus of about 30-35 species native to the warmer parts of both hemispheres. This genus was treated as *Andropogon* subgenus *Amphilophis* in H & C. *B. saccharoides* (silver beard grass) and *B. barbinodis* (cane bluestem) are important forage grasses.

SORGHUM. Sorghum, milo, broomcorn, kaffir. Stout annuals or caespitose, stoloniferous, or rhizomatous perennials. Culms herbaceous, the internodes solid, to 3 m tall. Inflorescence a large, open to contracted panicle. Spikelets in trios at branchlet tips (the lateral ones pedicellate and sterile) or in pairs below (one sessile and the other pedicellate). Sessile spikelets disarticulating with a rachis segment. Glumes 2, ± equal, 3- to several-nerved, leathery, awnless; sterile lemma membranous, 0- 2-nerved, awnless; fertile lemma membranous, 1- to 3-nerved, with a geniculate and twisted awn (deciduous in *S. halepense*); palea relatively long, 2-nerved. Lodicules 2; stamens 3; stigmas 2, red pigmented.

A genus of 30-35 species, only two of them native to the New World (none to North America). The genus is of considerable economic importance as a source of grains, fodder, and weeds. *S. bicolor* (sorghum, milo) [= *S. vulgare* in H & C] is the source of sugary juices for syrups, grain for cattle feed, millets for humans and domesticated animals, and broomcorn, from which traditional brooms are made; *S. halepense* (Johnson grass) is a tetraploid, pernicious weed.

SORGHASTRUM. Indian grass. Caespitose perennials. Culms herbaceous, to 2 m tall. Inflorescence a terminal panicle of rames. Spikelets paired, the pedicellate greatly reduced (often represented by nothing more than a hairy pedicel). Sessile spikelet disarticulating with rachis segment remaining attached. Glumes 2, ± equal, the lower 9-nerved and the upper 5-nerved, leathery; sterile lemma membranous, 2-nerved, awnless; fertile lemma membranous, 1-nerved (?), with a stout, twisted, geniculate awn; palea often reduced or absent. Lodicules 2; stamens 3; stigmas 2.

A genus of 15-20 species native to the warmer regions of both hemispheres. *S. nutans* (Indian grass) is a native of the tall grass prairie; two other species have more restricted distribution in the Southeast.

SUBTRIBE: ROTTBOELLINEAE

Inflorescence cylindrical, spike-like. Spikelets paired, awnless, embedded in cavities or hollow rachis joints, the pedicel often fused to the rachis. Disarticulation occurs as the rachis joints separate from one another at maturity. See Section 4 for a key to our North American taxa.

ROTTBOELLIA. Itch grass, Kelly grass. Robust annual. Blades to 3 cm wide. Sheaths papillose-hispid, the hairs irritating to some individuals. Inflorescence a subcylindric raceme, its apex with abortive spikelets only. Spikelets awnless, paired (one sessile and perfect, the other pedicellate and sterile), borne at the nodes of a thickened rachis. Upper rachis joints hollow, the thickened pedicel adnate to it, thereby making the pedicellate spikelet appear sessile. A genus of 3 species native to the Old World tropics. *R. cochinchinensis* (= *R. exaltata* in H & C) is introduced in Florida. It provides fodder.

ELIONURUS. Balsamscale. Erect perennials. Inflorescence a single spike-like raceme. Spikelets awnless, paired, one sessile and the other pedicellate, along a discontinuous rachis. The sessile spikelet perfect, appressed to the concave side of the rachis; the pedicellate spikelet staminate. Spikelet pair disarticulating with a segment of the rachis. A genus of about 14 species native to America, Africa, and Australia. Our species are found in the drier areas of the Southwest and in the prairies and pine woods of the Southeast. The spelling *Elyonurus* is used in older literature.

EREMOCHLOA. Centipede grass. *Eremochloa ophuroides*, native to Southeast Asia, has been introduced into Florida and other areas in the Southeast as a popular lawn grass and for erosion control. It is a low, rhizomatous perennial that forms dense turf. It produces spike-like racemes of paired sessile/pedicellate spikelets on terminal and axillary peduncles. The rachis is not thickened. The first glume of the sessile spikelet is winged at the summit.

HACKELOCHLOA. Pitscale grass. Annuals to 1 meter. Sheaths and blades papillose-hirsute. Inflorescence a series of many solitary, spike-like racemes enclosed in spathes. Spikelets awnless, paired, one sessile and the other pedicellate. Rachis joint and pedicel fused, clasped between the edges of the first glume of the sessile spikelet. The rounded, pitted appearance of the first glume is highly diagnostic. A genus of 2 species native to the Old World and New World tropics. *Hackelochloa granularis* has been introduced in the Southwest and in the Southeast. It is a limited source

of forage.

HEMARTHRIA. Limpo grass. Mostly perennials. Inflorescence a single flattened, axillary raceme. Spikelets paired, the sessile one sometimes awned, its lower glume slightly winged; pedicel of stalked spikelet fused to internode. A genus of 12 species native to the warmer regions of the Old World, especially of wet sites. *H. altissima* (= *Manisuris a.* in H & C) is adventive in the United States.

COELORACHIS. Joint-tail grass. Perennials, often with broad leaf blades. Inflorescence a single cylindrical or flattened raceme. Spikelets paired, less often in trios. Pedicellate spikelet well-developed or vestigial, its stalk free from the rachis. A genus of 20 or so species native to the tropics, especially on damp soils in savannas and grasslands. The four species found in North America were treated as species of *Manisuris* by H & C.

SUBTRIBE: ZEINAE

The grasses of this subtribe are characterized by highly modified, unisexual, dimorphic spikelets, borne within the same or in different inflorescences. This group is often treated as a distinct tribe, as in H & C, who called it Tripsaceae [= Maydeae of more recent authors].

If G. L. Stebbins was correct in concluding that grasses are most advanced of the flowering plants, then maize and its relatives may well be the most advanced of the most advanced! That's why I put them at the end of our survey.

COIX. Job's tears. Annuals or perennials. Culms herbaceous, the internodes solid, to 2 m tall. Leaf blades broad (to 4 cm). Inflorescence a raceme, but not immediately apparent as such. Staminate spikelets 2-flowered, in pairs or trios along a common rachis, protruding from an opening at apex of a very hard, white or drab, beadlike involucre. Pistillate spikelets enclosed within an involucre, typically in groups of 3 (1 fertile and 2 sterile).

A small genus of 4 or 5 species native to tropical Asia. *C. lacryma-jobi* (Job's tears) is a popular ornamental, its fruit-like involucres used in jewelry and rosaries. It has escaped from cultivation in the South.

TRIPSACUM. Gama grass. Robust, rhizomatous, caespitose perennials. Culms herbaceous, to 3+ m tall. Inflorescence a series of [1-] 2-several spike-like branches bearing pistillate spikelets on their lower portions and staminate ones above. Staminate spikelets 2-flowered, paired (1 sessile and 1 pedicellate) on one side of the rachis, disarticulating as a major segment of the inflorescence. Pistillate spikelets solitary and alternately inserted in hollow cavities of a thickened rachis, falling as separate bead-like units. Lodicules 2; stamens 0 or 3; stigmas 2.

A genus of 7-12 species native to warmer parts of the New World. *T. dactyloides* (eastern gama grass) is native to the eastern and central regions; two other species occur in Florida and Arizona.

ZEA. Maize, corn, Indian corn, teosinte. Robust annuals or perennials. Culms herbaceous, the internodes solid, to 5 m tall. Staminate spikelets paired, unequally pedicellate, in terminal inflorescences consisting of spike-like branches. Glumes broad, thin; lemma and palea hyaline. Pistillate spikelets paired, in axillary inflorescences, either sunken in cavities of a hardened rachis or sessile on a thickened, almost woody axis, the "cob." Glumes broad, thin, rounded, and much shorter than the mature caryopsis; lemma and palea membranous and hyaline. Lodicules 0; stamens 0 or 3; stigmas 2.

A genus of 5 species native to the New World. As treated here, the genus includes *Euchlaena*. *Z. mays* ssp. *mays* (maize or corn), the only important cereal native to the New World, is unknown in the wild; *Z. mays* ssp. *mexicana* is teosinte [= *Euchlaena m.* in H & C], whose evolution is intertwined with that of maize; *Z. diploperennis* is a recently discovered perennial teosinte endemic to Mexico with great agronomic potential.

COMPARISON OF NEW WORLD "MAYDEAE"

Character	*Zea*	*Euchlaena*	*Tripsacum*
Growth form	Annual	Annual	Perennial
Number of tillers	Few	Intermediate	Many
Leaf width	Wide	Intermediate	Narrow
Number leaf veins	Few	Intermediate	Many
# tassel branches	Intermediate	Many	Few*
♀ spklts. in tassel	No	No	Yes
Pollen size	Large	Intermediate	Small
Meiosis	Early	Intermediate	Late
Lateral inflorescence	Enclosed	Enclosed	Naked
Style length	Long	Intermediate	Short
Styles	Fused	Fused	Separate
Pistillate spikelets	Paired	Paired	Single
Rows ♀ spikelets	Many	Two	Two
Caryopses	Naked	Enclosed	Enclosed
Rachis	Solid	Brittle	Brittle
# chromosome knobs	Few	Intermediate	Many
Knob position	Internal	Internal & terminal	Terminal
X =	10	10	9
Drought resistance	Susceptible	Intermediate	Resistant

* True of *Tripsacum dactyloides*

[Source: After Mangelsdorf & Reeves, 1939: 205]

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SECTION 4 - AN OVERVIEW OF U. S. GRASSES

4.01 - STATISTICAL SUMMARY

Source	Subfamilies	Tribes	Genera	Species
Vasey (1883)	2	13	114	687
Hitchcock (1935)	2	14	159	1100
H & C (1951)	2	14	169	1398
Gould (1983)	6	22	124	1053
Smith (2002)	10	27	204	1405

4.02 - SUBFAMILIES, TRIBES, & GENERA OF CONTINENTAL NORTH AMERICA

SUBFAMILY: ARISTIDOIDEAE

Tribe: Aristideae
Aristida

SUBFAMILY: ARUNDINOIDEAE

Tribe: Arundineae
Arundo
Gynerium
Hakonechloa
Molinia
Phragmites
Thysanolaena

SUBFAMILY: BAMBUSOIDEAE

Tribe: Bambuseae
Arundinaria
Bambusa
Phyllostachys
Pleioblastus
Pseudosasa

Tribe: Olyreae
Olyra

SUBFAMILY: CENTOTHECOIDEAE

Tribe: Centotheceae
Chasmanthium

SUBFAMILY: CHLORIDOIDEAE

Tribe: Cynodonteae
Aegopogon
Bouteloua
Buchloë
Chloris
Ctenium
Cynodon
Enteropogon
Eustachys
Gymnopogon
Hilaria
Microchloa
Opizia
Schedonnardus
Spartina
Tragus
Willkommia
Zoysia

Tribe: Eragrostideae
Acrachne
Allolepis
Blepharidachne
Blepharoneuron
Calamovilfa
Cladoraphis
Crypsis
Dactyloctenium
Dinebra
Distichlis
Eleusine
Eragrostis
Erioneuron
Fingerhuthia
Leptochloa
Lycurus
Monanthochloë
Monroa
Muhlenbergia
Neyraudia
Pogonarthria
Redfieldia
Scleropogon
Sporobolus
Swallenia
Trichoneura
Tridens
Triplasis
Tripogon
Triraphis
Uniola
Vaseyochloa

Tribe: Orcuttieae
Neostapfia
Orcuttia
Tuctoria

Tribe: Pappophoreae
Cottea
Enneapogon

Pappophorum

SUBFAMILY: DANTHONIOIDEAE

Tribe: Danthonieae
Cortaderia
Danthonia
Rytidosperma
Schismus

SUBFAMILY: EHRHARTOIDEAE

Tribe: Ehrharteae
Ehrharta

Tribe: Oryzeae
Leersia
Luziola
Oryza
Zizania
Zizaniopsis

SUBFAMILY: PANICOIDEAE

Tribe: Andropogoneae
Andropogon
Apluda
Arthraxon
Bothriochloa
Chrysopogon
Coix
Coelorachis
Cymbopogon
Dichanthium
Elionurus
Eremochloa
Euclasta
Hackelochloa
Hemarthria
Heteropogon
Hyparrhenia
Imperata
Ischaemum
Microstegium
Miscanthus
Polytrias
Rottboellia
Saccharum
Schizachyrium
Sorghastrum
Sorghum
Themeda
Trachypogon
Tripsacum
Zea

Tribe: Paniceae
Alloteropsis
Amphicarpum
Anthaenantia
Anthephora
Axonopus
Brachiaria
Cenchrus
Digitaria
Echinochloa
Eriochloa
Hymenachne
Lasiacis
Melinis
Oplismenus
Panicum
Paspalum
Pennisetum
Reimarochloa
Sacciolepis
Setaria
Setariopsis
Stenotaphrum
Urochloa

SUBFAMILY: PHAROIDEAE

Tribe: Phareae
Pharus

SUBFAMILY: POÖIDEAE

Tribe: Ampelodesmeae
Ampelodesmos

Tribe: Aveneae
Agropogon
Agrostis
Aira
Alopecurus
Ammophila
Anthoxanthum
Apera
Arrhenatherum
Avena
Beckmannia
Calamagrostis
Calammophila
Cinna
Corynephorus
Deschampsia
Dissanthelium
Gastridium
Gaudinia
Helictotrichon
Holcus
Koeleria
Lagurus
Limnodea
Mibora
Milium
Phalaris
Phleum
Polypogon
Sphenopholis
Trisetum
Ventenata

Tribe: Brachypodieae
Brachypodium

Tribe: Brachyelytreae
Brachyelytrum

Tribe: Bromeae
Bromus

Tribe: Diarrheneae
Diarrhena

Tribe: Hainardieae
Hainardia
Parapholis
Scribneria

Tribe: Meliceae
Catabrosa
Glyceria
Melica
Pleuropogon
Schizachne

Tribe: Nardeae
Nardus

Tribe: Poeae
Arctagrostis
Arctophila
Briza
Coleanthus
Cutandia
Cynosurus
Dactylis
Desmazeria
Dupontia
Elyhordeum
Eremopoa
Festuca
Festulolium
Lamarckia
Lolium
Phippsia
Poa
Puccinellia
Sclerochloa
Scolochloa
Torreyochloa

Tribe: Stipeae
Oryzopsis
Piptochaetium
Ptilagrostis
Stipa

Tribe: Triticeae
Aegilops
Agropyron
Dasypyrum
Elymus
Eremopyrum
Hordeum
Secale
Triticum

Revised: 10 January 2005

4.03 - GRASS GENERA: A CHRONOLOGY

THE 18TH CENTURY

1753	*Aegilops*	Carolus Linnaeus
1753	*Agrostis*	Carolus Linnaeus
1753	*Aira*	Carolus Linnaeus
1753	*Alopecurus*	Carolus Linnaeus
1753	*Andropogon*	Carolus Linnaeus
1753	*Anthoxanthum*	Carolus Linnaeus
1753	*Aristida*	Carolus Linnaeus
1753	*Arundo*	Carolus Linnaeus
1753	*Avena*	Carolus Linnaeus
1753	*Briza*	Carolus Linnaeus
1753	*Bromus*	Carolus Linnaeus
1753	*Cenchrus*	Carolus Linnaeus
1753	*Cinna*	Carolus Linnaeus
1753	*Coix*	Carolus Linnaeus
1753	*Cynosurus*	Carolus Linnaeus
1753	*Dactylis*	Carolus Linnaeus
1753	*Elymus*	Carolus Linnaeus
1753	*Festuca*	Carolus Linnaeus
1753	*Holcus*	Carolus Linnaeus
1753	*Hordeum*	Carolus Linnaeus
1753	*Lagurus*	Carolus Linnaeus
1753	*Lolium*	Carolus Linnaeus
1753	*Melica*	Carolus Linnaeus
1753	*Milium*	Carolus Linnaeus
1753	*Nardus*	Carolus Linnaeus
1753	*Oryza*	Carolus Linnaeus
1753	*Panicum*	Carolus Linnaeus
1753	*Phalaris*	Carolus Linnaeus
1753	*Phleum*	Carolus Linnaeus
1753	*Poa*	Carolus Linnaeus
1753	*Saccharum*	Carolus Linnaeus
1753	*Secale*	Carolus Linnaeus
1753	*Stipa*	Carolus Linnaeus
1753	*Triticum*	Carolus Linnaeus
1753	*Uniola*	Carolus Linnaeus
1753	*Zea*	Carolus Linnaeus
1753	*Zizania*	Carolus Linnaeus
1756	*Pharus*	Patrick Browne
1759	*Olyra*	Carolus Linnaeus
1759	*Paspalum*	Carolus Linnaeus
1759	*Tripsacum*	Carolus Linnaeus
1763	*Apera*	Michel Adanson
1763	*Calamagrostis*	Michel Adanson
1763	*Mibora*	Michel Adanson
1763	*Phragmites*	Michel Adanson
1768	*Digitaria*	Victor Albrecht von Haller
1768	*Tragus*	Victor Albrecht von Haller
1770	*Agropyron*	Joseph Gaertner
1771	*Manisuris*	Carolus Linnaeus
1775	*Themeda*	Pehr Forsskal
1776	*Eragrostis*	Nathanael Mattaeus von Wolf
1776	*Phararoides*	Nathanael Matthaeus von Wolf
1779	*Anthephora*	J. C. D. von Schreber
1779	*Ehrharta*	Carl Peter Thunberg
1779	*Rottboellia*	Carolus Linnaeus f.
1788	*Chloris*	Olof Swartz
1788	*Eleusine*	Joseph Gaertner
1788	*Leersia*	Olof Peter Swartz
1789	*Bambusa*	Johann C. D. von Schreber
1789	*Crypsis*	William Aiton
1789	*Luziola*	Antoine Laurent de Jussieu
1789	*Molinia*	Franz von Paula von Schrank
1789	*Muhlenbergia*	Johann C. D. von Schreber
1789	*Spartina*	Johann C. D. von Schreber
1791	*Pappophorum*	Johann C. D. von Schreber
1792	*Imperata*	Domenico Maria Leone Cirillo
1794	*Hystrix*	Conrad Moench
1794	*Jarava*	H. Ruiz Lopez & José Antonio Pavón
1794	*Lamarckia*	Conrad Moench
1794	*Sorghum*	Conrad Moench
1796	*Dichanthium*	Pierre Remi Willemet
1798	*Polypogon*	Réné Louiche Desfontaine

THE 19TH CENTURY

1801	*Zoysia*	Carl Ludwig von Willdenow
1802	*Ventenata*	Georg Ludwig Koeler
1803	*Arundinaria*	Andre Michaux
1803	*Erianthus*	Andre Michaux
1803	*Oryzopsis*	Andre Michaux
1805	*Beckmannia*	Nicolaus Thomas Host
1805	*Bouteloua*	Mariano Lagasca y Segura
1805	*Cynodon*	Louis Claude Marie Richard
1805	*Danthonia*	Augustin Pyramus De Candolle
1805	*Koeleria*	Christian Hendrick Persoon
1805	*Pennisetum*	Louis Claude Richard
1805	*Trisetum*	Christian Hendrick Persoon
1805	*Vulpia*	Johann Georg Gmelin
1806	*Aegopogon*	Carl Ludwig von Willdenow
1806	*Elionurus*	Karl Sigismund Kunth
1807	*Heleochloa*	Nicolaus Thomas Host
1807	*Heteropogon*	Christian Hendrick Persoon
1809	*Ammophila*	Nicolaus Thomas Host
1809	*Dactyloctenium*	Carl Ludwig von Willdenow
1810	*Chondrosum*	Auguste Nicdise Desvaux
1810	*Elytrigia*	Auguste Nicdise Desvaux
1810	*Eustachys*	Auguste Nicdise Desvaux
1810	*Glyceria*	Robert Brown
1810	*Hemarthria*	Robert Brown
1810	*Hierochloe*	Robert Brown
1810	*Microchloa*	Robert Brown
1810	*Oplismenus*	A. M. F. J. Palisot de Beauvois
1810	*Sporobolus*	Robert Brown
1812	*Achnatherum*	A. M. F. J. Palisot de Beauvois
1812	*Anthaenantia*	A. M. F. J. Palisot de Beauvois
1812	*Arrhenatherum*	A. M. F. J. Palisot de Beauvois
1812	*Arthraxon*	A. M. F. J. Palisot de Beauvois
1812	*Axonopus*	A. M. F. J. Palisot de Beauvois
1812	*Brachyelytrum*	A. M. F. J. Palisot de Beauvois
1812	*Brachypodium*	A. M. F. J. Palisot de Beauvois
1812	*Catabrosa*	A. M. F. J. Palisot de Beauvois
1812	*Ceratochloa*	A. M. F. J. Palisot de Beauvois
1812	*Corynephorus*	A. M. F. J. Palisot de Beauvois
1812	*Deschampsia*	A. M. F. J. Palisot de Beauvois
1812	*Diarrhena*	A. M. F. J. Palisot de Beauvois
1812	*Diplachne*	A. M. F. J. Palisot de Beauvois
1812	*Echinochloa*	A. M. F. J. Palisot de Beauvois
1812	*Enneapogon*	A. M. F. J. Palisot de Beauvois
1812	*Gastridium*	A. M. F. J. Palisot de Beauvois
1812	*Gaudinia*	A. M. F. J. Palisot de Beauvois
1812	*Gymnopogon*	A. M. F. J. Palisot de Beauvois
1812	*Gynerium*	A. M. F. J. Palisot de Beauvois
1812	*Hymenachne*	A. M. F. J. Palisot de Beauvois
1812	*Leptochloa*	A. M. F. J. Palisot de Beauvois
1812	*Melinis*	A. M. F. J. Palisot de Beauvois
1812	*Monerma*	A. M. F. J. Palisot de Beauvois
1812	*Piptatherum*	A. M. F. J. Palisot de Beauvois
1812	*Schedonorus*	A. M. F. J. Palisot de Beauvois
1812	*Schismus*	A. M. F. J. Palisot de Beauvois
1812	*Sclerochloa*	A. M. F. J. Palisot de Beauvois
1812	*Setaria*	A. M. F. J. Palisot de Beauvois
1812	*Triplasis*	A. M. F. J. Palisot de Beauvois
1812	*Urochloa*	A. M. F. J. Palisot de Beauvois
1813	*Ctenium*	Georg Wolfgang Franz Panzer
1815	*Cymbopogon*	Curt Polycarp Joachin Sprengel
1816	*Eriochloa*	Karl Sigismund Kunth

1816	*Hilaria*	Karl Sigismund Kunth
1816	*Lycurus*	Karl Sigismund Kunth
1817	*Coleanthus*	Johann Heinrich Seidel
1817	*Tridens*	J. J. Roemer & J. A. Schultes
1817	*Tripogon*	J. J. Roemer & J. A. Schultes
1819	*Critesion*	C. S. Rafinesque-Schmaltz
1819	*Distichlis*	C. S. Rafinesque-Schmaltz
1819	*Sitanion*	C. S. Rafinesque-Schmaltz
1822	*Chrysopogon*	Carl Bernard von Trinius
1822	*Desmazeria*	B. C. J. Dumortier
1822	*Rostraria*	Carl Bernard von Trinius
1822	*Stenotaphrum*	Carl Bernard von Trinius
1822	*Vetiveria*	J. B. G. M. Bory de Saint-Vincents
1823	*Dupontia*	Robert Brown
1823	*Phippsia*	Robert Brown
1823	*Pleuropogon*	Robert Brown
1824	*Pleuraphis*	John Torrey
1827	*Ampelodesmos*	Johann Heinrich Friedrich Link
1827	*Catapodium*	Johann Heinrich Friedrich Link
1827	*Chasmanthium*	Johann Heinrich Friedrich Link
1827	*Helictotrichon*	Josef August Schultes
1829	*Amphicarpum*	Karl Sigismund Kunth
1829	*Cottea*	Karl Sigismund Kunth
1829	*Schizachyrium*	C. G. D. Nees von Esenbeck
1829	*Trachypogon*	C. G. D. Nees von Esenbeck
1829	*Trichachne*	C. G. D. Nees von Esenbeck
1830	*Alloteropsis*	Jan Swatopluk Presl
1830	*Cathestecum*	Jan Swatopluk Presl
1830	*Lophochloa*	Carl Ludwig Reichenbach
1830	*Opizia*	C. G. D. Nees von Esenbeck
1830	*Piptochaetium*	Jan Swatopluk Presl
1830	*Steinchisma*	C. S. Rafinesque-Schmaltz
1831	*Coelorachis*	Adolphe Théodore Brongniart
1832	*Euchlaena*	Heinrich Adolph Schrader
1833	*Coridochloa*	C. G. D. Nees von Esenbeck
1834	*Fingerhuthia*	C. G. D. Nees von Esenbeck
1835	*Thysanolaena*	C. G. D. Nees von Esenbeck
1836	*Dissanthelium*	Carl Bernard von Trinius
1836	*Enteropogon*	C. G. D. Nees von Esenbeck
1836	*Microstegium*	C. G. D. Nees von Esenbeck
1836	*Rhynchelytrum*	C. G. D. Nees von Esenbeck
1837	*Scolochloa*	Johann Heinrich Friedrich Link
1838	*Lophochlaena*	C. G. D. Nees von Esenbeck
1841	*Tetrachne*	C. G. D. Nees von Esenbeck
1842	*Vahlodea*	Elias Magnus Fries
1843	*Amphibromus*	C. G. D. Nees von Esenbeck
1843	*Phyllostachys*	P. von Siebold & J. Zuccarini
1846	*Scleropoa*	August Heinrich Grisebach
1848	*Anisantha*	Wilhelm Daniel Koch
1848	*Leymus*	Christian Ferdinand Hochstetter
1848	*Puccinellia*	Filippo Parlatore
1851	*Eremopyrum*	H. F. Conert & E. Spach
1852	*Arctagrostis*	August Heinrich Rudolf Grisebach
1852	*Arctophila*	Nils Johan Andersson
1852	*Leucopoa*	August Heinrich Rudolf Grisebach
1852	*Ptilagrostis*	August Heinrich Rudolf Grisebach
1853	*Brachiaria*	August Heinrich Rudolf Grisebach
1854	*Eremochloa*	Lodewijk Hendrik Buse
1854	*Nassella*	Auguste Nicdise Desvaux
1854	*Rhytidosperma*	Ernst Gottlieb von Steudel
1854	*Schedonnardus*	Ernst Gottlieb von Steudel
1855	*Trichoneura*	Nils Johan Andersson
1856	*Miscanthus*	Nils Johan Andersson
1856	*Munroa*	John Torrey
1859	*Buchloe*	Georg Engelmann
1859	*Monanthochloe*	Georg Engelmann
1860	*Cutandia*	Heinrich Moritz Willkomm
1868	*Avenula*	B. C. J. Dumortier
1869	*Bromopsis*	Jules Pierre Fourreau
1870	*Scleropogon*	Frederico Philippi
1871	*Zizaniopsis*	Doell & Ascherson
1881	*Trichloris*	George Bentham
1886	*Hyparrhenia*	Eugène Pierre Fournier
1886	*Orcuttia*	George Vasey
1886	*Scribneria*	Eduard Hackel
1887	*Blepharidachne*	Eduard Hackel
1887	*Cladoraphis*	Adrien René Franchet
1887	*Polytrias*	Eduard Hackel
1887	*Redfieldia*	George Vasey
1888	*Willkommia*	Eduard Hackel
1890	*Calamovilfa*	Frank Lamson Scribner
1891	*Bothriochloa*	Carl Ernst Otto Kuntze
1891	*Hackelochloa*	Carl Ernst Otto Kuntze
1894	*Limnodea*	Lyster Hoxie Dewey
1895	*Euclasta*	Adrien René Franchet
1896	*Neyraudia*	Joseph Dalton Hooker
1896	*Setariopsis*	F. L. Scribner & C. F. Millspaugh
1897	*Cortaderia*	Otto Stapf
1898	*Blepharoneuron*	George Valentine Nash
1899	*Neostapfia*	Joseph Burtt Davy

THE 20TH CENTURY

1900	*Sieglingia*	Luciano Bernardi
1901	*Sacciolepis*	George Valentine Nash
1901	*Sorghastrum*	George Valentine Nash
1903	*Erioneuron*	George Valentine Nash
1903	*Neeragrostis*	Benjamin Franklin Bush
1903	*Phanopyrum*	George Valentine Nash
1906	*Dasyochloa*	Per Axel Rydberg
1906	*Leptoloma*	Mary Agnes Chase
1906	*Sphenopholis*	Frank Lamson Scribner
1907	*Acrachne*	Emilio Chiovenda
1909	*Reimarochloa*	Albert Spear Hitchcock
1909	*Schizachne*	Eduard Hackel
1910	*Lasiacis*	Albert Spear Hitchcock
1910	*Podagrostis*	F. L. Scribner & E. D. Merrill
1912	*Hesperochloa*	Per Axel Rydberg
1919	*Bromelica*	Oliver Atkins Farwell
1920	*Acroceras*	Otto Stapf
1920	*Paspalidium*	Otto Stapf
1925	*Pleioblastus*	Takenoshin Nakai
1925	*Pseudosasa*	Takenoshin Nakai
1933	*Vaseyochloa*	Albert Spear Hitchcock
1934	*Eremopoa*	Roman Julievich Roshevitz
1934	*Psathyrostachys*	Sergei Arsenjevic Nevski
1934	*Taeniatherum*	Sergei Arsenjevic Nevski
1946	*Parapholis*	Charles Edward Hubbard
1949	*Torreyochloa*	George Lyle Church
1950	*Ectosperma*	Jason Swallen
1962	*Avenochloa*	Josef Holub
1963	*Swallenia*	Thomas R. Soderstrom & H. Decker
1965	*Allolepis*	Thomas R. Soderstrom & H. Decker
1967	*Hainardia*	Werner R. Greuter
1973	*Dinebra*	Nicolaus von Jacquin
1974	*Dichanthelium*	Frank Walton Gould
1980	*Lophopyrum*	Askell Löve
1980	*Pascopyrum*	Askell Löve
1980	*Pseudoroegneria*	Askell Löve
1980	*Thinopyrum*	Askell Löve
1982	*Aegilopodes*	Askell Löve
1982	*Cylindropyrum*	Askell Löve
1982	*Tuctoria*	John Raymond Reeder
1983	*Dendrocalamopsis*	Pai-chieh Keng

THE 21ST CENTURY

... the work continues!

4.04 - GRASS GENERA: ALPHABETICAL

The purpose of this section is to provide an alphabetical listing of the genera of North American grasses. The generic name in the left column is the one that I accept, unless you are referred to another name, as in the first entry. The abbreviations in the right column indicate the sub-family and tribe of that genus.

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Achnatherum →	*Stipa*
Achnella →	*Stipa*
Acrachne	Chl: Era
Acroceras	Pan: Pan
Aegilopodes →	*Aegilops*
Aegilops	Poo: Trt
Aegopogon	Chl: Cyn
Agrohordeum →	*Elymus*
Agropogon	Poo: Avn
Agropyron	Poo: Trt
Agrositanion →	*Elymus*
Agrostis	Poo: Avn
Aira	Poo: Avn
Allolepis	Chl: Era
Alloteropsis	Pan: Pan
Alopecurus	Poo: Avn
Ammophila	Poo: Avn
Ampelodesmos	Poo: Stp
Amphibromus →	*Helictotrichon*
Amphicarpum	Pan: Pan
Andropogon	Pan: And
Anisantha →	*Bromus*
Anthenantia	Pan: Pan
Anthephora	Pan: Pan
Anthoxanthum	Poo: Avn
Apera	Poo: Avn
Apluda	Pan: And
*Arctagrostis**	Poo: Poe
*Arctophila**	Poo: Poe
Aristida	Ars: Ars
Arrhenatherum	Poo: Avn
Arthraxon	Pan: And
Arundinaria	Bam: Bam
Arundo	Arn: Arn
Austrostipa →	*Stipa*
Avena	Poo: Avn
Avenochloa →	*Helictotrichon*
Avenula →	*Helictotrichon*
Axonopus	Pan: Pan
Bambusa	Bam: Bam
Beckmannia	Poo: Avn
Blepharidachne	Chl: Era
Blepharoneuron	Chl: Era
Bothriochloa	Pan: And
Bouteloua	Chl: Cyn
Brachiaria	Pan: Pan
Brachyelytrum	Poo: Brl
Brachypodium	Poo: Brp
Briza	Poo: Poe
Bromelica →	*Melica*
Bromopsis →	*Bromus*
Bromus	Poo: Brm
Buchloë	Chl: Cyn
Calamagrostis	Poo: Avn
Calammophila	Poo: Avn
Calamovilfa	Chl: Era
Catabrosa	Poo: Poe
Catapodium →	*Desmazeria*
Cathestecum →	*Bouteloua*
Cenchrus	Pan: Pan
Ceratochloa →	*Bromus*
Chasmanthium	Cnt: Cnt
Chloris	Chl: Cyn
Chondrosum →	*Bouteloua*
Chrysopogon	Pan: And
Cinna	Poo: Avn
Cladoraphis	Chl: Era
Coelorachis	Pan: And
Coix	Pan: And
Coleanthus	Poo: Poe
Coridochloa →	*Alloteropsis*
Cortaderia	Dan: Dnt
Corynephorus	Poo: Avn
Cottea	Chl: Pap
Critesion →	*Hordeum*
Crypsis	Chl: Era
Ctenium	Chl: Cyn
Cutandia	Poo: Poe
Cylindropyrum →	*Aegilops*
Cymbopogon	Pan: And
Cynodon	Chl: Cyn
Cynosurus	Poo: Poe
Dactylis	Poo: Poe
Dactyloctenium	Chl: Era
Danthonia	Dan: Dnt
Dasyochloa →	*Erioneuron*
Dasypyrum	Poo: Trt
Dendrocalamopsis →	*Bambusa*
Deschampsia	Poo: Avn
Desmazeria	Poo: Poe
Diarrhena	Poo: Dhr
Dichanthelium →	*Panicum*
Dichanthium	Pan: And
Digitaria	Pan: Pan
Dinebra →	Chl: Era
Diplachne →	*Leptochloa*
Dissanthelium †	Poo: Avn
Distichlis	Chl: Era
*Dupontia**	Poo: Poe
Echinochloa	Pan: Pan
Ectosperma →	*Swallenia*
Ehrharta	Poo: Ehr
Eleusine	Chl: Era
Elionurus	Pan: And
Elyhordeum	Poo: Trt
Elymus	Poo: Trt
Elysitanion →	*Elymus*
Elytesion →	*Elymus*
Elytrigia →	*Elymus*
Enneapogon	Chl: Pap
Enteropogon	Chl: Cyn
Eragrostis	Chl: Era
Eremochloa	Pan: And
Eremopoa	Poo: Poe
Eremopyrum	Poo: Trt
Erianthus →	*Saccharum*
Eriochloa	Pan: Pan
Erioneuron	Chl: Era
Euchlaena →	*Zea*
Euclasta	Pan: And
Eustachys	Chl: Cyn
Festuca	Poo: Poe
Festulolium	Poo: Poe
Fingerhuthia	Chl: Era
Gastridium	Poo: Avn
Gaudinia	Poo: Avn
Glyceria	Poo: Mel
Glyceria (p. p.) →	*Torreyochloa*
Gymnopogon	Chl: Cyn
Gynerium	Arn: Arn
Hackelochloa	Pan: And
Hakonechloa	Arn: Arn
Hainardia	Poo: Hhr
Heleochloa →	*Crypsis*
Helictotrichon	Poo: Avn
Hemarthria	Pan: And
Hesperochloa →	*Festuca*
Heteropogon	Pan: And
Hesperostipa →	*Stipa*
Hierochloë →	*Anthoxanthum*
Hilaria	Chl: Cyn
Hilaria (p. p.) →	*Pleuraphis*
Holcus	Poo: Avn
Hordeum	Poo: Trt
Hymenachne	Pan: Pan
Hyparrhenia	Pan: And
Hystrix →	*Elymus*
Imperata	Pan: And
Ischaemum	Pan: And
Jarava →	*Stipa*
Koeleria	Poo: Avn
Lagurus	Poo: Avn
Lamarckia	Poo: Poe
Lasiacis	Pan: Pan
Leersia	Ehr: Ory
Leptochloa	Chl: Era
Leptoloma →	*Digitaria*
Leucopoa →	*Festuca*
Leymus →	*Elymus*
Limnodea	Poo: Avn
Lolium	Poo: Poe
Lophochlaena →	*Pleuropogon*
Lophochloa →	*Koeleria*
Lophopyrum →	*Elymus*
Luziola	Ehr: Ory
Lycurus	Chl: Era
Manisuris (p. p.) →	*Coelorachis*
Manisuris (p. p.) →	*Hemarthria*
Melica	Poo: Mel
Melinis	Pan: Pan
Mibora	Poo: Avn
Microchloa	Chl: Cyn
Microstegium	Pan: And
Milium	Poo: Avn
Miscanthus	Pan: And
Molinia	Arn: Dnt
Monanthochloë	Chl: Era
Monerma →	*Hainardia*
Muhlenbergia	Chl: Era
Munroa	Chl: Era
Nardus	Poo: Nrd
Nassella →	*Stipa*

Neeragrostis → *Eragrostis*
Neostapfia Chl: Orc
Neyraudia Chl: Era

Olyra † Bam: Oly
Opizia Chl: Cyn
Oplismenus Pan: Pan
Orcuttia Chl: Orc
Oryza Ehr: Ory
Oryzopsis Poo: Stp

Panicum Pan: Pan
Pappophorum Chl: Pap
Parapholis Poo: Hhr
Pascopyrum → *Elymus*
Paspalidium → *Setaria*
Paspalum Pan: Pan
Pennisetum Pan: Pan
Phalaris Poo: Avn
Phalaroides → *Phalaris*
Phanopyrum → *Panicum*
Pharus Phr: Phr
Phippsia Poo: Poe
Phleum Poo: Avn
Phragmites Arn: Arn
Phyllostachys Bam: Bam
Piptatherum → *Oryzopsis*
Piptochaetium Poo: Stp
Pleioblastus Bam: Bam
Pleuraphis → *Hilaria*
Pleuropogon Poo: Mel
Poa Poo: Poe
Podagrostis → *Agrostis*
Pogonarthria Chl: Era
Polypogon Poo: Avn
Polytrias Pan: And
Psathyrostachys → *Elymus*
Pseudelymus → *Elymus*
Pseudoroegneria → *Elymus*
Pseudosasa Bam: Bam
Ptilagrostis Poo: Stp
Puccinellia Poo: Poe
Puccinellia (p. p.) → *Torreyochloa*

Redfieldia Chl: Era
Reimarochloa Pan: Pan
Rhynchelytrum → *Melinis*
Rhytidosperma → *Danthonia*
Rostraria → *Koeleria*
Rottboellia Pan: And

Saccharum Pan: And
Sacciolepis Pan: Pan
Schedonnardus Chl: Cyn
Schedonorus (p. p.) → *Festuca*
Schedonorus (p. p.) → *Lolium*
Schismus Dan: Dnt
Schizachne Poo: Mel
Schizachyrium Pan: And
Sclerochloa Poo: Poe
Scleropoa → *Desmazeria*
Scleropogon Chl: Era
Scolochloa Poo: Poe
Scribneria Poo: Hhr
Secale Poo: Trt
Setaria Pan: Pan
Setariopsis → Pan: Pan
Sieglingia → *Danthonia*
Sitanion → *Elymus*
Sitordeum → *Elymus*
Sorghastrum Pan: And
Sorghum Pan: And
Spartina Chl: Cyn
Sphenopholis Poo: Avn
Sporobolus Chl: Era
Steinchisma Pan: Pan
Stenotaphrum Pan: Pan
Stipa Poo: Stp
Stiporyzopsis → *Stipa*
Swallenia Chl: Era

Taeniatherum → *Elymus*
Themeda Pan: And
Thinopyrum → *Elymus*
Thysanolaena Arn: Arn
Torreyochloa Poo: Poe
Trachypogon Pan: And
Tragus Chl: Cyn
Trichachne → *Digitaria*
Trichloris → *Chloris*
Trichoneura Chl: Era
Tridens Chl: Era
Triplasis Chl: Era
Tripogon Chl: Era
Tripsacum Pan: May
Triraphis Chl: Era
Trisetum Poo: Avn
Triticum Poo: Trt
Tuctoria Chl: Orc

Uniola Chl: Era
Uniola (p. p.) → *Chasmanthium*
Urochloa Pan: Pan

Vahlodea → *Deschampsia*
Vaseyochloa Chl: Era
Ventenata Poo: Avn
Vetiveria → *Chrysopogon*
Vulpia → *Festuca*

Willkommia Chl: Cyn

Zea Pan: May
Zizania Ehr: Ory
Zizaniopsis Ehr: Ory
Zoysia Chl: Cyn

NOTES:

† = presumed to be extinct or extirpated

p. p. = in part

* = found in Alaska and Canada only

Revised: 11 January 2005

4.05 - GRASS GENERA: SYNOPSIS

Acrachne. One species: *A. racemosa*, adventive in southern California.

Acroceras. One species: *A. oryzoides*. ???

Aegilops. Goat grass. Three species: *Ae. cylindrica*, *Ae. ovata*, and *Ae. triuncialis*.

Aegopogon. One species: *Ae. tenellus*.

X *Agropogon*. One species: X *A. littoralis*, an inter-generic hybrid involving *Agrostis stolonifera* and *Polypogon monspeliensis*.

Agropyron. Crested wheatgrass. One to three species: (a much smaller genus than in H & C; most species have been transfered to *Elymus*). *A. desertorum*, *A. cristatum*, and *A. pectiniforme*.

Agrostis. Bent, bent grass, hair grass, redtop, tickle grass. About 40 species.

Aira. Hair grass, tickle grass. Three species: *A. caryophyllea*, *A. elegans*, and *A. praecox*.

Allolepis. One species: *A. texana*, native to TX.

Alloteropsis. One species: *A. cimicina.* FL.

Alopecurus. Foxtail, meadow foxtail. Eleven species.

Ammophila. Beach grass, European beach grass. Three species: *A. arenaria* (a European species introduced to control erosion on coastal sand dunes), *A. breviligulata*, and *A. champlainensis* (restricted to the Great Lakes region).

Ampelodesmos. Dis grass. One species, *A. mauri-tanica*, a Mediterranean species sometimes grown as an ornamental has escaped in Napa Co., CA.

Amphicarpum. Goober grass. Two species: *A. muhlenbergii* and *A. purshii,* are unusual in having underground cleistogamous spikelets.

Andropogon. Bluestem, beard grass, broom-sedge. About 14 species.

Anthaenantia. Silky scale. Two species: *A. rufa* and *A. villosa*.

Anthephora. One species: *A. hermaphrodita*.

Anthoxanthum. Vernal grass, sweet vernal grass. Two species: *A. aristatum* and *A. odoratum*.

Apera. Silky bent grass, wind grass. Two species: *A. spica-venti* and *A. interrupta*.

Apluda. Mauritian grass. One species: *A. mutica*, intro-duced in MD where it may not be persisting.

Arctagrostis. Polar grass. One species: *A. latifolia,* which is native to AK and Canada, but not found in the conterminous U. S.

Arctophila. Pendant grass. One species, *A. fulva*, which is native to AK and elsewhere, but not found in the conterminous U. S.

Aristida. Three-awn, arrow feather. Thirty-six species.

Arrhenatherum. Oat-grass. One species: *A. elatius*. Eurasia. Some plants have a series of small, bulb-like corms.

Arthraxon. One species: *A. hispidus*.

Arundinaria. Cane, switch cane. Three species: *A. gigantea*, with two subspecies and a hybrid between them (*A. g.* ssp. x *macrosperma*) of the eastern and southeastern U. S. are our only native woody bamboos. *A. pumila*, an ornamental bamboo from Japan, is naturalized in CA. *A. simonii* is naturalized in NV.

Arundo. Reed, giant reed. One species: *A. donax*. Robust perennial typically found along rivers, streams, and waterways.

Avena. Oat, wild oat. Ten species, all native to the Old World.

Axonopus. Carpet grass. Three species: *A. affinis*, *A. compressus*, and *A. furcatus*.

Bambusa. Hedge bamboo, common bamboo. Two species: *B. glauscens* and *B. vulgaris* have escaped from cultivation and are now established in FL.

Beckmannia. Slough grass. One species: *B. syzigachne*.

Blepharidachne. Eyelash grass. Two species: *B. bigelovii* and *B. kingii*.

Blepharoneuron. Pine dropseed. One species: *B. tricholepis*.

Bothriochloa. Silver bluestem. Fifteen species.

Bouteloua. Grama grass, sideoats grama. Twenty-two species. Includes *Cathestecum.*

Brachyelytrum. Short-husk. Two species: *B. erectum* and *B. septentrionale*.

Brachypodium. False brome. Three species (all European): *B. distachyon* occurs widely. *B. sylvaticum* is naturalized in Benton Co., OR. *B. pinnatum* occurs along the California coast.

Briza. Quaking grass, rattlesnake grass. Three species: *B. maxima* (often used in dried arrangements), *B. media*, and *B. minor*. European introductions.

Bromus. Brome, chess, cheat grass, rescue grass, ripgut, chess. Forty-five species.

Buchloë. Buffalo grass. One species: *B. dactyloides*, a native of the short grass and mixed grass prairies.

Calamagrostis. Reed grass, reed bent grass, bluejoint. Thirty-seven species.

X Calammophila. Reed grass. Two species, hybrids between *Calamagrostis* and *Ammophila.*

Calamovilfa. Sand reed. Five species.

Catabrosa. Brook grass. One species: *C. aquatica*.

Cenchrus. Sandbur. Twelve species.

Chasmanthium. Wild-oats, spike grass. Five species. The conspicuously flattened spikelets of *C. latifolium* are sometimes used in dried arrangements.

Chloris. Finger grass, windmill grass, feather grass, Rhodes grass. Twenty-four species.

Chrysopogon. Beard grass, khus-khus, vetiver grass. Three species: introduced grasses, mostly in the south-eastern U. S.

Cinna. Wood reed. Three species: *C. arundinacea*, *C. bolanderi*, and *C. latifolia*.

***Cladoraphis*.** Bristly love grass. One species: *C. cyperoides*, adventive in OR. Southern Africa.

Coelorachis. Joint grass, joint-tail, thintail. Four species. Treated as *Manisuris* in H & C.

Coix. Job's tears. One species: *C. lacryma-jobi*, established in FL and LA. Its grey-white, seed-like pistillate involucres are found in necklaces, rosaries, and junk jewelry.

Coleanthus. One species: *C. subtilis*, adventive in OR and WA.

Cortaderia. Pampas grass. Two species: *C. jubata* has become a major pest in northern CA. *C. dioica* is a popular ornamental.

Corynephorus. Gray hair grass. One species: *C. canescens*. Europe.

Cottea. One species: *C. pappophoroides*, native from AZ to TX.

Crypsis. Swamp timothy, prickle grass. Three species: *C. alopecuroides*, *C. schoenoides*, and *C. vaginiflora*. Eurasia & Africa. [= *Heleochloa* in H & C].

Ctenium. Toothache grass. Two species: *Ct. aromaticum* and *Ct. floridanum*. Grasses of the southeastern U. S., the latter endemic to FL.

Cutandia. One species: *C. memphitica*, aMediterranean introduction naturalized in CA. Doubtfully persisting.

Cymbopogon. Citronella grass. Three species: *C. citratus*, *C. nardus*, and *C. refractus*. Source of essential oil used in cooking and perfumes, etc.

Cynodon. Bermuda grass, star grass. Five species: *C. dactylon* is a popular lawn grass.

Cynosurus. Dogtail. Two species: *C. cristatus* and *C. echinatus*. European weeds.

Dactylis. Orchard grass, cocksfoot. One species: *D. glomerata*. Europe.

Dactyloctenium. Crowfoot grass. Two species: *D. aegyptium* naturalized along the Gulf and Atlantic coastal plains. *D. radulans*, from Australia, escaped in Tucson, AZ.

Danthonia. Poverty-oats, oat-grass. Thirteen species.

***Dasypyrum*.** Mosquito grass. One species: *D. villosum*, a Mediterranean introduction.

Deschampsia. Hair grass. Seven species: all of them native.

Desmazeria. Fern grass. One species: *D. rigida*, a European introduction.

Diarrhena. Beak grain. One species: *D. americana*, native to eastern and central states.

Dichanthium. Bluestem. Three species: *D. annulatum*, *D. aristatum*, and *D. sericeum*, Old World pasture grasses found in TX and LA.

Digitaria. Crab grass, witch grass, Arizona cottontop. About thirty species.

***Dinebra*.** Viper grass. One species: *D. retroflexa*, adventive in CA & NC. Tropical Africa and Asia.

***Dissanthelium*.** One species: *D. californicum,* native to San Clement, Santa Catalina Islands, and Baja California, presumed extinct in the United States (last collected in 1912).

Distichlis. Salt grass. One species: *D. spicata*, found typically in saline soils and coastal salt marshes.

Dupontia. Tundra grass. One speices: *D. fischeri*, native to AK and elsewhere, but not found in the conterminous U. S.

Echinochloa. Barnyard grass, jungle-rice, water grass, cockspur. Eight species.

Ehrharta. Veldt grass. Three species: *E. calycina*, *E. erecta*, and *E. longiflora* (all from S. Africa) naturalized in CA.

Eleusine. Goose grass, African millet, three-spike grass, yard grass. Three species: *E. coracana, E. indica* and *E. tristachya* are naturalized in scattered locations.

Elionurus. Balsam scale. Two species: *E. barbiculmis* and *E. tripsacoides*.

X *Elyhordeum*. Five species. An intergeneric hybrid between *Elymus* and *Hordeum*.

Elymus. Rye grass, wild-rye, quack grass, squirreltail, bottlebrush grass. Genus much larger or much smaller than in H & C, depending upon taxonomic treatment followed. About fifty-five species.

Enneapogon. Spike-pappus grass, 9-awned pappus grass. One species: *E. desvauxii*.

Enteropogon. Umbrella grass. Three species, two of them introduced from the Old World.

Eragrostis. Love grass, stink grass, pony grass. About 56 species.

Eremochloa. Centipede grass. One species: *E. ophuroides*, naturalized in TX and LA. Historic collection of *E. ciliaris* from San Francisco bay area.

Eremopyrum. Annual wheat grass. Three species: *E. bonepartis* and *E. orientale* are naturalized in NY. *E.*

triticeum is naturalized in the western U. S. Old World introductions.

Eriochloa. Cup grass. Eleven species.

Erioneuron. Fluff grass. Three species: *E. avenaceum*. *E. pilosum* and *E. pulchellum* are grasses of drier sites in the southwestern U. S.

Eustachys. Chickenfoot grass, finger grass, windmill grass. Seven species.

Festuca. Fescue, annual fescue, rye grass, darnel. As treated here, genus includes annual species often segregated into *Vulpia*, *Lolium* and X *Festulolium*. About 47 species.

Festulolium. Three species, hybrids between *Festuca* and *Lolium*.

Fingerhuthia. Zulu-fescue. One species: *F. africana,* adventive in AZ. Southern Africa, Asia.

Gastridium. Nit grass. One species: *G. ventricosum*, a European introduction, widely naturalized.

Gaudinia. One species: *G. fragilis*, a European introduction, found only in Sonoma Co., CA.

Glyceria. Manna grass, fowl meadow grass. Nineteen species.

Gymnopogon. Skeleton grass, beard grass. Three species: mostly eastern half of country; *G. floridana* endemic to FL and adjacent GA.

Gynerium. Uva grass. One species: *G. sagittatum*, a popular ornamental in dried arrangements. Escaping in FL.

Hackelochloa. One species: *H. granularis*, is naturalized in AZ, NM, and LA.

Hainardia. Thintail. One species: *H. cylindrica*, introduced from Europe.

Hakonechloa. Hakone grass, Japanese forest grass. One species: *H. macra*, escaped from cultivation in UT.

Helictotrichon. Spike-oat, alpine-oat. Three species: *H. hookeri*, *H. mortonianum*, and *H. pubescens*.

Hemarthria. Limpo grass. One species: *H. altissima*, endemic to TX.

Heteropogon. Tanglehead. Two species: *H. contortus* and *H. melanocarpus*, occur in AZ to TX.

Hilaria. Tabosa, curly-mesquite, galleta. XXX Two species: *H. jamesii* and *H. rigida* native, mostly from CA to UT, WY, and TX.

Holcus. Velvet grass. Two species: *H. mollis* (annual) and *H. lanatus* (perennial). Introduced from Europe and Africa.

Hordeum. Barley, squirreltail. Nine species.

Hymenachne. One species: *H. amplexicaulis*, found in FL.

Hyparrhenia. Thatching grass, jaragua grass. Two species: *H. rufa* and *H. hirta*. Neither may persist in North America.

Imperata. Cogon grass, satin tail.Three species: *I. cylindrica*, *I. brasiliensis*, and *I. brevifolia*.

Ischaemum. Muraina grass. Two species, introduced from Asia.

Koeleria. June grass. Two species: *K. macrantha* (a common native perennial) and *K. gerardii* (an introduced annual).

Lagurus. Hare's tail. One species, *L. ovatus*, a Mediterranean introduction. Sometimes used in dried arrange-ments.

Lamarckia. Golden top. One species: *L. aurea*, introduced from the Mediterranean.

Lasiacis. Small cane, tibisee. Two species: *L. divaricata* and *L. ruscifolia* (both restricted to FL).

Leersia. Cutgrass, white grass, catchfly grass. Five species. Grasses of moist woods and stream banks.

Leptochloa. Sprangletop. Twelve species.

Limnodea. Ozark grass. One species, *L. arkansana*. This genus endemic to North America.

Lolium. Rye grass, darnel. Six species, all introduced.

Luziola. Southern water grass. Three species: *L. bahiensis*, *L. carolinensis*, and *L. peruviana*. Aquatic grasses found mostly in Southeast.

Lycurus. Wolftail, Texas timothy. One species: *L. phleoides*, of drier sites in Southwest.

Melica. Onion grass, melic. Eighteen species. Some have small, onion-like bulbs.

Melinis. Two species: *M. minutiflora* (molasses grass) a Brazilian introduction; *M. repens* (ruby grass, Natal grass), an African introduction, from CA to TX. Includes taxa traditionally assigned to *Rhynchelytrum.*

Mibora. Early sand grass. One species: *M. minima*, a European introduction naturalized in MA.

Microchloa. Small grass. One species: *M. kunthii*, endemic to Cochise Co., AZ.

Microstegium. One species: *M. vimineum*, an Asian introduction.

Milium. Wood-millet. One species: *M. effusum*, a Eurasia introduction.

Miscanthus. Eulalia, plume grass, zebra grass. Four species: all Old World introductions, have become naturalized. Popular ornamentals.

Molinia. Moor grass. One species: *M. caerulea*, a Eurasian introduction.

Monanthochloë. Shore grass, key grass. One species: *M. littoralis*, Atlantic, Gulf, and California coasts. Its needle-like leaves are unique among N. American grasses.

Monroa. False buffalo grass. One species: *M. squarrosa*, native from California across Great Plains.

Muhlenbergia. Muhly, scratch grass, hair grass, nimble will, bull grass, satin grass, deer grass, ararejo grass. Seventy-three species.

Nardus. Moor mat grass. One species: *N. stricta*, a European introduction.

Neostapfia. Colusa grass. One species: *N. colusana*, endemic to vernal pools in California.

Neyraudia. Burma-reed. Two species: *N. arundinacea* and XXX introduced in CA and FL.

Olyra. One species: *O. latifolia*, known only in N. America from questionable historic collection from Tampa Bay area, FL.

Opizia. One species: *O. stolonifera*, occurs in Florida.

Oplismenus. Basket grass, wood grass. One species: *O. hirtellus*, naturalized in TX and LA.

Orcuttia. Orcutt grass. Five species: all endemic to vernal pools in California; one variety in Baja California. Other species cited in H & C are now in *Tuctoria*.

Oryza. Rice. Two species: *O. sativa* (cultivated rice), persists around paddies in CA, AR, MS, LA and FL. *O. rufipogon* naturalized in CA and FL.

Oryzopsis. Rice-grass, mountain-rice. Eleven species. Some species cited in H & C are now placed in *Stipa*.

Panicum. Panic grass, witch grass, millet, vine-mesquite, maiden cane. The largest genus of grasses in North America, which alone makes for a grand challenge.

Pappophorum. Pappus grass. Two species: *P. bicolor* and *P. mucronulatum* found in AZ and TX.

Parapholis. Sickle grass, hard grass. Two species: *P. incurva* and *P. strigosa* (known in N. America from recent collections around Humboldt Bay, in Humboldt Co., CA).

Paspalum. Knot grass, dallis grass, Vasey grass, paspalum, bahia grass. Forty-four species.

Pennisetum. Fountain grass, feather grass, buffel grass, Napier grass, elephant grass, kikuyu grass, pearl millet. Thirteen species. Pernicious weeds and graceful ornamentals.

Phalaris. Canary grass, reed canary grass, May grass. Eleven species.

Pharus. Creeping leafstalk grass. One species: *Ph. lap-pulaceus*; FL.

Phippsia. Ice grass, snow grass. One species: *Ph. algida*; native to CO, WY, and MT.

Phleum. Timothy. Six species: *Ph. pratense*, a Eurasian pasture grass now occurs widely in N. America. *Ph. alpinum* native to mid- and high altitude grasslands. Three other species naturalized locally, especially in OR.

Phragmites. Common reed, carrizo. One species: *Ph. australis*, common along water ways. Some authors suggest this species the most widely occurring vascular plant.

Phyllostachys. Bamboo. Two species: *Ph. aurea* (golden bamboo, fishpole bamboo) and *Ph. bambusoides* (timber bamboo, madake) escaped from cultivation in CA, NM, LA, and FL.

Piptochaetium. Piñon rice grass, needle grass. Six species: native species occur mostly in FL and Southwest.

Pleioblastus. Dwarf bamboo. Two species: *P. humilis* and *P. simonii* are escaped Japanese bamboos.

Pleuropogon. Semaphore grass. Five species: mostly grasses of Pacific coast; two endemic to CA.

Poa. Blue grass, winter grass, spear grass, mutton grass. About 80 species.

Pogonarthria. Herringbone grass. One species: *P. squarrosa*, introduced in AZ.

Polypogon. Beard grass, rabbitfoot grass, water bent grass. Five species: two native.

Polytrias. One species: *P. praemorsa*, introduced from Java.

Pseudosasa. Arrow bamboo, metake. One species: *P. japonica*, naturalized in FL.

***Ptilagrostis*.** Porter's needle grass. One subspecies, *P. mongholica* ssp. *porteri*, endemic to CO.

Puccinellia. Alkali grass. Thirty-two species.

Redfieldia. Blowout grass. One species: *R. flexuosa*, native to sandy sites.

Reimarochloa. Florida reimar grass. One species: *R. oligostachya*, native to FL.

Rottboellia. Itch grass. One species: *R. cochinchinensis*, naturalized in TX, LA and FL.

Rytidosperma. Hairy oat grass, hairy danthonia. Three introduced species.

Saccharum. Sugar cane, noble cane. Ten species: *S. saccharum* persists around sugar cane fields in FL. *S. spontaneum* (wild Asian sugar cane) also naturalized in FL. Includes *Erianthus.*

Sacciolepis. Cupscale. Two species: *S. striata* (native) and *S. indica*, naturalized in TX and perhaps in GA.

Schedonnardus. Wire grass, tumble grass, Texas crab grass. One species: *S. paniculatus*.

Schismus. Mediterranean grass. Two species: *S. arabicus* and *S. barbatus*, Old World introductions in CA and AZ.

Schizachne. False melic. One species, *S. purpurascens*, native.

Schizachyrium. Bluestem. Eleven species.

Sclerochloa. Hard grass. One species: *S. dura*, a European introduction.

Scleropogon. Burro grass. One species: *S. brevifolius*, native to CA to CO and TX.

Scolochloa. Marsh grass, prickle grass. One species: *S. festucacea*.

Scribneria. Scribner's grass. One species: *S. bolanderi*, native along Pacific coast from BC to CA.

Secale. Rye. Two species: *S. cereale*, cultivated rye, escapes widely. *S. montanum*, an Asian introduction, established in WA and CA.

Setaria. Foxtail, millet, bristle grass. Twenty-seven species.

***Setariopsis*.** One species: *S. auriculata*, naturalized in AZ.

Sorghastrum. Indian grass, wood grass. Four species: *S. apalachicolense*, endemic to FL; *S. nutans*, dominant of tall grass prairie.

Sorghum. Sorghum, sorgo, sorgho, durra, Johnson grass, Kafir-corn, Sudan grass, chicken-corn, broom-corn. Two species: *S. bicolor*, source of important forage and seed crops; *S. halepense* (Johnson grass), a pernicious weed, especially in agricultural areas.

Spartina. Cord grass, slough grass, marsh hay. Thirteen species: common grasses of prairies, marshes, and coastal sites.

Sphenopholis. Wedge grass, bunch grass. Five species: all native.

Sporobolus. Dropseed, smut grass, sacaton, poverty grass. Twenty-eight species.

Stenotaphrum. St. Augustine grass. One species: *S. secundatum*, popular lawn grass of Atlantic and Gulf coastal states, where it escapes.

Stipa. Needle grass, porcupine grass, winter grass, sleepy grass. Thirty-eight species.

Swallenia. Eureka Valley Dune grass. One species: *S. alexanderae*, endemic to sand dunes in Inyo Co., CA.

Themeda. Kangaroo grass. One species: *T. quadrivalvis* naturalized in LA.

Thysanolaena. Tiger grass. One species: *T. latifolia*, escaped ornamental from Southeast Asia.

Torreyochloa. XXX

Trachypogon. Crinkle awn. Two species: *T. montufari* and *T. secundus*, the latter indigenous from AZ to TX.

Tragus. Bur grass. Two species: *T. berteronianus* and *T. racemosus* (Old World introductions), naturalized in AZ, NM, and TX.

Trichoneura. Silveus grass. One species: *T. elegans*, native to TX.

Tridens. Purpletop, redtop, tridens. Twelve species. Some species in H & C now in *Erioneuron*.

Triplasis. Sand grass. Two species: *T. americana* and *T. purpurea*.

Tripogon. One species: *T. spicatus*, native to TX.

Tripsacum. Gama grass. Four species: *T. dacyloides* grows in prairies; *T. floridanum* endemic to FL.

***Triraphis*.** Purpleheads. One species: *T. mollis*, naturalized in TX.

Trisetum. Yellow-oats. Thirteen species: all but one native.

Triticum. Wheat. One species: *T. aestivum* established around agricultural fields.

Tuctoria. Tuctoria. Two species: *T. greenei* and *T. mucronata*, endemic to a few counties in CA.

Uniola. Sea-oats. One species: *U. paniculata*, native to coastal dunes of Atlantic and Gulf states. Often used in dried arrangements because of large, conspicuously flattened spikelets.

Urochloa. Signal grass, Guinea grass, brown-top millet, panicum, Pará grass. Fifteen species.

Vaseyochloa. Texas grass. One species: *V. multi-nervosa*, endemic to TX.

Ventenata. One species: *V. dubia*, Eurasian introduction naturalized in OR and CA.

Willkommia. One species: *W. texana*, endemic to San Patricio and Kleberg counties in TX.

Zea. Maize, corn, Indian corn, teosinte. One species: *Zea mays*; two subspecies of teosinte naturalized in SC and FL. Maize does not persist.

Zizania. Wild-rice, water-rice. Three species: *Z. texana* endemic to Hayes Co., TX.

Zizaniopsis. Water-millet, Texas wild-rice, marsh millet, southern wild-rice. One species: *Z. miliacea*, aquatic grass of southern U. S.

Zoysia. Zoysia, zoisia, matronella grass. Two species: *Z. materella* and *Z. tenuifolia*, popular lawn grasses.

Revised: 10 January 2005

4.06 - GRASSES : COMMON NAMES

Acapulco grass	Bouteloua dimorpha
adlay	Coix lacryma-jobi
African foxtail	Cenchrus ciliaris
African joint-tail	Hemarthria altissima
African millet	Eleusine corocana
African-timothy	Setaria sphacelata
agarista	Cynodon dactylon
agropiro	Elymus spp.
alkali grass	Puccinellia spp.
alkali grass	Torreyochloa spp.
alpine-oat (grass)*	Helictotrichon spp.
annual wheat grass	Eremopyrum spp.
aparejo (grass)	Muhlenbergia spp.
Arizona cottontop	Digitaria californica
arrocillo	Paspalum paniculatum
arrowfeather	Aristida purpurascens
Asian broom grass	Thysanolaena latifoliai
avena loco	Avena fatua
avenilla	Avena spp.
Bahia grass	Paspalum notatum
balsam scale	Elionurus tripsacoides
bamboo	Bambusa spp.
bamboo	Phyllostachys spp.
bamboo	Pseudosasa spp.
bamboo	Pleioblastus spp.
bamboo	Dendrocalamus latiflorus
bamboo grass	Thysanolaena maxima
banderilla	Bouteloua spp.
banderita	Bouteloua curtipendula
barb grass	Hainardia cylindrica
barba negra	Heteropogon contortus
barbas de indio	Andropogon bicornis
barbwire grass	Cymbopogon refractus
barley	Hordeum spp.
barley	Elyhordeum spp.
barnyard grass	Echinochloa spp.
basket grass	Oplismenus hirtellus
beach grass	Ammophila spp.
beach grass	Panicum amarum
beach wire grass	Dactyloctenium aegyptium
beak grain	Diarrhena americana
beard grass	Andropogon spp.
beard grass	Bothriochloa laguroides
beard grass	Schizachyrium spp.
beard grass	Agropogon spp.
beard grass	Polypogon spp.
beard grass	Gymnopogon spp.
beard grass	Chrysopogon spp.
beggartick grass	Aristida orcuttiana
bent (grass)	Agrostis spp.
bent grass	Apera spp.
Bermuda grass	Cynodon spp.
billion dollar grass	Echinochloa frumentacea
birdseed grass	Phalaris canariensis
birdwood grass	Cenchrus biflorus
birdwood grass	Pennisetum setigerum
biscuit grass	Paspalum vaginatum
blackoat grass	Piptochaetium avenaceum
blady grass	Imperata cylindrica
blowout grass	Redfieldia flexuosa
blue bunch grass	Festuca idahoensis
blue grass	Poa spp.
bluejoint	Elymus smithii
bluejoint	Calamagrostis spp.
bluestem	Schizachyrium spp.
bluestem	Andropogon spp.
bluestem	Bothriochloa spp.
bluestem	Elymus smithii
bluestem (grass)	Dichanthium spp.
bottlebrush (grass)	Elymus spp.
branching foxtails	Eustachys floridana
bristle grass	Setaria spp.
bristly love grass	Cladoraphis cyperoides
bristly spear grass	Piptochaetium setosum
brome [-o]	Bromus spp.
bronco grass	Bromus tectorum
brook grass	Catabrosa aquatica
broom-corn	Sorghum bicolor
broom-sedge	Andropogon glomeratus
broomcorn millet	Panicum miliaceum
browntop	Microstegium vimineum
browntop millet	Urochloa ramosa
Brunswick grass	Paspalum nicorae
buckskin grass	Urochloa arizonica
buffalo bunch grass	Festuca campestris
buffalo grass	Buchloë dactyloides
buffel grass	Pennisetum ciliare
bugseed grass	Alloteropsis cimicina
bull grass	Paspalum boscianum
bull grass	Muhlenbergia emersleyi
bunch grass	Sphenopholis spp.
bunch grass	Festuca spp.
bur grass	Tragus spp.
Burma reed	Neyraudia reynaudiana
burrero	Scleropogon brevifolius
burro grass	Scleropogon brevifolius
buryseed chloris	Enteropogon chlorideus
bush grass	Calamagrostis epigeois
button grass	Dactyloctenium radulans
California grass	Urochloa mutica
canary grass	Phalaris spp.
candy grass	Eragrostis cilianensis
cane	Gynerium sagittatum
cane	Lasiacis spp.
cane	Arundinaria spp.
canoe grass	Paspalum acuminatum
canyon grass	Eriochloa lemmonii
caña brava	Gynerium sagittatum
cape grass	Tribolium obliterum
Carib grass	Eriochloa spp.
Carib grass	Echinochloa polystachya
carpet grass	Axonopus spp.
carrizo	Arundo donax
carrizo	Phragmites australis
carrizo chico	Hymenachne amplexicaulis
carrycillo	Olyra latifolia
Catalina grass	Dissanthelium californicum
catchfly grass	Leersia spp.
centeno silvestre	Elymus canadensis
centipede grass	Eremochloa spp.
cheat (grass)	Bromus spp.
chess	Bromus spp.
chicken foot grass	Eustachys caribaea
chicken-corn	Sorghum bicolor
chloris	Chloris spp.
Christmas grass	Themeda arguens
citronella grass	Cymbopogon citratus
club-awn grass	Corynephorus canescens
cockfoot	Dactylis glomerata
cockspur grass	Echinochloa spp.
cogon grass	Imperata cylindrica
cola de zorra	Hordeum jubatum
cola de zorra	Elymus elymoides
Colorado grass	Urochloa texana
Columbia grass	Paspalum fimbriatum
Columbus grass	Sorghum almum

Colusa grass	Neostapfia colusana
common reed	Phragmites australis
coral-panicum	Setaria chapmanii
cord grass	Spartina spp.
corn	Zea mays ssp. mays
corn grass	Setaria barbata
corn grass	Setaria barbata
cotta grass	Cottea pappophorioides
cotton grass	Digitaria californica
cottontop	Digitaria spp.
couch grass	Elymus repens
couch grass	Cynodon dactylon
crab grass	Digitaria spp.
creeping leafstalk grass	Pharus lappulaceus
crinkle-awn (grass)	Trachypogon spp.
crowfoot (grass)	Dactyloctenium aegyptium
crown grass	Paspalum spp.
crypsis	Crypsis spp.
cup grass	Eriochloa spp.
cup scale	Sacciolepis ssp.
curly mesquite	Hilaria spp.
cut grass	Leersia spp.
Dallis grass	Paspalum dilatatum
darnel	Lolium spp.
deer grass	Muhlenbergia rigens
desert grass	Blepharidachne bigelovii
dichanthium	Dichanthium spp.
dis grass	Ampelodesmos mauritanica
doddering dillies	Briza media
dogtail grass	Cynosurus spp.
dogtooth grass	Cynodon aethiopicus
dogtown grass	Aristida purpurea
door mat grass	Nardus stricta
double comb grass	Dactyloctenium geminatum
dropseed	Sporobolus spp.
dropseed	Blepharoneuron tricholepis
dune grass	Elymus mollis
durra	Sorghum bicolor
elephant grass	Pennisetum purpureum
English blue grass	Festuca pratensis
espiga negra	Hilaria belangeri
eulalia	Miscanthus spp.
Eureka Valley dune grass	Swallenia alexandrae
eyelash grass	Blepharidachne kingii
fairy grass	Miscanthus nepalensis
fakahatchee grass	Tripsacum dactyloides
false bluestem	Schizachyrium spp.
false brome	Brachypodium spp.
false buffalo grass	Monroa squarrosa
false citronella grass	Cymbopogon nardus
false manna grass	Torreyochloa californica
false melic	Schizachne purpurascens
false needle grass	Oryzopsis kingii
false oat	Trisetum spp.
false Rhodes grass	Chloris pluriflora
false rice grass	Stipa papposa
feather grass	Pennisetum spp.
feather grass	Stipa neomexicana
feathertop	Calamagrostis epigeios
feathertop	Pennisetum villosum
feathertop	Calamagrostis epigeios
fern grass	Catapodium rigida
fescue	Festuca spp.
finger grass	Digitaria spp.
finger grass	Eustachys spp.
finger grass	Chloris spp.
fish-on-a-pole grass	Chasmanthium latifolium
flag grass	Sporobolus compositus
flat crab grass	Axonopus furcatus
flat-crab grass	Axonopus furcatus
flechilla	Stipa spp.
Florida grass	Cynodon transvaalensis
Florida rhaphis	Chrysopogon pauciflorus
fluff grass	Erioneuron pulchellum
fluff grass	Tridens spp.
fly-away grass	Agrostis hiemalis
fountain grass	Pennisetum spp.
fowl meadow grass	Glyceria spp.
foxtail	Alopecurus spp.
foxtail	Setaria spp.
foxtail millet	Setaria italica
fragile grass	Aegopogon spp.
fragile-oat	Gaudinia fragilis
French oat grass	Gaudinia fragilis
funeral grass	Stipa arida
galleta	Hilaria spp.
gama grass	Tripsacum spp.
German millet	Setaria italica
giant cut grass	Zizaniopsis miliacea
giant reed	Arundo donax
giant rye grass	Festuca gigantea
Glenwood grass	Sacciolepis indica
goat grass	Aegilops spp.
golden-timothy	Setaria sphacelata
goldentop	Lamarckia aurea
goober grass	Amphicarpum spp.
goose grass	Eleusine indica
goose grass	Acrachne racemosa
gordura	Melinis minutiflora
grader grass	Themeda quadrivalvis
grama (grass)	Bouteloua spp.
gray hair grass	Corynephorus canescens
Guatemala grass	Tripsacum laxum
guinea grass	Urochloa spp.
gyp grass	Sporobolus nealleyi
Habana oat grass	Themeda quadrivalvis
hair grass	Muhlenbergia spp.
hair grass	Deschampsia spp.
hair grass	Aira spp.
hair grass	Corynephorus canescens
hair grass	Agrostis spp.
hairy oat grass	Rytidosperma spp.
hairy-nerve grass	Trichoneura elegans
Hakone grass	Hakonechloa macra
hard grass	Sclerochloa dura
hard grass	Parapholis spp.
Harding grass	Phalaris aquatica
hare's tail	Lagurus ovatus
heath grass	Danthonia decumbens
hedgehog grass	Cenchrus echinatus
herd grass	Agrostis alba
herringbone grass	Pogonarthria squarrosa
Hilo grass	Paspalum conjugatum
hoe grass	Muhlenbergia porteri
hog millet	Panicum miliaceum
holy grass	Anthoxanthum spp.
hurrah grass	Paspalum setaceum
hurricane sour grass	Bothriochloa pertusa
ice grass	Phippsia algida
Indian corn	Zea mays ssp. mays
Indian grass	Sorghastrum spp.
Indian millet	Stipa hymenoides
Indian rice grass	Stipa hymenoides
Indian woodoats	Chasmanthium latifolium
Italian millet	Setaria italica
itch grass	Rottboellia cochinchinensis
Japanese forest grass	Hakonechloa macra
Japanese lawn grass	Zoysia japonica
jaraguá grass	Hyparrenhia rufa
Java (-nese) grass	Polytrias amaura
Job's tears	Coix lacryma-jobi

Johnson grass	Sorghum halepense
joint grass	Coelorachis spp.
joint head	Arthraxon hispidus
joint-tail	Coelorachis spp.
June grass	Poa pratensis
June grass	Koeleria spp.
jungle-rice	Echinochloa colona
Kafir-corn	Sorghum bicolor
kangaroo grass	Themeda quadrivalvis
Kay's grass	Bouteloua kayii
Kelly grass	Rottboellia cochinchinensis
key grass	Monanthochloë littoralis
khas-khas	Chrysopogon zizanioides
khus-khus	Chrysopogon zizanioides
kikuyu grass	Pennisetum clandestinum
Kleberg grass	Dichanthium annulatum
Klein grass	Panicum coloratum
knot grass	Paspalum notatum
kodo millet	Paspalum scrobiculatum
Koeler's grass	Koeleria asiatica
koeleria	Koeleria spp.
Korean temple grass	Zoysia japonica
kyasuma grass	Pennisetum pedicellatum
lace grass	Eragrostis capillaris
lamilla	Bouteloua juncea
Laurisa grass	Pennisetum orientale
leafstalk grass	Pharus lappulaceus
lemon grass	Ctenium aromaticum
lemon grass	Cymbopogon citratus
limpo grass	Hemarthria altissima
liverseed grass	Urochloa spp.
long-awned wood grass	Brachyelytrum aristosum
longtom	Paspalum lividum
lop grass	Bromus hordeaceus
love grass	Eragrostis spp.
lyme grass	Elymus spp.
Madagascar grass	Neyraudia arundinacea
madake	Phyllostachys bambusoides
maicillo	Tripogon spicatus
maiden cane	Amphicarpum spp.
maiden cane	Panicum hemitomon
maize	Zea mays ssp. mays
Manila grass	Zoysia spp.
manna grass	Glyceria spp.
marram grass	Ammophila arenaria
marram grass	Calammophila baltica
marsh grass	Scolochloa festucacea
marsh hay	Spartina patens
marsh millet	Zizaniopsis miliacea
mary grass	Setaria barbata
Mascarene grass	Zoysia tenuifolia
mat grass	Nardus stricta
mat grass	Axonopus spp.
matronella grass	Zoysia spp.
Mauritian grass	Apluda mutica
may grass	Phalaris caroliniana
meadow grass	Poa spp.
Mediterranean grass	Schismus spp.
medusa head (grass)	Elymus caput-medusae
melic	Melica spp.
Memphis grass	Cutandia memphitica
metake	Pseudosasa japonica
Mexican teosinte	Zea perennis
millet	Paspalum spp.
millet	Setaria spp.
millet	Urochloa spp.
millet	Pennisetum spp.
millet	Panicum spp.
millet	Echinochloa spp.
millet	Eleusine spp.
millet grass	Milium effusum
milo	Sorghum bicolor
mission grass	Pennisetum polystachyon
molasses grass	Melinis minutiflora
moor grass	Molinia caerulea
moor mat grass	Nardus strictus
mosquito grass	Dasypyrum villosum
moss grass	Coleanthus subtilis
mountain bunch grass	Festuca arizonica
mountain-rice	Stipa webberi
mountain-rice	Oryzopsis spp.
muhly	Muhlenbergia spp.
Munro grass	Panicum rigidulum
muraina grass	Ischaemum spp.
mutton grass	Poa fendleriana
Napier grass	Pennisetum purpureum
nard grass	Cymbopogon nardus
Natal grass	Melinis repens
navajita	Bouteloua spp.
needle grama	Bouteloua aristidoides
needle grass	Stipa spp.
needle grass	Piptochaetium spp.
needle grass	Aristida spp.
needle-and-thread (grass)	Stipa comata
nimblewill	Muhlenbergia schreberi
nit grass	Gastridium ventricosum
noble cane	Saccharum officinarum
North Africa grass	Ventenata dubia
oat	Avena spp.
oat grass	Trisetum spp.
oat grass	Piptochaetium spp.
oat grass	Danthonia spp.
oat grass	Arrhenatherum spp.
oatmeal grass	Leersia lenticularis
oil grass	Cymbopogon iwarancusa
one-glumed hard grass	Hainardia cylindrica
onion grass	Melica spp.
orange grass	Ctenium aromaticum
orchard grass	Dactylis glomerata
Orcutt grass	Orcuttia spp.
Ozark grass	Limnodea arkansana
paja mansé	Paspalum quadrifarium
palisade grass	Urochloa brizantha
palm grass	Setaria palmifolia
pampas grass	Cortaderia spp.
pangola grass	Digitaria decumbens
panic grass	Panicum spp.
panic grass	Steinchisma hians
panicum	Urochloa spp.
panicum	Panicum spp.
pappus grass	Enneapogon desvauxii
pappus grass	Pappophorum spp.
Pará grass	Urochloa mutica
paspalidium	Setaria spp.
paspalum	Paspalum spp.
pasto chino	Buchloë dactyloides
pata de gallo	Cynodon dactylon
pato de gallo	Chloris cucullata
peanut grass	Amphicarpum purshii
pearl millet	Pennisetum americanum
pendant grass	Arctophila fulva
pigeon grass	Setaria pumila
pili grass	Heteropogon contortus
pine grass	Festuca arizonica
pine grass	Calamagrostis spp.
pit grass	Hackelochloa granularis
pitscale grass	Hackelochloa granularis
plume grass	Miscanthus spp.
plume grass	Saccharum spp.
plush grass	Chloris radiata
poison darnel	Lolium temulentum
polar grass	Arctagrostis latifolia

pony grass	Eragrostis hypnoides
popotillo	Andropogon spp.
popotillo colorado	Schizachyrium scoparium
popotillo del pinar	Blepharoneuron tricholepis
porcupine grass	Stipa spp.
Porter's needle grass	Ptilagrostis porteri
poverty grass	Sporobolus spp.
poverty-oats	Danthonia spp.
prickle grass	Crypsis spp.
prickle grass	Scolochloa festucacea
prickle-fescue	Scolochloa festucacea
proso millet	Panicum miliaceum
pull-and-be-damned	Paspalum lividum
puna grass	Stipa brachychaeta
purple needle grass	Triraphis mollis
purple heads	Triraphis mollis
purpletop	Tridens flavus
quack grass	Elymus repens
quack grass	Elyhordeum spp.
quaking grass	Briza spp.
quick grass	Elymus repens
quitch grass	Elymus repens
rabbit foot grass	Polypogon monspeliensis
ragi	Eleusine corocana
rat's tail	Sporobolus jacquemontii
rattlesnake chess	Bromus briziformis
rattlesnake grass	Briza maxima
Ravenna grass	Saccharum ravennae
redtop	Tridens flavus
redtop	Agrostis spp.
reed (grass)	Cinna spp.
reed (grass)	Phragmites australis
reed (grass)	Calamagrostis spp.
reed bent grass	Calamagrostis spp.
reed canary grass	Phalaris arundinacea
reed grass	Calammophila spp.
reimar grass	Reimarochloa oligostachya
rescue grass	Bromus catharticus
Rhodes grass	Chloris spp.
rice	Oryza sativa
rice grass	Piptochaetium spp.
rice grass	Oryzopsis spp.
rice grass	Stipa spp.
ring grass	Muhlenbergia spp.
ripgut grass	Bromus rigidus
river grass	Echinochloa polystachya
river-oats	Chasmanthium latifolium
rooi grass	Themeda triandra
rosette grass	Panicum spp.
ruby grass	Melinis repens
rush grass	Sporobolus spp.
rye	Secale spp.
rye grass	Lolium spp.
rye grass	Elymus spp.
sabi grass	Urochloa mosambicensis
sacaton	Sporobolus spp.
salt and pepper grass	Deschampsia caespitosa
salt grass	Allolepis texana
salt grass	Distichlis spp.
salt grass	Sporobolus airoides
salt meadow grass	Leptochloa panicoides
sand bunch grass	Stipa hymenoides
sand bur(r)	Cenchrus spp.
sand grass	Triplasis spp.
sand grass	Mibora minima
sand reed	Calamovilfa spp.
sandbur grass	Cenchrus spp.
sandspur grass	Cenchrus gracillimus
satin grass	Muhlenbergia racemosa
satintail	Imperata spp.
schismus	Schismus spp.
scratch grass	Muhlenbergia asperifolia
Scribner's grass	Scribneria bolanderi
sea lyme grass	Elymus mollis
sea-oat	Uniola paniculata
semaphore grass	Pleuropogon spp.
shore grass	Monanthochloë littoralis
short husk (grass)	Brachyelytrum spp.
Siberian grass	Eremopoa persica
sickle grass	Parapholis spp.
signal grass	Brachiaria eruciformis
signal grass	Urochloa spp.
silk grass	Stipa hymenoides
silk reed	Neyraudia reynaudiana
silky scale	Anthaenantia spp.
silky-bent	Apera spp.
silver beard grass	Bothriochloa spp.
silver grass	Miscanthus spp.
Silveus grass	Trichoneura elegans
skeleton grass	Gymnopogon spp.
skunk grass	Eragrostis cilianensis
sleepy grass	Stipa robusta
slender grass	Leptochloa panicea ssp. mucronata
slough grass	Spartina spp.
slough grass	Beckmannia syzigachne
small cane	Lasiacis spp.
small carpet grass	Arthraxon hispidus
small grass	Microchloa kunthii
smut grass	Sporobolus indicus
snow grass	Phippsia spp.
soap grass	Cymbopogon refractus
sorghum	Sorghum bicolor
sorgo [-gho]	Sorghum bicolor
sour grass	Bothriochloa pertusa
sour grass	Digitaria insularis
South African bluestem	Hyparrhenia hirta
southern wild-rice	Zizaniopsis miliacea
spear grass	Poa spp.
spider grass	Aristida ternipes
spike bur grass	Tragus spp.
spike grass	Elionurus barbiculmis
spike grass	Chasmanthium spp.
spike-oat	Helictotrichon hookeri
spiral grass	Tuctoria spp.
sprangletop	Leptochloa spp.
squirreltail	Hordeum spp.
squirreltail	Elymus spp.
St. Augustine grass	Stenotaphrum secundatum
star grass	Cynodon plectostachyus
Stebbins' grass	Ehrharta calycina
stiff brome	Brachypodium spp.
stiff grass	Catapodium rigidum
stink grass	Eragrostis cilianensis
stipa	Stipa spp.
strand-wheat	Elymus arenarius
Sudan grass	Sorghum bicolor
Sudan negro	Sorghum almum
sugar cane	Saccharum spp.
summer grass	Alloteropsis cimicina
swamp oat grass	Sphenopholis pensylvanica
swamp-timothy	Crypsis schoenoides
sweet grass	Glyceria fluitans
sweet grass	Glyceria septentrionalis
sweet grass	Anthoxanthum ssp.
switch cane	Arundinaria gigantea
switch grass	Panicum virgatum
tabosa	Hilaria mutica
talquezal	Paspalum virgatum
tanglehead	Heteropogon spp.
tanner grass	Urochloa arrecta
teff	Eragrostis tef
teosinte	Zea mays
Texas crab grass	Schedonnardus paniculatus
Texas grass	Panicum bulbosum

Texas grass	Vaseyochloa multinervosa
Texas millet	Urochloa texana
Texas wild-rice	Zizaniopsis miliacea
Texas winter grass	Stipa leucotricha
Texas-panicum	Urochloa texana
Texas-timothy	Lycurus phleoides
thatch grass	Hyparrhenia hirta
thatching grass	Hyparrhenia spp.
thimble grass	Fingerhuthia africana
thintail grass	Coelorachis spp.
thintail grass	Hainardia cylindrica
Thompson grass	Paspalum distichum
three-awn grass	Aristida spp.
three-spike grass	Eleusine tristachya
tibisee	Lasiacis spp.
tick grass	Eragrostis echinochloidea
tickle grass	Aira spp.
tickle grass	Agrostis spp.
tiger grass	Thysanolaena latifolia
timothy	Phleum spp.
tobosa	Hilaria mutica
tobosa menudo	Hilaria belangeri
toothache grass	Ctenium spp.
torpedo grass	Panicum repens
tres barbas	Aristida oligantha
tridens	Tridens spp.
tridens	Erioneuron spp.
trisetum	Trisetum spp.
triticale	Triticosecale rimpaui
trompetilla	Hymenachne amplexicaulis
tuctoria	Tuctoria spp.
tumble grass	Schedonnardus paniculatus
tumble grass	Eragrostis spectabilis
tundra grass	Dupontia fischeri
tussock grass	Stipa neesiana
umbrella grass	Enteropogon spp.
uniola	Chasmanthium spp.
uva (grass)	Gynerium sagittatum
vanilla grass	Anthoxanthum spp.
Vasey grass	Paspalum urvillei
veldt grass	Ehrharta spp.
velvet grass	Holcus spp.
vernal grass	Anthoxanthum spp.
vetiver grass	Chrysopogon zizanioides
vine-mesquite	Panicum obtusum
viper grass	Dinebra retroflexa
wallaby grass	Rytidosperema spp.
wallaby grass	Danthonia spp.
water grass	Echinochloa spp.
water grass	Luziola spp.
water millet	Zizaniopsis miliacea
water-rice	Zizania spp.
waterside-reed	Pennisetum macrourum
wedge grass	Sphenopholis spp.
weeping grass	Ehrharta calycina
West Indian marsh grass	Hymenachne amplexicaulis
wheat	Triticum spp.
wheat grass	Agropyron spp.
wheat grass	Elymus spp.
white grass	Leersia virginica
whorl grass	Catabrosa aquatica
wild cane	Gynerium sagittatum
wild rye	X Elyhordeum ssp.
wild rye	Elymus spp.
wild-oats	Chasmanthium spp.
wild-rice	Zizania ssp.
wild-timothy	Muhlenbergia glomerata
wind grass	Apera interrupta
windmill grass	Eustachys spp.
windmill grass	Chloris spp.
winter grass	Poa annua
winter grass	Stipa spp.
wire grass	Eleusine indica
wire grass	Schedonnardus paniculatus
wire stem	Muhlenbergia mexicana
witch grass	Digitaria spp.
witch grass	Panicum spp.
wolftail	Lycurus phleoides
wood grass	Oplismenus hirtellus
wood grass	Sorghastrum spp.
wood reed	Cinna spp.
wood-millet	Milium effusum
wood-oats	Chasmanthium spp.
woolly grass	Erioneuron spp.
yard grass	Eleusine indica
yellow-oat	Trisetum spp.
Yorkshire fog	Holcus lanatus
zacata ovillo	Dactylis glomerata
zacate araña	Muhlenbergia porteri
zacate burro	Scleropogon brevifolius
zacate colorado	Heteropogon contortus
zacate del amor	Eragrostis curvula
zacate gigante	Leptochloa dubia
zacate guta	Panicum obtusum
zacate llorón	Eragrostis curvula
zacate maicero	Tripogon spicatus
zacate pelillo	Chloris pluriflora
zacate punta blanca	Digitaria californica
zacate triguillo	Elymus elymoides
zacatón alcalino	Sporobolus airoides
zacatón arenoso	Sporobolus cryptanthus
zebra grass	Miscanthus sinensis
zig-zag grass	Panicum dichotomiflorum
zoisia	Zoysia spp.
zoysia	Zoysia spp.
Zulu-fescue	Fingerhuthia africana

* (grass) indicates that the word grass is sometimes used as part of the common name.

Revised: 12 January 2005

4.07 - THE H & C MANUAL: AN UPDATE

Why are we using a book that first appeared in 1935 and then revised in 1951? Half a century is a long time, even in systematics! The answer is amazingly simple -- nothing has come along to take its place. Hitchcock & Chase remains the only comprehensive treatment of the grasses of the United States. The late Frank Gould, John Kartesz, and I have compiled checklists for the United States and for North America, but they are nothing more than that.

But, help is on the way! In 2003, Oxford University Press published the first of a two-volume treatment of the grasses of North America. It will be part of the larger "Flora of North America" project. The FNA is a first-class operation. The other volume is scheduled to appear in 2006. Now the bad news. The volumes will cost about $100 each! There is a chance that a one volume, scaled-down version may become available.

Just how out-of-date are the names of subfamilies, tribes, genera, and individual grasses? In this section of the syllabus you will see a comparison of the subfamilies, tribes, and genera used in The Manual (left entry) versus today's version of the truth (right entry). You will also have access to a notebook in the lab that will permit you to look up any species name used in The Manual to see if it is still current. Of course, I am the person who compiled this list and other experts would not always agree with me.

TWO VERY DIFFERENT VIEWS

HITCHCOCK & CHASE
(The Old Testament)

Subfamily: Festucoideae
- Tribe: Bambuseae
- Tribe: Festuceae
- Tribe: Hordeae
- Tribe: Aveneae
- Tribe: Agrostideae
- Tribe: Zoysieae
- Tribe: Chlorideae
- Tribe: Phalarideae
- Tribe: Oryzeae
- Tribe: Zizanieae

Subfamily: Panicoideae
- Tribe: Melinideae
- Tribe: Paniceae
- Tribe: Andropogoneae
- Tribe: Tripsaceae

GRASS PHYLOGENY GROUP
(The New Testament)

Subfamily: Bambusoideae
- Tribe: Bambuseae
- Tribe: Olyreae

Subfamily: Pharioideae
- Tribe: Phareae

Subfamily: Ehrhartoideae
- Tribe: Oryzeae
- Tribe: Ehrharteae

Subfamily: Centothecoideae
- Tribe: Centotheceae

Subfamily: Pooideae
- Tribe: Triticeae
- Tribe: Brachypodieae
- Tribe: Bromeae
- Tribe: Poeae
- Tribe: Ampelodesmeae
- Tribe: Meliceae
- Tribe: Stipeae
- Tribe: Nardeae
- Tribe: Brachyelytreae
- Tribe: Diarrheneae

Subfamily: Arundinoideae
- Tribe: Arundineae

Subfamily: Danthonioideae
- Tribe: Danthonieae

Subfamily: Aristidoideae
- Tribe: Aristideae

Subfamily: Chloridoideae
- Tribe: Pappophoreae
- Tribe: Orcuttieae
- Tribe: Cynodonteae
- Tribe: Eragrostideae
- Tribe: Leptureae

Subfamily: Panicoideae
- Tribe: Paniceae
- Tribe: Andropogoneae

SUBFAMILIES

As you will see from the table below, the subfamily Panicoideae of H & C came through unscathed, but look at what happened to their Festucoideae. One large subfamily became nine.

Festucoideae	Pooideae
	Pharoideae
	Bambusoideae
	Erhartoideae
	Centothecoideae
	Chloridoideae
	Aristidoideae
	Arundinoideae
	Danthonioideae
Panicoideae	Panicoideae

TRIBES

At the tribe level, three things have happened. Some have been merged (Melinidae with Paniceae), some have been been split into smaller tribes (look at Festuceae!), and some are again unchanged.

Agrostideae	Aveneae
	Stipeae
	Eragrostideae
	Brachyelytreae
	Aristideae
Andropogoneae	Andropogoneae
Aveneae	Aveneae
Bambuseae	Bambuseae
Chlorideae	Cynodonteae
	Eragrostideae
Festuceae	Poeae
	Eragrostideae

	Orcuttieae
	Pappophoreae
	Arundineae
	Danthonieae
	Aeluropodieae
	Diarrheneae
	Bromeae
	Aveneae
	Meliceae
	Ampelodesmeae
	Triticeae
Hordeae	Triticeae
	Brachypodieae
	Hainardieae
	Poeae
Melinidae	Paniceae
Oryzeae	Oryzeae
Paniceae	Paniceae
Phalarideae	Aveneae
Tripsaceae	Maydeae
Zizanieae	Oryzeae
Zoysieae	Cynodonteae

GENERA

The genera below are arranged as they are in H & C. The entry in the right-hand column tells you whether the genus is still recognized and its taxonomic position.

AVENEAE

Aira	Unchanged
Arrhenatherum	Unchanged
Avena	Unchanged
Corynephorus	Unchanged
Danthonia	Danthonioideae: Danthonieae
Deschampsia	Unchanged
Helictotrichon	Unchanged
Holcus	Unchanged
Koeleria	Unchanged
Schismus	Danthonioideae: Danthonieae
Sieglingia	Danthonia
Sphenopholis	Unchanged
Trisetum	Unchanged

BAMBUSEAE

Arundinaria	Bambusoideae: Bambuseae

FESTUCEAE

Ampelodesmos	Unchanged
Blepharidachne	Chloridoideae: Eragrosteae
Brachypodium	Pooideae: Triticeae
Briza	Unchanged
Bromus	Pooideae: Bromeae
Catabrosa	Unchanged
Cortaderia	Danthonioideae: Danthonieae
Cottea	Chloridoideae: Pappophoreae
Cutandia	Unchanged
Cynosurus	Unchanged
Dactylis	Unchanged
Desmazeria	Unchanged
Diarrhena	Pooideae: Diarrheneae
Dissanthelium	Pooideae: Aveneae
Distichlis	Chloridoideae: Aeluropodieae
Enneapogon	Chloridoideae: Pappophoreae
Eragrostis	Chloridoideae: Eragrosteae
Festuca	Unchanged
Glyceria	Pooideae: Meliceae
Hesperochloa	Unchanged
Lamarckia	Unchanged
Melica	Pooideae: Meliceae
Molinia	Arundinoideae: Arundineae
Monanthochloe	Chloridoideae: Aeluropodieae
Monroa	Chloridoideae: Eragrosteae
Neostapfia	Chloridoideae: Orcuttieae
Neyruadia	Chloridoideae: Eragrosteae
Orcuttia	Chloridoideae: Orcuttieae
Pappophorum	Chloridoideae: Pappophoreae
Phragmites	Arundinoideae: Arundineae
Pleuropogon	Pooideae: Meliceae
Poa	Unchanged
Puccinellia	Unchanged
Redfieldia	Chloridoideae: Eragrosteae
Schizachne	Pooideae: Meliceae
Sclerochloa	Unchanged
Scleropoa	Unchanged [Desmazeria]
Scleropogon	Chloridoideae: Eragrosteae
Scolochloa	Unchanged
Swallenia	Chloridoideae: Aeluropodieae
Tridens	Chloridoideae: Eragrosteae
Triplasis	Chloridoideae: Eragrosteae
Uniola	Chloridoideae: Eragrosteae
Vaseyochloa	Chloridoideae: Eragrosteae

AGROSTIDEAE

Agrostis	Unchanged
Alopecurus	Unchanged
Ammophila	Unchanged
Apera	Unchanged
Aristida	Aristidoideae: Aristideae
Blepharoneuron	Chloridoideae: Eragrosteae
Brachyelytrum	Pooideae: Brachyelytreae
Calamagrostis	Unchanged
Calamovilfa	Chloridoideae: Eragrosteae
Cinna	Unchanged
Coleanthus	Pooideae: Poeae
Crypsis	Chloridoideae: Eragrosteae
Gastridium	Unchanged
Heleochloa	Chloridoideae: Eragrosteae [Crypsis]
Lagurus	Unchanged
Limnodea	Unchanged
Lycurus	Chloridoideae: Eragrosteae
Milium	Pooideae: Stipeae
Muhlenbergia	Chloridoideae: Eragrosteae
Oryzopsis	Pooideae: Stipeae
Phippsia	Pooideae: Poeae
Phleum	Unchanged
Piptochaetium	Pooideae: Stipeae
Polypogon	Unchanged
Sporobolus	Chloridoideae: Eragrostideae
Stipa	Pooideae: Stipeae

ANDROPOGONEAE

Arthraxon	Unchanged
Chrysopogon	Unchanged
Elyonuris	Elionuris
Erianthus	Saccharum
Hackelochloa	Unchanged
Heteropogon	Unchanged
Hyparrhenia	Unchanged
Imperata	Unchanged
Manisuris	Coelorachis & Hemarthria
Microstegium	Unchanged
Miscanthus	Unchanged
Rottboellia	Unchanged
Saccharum	Unchanged
Sorghastrum	Unchanged
Sorghum	Unchanged
Trachypogon	Unchanged

CHLORIDEAE

Beckmannia	Pooideae: Aveneae
Bouteloua	Chloridoideae: Cynodonteae
Buchloe	Chloridoideae: Cynodonteae
Cathestecum	Chloridoideae: Cynodonteae
Chloris	Chloridoideae: Cynodonteae
Ctenium	Chloridoideae: Cynodonteae
Cynodon	Chloridoideae: Cynodonteae
Dactyloctenium	Chloridoideae: Eragrostideae
Eleusine	Chloridoideae: Eragrostideae
Gymnopogon	Chloridoideae: Cynodonteae
Leptochloa	Chloridoideae: Eragrostideae
Microchloa	Chloridoideae: Cynodonteae
Munroa	Chloridoideae: Eragrostideae
Schedonnardus	Chloridoideae: Cynodonteae
Spartina	Chloridoideae: Cynodonteae
Trichloris	Chloridoideae: Cynodonteae [Chloris]
Trichoneuron	Chloridoideae: Eragrostideae
Tripogon	Chloridoideae: Eragrostideae
Wilkommia	Chloridoideae: Cynodonteae

HORDEAE

Aegilops	Unchanged
Agropyron	Unchanged
Elymus	Unchanged
Hordeum	Unchanged
Hystrix	Unchanged
Lolium	Pooideae: Poeae
Monerma	Pooideae: Hainardieae
Parapholis	Pooideae: Hainardieae
Scribneria	Pooideae: Hainardieae
Secale	Unchanged
Sitanion	Unchanged
Triticum	Unchanged

MELINIDAE

Melinis	Paniceae

ORYZEAE

Leersia	Erhartoideae: Oryzeae
Oryza	Erhartoideae: Oryzeae

PANICEAE

Amphicarpum	Unchanged
Anthaenantia	Unchanged
Axonopus	Unchanged
Brachiaria	Unchanged
Cenchrus	Unchanged
Digitaria	Unchanged
Echinochloa	Unchanged
Eriochloa	Unchanged
Lasiacis	Unchanged
Leptoloma	Digitaria
Olyra	Bambusoideae: Olyreae
Oplismenus	Unchanged
Panicum	Unchanged
Paspalum	Unchanged
Pennisetum	Unchanged
Reimarochloa	Unchanged
Rhynchelytrum	Melinis
Sacciolepis	Unchanged
Setaria	Unchanged
Stenotaphrum	Unchanged
Trichachne	Digitaria

PHALARIDEAE

Anthoxanthum	Aveneae
Hierochloe	Anthoxanthum
Phalaris	Aveneae

TRIPSACEAE

Coix	Andropogoneae
Euchlaena	Zea
Tripsacum	Andropogoneae
Zea	Andropogoneae

ZIZANIEAE

Hydrochloa	Luziola
Luziola	Erhartoideae: Oryzeae
Pharus	Pharoideae: Phareae
Zizania	Erhartoideae: Oryzeae
Zizaniopsis	Erhartoideae: Oryzeae

ZOYSIEAE

Aegopogon	Chloridoideae: Cynodonteae
Hilaria	Chloridoideae: Cynodonteae
Tragus	Chloridoideae: Cynodonteae
Zoysia	Chloridoideae: Cynodonteae

4.08 - FORAGE GRASSES

There is another vastly important group of grasses -- those that we feed to our domesticated animals, especi-ally horses, dairy cattle and beef cattle. **Forage** is the general term for plants consumed by livestock. In the broad sense, the term includes pasture and browse plants, straw, hay, and silage. Another way of looking at it is that we use dairy and beef cattle to transform plants into meat, milk, and other dairy products. In the United States alone, forage crops constitute a multibillion dollar industry. It is estimated that more than half of the earth's land surface is devoted to pastures and meadows used for grazing by farm animals.

The high cellulose levels of grass stems and leaves make these tissues relatively difficult for most animals to digest. However, the bacteria that inhabit the intestinal tracts of both ruminants and nonruminants carry out a fermentation process that reduces the cellulose to simpler compounds. We also create an environment in which anaerobic fermentation can occur when we put silage into a silo. For all practical purposes, chopped up plant material is pickled by being bathed in organic acids that are produced by the bacteria. If done properly, silage can be stored for years. It certainly doesn't sound very appetizing, does it? Do you like sauerkraut? How is it prepared?

Although literally thousands of plant species can provide palatable food for our domesticated animals, all of the important forage plants are either grasses or legumes. Most of them are Old World introductions, especially from Europe and Africa.

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FORAGE GRASSES

Bahia grass [*Paspalum notatum*]	Used especially in the southeastern U. S.
Bent grass [*Agrostis* spp.]	Excellent forage; common in western states
Bermuda grass [*Cynodon dactylon*]	Also an aggressive weed and lawn grass
Big bluestem [*Andropgon gerardii*]	Provides excellent forage
Black grama [*Bouteloua eriopoda*]	Important southwestern species
Blue grama grass [*Bouteloua gracilis*]	Best while immature
Brome grasses [*Bromus* spp.]	Very important in dry, cool regions
Buffalo grass [*Buchloë dactyloides*]	Native grass of cool, dry prairies
Bush muhly [*Muhlenbergia porteri*]	Native southwestern species
Crested wheat grass [*Agropyron cristatum*]	Good in cool, dry areas
Dallis grass [*Paspalum dilatatum*]	Well adapted to Cotton Belt states and California's C. Valley
Fescues [*Festuca* spp.]	Well adapted to warm summers
Gama grass [*Tripsacum dactyloides*]	Excellent forage; southeastern states
Hair grass [*Deschampsia cespitosa*]	Used in northern and western states
Harding grass [*Phalaris aquatica*]	Across the southern states
Indian grass [*Sorghastrum nutans*]	Excellent forage; eastern and central states
June grass [*Koeleria macrantha*]	Commonly used, except in the Southeast
Kentucky bluegrass [*Poa pratensis*]	One of the best and most palatable
Little bluestem [*Schizachyrium scoparium*]	Best when immature
Love grasses [*Eragrostis* spp.]	Widely used in southern Great Plains
Maiden cane [*Panicum hemitomon*]	Native grass of the Southeast coastal plain
Onion grass [*Melica bulbosa*]	Used especially in Northwestern states; native
Orchard grass [*Dactylis glomerata*]	Does well in cool, humid regions
Pangola grass [*Digitaria decumbens*]	Popular in Florida; native to Africa
Pearl millet [*Pennisetum americanum*]	Also a major human food in Africa and India
Redtop [*Agrostis stolonifera*]	One of the best wetland forage grasses
Reed canary grass [*Phalaris arundinacea*]	Well adapted to wet areas
Rye grasses [*Lolium* spp.]	Winter/irrigated pasture in southern states and California
Sidoats grama [*Bouteloua curtipendula*]	Provides forage over much of the country
Sorghum [*Sorghum bicolor*]	Also used for grain, silage, and syrup
Spike trisetum [*Trisetum spicatum*]	Used in the West and in the Northeast
Sudan grass [*Sorghum sudanense*]	Hybrids with sorghum widely used
Timothy [*Phleum pratense*]	Eurasian; widely planted
Wheat grasses [*Agropyron* spp.]	Good in cool, dry regions
Wild oats [*Avena fatua*]	Commonly used, except in southeastern states
Wild ryes [*Elymus* spp.]	Natives of the Pacific Northwest

[With thanks to Prof. K. O. Fulgham for his assistance.]

4.09 - WEEDY GRASSES

"What is a weed? A plant whose virtues have not yet been discovered." (Ralph Waldo Emerson)

Weeds are of great economic importance, mostly in the negative sense. It is estimated that weeds cost the American farmer several billion dollars each year by reducing both the quantity and the quality of crops produced. Their damage causes a loss as large as insect injury and disease combined. Another reason for studying weeds is their intimate association with our own species. Many of them are essentially our wards and they would perish without our encouragement. As Edgar Anderson said, "... the history of weeds is the history of man."

A DEFINITION

There are many definitions of a weed. Inherent in most of them is the idea that a plant is a weed if it is growing where we do not wish it to be. The picture of a well-manicured lawn dotted with dandelions comes easily to mind. There are problems with this approach. If I am growing irises, then a rose that appears in my garden is a weed. Bermuda grass is a highly prized lawn grass in much of the southern United States. Elsewhere it tends to live in disturbed areas. Is Bermuda grass a weed?

A good botanical definition of a weed is that of Herbert Baker, a botanist at the University of California at Berkeley. A plant is a weed, "... *if, in any specified geographical area, its populations grow entirely or predominately in situations markedly disturbed by man (without, of course, being deliberately cultivated plants)*." Remember that disturbed sites include not only relatively undesirable vacant lots and roadsides, but also our prime agricultural lands. Some weeds invade one or the other; some live in both.

Weeds are such a problem in the agricultural states that there is legislation against them. Many states have weed laws that require the farmer to use varying degrees of control against weedy plants. The "primary noxious weeds" are considered so bad that the land owner is required to destroy them if he discovers them on his property.

CHARACTERISTICS

There are certain biological features that many weedy plants have. Many grasses are excellent weeds because they:

- ☼ can persist from year to year in an area;
- ☼ reproduce vegetatively, by such means as rhizomes or stolons that allow the plants to spread quickly and efficiently;
- ☼ have seeds that can germinate in many different environments;
- ☼ have high seed production;
- ☼ set seed in a wide variety of conditions;
- ☼ have rapid seedling growth;
- ☼ have a "general purpose" set of genes that will enable the plants to compete very effectively against native plants when they are competing on disturbed sites;
- ☼ often contain multiple genomes derived through hybridization;
- ☼ are self-pollinated or substitute some asexual means of reproduction for a sexual one; and
- ☼ may be unpalatable or even toxic to livestock or herbivores.

If we were to construct the "perfect weedy grass," it would:

- ☼ be physically attractive
- ☼ mimic a crop
- ☼ be a perennial
- ☼ reproduce both sexually and asexually
- ☼ have long-lived seeds
- ☼ produce numerous seeds over a long period
- ☼ germinate its seeds early in the growing season
- ☼ germinate its seeds in many environments
- ☼ have rapid seedling growth
- ☼ be unpalatable to livestock
- ☼ have chemical/physical defense mechanisms
- ☼ thrive in disturbed habitats.

Can we say anything positive about weeds? Certainly! In ruined and abandoned areas, weeds make up much of the flora. Many of the more attractive plants that city folks see these days are weeds. They also retard or prevent erosion along many of our roadsides.

NOXIOUS GRASSES & SEDGES OF CALIFORNIA*

Aegilops cylindrica	Jointed goat grass [B]
Aegilops ovata	Ovate goat grass [B]
Aegilops triuncialis	Barb goat grass [B]
Elymus caput-medusae	Medusa head grass [C]
Elymus repens	Quack grass [B]
Cenchrus echinatus	Southern sand bur [C]
Cenchrus incertus	Coast sand bur [C]
Cenchrus longispinus	Mat sand bur [C]
Cynodon	Bermuda grass [C]
Cyperus esculentus	Yellow nut grass [B]
Cyperus rotundus	Purple nut grass [B]
Heteropogon contortus	Tanglehead [A]
Imperata cylindrica	Satintail [B]
Muhlenbergia schreberi	Nimblewill [B]
Oryza rufipogon	Perennial wild red rice [B]
Panicum antidotale	Blue panic grass [B]
Pennisetum clandestinum	Kikuyu grass [C]
Setaria faberi	Giant foxtail [B]
Sorghum halepense	Johnson grass [C]
Stipa brachychaeta	Puna grass [A]

Ratings:

A = Subject to state enforced action involving eradication, quarantine, containment, rejection, or other holding action at state or county level

B = Subject to eradication, containment, control, or other holding action at the discretion of the county commissioner

C = Not subject to state enforced action, except to retard spread

[Source: California Dept. of Food & Agriculture]

GRASSES: EXOTIC PEST PLANT LIST

A. Pest Plants of Greatest Ecological Concern:

Aegilops triuncialis (barbed goat grass)
Avena barbata (slender wild oat)
Avena fatua var. *fatua* (wild oat)
Brachypodium distachyon (false brome)
Bromus diandrus (ripgut brome)
Lolium multiflorum (Italian ryegrass)
Schismus arabicus (Mediterranean grass)
Schismus barbatus (Mediterranean grass)

B. Potential to Spread Explosively:

Spartina anglica (cord grass)
Spartina densiflora (dense-flowered cord grass)
Spartina patens (salt-meadow cord grass)

C. Most Invasive Pest Plants (Widespread):

Ammophila arenaria (European beach grass)
Arundo donax (giant reed)
Bromus tectorum (cheat grass)
Cortaderia jubata (Andean pampas grass)
Cortaderia selloana (pampas grass)
Elymus caput-medusae (medusa head)
Pennisetum setaceum (fountain grass)

D. Most Invasive Pest Plants (Regional):

Bromus rubens (red brome)
Ehrharta calycina (veldt grass)
Spartina alterniflora (smooth cord grass)

E. Wildland Plants of Lesser Invasiveness:

Ehrharta erecta (veldt grass)
Festuca arundinacea (tall fescue)
Holcus lanatus (velvet grass)
Phalaris aquatica (Harding grass)
Ischaemum rugosum (murain grass)
Nassella trichotoma (serrated tussock)
Leptochloa chinensis (Asian sprangletop)
Oryza longistaminata (red rice)

Oryza punctata (red rice)
Oryza rufipogon (red rice)
Paspalum scrobiculatum (Kodo millet)
Pennisetum clandestinum (kikuyu grass)
Pennisetum macrourum (African feather grass)

Pennisetum pedicellatum (kyasuma grass)
Pennisetum polystachion (mission grass)
Rottboellia cochinchinensis (itch grass)
Saccharum spontaneum (wild sugarcane)
Setaria pallide-fusca (cattail grass)
Urochloa panicoides

[Source: California Exotic Pest Council]

FEDERALLY LISTED GRASSES
[Listed as of 08 September 2000]

Avena sterilis (animated oat)
Chrysopogon aciculatus (pilipiliula)
Digitaria abyssinica (African couch grass)
Digitaria velutina (velvet finger grass)
Imperata brasiliensis (Brazilian satintail)

Imperata cylindrica (cogon grass)

A CHECKLIST OF WEEDY GRASSES OF THE UNITED STATES

Aegilops cylindrica
Aegilops geniculata
Aegilops triuncialis
Agropyron cristatus
Agrostis canina
Agrostis gigantea
Agrostis stolonifera
Agrostis tenuis
Alopecurus aequalis
Alopecurus geniculatus
Alopecurus myosuroides
Alopecurus rendlei
Andropogon gerardii
Andropogon glomeratus
Andropogon ternarius
Andropogon virginicus
Anthoxanthum aristatum
Anthoxanthum odoratum
Apera spica-venti
Aristida adscensionis
Aristida longiseta
Aristida oligantha
Arrhenatherum elatius
Arundo donax
Avena barbata
Avena fatua
Avena sterilis
Axonopus affinis
Axonopus compressus

Bothriochloa saccharoides
Bouteloua aristidoides
Bouteloua gracilis
Brachiaria fasciculata
Brachiaria mutica
Brachiaria plantaginea
Brachiaria platyphylla
Brachiaria reptans
Brachiaria texana
Brachypodium distachyon
Briza maxima
Briza media
Briza minor
Bromus arvensis
Bromus catharticus
Bromus commutatus
Bromus diandrus
Bromus erectus
Bromus hordeaceus
Bromus inermis
Bromus japonicus
Bromus lanceolatus
Bromus rigidus
Bromus rubens
Bromus secalinus
Bromus sterilis
Bromus tectorum

Catapodium rigidum
Cenchrus biflorus
Cenchrus brownii
Cenchrus ciliaris
Cenchrus echinatus
Cenchrus incertus
Cenchrus longispinus
Cenchrus myosuroides
Cenchrus pauciflorus
Cenchrus tribuloides
Chloris gayana
Chloris polydactylon
Chloris virgata
Coix lacryma-jobi
Cynodon dactylon
Cynosurus cristatus
Cynosurus echinatus

Dactyloctenium aegyptium
Deschampsia cespitosa
Deschampsia flexuosa
Dichanthium annulatum
Dichanthium aristatum
Digitaria ciliaris
Digitaria filiformis
Digitaria horizontalis
Digitaria ischacne
Digitaria longiflora
Digitaria sanguinalis
Digitaria violaceus

Echinochloa colona
Echinochloa crus-galli
Echinochloa crus-pavonis
Eleusine indica
Elymus caninus
Elymus caput-medusae
Elymus repens
Eragrostis barrelieri
Eragrostis cilianensis
Eragrostis curvula
Eragrostis mexicana
Eragrostis minor
Eragrostis pectinacea
Eragrostis pilosa
Eragrostis tenella
Eragrostis unioloides
Eragrostis virescens
Eriochloa gracilis
Eriochloa punctata

Festuca arundinacea
Festuca ovina
Festuca rubra

Heteropogon contortus
Holcus lanatus
Holcus mollis
Hordeum jubatum
Hordeum leporinum
Hordeum murinum
Hordeum pusillum

Imperata brasiliensis
Imperata cylindrica

Koeleria phleoides
Koeleria pyramidata

Lagurus ovatus
Lamarckia aurea
Leersia hexandra
Leersia oryzoides
Leptochloa fascicularis
Leptochloa filiformis
Leptochloa scabra
Leptochloa unnervia
Leptochloa virgata
Lolium multiflorum
Lolium perenne
Lolium persicum
Lolium remotum
Lolium temulentum

Melinis repens
Microstegium vimineum
Miscanthus floridus
Muhlenbergia schreberi

Oplismenus hirtellus
Oryza rufipogon
Oryzopsis miliacea

Panicum antidotale
Panicum capillare
Panicum clandestinum
Panicum dichotomiflorum
Panicum dichotomiflorum
Panicum gattingeri
Panicum maximum
Panicum miliaceum
Panicum obtusum
Panicum repens
Panicum trichoides
Panicum virgatum
Paspalidium geminatum
Paspalum ciliatifolium
Paspalum conjugatum
Paspalum dilatatum
Paspalum distichum
Paspalum fluitans
Paspalum laeve
Paspalum lividum
Paspalum notatum
Paspalum paspaloides
Paspalum plicatulum
Paspalum scrobiculatum
Paspalum urvillei
Paspalum vaginatum
Paspalum virgatum
Pennisetum americanum
Pennisetum clandestinum
Pennisetum polystachyon
Pennisetum purpureum
Pennisetum villosum
Phalaris aquatica

Phalaris arundinacea
Phalaris brachystachya
Phalaris canariensis
Phalaris minor
Phalaris phalaroides
Phragmites australis
Poa annua
Poa bulbosa
Poa compressa
Poa pratensis
Poa trivialis
Polypogon monspeliensis
Polypogon viridis

Rottboellia cochinchinensis

Schizachyrium scoparium
Setaria barbata
Setaria faberi
Setaria glauca
Setaria gracilis
Setaria italica
Setaria lutescens
Setaria palmifolia
Setaria sphacelata
Setaria verticillata
Setaria viridis
Sorghum bicolor
Sorghum halepense
Sporobolus airoides
Sporobolus juncea
Sporobolus neglectus
Sporobolus pyramidalis
Sporobolus vaginiflorus
Sporobolus virginicus
Stenotaphrum secundatum

Tragus berteronianus
Tragus racemosus

Vulpia bromoides
Vulpia myuros

Zoysia matrella

MAJOR WEEDY GRASSES OF THE WORLD

Arundinoideae

Arundineae
Phragmites australis
Phragmites karka

Chloridoideae

Cynodonteae
Cynodon dactylon

Eragrostideae
Dactyloctenium aegyptium
Eleusine indica
Leptochloa chinensis
Leptochloa panicea

Ehrhartoideae

Oryzeae
Leersia hexandra

Panicoideae

Paniceae
Axonopus compressus
Brachiaria mutica
Cenchrus echinatus
Digitaria abysinnica
Digitaria ciliaris
Digitaria sanguinalis
Echinochloa colona
Echinochloa crus-galli
Imperata cylindrica
Ischaemum rugosum
Panicum maximum
Panicum repens
Paspalum conjugatum
Paspalum dilatatum
Pennisetum clandestinum
Pennisetum pedicellatum
Pennisetum polystachion
Pennisetum purpureum
Rottboellia cochinchinensis
Setaria verticillata
Setaria viridis
Sorghum halepense

Pooideae

Aveneae
Avena fatua

Poeae
Lolium temulentum

[Source: Chapman & Peat, 1992: 86]

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4.10 - ORNAMENTAL & LAWN GRASSES

Grasses have, of course, long been used for lawns. Less appreciated has been their use as more showy ornamentals. You may have noticed how many more grasses are now being offered for landscaping purposes and that there are now a number of books on ornamental grasses available.

HERBACEOUS ORNAMENTALS

Agrostis nebulosa (cloud grass)
Alopecurus lanatus (woolly foxtail grass)
Alopecurus pratensis (foxtail grass)
Ampelodesmos mauritanicus (dis grass)
Andropogon gerardii (big bluestem)

Andropogon glomeratus (bushy bluestem)
Andropogon ternarius (split beard bluestem)
Anthoxanthum odoratum (velvet grass)
Apera spica-venti (silky bent)
Aristida purpurea (purple three-awn grass)

Arrhenatherum elatius (tall oat grass)
Arundo donax (giant reed, carrizo)
Arundo pliniana (arrow-reed)
Avena sterilis (animated oat)
Beckmannia syzigachne (slough grass)

Bothriochloa barbinodis (cane bluestem)
Bouteloua curtipendula (side-oats grama)
Bouteloua gracilis (blue grama)
Briza maxima (giant quaking grass)
Briza media (common quaking grass)

Bromus brizaeformis (rattlesnake chess)
Bromus ramosus (wood brome)
Calamagrostis acutiflora (feather reed grass)
Calamagrostis arundinacea (fall-blooming reed grass)
Calamagrostis canescens (purple small reed)

Calamagrostis epigejos (bush grass)
Chasmanthium latifolium (wild-oats)
Chloris virgata (finger grass)
Coix lacryma-jobi (Job's tears)
Cortaderia fulvida (erect-plumed tussock grass)

Cortaderia jubata (purple pampas grass)
Cortaderia selloana (pampas grass)
Cymbopogon citratus (lemon grass)
Cynodon dactylon (Bermuda grass)
Dactylis glomerata (orchard grass)

Deschampsia caespitosa (tufted hair grass)
Deschampsia flexuosa (crinkled hair grass)
Elymus arenarius (blue lyme grass)
Elymus hystrix (bottlebrush grass)
Elymus magellanicus (Magellan blue grass)
Eragrostis curvula (weeping love grass)

Eragrostis spectabilis (purple love grass)
Eragrostis suaveolens
Eragrostis tef (teff)
Eragrostis trichodes (sand love grass)
Erianthus contortus (bent awn plume grass)
Erianthus giganteus (sugar cane plume grass)
Erianthus ravennae (ravenna grass)
Festuca geniculata
Festuca gigantea (giant fescue)
Festuca ovina (sheep fescue)
Glyceria maxima (reed manna grass)
Gynerium sagittatum (uva grass)
Helictotrichon sempervirens (blue oat grass)

Holcus mollis (velvet grass)
Hordeum jubatum (foxtail barley, squirreltail)
Koeleria brevis (blue hair grass)
Koeleria glauca (large blue hair grass)
Lagurus ovatus (hare's tail, rabbit-tail grass)

Lamarckia aurea (golden top)
Melica altissima (Siberian melic)
Melica ciliata (hairy melic)
Melica uniflora (wood melic)
Melinis repens (ruby grass, Natal grass)

Mibora minima (sand bent)
Milium effusum (wood millet)
Miscanthus giganteus (Chinese silver grass)
Miscanthus nepalensis (Himalaya fairy grass)
Miscanthus sacchariflorus (eulalia)

Miscanthus sinensis (eulalia)
Miscanthus transmorrisonensis (evergreen miscanthus)
Molinia caerulea (purple moor grass)
Muhlenbergia dumosa (bamboo muhly)
Muhlenbergia emersleyi (bull grass)

Muhlenbergia filipes (purple muhly)
Muhlenbergia rigens (deer grass)
Oplismenus hirtellus (basket grass)
Oplismenus imbecillicus (basket grass)
Oryza sativa (rice)

Oryzopsis miliacea (smilo grass, rice grass)
Panicum miliaceum (common millet, proso m.)
Panicum virgatum (switch grass)
Pennisetum alopecuroides (Chinese pennisetum)
Pennisetum caudatum (white-flowering feather grass)

Pennisetum latifolium (Uruguay pennisetum)
Pennisetum macrostachyum
Pennisetum orientale (Oriental feather grass)
Pennisetum setaceum (fountain grass)
Pennisetum villosum (feathertop)

Phalaris arundinacea (reed canary grass)
Phalaris canariensis (canary grass)
Phragmites australis (common reed)
Phragmites macra (hakone grass)
Polypogon monspeliensis (annual beard grass)

Saccharum officinarum (sugar cane)
Schizachyrium scoparium (little bluestem)
Sesleria caerulea (blue moor grass)
Setaria italica (foxtail millet)
Setaria lutescens (yellow foxtail)
Setaria palmifolia (palm grass)
Setaria poiretiana (Poiret's bristle grass)

Sorghum bicolor (sorghum, African millet)
Sorghastrum nutans (Indian grass)
Spartina pectinata (prairie cord grass)
Spodiopogon sibericus (frost grass)
Stenotaphrum secundatum (St. Augustine grass)

Stipa arundinacea (pheasant's tail grass)

Stipa calamagrostis
Stipa capillata (feather grass)
Stipa gigantea (golden oats)
Stipa hymenoides (Indian rice grass)

Stipa ichu (Peruvian feather grass)
Stipa pennata (European feather grass)
Stipa ramosissima (pillar of smoke)
Stipa splendens (chee grass)
Stipa tenacissima (esparto)

Themeda triandra (Japanese themeda)
Thysanolaena maxima (tiger grass)
Tripsacum dactyloides (eastern gama grass)
Uniola latifolia (sea-oats)
Zea mays (maize, corn)
Zizania aquatica (wild-rice)

ORNAMENTAL BAMBOOS

Arundinaria amabilis (Tonkin bamboo)
Arundinaria disticha (dwarf fernleaf bamboo)
Arundinaria humilis
Arundinaria simonii (Simon bamboo, medake)
Arundinaria variegata (dwarf whitestripe bamboo)

Bambusa arundinacea (giant thorny bamboo)
Bambusa beecheyana (Beechey bamboo)
Bambusa glaucescens (hedge bamboo)
Bambusa oldhamii (timber bamboo, Oldham's bamboo)
Bambusa pervariabilis

Bambusa polymorpha
Bambusa textilis
Bambusa tulda
Bambusa tuldoides (punting pole bamboo)
Bambusa ventricosa (Buddha's belly bamboo)

Bambusa vulgaris
Chimonobambusa falcata
Chimonobambusa marmorea (marbled bamboo)
Chimonobambusa quadrangularis (square-stem b.)
Dendrocalamus asper

Dendrocalamus latiflorus (sweet bamboo)
Dendrocalamus strictus (Calcutta bamboo, male b.)
Phyllostachys aurea (fishpole bamboo)
Phyllostachys aureosulcata (yellowgroove bamboo)
Phyllostachys bambusoides (madake, timber bamboo)
Phyllostachys dulcis (sweetshoot bamboo)
Phyllostachys flexuosa
Phyllostachys eyeri (Meyer's bamboo)

Phyllostachys nigra (black bamboo, Henon's bamboo)
Phyllostachys nuda
Phyllostachys pubescens (moso bamboo)
Phyllostachys viridi-glaucescens
Phyllostachys viridis

Phyllostachys vivax
Pseudosasa japonica (metake, arrow bamboo)
Sasa disticha (dwarf fernleaf bamboo)
Sasa palmata (palmate bamboo)
Sasa tessellata

Sasa veitchii (kumazasa)
Semiarundinaria fastuosa (narihira bamboo)
Semiarundinaria murieiae
Semiarundinaria nitida
Shibataea kumasaca
Yoshania aztecorum

LAWN GRASSES

Agrostis palustris (creeping bent grass)
Agrostis tenuis (colonial gent grass)
Cynodon dactylon (Bermuda grass)
Eremochloa ophuroides (centipede grass)
Festuca arundinacea (tall fescue)

Festuca longifolia (hard fescue)
Festuca rubra (red fescue)
Lolium multiflorum (annual rye grass)
Lolium perenne (perennial rye grass)
Paspalum notatum (Bahia grass)

Paspalum vaginatum (seashore paspalum)
Poa pratensis (Kentucky blue grass)
Poa trivialis (rough-stalk blue grass)
Stenotaphrum secundatum (St. Augustine grass)
Zoysia matrella (zoysia)

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4.11 - ENDEMIC GRASSES

Agrostis ampla (western bent grass)	OR, CA
Agrostis aristiglumis (awned bent grass)	Marin Co., CA
Agrostis blasdalei var. *blasdalei* (Blasdale's bent grass)	CA
Agrostis blasdalei var. *marinensis* (Marin bent grass)	CA
Agrostis clivicola var. *clivicola* (coastal bluff bent grass)	CA
Agrostis clivicola var. *punta-reyesensis* (Pt. Reyes bent grass)	CA
Agrostis densiflora (California bent grass)	OR, CA
Agrostis exarata var. *minor* (spike bent grass)	NM
Agrostis hallii (Hall's bent grass)	OR, CA
Agrostis hendersonii (Henderson's bent grass)	OR, CA
Agrostis hooveri (Hoover's bent grass)	CA
Agrostis howellii (Howell's bent grass)	OR
Agrostis lepida (Sequoia bent grass)	CA
Agrostis longiligula	*???*
Agrostis microphylla var. *major*	*???*
Alopecurus aequalis var. *sonomensis* (Sonoma foxtail)	CA
Alopecurus howellii (Howell's meadow foxtail)	WA, OR
Amphicarpum amphicarpon (annual peanut grass)	eastern U. S.
Amphicarpum muhlenbergianum (blue maiden cane)	southeastern U. S.
Andropogon arctatus (pinewoods bluestem)	AL, FL
Andropogon floridanus (Florida bluestem)	GA, AL, FL
Andropogon glomeratus var. *glaucopsis* (purple bluestem)	southeastern U. S.
Andropogon gyrans var. *stenophyllus* (Elliott's bluestem)	TX to NC
Andropogon liebmannii (Liebmann's bluestem)	southeastern U. S.
Andropogon ternarius var. *cabanisii*	FL
Andropogon tracyi (Tracy's bluestem)	southeastern U. S.
Andropogon virginicus var. *decipiens* (broom-sedge bluestem)	southeastern U. S.
Andropogon virginicus var. *glaucus* (chalky bluestem)	NJ to TX
Anthaenantia rufa (purple silky scale)	southeastern U. S.

Anthaenantia villosa (green silky scale) — southeastern U. S.

Aristida condensata (big three-awn) — southeastern U. S.
Aristida desmantha (sand three-awn) — central U. S.
Aristida dichotoma var. *curtissii* (Curtiss's three-awn) — central & southeastern U. S.
Aristida dichotoma var. *dichotoma* (churchmouse three-awn) — central & eastern U. S.
Aristida gyrans (corkscrew three-awn) — GA, FL

Aristida lanosa var. *lanosa* (woolly sheathed three-awn) — eastern U. S.
Aristida mohrii (Mohr's three-awn) — southeastern U. S.
Aristida palustris (long leaf three-awn) — southeastern U. S.
Aristida patula (tall three-awn) — FL
Aristida purpurascens var. *tenuispica* (Hillsboro three-awn) — NC to MS

Aristida purpurascens var. *virgata* (pinewoods three-awn) — southeastern U. S.
Aristida ramosissima (s-curve three-awn) — central & eastern U. S.
Aristida rhizomorpha (Florida three-awn) — FL
Aristida schiediana var. *orcuttiana* (single three-awn) — southeastern U. S.
Aristida simpliciflora (Chapman's three-awn) — southeastern U. S.

Aristida tuberculosa (seaside three-awn) — eastern U. S.
Arundinaria gigantea ssp. *gigantea* (switch cane) — DE to TX, FL
Arundinaria gigantea ssp. x *macrosperma* (switch cane) — VA to AL
Arundinaria gigantea ssp. *tecta* (switch cane) — southeastern U. S.
Blepharidachne kingii (King's eyelash grass) — CA, ID, UT, NV

Bothriochloa exaristata (awnless bluestem) — CA, TX, LA
Bothriochloa hybrida (hybrid bluestem) — TX, LA
Bouteloua kayi (Kay's grass) — Brewster Co., TX
Brachyelytrum erectum (bearded shorthusk) — eastern & central U. S.
Bromus berterianus var. *excelsus* (Chilean chess) — CA, AZ ???
Bromus frondosus (weeping brome) — southwestern U. S.
Bromus grandis (tall brome) — CA +++ ???
Bromus kalmii (Kalm's brome) — north-central & northeastern U. S.

Bromus laevipes (woodland brome) — WA, OR, NV, CA
Bromus luzonensis (hoary brome) — WA, OR, CA, ID, NV
Bromus marginatus (mountain brome) — western & central U. S.
Bromus maritimus (maritime brome) — OR, CA
Bromus orcuttianus var. *hallii* (Orcutt's brome) — CA

Bromus polyanthus var. *paniculatus* (Great Basin brome) — southwestern U. S.
Bromus polyanthus var. *polyanthus* (Colorado brome) — western U. S.
Bromus pseudolaevipes (woodland brome) — CA
Bromus suksdorfii (Suksdorf's brome) — WA, OR, ID, CA, NV
Calamagrostis bolanderi (Bolander's reed grass) — CA

Calamagrostis breweri (Brewer's reed grass) — OR, CA
Calamagrostis cainii (Cain's reed grass) — TN, NC
Calamagrostis californica — ???
Calamagrostis coarctata (Nuttall's reed grass) — eastern & southeastern U. S.
Calamagrostis fernaldii (Fernald's reed grass) — Piscataquis Co., ME

Calamagrostis foliosa (leafy reed grass) — CA
Calamagrostis howellii (Howell's reed grass) — WA, OR
Calamagrostis koelerioides (tufted pine grass) — western U. S.
Calamagrostis x *lactea* (bluejoint) — WA, OR, CA
Calamagrostis muriana (Muir's reed grass) — CA

Calamagrostis ophiditis (serpentine reed grass) — CA
Calamagrostis perplexa (wood reed grass) — Tompkins Co., NY
Calamagrostis porteri ssp. *inseparata* (Porter's reed grass) — eastern U. S.
Calamagrostis porteri ssp. *porteri* (Porter's reed grass) — eastern U. S.
Calamagrostis scopulorum (Jones' reed grass) — western U. S.

Calamagrostis tweedyi (Tweedy's reed grass) — WA, MT, ID
Calammophila don-hensonii (Henson's reed grass) — MI
Calamovilfa arcuata (Cumberland sand reed) — OK, AR, AL, TN
Calamovilfa brevipilis var. *brevipilis* (pine barren sand reed) — NJ to SC
Calamovilfa brevipilis var. *calvipes* — VA

Calamovilfa curtisii (Florida sand reed) — FL
Calamovilfa gigantea (big sand reed) — south-central & southwestern U. S.
Chasmanthium laxum var. *laxum* (spike grass) — southeastern U. S.

Chasmanthium laxum var. *sessiliflorum* (long leaf uniola)	southeastern U. S.
Chasmanthium nitidum (shiny uniola)	southeastern U. S.
Chasmanthium ornithorhynchum (bird bill uniola)	southeastern U. S.
Chloris x *subdolichostachya* (short-spike windmill grass)	AZ to KS, LA
Chloris texensis (Texas windmill grass)	TX
Cinna bolanderi (Bolander's reed grass)	CA
Coelorachis cylindrica (Carolina joint-tail)	southeastern U. S.
Coelorachis rugosa (wrinkled joint-tail)	southeastern U. S.
Coelorachis tessellata (lattice joint-tail)	LA to FL
Coelorachis tuberculosa (Florida joint-tail)	southeastern U. S.
Ctenium aromaticum (toothache grass)	VA to FL, LA
Ctenium floridanum (Florida toothache grass)	GA, FL
Danthonia epilis (Carolina oat grass)	southeastern U. S.
Danthonia sericea (downy oat grass)	eastern U. S.
Digitaria arenicola (sand witch grass)	TX
Digitaria cognata (fall witch grass)	eastern & central U. S.
Digitaria filiformis var. *filiformis* (Caribbean crab grass)	southeastern U. S. ???
Digitaria floridana (Florida crab grass)	Hernando Co., FL
Digitaria horizontalis (Jamaica crab grass)	southeastern U. S. ???
Digitaria leucocoma	Lake Co., FL
Digitaria pauciflora (two-spike finger grass)	Dade Co., FL
Digitaria pubiflora (western witch grass)	southwestern U. S.
Digitaria simpsonii (Simpson's	
Dissanthelium californicum (Catalina grass)	CA (CFP)
Elyhordeum californicus	*???*
Elyhordeum iowense (Iowa barley)	MT, ND, NB, IA
Elyhordeum piperi (Piper's barley)	WA
Elyhordeum stebbinsianum (Stebbins' barley)	WA, OR, CA
Elymus ambiguus var. *ambiguus* (Rocky Mountain lyme grass)	UT, MT to NM
Elymus arenicola (sand lyme grass)	WA, OR, MT, ID
Elymus x*aristatus* (purple wheat grass)	western U. S.
Elymus arizonicus (Arizona wild rye)	CA, AZ, NM, TX
Elymus californicus (California bottlebrush)	CA
Elymus elymoides ssp. *hordeoides* (western squirreltail)	WA, OR, ID, CA, NV
Elymus flavescens (sand lyme grass)	WA, OR, ID, SD
Elymus laevis (California wild rye)	CA
Elymus x *multiflorus*	CA, CFP ?
Elymus multisetus (big wild rye)	western U. S.
Elymus pacificus (Pacific wild rye)	CA
Elymus salinus ssp. *mojavensis* (Salina wild rye)	CA, AZ
Elymus salinus ssp. *salinus* (Salina wild rye)	western U. S.
Elymus sierrae (Sierra wild rye)	CA, NV
Elymus simplex (smooth wild rye)	western U. S.
Elymus stebbinsii ssp. *septentrionalis* (Stebbins' wild rye)	CA
Elymus stebbinsii ssp. *stebbinsii* (Stebbins' wild rye)	CA
Elymus trachycaulus ssp. *sierrus*	Source ???
Elymus villosus var. *arkansanus* (hairy wild rye)	central & eastern U. S.
Eragrostis bahiensis (bahia love grass)	LA, AL, FL
Eragrostis lutescens (six week's love grass)	WA, CA, NV, CO, AZ, NM
Eragrostis pectinacea var. *miserrima* (desert love grass)	TX to FL
Eragrostis pectinacea var. *tracyi* (Tracy's love grass)	FL
Eragrostis refracta (coastal love grass)	southeastern U. S.
Eragrostis swallenii (Swallen's love grass)	TX
Eragrostis trichodes (sand love grass)	central & eastern U. S.
Eriochloa michauxii var. *michauxii* (long leaf cup grass)	southeastern U. S.
Eragrostis michauxii var. *simpsonii* (Simpson's cup grass)	FL
Eustachys floridana (Florida finger grass)	AL, GA, FL
Eustachys glauca (salt marsh windmill grass)	southeastern U. S.
Eustachys neglecta (four-spike windmill grass)	FL
Festuca arizonica (Arizona fescue)	AZ, CO, NM, TX
Festuca brachyphylla ssp. *coloradensis* (alpine fescue)	western U. S.

Festuca californica var. *californica* (California fescue)	OR, CA
Festuca calligera (southwestern fescue)	southwestern U. S.
Festuca dasyclada (Utah fescue)	UT, CO
Festuca elliotea (squirrel-tail six-weeks grass)	south-central & southeastern U. S.
Festuca elmeri (Elmer's fescue)	WA, OR, CA
Festuca howellii (Howell's fescue)	WA, OR, CA
Festuca kingii (spiked fescue)	western U. S.
Festuca ligulata (Guadalupe fescue)	TX
Festuca minutiflora (small-flowered fescue)	western U. S.
Festuca occidentalis (western fescue)	western U. S.
Festuca paradoxa (clustered fescue)	central & eastern U. S.
Festuca parishii (California fescue)	CA
Festuca prolifera (proliferous fescue)	ME, NM (Canada only ???)
Festuca rubra ssp. *arctica* (red fescue)	NH (+ ?)
Festuca rubra ssp. *deniuscula* (red fescue)	OR, CA
Festuca sororia (ravine fescue)	AZ, CO, UT, NM
Festuca thurberi (Thurber's fescue)	AZ, NM, CO, UT, WY
Festuca versuta (Texas fescue)	OK, TX
Festuca viridula (green leaf fescue)	western U. S.
Festuca washingtoniana (Washington fescue)	WA
Glyceria acutiflora (creeping manna grass)	eastern U. S.
Glyceria nubigena (Great Smoky Mountain manna grass)	NC, TN
Glyceria septentrionalis var. *arkansana* (Arkansas manna grass)	OK, TX, southeastern U. S.
Gymnopogon brevifolius (slim skeleton grass)	south-central & southeastern U. S.
Gymnopogon chapmanianus (Chapman's skeleton grass)	GA, FL
Helictotrichon mortonianum (Morton's alpine-oat)	UT, CO, NM
Hilaria jamesii (galleta)	western U. S.
Hordeum arizonicum (Arizona barley)	CA, AZ, NM
Hordeum brachyantherum ssp. *californicum* (California barley)	OR, CA, NV
Leersia hexandra (southern cut grass)	southeastern U. S.
Leersia lenticularis (catchfly grass)	eastern U. S.
Melica aristata (awned melic)	WA, OR, CA, NV, KT
Melica bulbosa var. *inflata*	WA, CA
Melica californica var. *californica* (California melic)	OR, CA
Melica californica var. *nevadensis* (California melic)	CA
Melica fugax (little onion grass)	WA, OR, CA, ID, NV
Melica geyeri var. *aristulata* (Geyer's onion grass)	CA
Melica geyeri var. *geyeri* (Geyer's onion grass)	OR, CA, NV
Melica imperfecta (coast range melic)	CA (CFP)
Melica mutica (two-flowered melic)	eastern U. S.
Melica porteri var. *laxa* (Porter's melic)	AZ, NM, TX
Melica porteri var. *porteri* (Porter's melic)	UT, CO, AZ, NM, TX
Melica stricta var. *albicaulis* (nodding onion grass)	CA
Melica stricta var. *stricta* (nodding onion grass)	OR, CA, NV, UT
Melica subulata var. *pammelii* (Pammel's onion grass)	ID, MT, WY
Melica torreyana (Torrey's melic)	CA
Muhlenbergia bushii (nodding muhly)	central & eastern U. S.
Muhlenbergia californica (California muhly)	CA [extinct]
Muhlenbergia expansa (cutover muhly)	southeastern U. S.
Muhlenbergia filiculmis (slim stem muhly)	southwestern U. S.
Muhlenbergia jonesii (Modoc muhly)	CA
Muhlenbergia pungens (sandhill muhly)	western & central U. S.
Muhlenbergia reverchonii (seep muhly)	OK, TX
Muhlenbergia sericea (dune hair grass)	southeastern U. S.
Muhlenbergia thurberi (Thurber's muhly)	NV, UT, CO, AZ, NM
Muhlenbergia torreyana (New Jersey muhly)	northeastern U. S.
Muhlenbergia villiflora var. *villosa* (hairy muhly)	NM, TX
Muhlenbergia virescens (screw-leaf muhly)	AZ, NM
Neostapfia colusana (Colusa grass)	CA
Orcuttia californica (California orcutt grass)	CA (CFP)
Orcuttia inaequalis (San Joaquin Valley orcutt grass)	CA

Orcuttia pilosa (hairy Orcutt grass) CA
Orcuttia tenuis (slender Orcutt grass) CA
Orcuttia viscida (Sacramento Orcutt grass) Sacramento Co., CA
Oryzopsis contracta (contracted rice grass) MT, WY, CO
Oryzopsis hendersonii (Henderson's rice grass) WA, OR, ID

Oryzopsis kingii (King's mountain-rice) CA
Oryzopsis porteri (Porter's needle grass) CO
Oryzopsis wallowaensis (Wallowa rice grass) OR
Oryzopsis webberi (Webber's rice grass) western U. S.
Panicum acuminatum var. *columbianum* northeastern U. S.

Panicum acuminatum var. *consanguineum* (blood panic grass) southeastern U. S.
Panicum acuminatum var. *sericeum* western U. S.
Panicum anceps var. *anceps* (beaked panic grass) south-central & southeastern U. S.
Panicum anceps var. *rhizomatum* (beaked panic grass) southeastern U. S.
Panicum boscii (Bosc's panic grass) eastern U. S.

Panicum brachyantherum (pimple panic grass) OK, TX, AR, LA, MS
Panicum capillare var. *hillmanii* (Hillman's panic grass) CA, IA, south-central U. S.
Panicum chamaelonche var. *breve* FL
Panicum consanguineum (Kunth's panic grass) southeastern U. S.
Panicum dichotomiflorum var. *puritanorum* eastern U. S.

Panicum dichotomum var. *glabrifolium* (fall panic grass) FL
Panicum dichotomum var. *lucidum* (fall panic grass) eastern & southeastern U. S.
Panicum dichotomum var. *mattamuskeetense* MA to FL
Panicum dichotomum var. *nitidum* southeastern U. S.
Panicum ensifolium var. *curtifolium* southeastern U. S.

Panicum ensifolium var. *breve* FL
Panicum gymnocarpon (savanna) southeastern U. S.
Panicum malacophyllum (soft-leaved panic grass) central & eastern U. S.
Panicum mohavense (Mohave panic grass) AZ, NM
Panicum philadelphicum ssp. *lithophilum* GA, NC, SC

Panicum philadelphicum ssp. *philadelphicum* (Philadelphia panic grass) eastern U. S.
Panicum ovale var. *pseudopubescens* (egg-leaf panic grass) central & eastern U. S.
Panicum perlongum (long-sheath panic grass) central U. S.
Panicum ravenelii (Ravenell's panic grass) eastern & southeastern U. S.
Panicum rigidulum var. *abscissum* (cut throat panic grass) FL

Panicum rigidulum var. *combsii* (Comb's panic grass) southeastern U. S.
Panicum rigidulum var. *elongatum* eastern U. S.
Panicum rigidulum var. *pubescens* southeastern U. S.
Panicum rigidulum var. *rigidulum* (redtop panic grass) CA, OR, eastern U. S.
Panicum scabriusculum (tall swamp panic grass) southeastern U. S.

Paspalum bifidum (pitchfork paspalum) southeastern U. S.
Paspalum distichum (knot grass) western, south-central, eastern U. S. ??
Paspalum floridanum var. *floridanum* (Florida paspalum) eastern U. S.
Paspalum laeve (field paspalum) eastern U. S.
Paspalum lividum (longtom) southeasternU. S.

Paspalum separatum TX ???
Paspalum setaceum var. *longepedunculatum* (bare stem paspalum) southeastern U. S.
Paspalum setaceum var. *muhlenbergii* (hurrah grass) central & eastern U. S.
Paspalum setaceum var. *psammophila* (sand paspalum) eastern U. S.
Paspalum setaceum var. *supinum* (supine paspalum) southeastern U. S.

Phalaris californica (California canary grass) OR, CA (CFP)
Phalaris lemmonii (Lemmon's canary grass) CA
Piptochaetium avenacioides (Florida needle grass) FL
Pleuropogon californicus var. californicus (California semaphore grass) CA
Pleuropogon californicum var. davyi (Davy's semaphore grass) CA

Pleuropogon hooverianus (Hoover's semaphore grass) CA
Pleuropogon oreganus (Oregon semaphore grass) OR
Poa arctica ssp. *aperta* (arctic blue grass) CO, WY, NM
Poa arctica ssp. *grayana* (Gray's blue grass) MT to NM, UT
Poa arnowiae (Arnow's blue grass) ID, UT

Poa atropurpurea (San Bernardino blue grass) CA
Poa autumnalis (autumn blue grass) OK, TX
Poa bolanderi (Bolander's blue grass) WA, OR, CA, ID, UT
Poa chambersii (Chambers' blue grass) Lane Co., OR
Poa chapmaniana (Chapman's blue grass) central & eastern U. S.

Poa curtifolia (Little Mountain blue grass) WA
Poa cusickii ssp. *cusickii* (Cusick's blue grass) WA, OR, CA, MT, ID, NV
Poa cuspidata (early blue grass) southeastern U. S.
Poa douglasii (sand dune blue grass) CA
Poa x *fibrata* ???

Poa hartzii ssp. *alaskana* (Hartz's blue grass) AK
Poa keckii (Keck's blue grass) CA
Poa liebergii (Leiberg's blue grass) WA, OR, ID
Poa macroclada ID, MT, CO
Poa x *multnomae* (Multnomah Falls blue grass) OR

Poa napensis (Napa blue grass) Napa Co., CA
Poa occidentalis (New Mexico blue grass) AZ, CO, NM, TX
Poa paludigena (bog blue grass) northeastern U. S.
Poa piperi (Piper's blue grass) OR, CA
Poa pringlei (Pringle's blue grass) OR, CA

Poa reflexa (nodding blue grass) western U. S.
Poa rhizomata (timber blue grass) OR, CA
Poa sierrae (Sierra blue grass) CA
Poa stebbinsii (Stebbins' blue grass) CA
Poa tenerrima (delicate blue grass) CA

Poa tracyi (Tracy's blue grass) CO, NM
Poa unilateralis ssp. *pachypholis* WA
Poa wolfii (Wolf's blue grass) eastern U. S.
Puccinellia howellii (Howell's alkali grass) Shasta Co., CA
Puccinellia parishii (Parish's alkali grass) CA, AZ, NM

Puccinellia simplex (little alkali grass) CA, UT
Puccinellia sublaevis (smooth alkali grass) AK
Redfieldia flexuosa (blowout grass) western & central U. S.
Saccharum alopecuroides (silver plume grass) southeastern U. S.
Saccharum baldwinii (narrow-plume plume grass) southeastern U. S.

Saccharum brevibarbe var. *brevibarbe* south-central & southeastern U. S.
Saccharum brevibarbe var. *contortum* (bent-awn plume grass) south-central & southeastern U. S.
Saccharum coarctum (bunched plume grass) southeastern U. S.
Schizachyrium maritimum (seashore false bluestem) LA, AL, MS, FL
Schizachyrium niveum (pine scrub false bluestem) FL

Schizachyrium rhizomatum (Florida false bluestem) FL
Schizachyrium scoparium var. *divergens* (little bluestem) south-central & southeastern U. S.
Schizachyrium scoparium var. *neomexicanum* (little bluestem) AZ, NM, TX
Schizachyrium scoparium var. *stoloniferum* (little bluestem) southeastern U. S.
Schizachyrium sericatum (little bluestem) Ramrod Key, FL

Scribneria bolanderi (Scribner's grass) WA, OR, CA
Setaria reverchonii ssp. firmula [ssp. not in K & M] TX ???
Sorghastrum elliottii (slender Indian grass) south-central & southeastern U. S.
Sorghastrum secundum (lop-sided Indian grass) southeastern U. S.
Spartina bakeri (sand cord grass) TX, GA, SC, FL

Spartina cynosuroides (big cord grass) MA to TX gulf coast
Sphenopholis filiformis (long-leaf wedge grass) southeastern U. S.
Sphenopholis longiflora (Texas wedge grass) TX, AR, LA
Sphenopholis x *pallens* (wedge grass) eastern U. S.
Sphenopholis pensylvanica (swamp wedge grass) eastern & southeastern U. S.

Sporobolus clandestinus (hidden dropseed) central & eastern U. S.
Sporobolus compositus var. *drummondii* (meadow dropseed) south-central & southeastern U. S.
Sporobolus compositus var. *macer* (Mississippi dropseed) south-central U. S.
Sporobolus coromandelianus (whorled dropseed) southwestern, central, & eastern U. S.
Sporobolus floridanus (Florida dropseed) AL ,GA, SC, FL

Sporobolus interruptus (black dropseed) AZ

Sporobolus pinetorum (Carolina dropseed)	NC, SC, GA
Sporobolus silveanus (Silveus' dropseed)	OK, TX, LA
Sporobolus teretifolius (wire-leaf dropseed)	NC, SC, GA, AL
Sporobolus texanus (Texas dropseed)	south-central & southwestern U. S.
Sporobolus tharpii (Tharp's dropseed)	Padre Island, TX
Stipa arida (funeral grass)	southwestern U. S.
Stipa californica (California needle grass)	WA, OR, CA, ID, NV
Stipa cernua (nodding needle grass)	CA
Stipa coronata (giant stipa)	CA (CFP)
Stipa diegoensis (San Diego needle grass)	CA (CFP)
Stipa x *latiglumis* (Yosemite needle grass)	CA
Stipa lemmonii var. *pubescens* (Crampton's needle grass)	CA
Stipa lepida (small-flowered needle grass)	CA, AZ (MX ???)
Stipa lettermanii (Letterman's needle grass)	western U. S.
Stipa lobata (little-awn needle grass)	AZ, NM, TX
Stipa nevadensis (Nevada rice grass)	western U. S.
Stipa occidentalis var. *occidentalis* (western needle grass)	CA (Canada ??)
Stipa perplexa (New Mexico rice grass)	UT, AZ, NM, TX
Stipa pinetorum (pine woods needle grass)	western U. S.
Stipa porteri (Porter's needle grass)	CO
Stipa pulchra (purple needle grass)	CA (CFP)
Stipa scribneri (Scribner's needle grass)	western & central U. S.
Stipa shoshoneana (Shoshone needle grass)	ID, NV
Stipa stillmanii (Stillman's needle grass)	CA
Stipa thurberiana (Thurber's needle grass)	western U. S.
Stipa webberi (Webber's mountain-rice)	western U. S.
Swallenia alexandrae (Eureka Valley dune grass)	Inyo Co., CA
Torreyochloa erecta (spiked alkali grass)	OR, CA, NV
Tridens ambiguus (pine barrens tridens)	NC to TX
Tridens buckleyanus (Buckley's tridens)	TX
Tridens carolinianus (Carolina fluff grass)	NC to LA
Tridens congestus (pink tridens)	TX
Tridens flavus var. *chapmanii* (Chapman's tridens)	KS to TX, southeastern U. S.
Tridens muticus var. *elongatus* (rough tridens)	southwest & south-central U. S.
Tridens strictus (long-spike tridens)	south-central & southeastern U. S.
Triplasis americana (perennial sand grass)	southeastern U. S.
Tripsacum floridanum (Florida gama grass)	FL
Trisetum orthocahaetium (bitter root false oat)	Missoula Co., MT
Trisetum projectum	CA
Tuctoria greenei (awnless spiral grass)	CA
Tuctoria mucronata (prickly spiral grass)	Solano Co., CA
Vaseyochloa multinervosa (Texas grass)	TX
Zizania texana (Texas wild-rice)	Hayes Co., TX

Revised: 12 January 2005

4.12 - INTRODUCED GRASSES WITH LIMITED DISTRIBUTION*

Acrachne racemosa (goose grass)	Riverside Co., CA
Aegilops crassa (Persian goat grass)	NY
Aegilops geniculata (ovate goat grass)	CA, VA, NY
Aegopogon cenchroides (Guatemalan fragile grass)	CA
Agropyron orientale (oriental wheat grass)	NY
Agropyron squarrosum	NY
Agrostis tandilensis (Argentine bent grass)	CA
Aira caryophyllea var. *cupiana* (silver hair grass)	CA
Alloteropsis cimicina (bug seed grass)	MD, FL
Alopecurus creticus (Cretan meadow foxtail)	PA (historic)

Alopecurus rendlei (Rendle's meadow foxtail)	PA
Ampelodesmos mauritanica (dis grass ... or it is dat grass?)	CA
Amphibromus neesii (wallaby grass)	CA
Amphibromus scabrivalvis (swamp wallaby grass)	CA, LA
Andropogon bicornis (barbas de indio)	FL
Anthephora hermaphrodita (old field grass)	FL
Apluda mutica (Mauritian grass)	MD
Avena occidentalis (western oat)	CA
Avena strigosa (black oat)	CA, MA
Bambusa multiplex (hedge bamboo)	FL
Bambusa oldhamii (Oldham's bamboo)	TX
Bambusa vulgaris (common bamboo)	SC, FL
Brachypodium caespitosum (false brome)	CA
Brachypodium phoenicoides (Mediterranean false brome)	CA
Brachypodium sylvaticum (slender false brome)	Benton Co., OR
Bromus alopecuros	Source ???
Bromus hordeaceus ssp. *pseudothominei* (soft brome)	MO, NY
Bromus lepidus (slender soft brome)	NY, CT, MA
Cenchrus biflorus (Indian sandbur)	AL, NY
Chloris barbata (swollen finger grass)	TX, LA
Chloris elata (many-flowered windmill grass)	MS, FL
Chloris pectinata (comb windmill grass)	SC (historic)
Chloris radiata (radiate windmill grass)	OR (extirpated?), FL
Chloris truncata (Australian finger grass)	CA, SC
Chloris ventricosa (plump windmill grass)	SC, VA
Chrysopogon fulvus (red false beard grass)	FL
Chrysopogon pauciflorus (Florida rhaphis)	TX, NC, FL
Chrysopogon zizanioides (khus-khus)	LA
Cladoraphis cyperoides (bristly love grass)	OR (historic)
Coleanthus subtilis (moss grass)	WA, OR
Cortaderia jubata (purple pampas grass)	OR, CA
Crypsis alopecuroides (foxtail prickle grass)	WA, OR, CA
Crypsis schoenoides (swamp prickle grass)	OR, CA, UT
Crypsis vaginiflora (modest prickle grass)	CA, NV, ID
Cutandia memphitica (Memphis grass)	CA
Cymbopogon iwarancusa (oil grass)	FL
Cymbopogon nardus (citronella grass)	FL
Cynodon aethiopicus (Ethiopian dogtooth grass)	TX, FL
Cynodon dactylon var. *aridus* (couch grass)	AZ
Cynodon dactylon var. x *magennisii* (Magennis' Bermuda grass)	TX, AL
Cynodon aristiglumis	Source ???
Cynodon nlemfuensis var. *nlemfuensis* (African Bermuda grass)	TX
Cynodon nlemfuensis var. *robustus* (African Bermuda grass)	TX
Cynodon plectostachyus (star grass)	CA
Dactylis glomerata var. *aschersoniana* (orchard grass)	NY
Dactyloctenium radulans (button grass)	AZ, MA, SC
Dasypyrum villosum (mosquito grass)	PA (historic)
Dendrocalamus latiflorus (giant bamboo)	NC
Dichanthium annulatum (Kleberg bluestem)	TX, LA, FL
Dichanthium sericeum (Queensland bluestem)	TX, FL
Digitaria longiflora (Indian crab grass)	FL
Digitaria milanjiana (Madagascar finger grass)	TX, FL
Digitaria nuda (naked crab grass)	FL
Digitaria setigera (East Indian crab grass)	FL
Dinebra retroflexa (viper grass)	CA, MD, NC
Echinochloa crusgalli ssp. *spiralis* (barnyard grass)	CA
Echinochloa esculenta (Japanese millet)	MO
Echinochloa oryzicola (late barnyard grass)	CA
Echinochloa oryzoides (early barnyard grass)	CA, LA
Echinochloa utilis	*Source ???*
Ehrharta calycina (weeping veldt grass)	CA, TX

Ehrharta erecta (panic veldt grass)	CA
Ehrharta longiflora (long-flowered veldt grass)	CA
Eleusine coracana ssp. *africana* (finger millet, ragi)	SC
Elyhordeum atlanticus (Russian quack grass)	OR, CA
Elymus pycnanthus (tick grass)	OR, NB, TX
Elymus racemosus (giant wild rye)	WA, OR (?), WY
Enneapogon cenchroides (soft feather pappus grass)	AZ
Enneapogon mollis (soft feather pappus grass)	AZ
Enteropogon dolichostachyus	SC
Enteropogon prieurii (Prieuri's umbrella grass)	NC, AL (historic)
Eragrostis airoides (darnel love grass)	Brazos Co., TX
Eragrostis atrovirens (thalia love grass)	FL
Eragrostis ciliaris var. *laxa* (gopher tail love grass)	FL
Eragrostis cylindriflora (tube-flowered love grass)	MD
Eragrostis echinochloidea (African love grass)	AZ, MD
Eragrostis elongata (long love grass)	DC, SC, FL
Eragrostis gangetica (slim-flowered love grass)	LA, MS, FL
Eragrostis plana (South African love grass)	SC
Eragrostis scaligera (tender love grass)	FL
Eragrostis setifolia (never-fail love grass)	SC
Eragrostis unioloides (Chinese love grass)	MD, GA, FL
Eremochloa ciliaris (centipede grass)	San Francisco Co., Ca (historic)
Eriochloa fatmensis (tropical cup grass)	CA, AZ, MS
Eriochloa leersioides (sharp cup grass)	CA (historic)
Eriochloa polystachya (Carib grass)	TX, MS, FL
Eriochloa pseudoacrotricha (vernal cup grass)	TX, MS
Eustachys distichophylla (weeping love grass)	CA, TX (?), GA, FL
Eustachys paspaloides var. *caribaea*	Source ???
Festuca arvernensis (blue fescue)	CA (?), NM
Festuca ciliata (fringed six-weeks grass)	PA
Festuca gigantea (giant fescue)	MI, CT, NY
Festuca heteromalla (spreading fescue)	WI
Festuca rigescens	AZ (historic)
Festulolium loliaceum	NY, SC
Fingerhuthia africana (zulu-fescue)	AZ
Gaudinia fragilis (fragile-oat)	Sonoma Co., CA
Glyceria declinata (waxy manna grass)	CA, LA, NY
Gynerium sagittatum (uva grass, wild cane)	FL
Hakonechloa macra (Hakone grass, Japanese forest grass)	UT
Hemarthria altissima (limpo grass)	TX, FL
Hordeum bulbosum (bulbous barley)	CA
Hyparrhenia hirta (thatch grass)	CA, TX, FL
Hyparrhenia rufa (jaraguá grass)	FL
Ischaemum indicum (Indian muraina grass)	MD
Ischaemum rugosum (ribbed muraina grass)	TX, MD
Lamarckia aurea (goldentop)	CA, AZ, TX
Leptochloa chloridiformis (Argentine sprangletop)	TX (historic)
Leptochloa digitata (cane sprangletop)	SC
Lolium temulentum ssp. *remotum* (poison darnel)	ND (historic)
Mibora minima (early sand grass)	NY, MA
Milium vernale (spring millet grass)	ID
Miscanthus floridulus (giant Chinese silver grass)	MO, AR
Muhlenbergia diversiglumis	Galveston Co., TX
Neyraudia arundinacea (Madagascar grass)	CA (unverified)
Neyraudia reynaudiana (Burma reed)	FL
Opizia stolonifera (Acapulco grass)	FL
Oplismenus hirtellus var. *hirtellus* (wood grass)	FL
Oplismenus hirtellus var. *undulatifolius* (basket grass)	MD
Oryza rufipogon (wild red rice)	CA, FL
Oryza sativa var. *fatua* (rice)	FL
Panicum alatum var. *alatum* (winged panic grass)	CA, AZ

Panicum alatum var. *longiflorum* (winged panic grass)	CA
Panicum bergii (Berg's panic grass)	TX, GA, AL
Panicum napaliense (Napal panic grass)	NM
Panicum paludosum (aquatic panic grass)	MD
Pappophorum pappiferum (limestone pappus grass)	(Peterson et al. 2001: 179)
Parapholis strigosa (hard grass)	Humboldt Co., CA
Paspalum almum (Comb's crown grass)	TX, LA
Paspalum coryphaeum (emperor crown grass)	FL
Paspalum fimbriatum (fringed crown grass)	FL
Paspalum malacophyllum (ribbed crown grass)	TX
Paspalum modestum (water paspalum)	TX, LA
Paspalum nicorae (Brunswick grass)	AL, GA, FL
Paspalum notatum var. *latiflorum*	TX (Source ???)
Paspalum wrightii (Wright's paspalum)	TX
Pennisetum advena (purple feather grass)	CA, TX
Pennisetum clandestinum (kikuyu grass)	CA, AZ
Pennisetum flaccidum (Himalayan fountain grass)	TX
Pennisetum latifolium (Uruguay fountain grass)	CA
Pennisetum macrourum (African feather grass)	CA
Pennisetum nervosum (bent-spike fountain grass)	CA, TX
Pennisetum orientale (laurisa grass)	TX
Pennisetum pedicellatum ssp. *unispiculum* (kyasuma grass)	FL
Pennisetum petiolare (petioled fountain grass)	IA
Pennisetum polystachyon ssp. *setosum* (West Indian pennisetum)	AZ, NV, FL
Pennisetum purpureum (Napier grass, elephant grass)	CA, TX, FL
Phalaris aquatica (Harding grass)	OR, CA
Phalaris coerulescens	CA
Phleum arenarium (sand timothy)	OR, MA, NY
Phleum paniculatum (British timothy)	OR, NY
Phleum subulatum (Italian timothy)	OR, MA, PA
Phragmites karka (tall reed)	TX
Phyllostachys dulcis (sweet shoot bamboo)	MA
Phyllostachys flexuosa (zig-zag bamboo)	MD
Phyllostachys meyeri (Meyer's bamboo)	MD
Phyllostachys rubromarginata (red-margined bamboo)	SC
Phyllostachys viridiglauscens (green-wax golden bamboo)	NJ
Piptochaetium setosum (bristly spear grass)	CA
Piptochaetium stipoides var. *purpurascens*	CA
Pleioblastus humilis (dwarf bamboo)	CA
Pleioblastus simonii (Simon's bamboo)	NV, GA
Poa chaixii (Chaix's spear grass)	MN, NY
Pogonarthria squarrosa (herringbone grass)	Cochise Co., CA
Polypogon australis (Chilean beard grass)	WA, CA, NM
Polypogon imberbis (bear grass)	CA
Polytrias amaura (Java grass)	FL
Puccinellia rupestris (British alkali grass)	WA, PA, NY
Rytidodosperma biannulare (wallaby grass)	OR, CA
Rytidosperma penicillatum (hairy wallaby grass)	OR, CA
Rytidosperma racemosum (wallaby grass)	CA
Rytidosperma semiannulare (wallaby grass)	CA
Saccharum bengalense (wild sugar cane)	Zuloaga et al. 2003: 551
Saccharum spontaneum (wild Asian sugar cane)	FL
Schizachyrium sanguineum var. *sanguineum* (crimson false bluestem)	AL, FL
Secale montanum (wild rye)	WA, CA
Setaria barbata (Mary grass)	MS, FL
Setaria megaphylla (big leaf bristle grass)	LA, FL
Setaria nigrirostris (black bristle grass)	OR (historic)
Setaria pumila ssp. *pallidefusca* (yellow bristle grass)	OR, LA
Setaria rariflora (Brazilian bristle grass)	AL, FL
Setaria setosa (West Indian bristle grass)	NJ, AL, FL
Setaria sphacelata (golden-timothy)	CA, AL, FL

Setariopsis auriculata	Pima Co., AZ
Sorghum bicolor ssp. *arundinaceum* (wild sorghum)	CA, FL
Sporobolus creber	Glenn Co., CA
Stipa capensis (Mediterranean needle grass)	CA
Stipa manicata (Ecuador needle grass)	CA
Stipa neesiana (Uruguayan tussock grass)	AL
Stipa papposa (false rice grass)	???
Stipa plumosa (South American rice grass)	CA
Themeda arguens (Christmas grass)	VA, MD
Themeda quadrivalvis var. *helferi* (kangaroo grass)	KS
Themeda quadrivalvis var. *quadrivalvis* (grader grass)	CA, LA, FL
Themeda triandra (rooi grass)	TX
Thysanolaena latifolia (tiger grass)	???
Tragus australianus (Australian bur grass)	SC
Tragus berteronianus (spike bur grass)	AZ, NM, TX
Tragus heptaneuron (Kenyan bur grass)	SC
Tribolium obliterum (cape grass)	Monterey Co., CA
Triraphis mollis (purple heads)	TX
Trisetum aureum (golden false oat)	NJ (historic)
Triticum spelta (spelt wheat)	KT, VT
Triticum turgidum (rivet wheat)	NY
Urochloa arrecta (African signal grass)	FL
Urochloa brizantha (palisade signal grass)	TX
Urochloa mosambicensis (sabi grass)	TX
Urochloa oligobrachiata (few-bracted liverseed grass)	FL
Urochloa piligera (hairy signal grass)	FL
Urochloa platytaenia	Source ???
Urochloa subquadripara (two-fingered guinea grass)	FL
Urochloa villosa (two-ranked liverseed grass)	MD, VA
Zea mays ssp. *parviglumis* (teosinte)	FL
Zea perennis (Mexican teosinte)	SC
Zoysia matrella var. *matrella* (Manila temple grass)	AL, GA, FL
Zoysia tenuifolia (Mascarene grass)	LA, FL

* I define limited distribution as those grasses found in no more than three states. This is, of course, an entirely arbitrary decision. You can easily see which ones are found in only one or two states, if you should prefer a narrower limit.

Revised: 02 January 2005

SECTION 5 - GRASS IDENTIFICATION

5.01 - SPECIMEN COLLECTION & PREPARATION

The principal reason for collecting is to provide permanent, representative specimens of plants for future study. In the case of smaller vascular plants, such as annual herbs, the specimen often consists of one to several complete individuals. In larger plants, such as trees or shrubs, a specimen usually consists of representative portions of vegetative and reproductive material.

Many specimens collected by students in university botany classes or by the serious amateur will eventually become housed in an herbarium, a permanent collection of pressed and dried plant specimens. Here the plants will be examined by botanists interested in such matters as distribution, verification of determinations, blooming and fruiting times, general morphological features, and anatomical details. Herbarium specimens are frequently loaned to experts doing monographic work and duplicates are often exchanged among herbaria.

EQUIPMENT

The following items are useful: field press, plant press, plastic bags, digger, clippers, pocket knife, compass, altimeter, coin envelopes, pickling fluids, camera, and notebook. While none of them is absolutely essential, having the proper collecting gear close at hand can result in greater efficiency and better specimens. By a "digger," I mean any of a variety of implements, such as a geologist's pick, a dandelion digger, a gardener's trowel or even a large screwdriver.

Although specimens may be stored temporarily in plastic bags or other containers, they should be pressed as soon as possible. Pressing flattens the plants so that they do not curl or wrinkle and it also brings the plant parts into direct contact with newspapers and indirectly with blotters and corrugates, thereby beginning the drying process. There are two types of plant presses. One is the temporary field press. It is usually small, light-weight, and easy to carry in a pack. You do not buy a field press; you make your own out of cardboard or press-board end pieces, newspapers, and perhaps a few blotters, the whole thing being bound up by a strap or belt. Those of you who are backers will find that you can accommodate an amazing number of plants in a field press. Specimens will last for a few days in such a temporary press until you can transfer them to a regular press.

A standard plant press (12" X 18") is too bulky and heavy to carry about in the field. Although you can construct your own, most of them are purchased, usually at great price, from one of the biological supply houses. A regular plant press has wooden or light metal end pieces called frames. Between the two frames is a series of blotters, and corrugates or ventilators arranged in a particular sequence. Two common arrangements are repeating units made up of corrugate-blotter-blotter-corrugate, and corrugate-blotter-blotter-blotter-corrugate. In the first plan, a specimen in a single fold of newspaper is inserted between the two blotters (corrugate-blotter-specimen-blotter-corrugate). In the second option, two specimens are inserted (corrugate-blotter-specimen-blotter-specimen-blotter-corrugate). An empty plant press has about a foot or so of pressing material in it.

COLLECTING SPECIMENS

You should be guided by one overriding consideration, to collect and prepare a permanent specimen that is as much like the living plant as possible, given the constraints of the pressing and drying techniques. Flower color may fade or change and three dimensional forms are flattened, but a wealth of scientific information and even a certain aesthetic quality remain intact.

Always keep in mind that the specimen that you collect must be determined eventually. Most keys and descriptions rely heavily upon the structure of the flower and fruit. Collecting herbaceous plants in the vegetative state is probably futile. I suggest that you collect extra flowering and fruiting material for use during the identification process. In this way the specimen itself can remain intact. This additional material should be submitted as a part of the specimen. It will be placed in a fragment folder and mounted on the herbarium sheet along with the plant. As you become more familiar with the genera, you will learn what plant features are critical for accurate determination.

With herbaceous plants, it is also standard practice to gather underground parts. The nature of the root system or subterranean stems may be critical. "Top-snatching" is a dreadful habit. Roots and other underground plant parts should be cleaned carefully to remove soil or mud.

A major problem facing the inexperienced collector is what constitutes enough plant material to make an acceptable specimen. In the case of small annuals, a specimen is not a single plant, but a few to many, depending upon their size. A single larger annual or smaller perennial is usually sufficient. With experience comes the almost unconscious habit of deciding that a particular plant will make a suitable specimen because it will fit on an herbarium sheet of 12" X 18". However, many larger herbs and most woody plants are too large to accommodate within these limits. Special techniques are used here. These will be discussed later.

PRESSING SPECIMENS

Plants are first placed in a single fold of newsprint. One of the most common errors is to assume that if a single fold of newspaper is good, then an entire section will be just that much better. All you accomplish is retarding the drying process by having several layers of wet newsprint. Tabloid newspaper, such as "The National Inquirer" or "The Lumberjack" are just the right size. If you use a full-sized newspaper, then tear it down the middle to yield two single fold sections of about 11" X 15". Do not exceed this size or the plant specimens may not fit on the herbarium sheet. Do not use slick, clay-finish newsprint from magazines or catalogues. It will not absorb moisture from the specimen.

Annuals and small perennials fit nicely in the newspaper and present no particular problem. But, some herbs are too tall and/or broad to be accommodated properly. If the problem is mainly one of height, consider folding the plant. This works well if it is no more than about a half meter tall. Fold the plant in such a way that the parts do not obscure one another. Too much bulk may also impair proper drying. Make sharp bends, not gently rounded ones. These may be held in place during the drying process by using **flexostats**. You make you own by cutting and index card or computer card into segments about 4 cm x 8 cm. Cut a slit about 3 cm long in each and slip the "knee" of the plant through the opening. After the plant has dried, remove the flexostat and reuse it. Still larger plants may be subdivided into two or more sections. Such a suite of specimens is often the most practical method of collecting larger herbaceous plants.

It is important that you put only one kind of plant inside the newspaper. The collection number (see below) for that particular plant should be written prominently along one margin. This will assist you later in sorting material and in finding a particular specimen. Some arranging of plant parts and trimming can now be done. Leaves and stems should be positioned so that they do not overlap unnecessarily. Leaf blades should be turned so that some of them have the upper surface exposed, while in others the lower surface may be seen in the final specimen. Specimen quality can often be improved by some judicious pruning of excess bulk. If parts are removed, leave a short stub so that it is evident what has occurred. This is also a good time to get rid of the dirt or mud trapped in the roots. It can ruin the specimen and label if allowed to remain.

This process of putting specimens in a single fold of newsprint, trimming and arranging, and assigning collection numbers (see below) is done until the press is filled or you have run out of plants. The plant press is now closed by tightening the straps, belts or ropes. It must be cinched tight enough to flatten the specimens and bring them into firm contact with the pressing materials. Presses will loosen as the plant dry. Tighten the straps from time to time.

FIELD DATA

At the same time that it is vital to collect and prepare adequate plant specimens, it is just as critical to take down the necessary field data. Without them, the specimens are scientifically worthless. Data may be recorded in permanent notebooks carried into the field or written in temporary pocket notebooks. Either method has its advantages and disadvantages. The important point is, however, to write down your field data, rather than relying on your memory.

The collection site is probably the single most important bit of data. This should be as precise as possible. I suggest the following sequence:

1) state
2) county or parish
3) quadrangle name
4) tier, range, and section (or latitude and longitude)
5) reference to a more or less permanent location, such as towns, highways, rivers, particularly those that can be found on ordinary highway maps

Quadrangle names, tier, range and section coordinates, and latitude/longitude are found on topographic maps available from the United States Geological Survey. Some of this information may also be found on U.S. Forest Service and Bureau of Land Management maps. The new hand-held GPS devices allow for very accurate site data.

Other data that you should enter in your records include:

1) habitat information (vegetation type, associated species, geology of the site, soil type, etc.)
2) elevation
3) remarks on the frequency of the plant at that site
4) remarks on the plant itself (size, color, odor, etc.)
5) collection date
6) personal collection number for that plant specimen

The personal collection number is the number that you assign to this particular specimen. A different collection number is given to each different collection of a particular kind of plant that you make during your career as a field botanist. Your first collection bears the number "1". You will now use a different number anytime you collect a new plant at this site, anytime you move from one location to another, or anytime you collect on a different day. Perhaps a few illustrations will help to clarify this matter.

1) If I collect ten different kinds of plants at a certain site, I will have ten collection numbers.

2) If I collected each of the ten plants in duplicate or triplicate, I would still have only ten collection numbers, each in duplicate or triplicate. This is the only situation in which a collection number is used more than once.

3) If I move to a second site and collect five more plants, I will have five more collection numbers. This is true whether or not any or all of the five plants duplicate species collected at the first site. New numbers are assigned because this a different collection site.

4) If I should return to any of these sites at a later date, all of the plant collections made at that time would get new numbers.

It is not uncommon to be unsure whether two plants belong to the same or different species or varieties. If

in doubt, assign them different numbers. Should they later turn out to be the same thing, combine them under the first collection number. If what you thought in the field to be duplicates are later determined as two or more different taxa, then call one of them 682 and the other 682A or 682A and 682B.

DRYING SPECIMENS

Once plants have been put into the plant press, they must be dried. Presses may be left out in the sunlight or they may be strapped into rooftop racks on automobiles, much to the curiosity of fellow motorists. But the usual method is to put the plant press in an electric or steam drier. These are found on most college campuses.

How long should plants remain in the drier? Until the plants are dry and no longer. The length of time will depend upon the kind of drier, the types of plants collected, the arrangement of pressing materials in the press, and how many other presses are in the drier. While 48 hours is often sufficient for most plants, it is critical to check the presses. Are the newspapers still slightly damp? Does the plant still feel and smell wet? Will your thumbnail leave an impression in a stem or petiole? If the answer is "yes" to any of these questions, then the plant needs to remain in the drier. If you take them out too soon, the plants will mold. If, however, they are dried too long, they will discolor badly and become very brittle. Remember to check the straps periodically. Presses will loosen during the drying process and curling of plant parts can occur.

LABELS

If specimens are to be deposited in an herbarium or submitted as part of a class requirement, they must be accompanied by a label that gives the pertinent collection data for that plant. Labels should be made from high quality paper, preferably 100% rag content bond paper. Most herbaria supply them to collectors. Label information should be typed. Permanent ink is an acceptable alternative. do not use ballpoint pen or soft lead pencil. Labels should provide at least the following information:

1) scientific name of the plant
2) location data
3) location date
4) your name
5) collection number for the specimen

The scientific name, for purposes of completeness and accuracy, must include the authority. Location data has already been discussed. Dates should be presented as 12 March 1979 or March 12, 1979, not 3-12-79. In the last example, the date may be read in at least four different ways. Use your first name or initials, not just your last name, unless you are Carolus Linnaeus, Willis Lynn Jepson, Asa Gray, or some other equally famous dead botanist. Put the collection number beside your name.

In addition to these essential elements, you may also wish to provide habitat data, along with commentary on the plant itself. A series of sample labels is appended to this handout. Once completed, the labels are slipped inside the newspaper with the plant specimen. Do not glue, tape, or staple either the plant or the label to the newspaper. Both will eventually be removed and mounted on an herbarium sheet for permanent reference.

THE ETHICS OF PLANT COLLECTING

While there are certainly valid educational and scientific reasons for plant collecting, important questions should be considered before taking specimens. Will the collecting of this plant contribute to educational or scientific advancement? What will be the impact on the population of the removal of this plant?

In 1993, California Native Plant Society adopted a set of guidelines regarding plant collecting for educational/scientific purposes. The following points are based on that statement.

☼It is illegal to collect plants along a highway right-of-way, in national parks, national monuments or national forests, state parks, or most local parks without a collecting permit, which may be obtained from the appropriate supervising agency.

☼It is legal and permissible to collect plants on private lands, provided that permission of the landowner is obtained.

☼It is the responsibility of an instructor to ensure that students are made aware of rare plants that are endemic to the area in which collecting is to take place, and to caution students against collecting these plants.

☼Collecting should be limited to the taking of as little plant material as necessary to allow identification.

☼Collecting should be done inconspicuously. Casual observers may not understand the reasons for such activities and may feel they can do likewise.

☼The Society encourages all botany instructors to use common plants, especially weedy or garden species, for demonstrating collecting techniques, structures, and taxonomic features.

☼The primary justification for collecting plants for herbaria is that they contribute to increased knowledge of the California flora. Repeated collecting in well known areas may serve no useful purpose. While it is important to document the distribution of plants, including rare species, it is critical to evaluate the impact of collecting.

☼A key to ensuring preservation of California's diverse flora and fauna is to develop a public informed of their value. For this reason, CNPS encourages limited and discriminating collection of plants as part of the educational process.

SOME FAMOUS LAST WORDS

"No, let's not stop here. There will be lots more of them down the road."

"No reason to collect this. It's just a weed."

"I really shouldn't take the last one, but ...."

"This stuff lasts forever in a plastic bag. We'll press all these plants when we get back to campus."

"Sure, dump everything in the same plastic bag. We can sort them out later."

"Are you kidding? Why number them now? We'll never get these specimens mixed up."

"Let's not take the time. We'll be able to find all of these locations on the maps when we get back home."

"No, this plant press isn't too high."

"Why anchor this stuff down? There's no wind."

"Oh well, you probably didn't need the rhizome anyway."

"Get that one. It will fit in the press!"

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5.02 - GRASS FLORAS & CHECKLISTS

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5.03 - DICHOTOMOUS KEYS

INTRODUCTION

A key is a logical device that assists you in the identification -- not the classification -- of an unknown organism. The keys used in botany usually take the form of a series of paired statements that describe various aspects of the plants treated therein. Each statement is called a **lead**; the two leads together constitute a **couplet**. The leads of a couplet are written in such a way that they are contrasting or contradictory propositions, as in:

1. Florets 1 . . . . . *Agrostis*
1. Florets 2 or more . . . *Festuca*

You must decide in each case which of the two statements best describes the unknown plant. These decisions then determine a somewhat serpentine pathway through a series of subsequent couplets. Because you are presented with a series of paired statements, the key is called a **dichotomous key** (Greek, in two + to cut).

TYPES OF KEYS

Dichotomous keys may be simple or complex, long or short, utilize a wide combination of floral and vegetative features or be restricted to statements relating to a particular aspect of the plants, such as leaf features. A key is termed **natural** if it is constructed in such a way that it shows evolutionary affinities or **artificial** if there is no concern shown for relationships. Most modern keys are artificial ones.

Two types of keys are recognized on the basis of their mechanical structure. In the **bracket key** the leads of a couplet are always together. Each statement ends in the name of a taxon or in the number or letter of the next couplet that is to be read, as in the example below. The "Key to the U. S. Species of *Spartina*" in this syllabus is an example of a bracket key.

In the **indented key** or **yoked key** a subordinate lead is indented beneath the statement preceding it. Each type of key has its advantages. The indented key is easier to follow and allows the user to more easily grasp the subgroupings and logic of the key. The bracket key is preferred by editors and publishers because it is easier to set up and requires less space. The keys in Hitchcock & Chase are examples of indented keys.

WRITING A DICHOTOMOUS KEY

I suggest the following steps be done when you are attempting to write a dichotomous key.

- ☼ Carefully define the taxa to be included. If nothing else, make a checklist of the plants that you must consider.
- ☼ Give the key a descriptive title, such as "A Key to the Grasses of Humboldt County, California". This will immediately alert the potential user of the appropriateness of the key.
- ☼ Examine the plants to be treated. Determine a series of "key characters" that will discriminate among the taxa. Remember that you are primarily interested in how the plants are different from one another. These traits should be stable, easily observed features that are usually present through much of the year. Most keys employ macroscopic features or those that are visible under low magnification. Try to minimize the use of ephemeral traits.
- ☼ Prepare a comparison chart, putting the taxa to be keyed along one axis and the characters along the other. A particular feature that looked promising may not be that useful once this chart is completed. During the writing of the key statements, you may have to return to this comparison chart and add additional columns of features before all taxa can be distinguished.
- ☼ Examine the comparison chart to discover a trait that will divide the plants into two groups of about the same size. There may be several possible characters that you can use. With experience you will learn to weigh the relative merits of characters. Once this feature is chosen, it is defined in terms to two opposing character states. This will be the first couplet of the key. This process of selecting features continues until all of the taxa have been incorporated into the key.
- ☼ It is critical that the key be strictly dichotomous. For each statement there can be only one alternative lead.
- ☼ Select the key format (indented or bracket) that you wish to use. Do not attempt to hybridize these two structures. The internal logic of the key must be maintained consistently through the entire series of statements.
- ☼ Select key characters that are in opposition to one another and that are mutually exclusive. The

unknown plant should fit under one, and only one, of the contradictory propositions.

- ☼ Use parallel construction within a couplet. If the first lead describes leaf shape, then so must the other lead of the pair.

- ☼ The initial word of each lead should be the name of the plant part being described. This is followed by the adjective, as in "Plants annual" or "Leaves hairy," rather than "Annual plants" or "Leaves hairy."

- ☼ Omit verbs. They are not necessary. Although it will look a bit awkward at first, you will quickly get use to it.

- ☼ The statements in a key may be numbered or lettered to make it easier to find the other member of a couplet. This is seldom a problem in shorter keys, but can become a frustration in longer keys that run to several pages. Once you have used a number or letter for a particular couplet, do not reuse it.

- ☼ Whenever possible, phrase the leads in a positive form. Avoid the use of "not as above" as the contrasting statement of a couplet. It provides no information about the plants falling on that side of the dichotomy.

- ☼ Avoid ill-defined characters. What is meant by the terms "tall," broad," and "rough?" Use precise botanical terminology.

- ☼ It is often useful to include measurements. Avoid overlapping limits in variation, as in "Leaves 3-7 cm long" vs. "Leaves 5-12 cm long". Under which lead is a plant with a leaf 7 cm long?

- ☼ The simplest keys usually contrast one feature in a statement. Better keys employ two or more features, separated by semicolons, as in:

    1. Inflorescence a panicle; glumes awned
    1. Inflorescence a spike; glumes awnless

- ☼ Sometimes it may be necessary to bring a plant out in more than one place in a key if it has two or more character states for a particular trait.

SOME HINTS IN USING KEYS

- ☼ Make sure that you are using the right key. It is both a waste of time and an embarrassment to spend several hours attempting to identify a plant in the wrong key.

- ☼ Read the key very carefully. If it is a good key, the author has spent a great deal of time selecting the right words. Much frustration results from misreading. There is a world of difference in the meaning of "and" and "or." They are not interchangeable.

- ☼ Watch for weasel words, such as "mostly" and "usually." Most of us who write keys use these words as avenues of escape when we do not want to be pinned down.

- ☼ Read both leads of the couplet before making your decision. The first lead may sound pretty good, but the second half may be perfect.

- ☼ Do not base your decision on a single observation, particularly when you are being asked about measurements.

- ☼ If neither lead seems to make any sense at all, you have probably made an error in keying and should not be in that section. Go back a step or two and check yourself.

- ☼ Check to see if there is a glossary at the back of the key. Authors vary in their use of certain terms and you will have to get use to the eccentricities of the writer.

- ☼ Do not assume that a key says something that it does not. In the second lead below, the author has not said that the leaves are alternate.

    1. Plant annual; leaves opposite
    1. Plants perennial

- ☼ If you are not confident about which lead to take, try both of them. One pathway should get you into difficulty fairly quickly.

- ☼ If one side of a dichotomy will take you to a relatively small number of plants, check out their descriptions or look at drawings. This additional knowledge may be helpful to you. Also, as you gain more knowledge of the flora you will be able to eliminate certain leads because they will take you to plants that you know.

- ☼ Learn to weigh the relative values of characters used in keys. Features of flower and fruit tend to be more important than those of plant height, for instance.

- ☼ When you have arrived at a determination, you should check it against a technical description, illustration, or specimen.

FEATURES USED IN GRASS KEYS

Growth Form (Habit)
Annual
Herbaceous perennial
Woody perennial
Tufted
Caespitose
Rhizomatous
Stoloniferous
Bulbous

Culms
Round or flattened
Solid or hollow
Erect or decumbent

Leaves
Blades
- Flat
- Rolled
- Bow-shaped tips
- Nature of margins

Sheaths
- Rounded
- Flattened

Auricles
- Present
- Absent

Inflorescence
Terminal or axillary
Open or contracted
Included or exserted
Balanced or 1-sided
Involucre present or absent
Type
- Panicle
- Raceme
- Spike
- Digitate
- Solitary

Rachis
Intact at maturity (continuous)
Shattering at maturity (discontinuous)

Spikelets
Similar or dissimilar
Number per node
- 1, 2, 3, etc.
- Fascicles

Position relative to rachis
- Inserted edgewise
- Inserted flatwise

Sunken in corky or fleshy rachis
Covered by involucre
Subtended by spines/bristles
Compression
- Lateral
- Dorsal
- Terete

Disarticulation
- Above glumes
- Below glumes
- Falling singly
- Falling in groups
- Falling with rachis segment

Glumes
Number (2, 1, 0)
United or separate
Size relative to one another
Size relative to lemma(s)
Glabrous or variously hairy
Nerve number
Nature of apex
Awned or awnless

Floret
Number
Sexuality
- Perfect
- Pistillate
- Staminate

Degree of reduction
- All ± similar
- Upper reduced
- Lower reduced
- Upper and lower reduced

Lemma
Size relative to glumes
Size relative to palea
Texture
- Membranous
- Papery
- Indurate

Nerve number
Nerves converging or parallel
Glabrous or variously hairy
Nature of apex
- Acute
- Rounded
- Bifid
- Truncate

Sterile or fertile
Awned or awnless
Awn attachment
Nature of callus
- Glabrous
- Bearded
- Cobwebby

Palea
Present or absent
Texture
Size relative to lemma
Nerve number
Awn absent or present
Wings present or absent

Rachilla
Extension
- Beyond uppermost floret
- Not extended

Rudiments
- Ending in rudiment
- Not ending in rudiment

Glabrous or variously hairy

SECTION 6 - SELECTED TOPICS

6.01 - SCIENTIFIC & COMMON NAMES OF GRASSES

Grasses often have two names. One is a common name used by most of us in everyday circumstances when we make reference to a weed growing in the yard, an ornamental, or to one of the widely grown cereal crops. Grasses also have scientific names (or Latin names, as they are sometimes called) used by scientists and by the "serious" amateur. In this course, you and I will be using both common names and scientific names. You will need to be able to communicate with more than one audience.

COMMON NAMES

It would be foolish for me to maintain that common names have no value. They are the only names known to most of us. These names are often simple, easy to remember, descriptive, colorful, pleasing to the ear, and easy to pronounce. Given this impressive list of advantages, why do we not simply use common names for grasses and be done with it? There are several reasons why scientists do not use them.

- A grass may have more than one common name. *Stipa hymenoides* is commonly called Indian ricegrass, Indian millet, silk grass, and sand bunch grass.
- The same common name may be used for more than one plant. We all know corn when we see it. You may be surprised to learn that in other English-speaking countries, their corn is what we call wheat.
- Many common names are confusing and misleading. Kentucky bluegrass is not blue, nor is it native to Kentucky. Broomcorn is not a kind of corn, but a variety of sorghum. The heavenly-bamboo is not a kind of bamboo, but a member of the barberry family.
- Because there are no universally accepted rules for giving common names to grasses, we cannot say that a particular one is **the** correct common name.
- Common names do not provide an indication of close relationship among the plants that share the name. Sour-grass, arrow-grass, blue-eyed grass, grass (marijuana), and China-grass are not kinds of grasses, nor are they are related to one another.
- Probably the most serious difficulty is that most grasses do not have common names. We have used only a small portion of the half million or so kinds of plants to the extent that common names have been applied to them. This is a problem for authors of field guides, for consultants who write environmental impact statements, and for staff members in various state and federal agencies who must prepare material for general consumption. Authors have attempted to compensate for this lack of common names by inventing them, usually by translating the scientific name into English. The advantage of Orcutt's brome over *Bromus orcuttianus* or the spicate trisetum over *Trisetum spicatum* is not immediately apparent to me.

A word or two about the spelling of the common names of grasses. You will notice inconsistencies from one text to another. For instance, *Stipa comata* is variously called needle and thread, needle and thread grass, needle-and-thread grass, and needleandthread grass. The last spelling seems terribly awkward. Some floras list needlegrass; others, needle grass. Some authors capitalize common names (Giant Needle Grass); others do not (giant needle grass). *Sorghum halepense* is Johnson grass, but *Tuctoria greenei* is Greene's tuctoria. Apostrophes come and go.

SCIENTIFIC NAMES

Although scientific names may cause you some discomfort, their advantages to the botanist are compelling.

- There is a single, universally recognized name for each plant. Because they are used by botanists all over the world, scientific names facilitate the free transfer of ideas and information. Consider the difficulties that would arise if the botanists in the United States, England, Germany, Russia, China, etc. each had their own independent set of names for the plants of their countries.
- The same scientific name may not be used for more than one kind of plant. Once it has been published, that name cannot be used again for any other plant.
- Scientific names are given according to an "International Code of Botanical Nomenclature." These regulations are reviewed every four years at International Botanical Congresses. There is, therefore, a legally correct scientific name.
- Inherent in our system of scientific names is the concept of evolutionary or genetic relationship. When we place einkorn wheat, emmer wheat, and bread wheat in the same genus (*Triticum*), we do so because we have concluded that the morphological, anatomical, genetic, and chemical traits that they share suggest that they are closely related. Because there is a set of features associated with the name, it has predictive value. The better we have circumscribed the taxa, the higher the value.

There are some difficulties with scientific names. They can be difficult to pronounce, especially if you did not

learn to divide words into syllables early on in your education. You might note, however, that such familiar and easily pronounced common names as aster, rhododendron, magnolia, chrysanthemum, petunia, and begonia are also the first part of the scientific names of these plants. My own experience in teaching undergraduates to use scientific names is that once you can get past the psychological barrier that these are terribly long words that only those who have had a strong background in Latin and Greek can pronounce, then you will become much more comfortable with them and begin using them rather easily.

WHY ALL THE NAME CHANGES?

One of the more frustrating features of scientific names, especially for someone who is just learning about them, is that they are changed from time to time. Just when you think that you have become familiar with the scientific names for a particular group of plants, someone will publish a new revision of the group and you discover that some of the names have been changed. These changes come about for several reasons. As new information about the anatomy, chemistry, and genetics of plants becomes known, it may cause botanists to rethink the evolutionary relationships among the plants being studied. These changes may require us to revise the scientific names to reflect the new level of information now available to us. Sometimes names are changed, not for biological reasons, but because someone studying a group may discover that the name given to a particular plant has to be rejected because it violated some provision of the International Code of Botanical Nomenclature. For example, the name may not have been properly published in a scientific journal. One 19th century botanist was a public school principal who handed out printed copies of his newly described plants to his students at graduation each spring. This is not exactly legal.

Examples point out one of the important operating principles in plant classification. As new information becomes available and as errors are discovered, we make adjustments and corrections. What appears to be a fine scheme of classification today may be modified drastically or even discarded completely at some point in the future.

COMPONENTS

If we examine the botanical works of the 15th and 16th centuries, we see that the name of a plant was often a **polynomial**, a lengthy series of descriptive words, typically in Latin, as in "*Convolvulus argentateus foliis ovatis divisis basi truncatis: laciniis intermediis duplo longioribus*." These phrase names became increasingly awkward because the discovery of a new kind of plant required that the existing polynomial be slightly modified so that it could be distinguished from the older one.

A new way of naming plants was developed over two centuries ago to replace the polynomials. It was popularized by Carolus Linnaeus, the leading botanist of his time. This system was based upon the principle that each plant (or animal for that matter, because they are named according to the same scheme) is given a scientific name that consists of two components, both of them parts of the taxonomic hierarchy mentioned above. The first element of the scientific name is the **genus** (or generic name), as in *Triticum*, the genus of wheat. The plural of genus is **genera**, not genuses. The second element is the **specific epithet**, as in *aestivum*, the particular kind of wheat called bread wheat. This second element of the scientific name is often incorrectly called the "species." It is the genus and specific epithet together that form the species name. *Triticum aestivum* is the species name of bread wheat. Because the name of a plant or animal is the combination of these two words, the scientific name is called a **binomial** and we call this scheme of giving technical names to organisms the **Binomial System of Nomenclature**.

The binomial, for reasons of completeness and accuracy, is followed by the name (typically abbreviated) of the person or persons who first published that name for the plant. For example, in the scientific name *Zea mays* L., the "L." stands for Linnaeus. This part of the scientific name is the **authority**.

It is sometimes necessary to move the name of a plant from one genus to another, usually because more recent research has demonstrated that the plant was incorrectly assigned to a particular genus. For instance, in 1753 Linnaeus published the name *Panicum dactylon* for the plant that we now call Bermuda grass. In 1805, Christian Persoon transferred the epithet (or "moved the species," as we say more informally) from *Panicum* to the new genus *Cynodon*. The scientific name of Bermuda grass then becomes *Cynodon dactylon* (L.) Persoon. The person whose name is in the parentheses first published the specific epithet for the plant. The name after the parentheses is that of the person who transferred it into the genus where it now resides.

It is often useful to recognize and to name variation below the species level. The two most widely used are the **subspecies** (abbreviated ssp.) and the **variety** (abbreviated var.). These names also have authorities, as in *Bromus vulgaris* (Hook.) Shear var. *robustus* Shear. If the subspecies or varietal name is a repeat of the specific epithet, then the authority is not repeated, as in *Zea mays* L. ssp. *mays*.

An additional explanation is needed for the term variety. For reasons that are obvious, we have developed many different cultivated strains of a particular crop plant or ornamental. There are literally thousands of different kinds of rice. There are probably hundreds of different kinds of tuberous begonias. In general parlance, we often call these varieties. However, for purposes of formal nomenclature, these variations are considered too minor and often too short-lived to warrant giving them a scientific name. The variety of botanical nomenclature is not used in these instances. Instead, we employ the term **cultivar** (abbreviated cv.). A kind of sorghum used to make molasses in the Southwest by American Indians is *Sorghum bicolor* cv. 'Apache Red Cane.'

Many of our economic plants are of hybrid origin, that is they result from the accidental or purposeful crossing of two closely related plants. This can be reflected in the scientific name of the plant by inserting an "X." If the X occurs before the generic name, then the plant is considered the result of a cross between two plants in different genera. X *Agropogon* is an intergeneric hybrid between *Agrostis* and *Polypogon*. If the X occurs between the generic

name and the specific epithet, then the plant is the product of a cross between two species in the same genus, as in *Tridens* x *oklahomensis*.

THE ORIGIN OF NAMES

Most of the words that make up scientific names are derived from Latin or Greek, although there is no requirement that they must be. Modern names and even nonsensical ones have been used. Many students, however, believe that there must be some requirement that scientific names be as long and unpronounceable as possible. This reveals a certain lack of scholarship. Even a rudimentary knowledge of etymology is very helpful in understanding the composition of scientific names. The following examples may be helpful.

Commemorative Names: *Lamarckia, Scribneria,* and *Orcuttia* are named after J. B. A. P. Monnet de Lamarck (the famous French naturalist), Frank L. Scribner (a noted American agrostologist), and Charles Russell Orcutt (a San Diego botanist). *Agnesia* is named after Agnes Chase.

Classical/Aboriginal Names: *Agrostis, Bromus, Festuca*, and *Poa* are all ancient Latin names for grasses.

Geographical Names: *anglicus* (from England), *gallicus* (from France), *canadensis* (from Canada), *australis* (southern)

Habitat: *arenarius* (growing in sand), *campestris* (of the fields), *fluviatilis* (of the rivers), *riparius* (of the river banks), *sativus* (cultivated), *littoralis* (of the seashore).

Growth Form: *arboreus* (tree), *repens* (creeping), *scandens* (climbing), *pusillus* (insignificant).

Structural Feature: *amabilis* (lovely in appearance), *bulbosum* (having a swollen part), *gracilis* (slender), *mollis* (soft hairy), *scoparius* (broom-like).

Use: *esculentus* (edible), *officinalis* (recognized as medically important), *textilis* (having useful fibers)

DERIVATION OF GENERIC NAMES OF GRASSES

Achnatherum [Gk., awned scale]
Aegilops [L., ancient name for wheat]
Aegopogon [Gk., goat + beard]
Agropyron [Gk., wild + wheat]
Agrostis [Gk., a kind of grass, pasture]
Aira [Gk., a kind of grass]
Allolepis [Gk., different + scale]
Alopecurus [Gk., fox + tail]
Ammophila [Gk., sand + loving]
Ampelodesmos [Gk., grape leaves + to tie together]
Amphicarpum [Gk., double + fruit-bearing]
Andropogon [Gk., man + beard]
Anthaenantia [Gk., flower + contrary]
Anthephora [Gk., flower + to bear]
Anthoxanthum [Gk., yellow + flower]
Apera [Gk., not maimed]
Apluda [L., chaff]
Arctagrostis [L., arctic + a kind of grass]
Arctophila [L., arctic + G., to love]
Aristida [L., a stout hair, awn]
Arrhenatherum [Gk., male + awn]
Arthraxon [Gk., joint + axis]
Arundo [L., a reed grass]
Avena [L., oats]
Axonopus [Gk., axis + foot]

Beckmannia [J. Beckmann, German botanist]
Blepharidachne [Gk., eyelash + chaff]
Blepharoneuron [Gk., eyelash + nerve]
Bothriochloa [Gk., pit + grass]
Bouteloua [C. and E. Boutelou, Spanish botanists]
Brachiaria [L., arm]
Brachyelytrum [Gk., short + husk]
Brachypodium [Gk., thick + foot]
Briza [Gk., a kind of nodding grain]
Bromus [Gk., food, ancient name for oats]
Buchloe [Gk., buffalo + grass]

Calamagrostis [Gk., a reed grass]
Calamovilfa [Gk., reed + Vilfa, a grass genus]
Catabrosa [Gk., devouring]
Cathestecum [Gk., stationary]
Cenchrus [Gk., an ancient name]
Chloris [Gk., Goddess of flowers]
Chrysopogon [Gk., golden + beard]
Cinna [Gk., a kind of grass]
Coix [Gk., a kind of palm]
Coleanthus [Gk., sheath + flower]
Cortaderia [Sp., cutting]
Corynephorus [Gk., club-bearing]
Crypsis [Gk., hidden]
Ctenium [Gk., a small comb]
Cymbopogon [Gk., boat + beard]
Cynodon [Gk., dog + tooth]
Cynosurus [Gk., dog + tail]

Dactylis [Gk., finger]
Dactyloctenium [Gk., finger + small comb]
Danthonia [E. Danthione, French botanist]
Dasyochloa [Gk., hairy + grass]
Deschampsia [J. Deslongchamps, French botanist]
Desmazeria [J. B. Desmazieres, French botanist]
Diarrhena [Gk., twice + male]
Dichanthelium [Gk., twice + flowering]
Digitaria [L., finger]
Dinebra [Arabic, little tail]
Dissanthelium [Gk., two + small flower]
Dupontia XXX

Distichlis [Gk., two-ranked]
Echinochloa [Gk., hedgehog + grass]
Ehrharta [J. F. Ehrhart, German botanist]
Eleusine [Gk., Eleusis, an ancient town]
Elionurus [Gk., to roll + tail]
Elymus [Gk., a kind of millet]
Elytrigia [Elymus + Triticum]
Enneapogon [Gk., nine + beard]
Enteropogon [G., intestine + beard]
Eragrostis [Gk., love + grass]
Eremochloa [Gk., centipede + grass]
Erianthus [Gk., wool + flower]
Eriochloa [L., woolly + grass]
Erioneuron [Gk., woolly + nerve]
Euchlaena [Gk., true or well + cloak]

Festuca [L., classical name for a weedy grass]
Fingerhuthia [K. A. Fingerhuth, German botanist]

Gastridium [Gk., a small pouch or sac]
Gaudinia [J. F. P. G. Gaudin, French botanist]
Glyceria [Gk., sweet]
Gymnopogon [Gk., naked + beard]

Gynerium [Gk., female + wool]

Hackelochloa [E. Hackel + Gk., grass]
Hainardia [P. Hainardi, Swiss phytogeographer]
Hakonechloa [Mt. Hakon (in Japan) + Gk., grass]
Heleochloa [Gk., marsh + grass]
Helictotrichon [Gk., twisted + bristle]
Hemarthria [Gk., blood (?) + joint]
Hesperostipa [Gk., western + tow]
Heteropogon [Gk., different + beard]
Hierochloe [Gk., holy + grass]
Hilaria [A. de St. Hilaire, French botanist]
Hordeum [L., classical name for barley]
Holcus [L., a kind of grass]
Hydrochloa [Gk., water + grass]
Hyparrhenia [Gk., below + male]
Hystrix [Gk., porcupine]

Imperata [F. Imperato, Italian naturalist]
Ischaemum [G., hip-socket joint]

Koeleria [G. L. Koeler, German botanist]

Lagurus [Gk., hair + tail]
Lamarckia [J. B. Lamarck, French naturalist]
Lasiacis [Gk., woolly + point]
Leersia [J. D. Leers, German apothecary]
Leptochloa [Gk., slender + grass]
Leptoloma [Gk., thin + border]
Leymus [Anagram of Elymus]
Limnodea [Alteration of Limnas, a grass genus]
Lolium [L., classical name for darnel]
Luziola [Luzula, a genus of sedges + resembling]
Lycurus [Gk., wolf + tail]

Manisuris [Gk., necklace + tail]
Melica [L., honey]
Melinis [Gk., a kind of millet]
Microchloa [Gk., small + grass]
Microstegium [Gk., small + cover]
Miscanthus [Gk., stalk + flower]
Molinia [J. I. Molina, Jesuit missionary-botanist]
Monanthochloe [Gk., one + flower + grass]
Monerma [Gk., one + support]
Monroa [W. Munro, English botanist]
Muhlenbergia [H. L. E. Muhlenberg, Penn. botanist]

Nassella [L., a kind of basket]
Neostapfia [Gk., new + O. Stapf, British botanist]
Neyraudia [Anagram of Reynaudia]

Olyra [Gk., an ancient name for a kind of grain]
Oplismenus [Gk., armed]
Orcuttia [C. Orcutt, California botanist]
Oryza [Gk., classical name for rice]
Oryzopsis [Gk., rice + resembling]

Panicum [L., ancient name for common millet]
Pappophorum [Gk., pappus + bearing]
Parapholis [Gk., beside + scale]
Pascopyrum [L., pasture + Gk., wheat]
Paspalum [Gk., a kind of grass]
Pennisetum [L., feather + bristle]
Phalaris [Gk., a grass with shiny spikelets]
Pharus [Gk., mantle or cloth]
Phippsia [C. J. Phipps] XXX
Phleum [Gk., a marsh reed]
Phragmites [Gk., growing in hedges along streams]
Piptatherum [Gk., falling + bristle]
Piptochaetium [Gk., falling + hair]
Pleuraphis [Gk., side + needle]
Pleuropogon [Gk., side + beard]
Poa [Gk., ancient name]
Pogonarthria [G., beard + a joint]
Polypogon [Gk., many + beard]
Pseudoroegneria [Gk., false + a name for Elymus]
Ptilagrostis [Gk., feather + grass]
Puccinellia [B. Puccinelli, Italian botanist]

Redfieldia [J. H. Redfield, Philadelphia businessman]
Reimarochloa [J. A. H. Reimarus + Gk., grass]
Rhynchelytrum [L., beak + scale]
Rottboellia [C. F. Rottboell, Danish botanist]

Saccharum [L., sugar]
Sacciolepis [Gk., small bag + scale]
Schedonnardus [Gk., near + Nardus, a grass genus]
Schismus [Gk., split]
Schizachne [Gk., split + chaff]
Schizachyrium [Gk., split + chaff]
Sclerochloa [Gk., hard + grass]
Scleropogon [Gk., hard + beard]
Scolochloa [Gk., prickle + grass]
Scribneria [F. L. Scribner, American botanist]
Secale [L., classical name for rye]
Setaria [L., bristle]
Setariopsis [L., Setaria + resembling]
Sieglingia [Siegling, German botanist]
Sitanion [Gk., a kind of grain]
Sorghastrum [Sorghum + L., a poor imitation of]
Sorghum [It., sorgho]
Spartina [Gk., cord]
Sphenopholis [Gk., sedge + scale]
Sporobolus [Gk., seed + to throw]
Stenotaphrum [Gk., narrow + trench]
Stipa [L., tow]
Swallenia [J. Swallen, American botanist]

Taeniatherum [Gk., ribbon + awn]
Themeda [Arabian name for this grass]
Thysanolaena [G., fringe + cloak]
Torreyochloa [J. Torrey, American botanist + grass]
Trachypogon [Gk., rough + beard]
Tragus [Gk., he-goat]
Tribolium [L., three + fiery arrow]
Trichachne [Gk., hair + chaff]
Trichloris [Gk., three + Chloris, a grass genus]
Trichoneura [Gk., hair + nerve]
Tridens [L., three + tooth]
Triplasis [Gk., three + awn]
Tripogon [Gk., three + beard]
Tripsacum [Uncertain: perhaps Gk., to rub]
Trisetum [L., three + bristle]
Tuctoria [Anagram of Orcuttia]

Uniola [L., a kind of grass]
Urochloa [Gk., tail + grass]

Vaseyochloa [G. Vasey, American botanist + grass]
Ventenata [P. Ventenat, French botanist]
Vetiveria [Tamil name for this grass]
Vulpia [J. S. Vulpius, German botanist]

Willkommia [H. M. Willkomm, German botanist]

Zea [Gk., a kind of grain]
Zizania [Gk., a weed of grain fields]
Zizaniopsis [Gk., Zizania + resembling]
Zoysia [K. von Zois, German botanist]

PRONUNCIATION

The International Code of Botanical Nomenclature states that scientific names of plants are to be treated as Latin words, regardless of their origin. A few of the more scholastically inclined botanists will argue,

therefore, that we ought to pronounce scientific names according to the strict rules of the sounds of vowels and consonants in Latin and that great care should be taken in accenting the proper syllable. But, there are traditional English, reformed academic, and Church Latin versions of Latin to choose from, each with its own set of rules for pronunciation.

Most American botanists pronounce the scientific names of plants as though they were English words. Some of us follow the rules in Latin for determining which syllable is accented; most of us do not. Many of us pronounce scientific names the way we were taught as under-graduates (if any formal discussion occurred) or more commonly we imitate the way our professors said them when we took their classes. These become the familiar and "correct" way to pronounce the scientific names of plants.

The following is an attempt on my part to present a basic guide to pronouncing vowels, consonants, and diphthongs, together with some of the rules for accenting syllables.

- ☼ The letters of the Latin alphabet are basically the same as ours, except that J, U, and W did not occur in the classical version.
- ☼ Each syllable will contain a vowel or a double vowel combination (ae, au, ei, oe, or ui). The latter are called diphthongs.
- ☼ Pronounce all of the syllables. *Secale* is "see-**kal**-e," not "**see**-kale."
- ☼ Final vowels are long, with the exception of a. If a word ends in two vowels (unless they are a diphthong), they are sounded separately. The epithet *angustifolia* is pronounced "an-gust-i-fo-li-ah."
- ☼ The diphthongs "ae" and "oe" have the sound "e," as in beat; "au" has the sound of "aw," as in the word awful; "ei" usually has the sound "i," as in site; "eu" has the sound of "u," as in neuter; and "ui" has the ui-sound in the word ruin.
- ☼ The "oi" in the ending "-oides" is treated as a diphthong by most American botanists and we give it the sound that "oi" has in the word oil. This habit is considered close to barbaric by English and Europeans who are much more persnickety about such matters. Because these two vowels do not form a diphthong, they should be pronounced separately, so that the ending "-oides" has the sound "-o-e-deez."
- ☼ A single consonant is placed with the following vowel, as in "pa-ter." Double consonants are separated, as in "am-mi." If there are two or more consonants, the first one is usually put with the preceding vowel, as in "an-gli-cus."
- ☼ B, d, f, h, l, m, n, p, qu, and z are pronounced the same in Latin and English.
- ☼ The consonants c and g are soft (that is, have the sounds of "s" and "j") if they are followed by ae, e, i, oe, or y. Otherwise, the c is pronounced like a "k" and the g is also hard, as in "go." The s is always pronounced as it is in the word "so," not as a "z." An initial x is pronounced as a "z," not "ek-z." *Xerochloa* is pronounced "zero-o-chlo-a," not "ek-zero-chlo-a."
- ☼ The first letter is silent in words beginning with cn, ct, gn, mn, pn, ps, pt, and tm.

Accenting the proper syllable can be tricky. Sometimes the author of a flora or other manual may provide assistance by including an accent mark. Most do not. If included, they are for the convenience of the reader and they are not part of the scientific name itself. If you must determine which syllable to accent, the following rules may be helpful.

Words of two syllables are always accented on the first syllable. The genus of Kentucky bluegrass is "**Po**-a." In words of three or more syllables, the last syllable is never accented. The stress will fall either on the next to the last syllable (the penultimate syllable), as in "ar-**ven**-sis," or on the third from the last syllable (antepenultimate), as in "**an**-gli-cus."

No matter how long the word, the accent can never be to the left of the antepenultimate syllable. Deciding between these two options is a difficult choice. Accent the penultimate syllable if it ends in a consonant, diphthong, or in a long vowel.

Commemorative names (patronyms) present a special problem because giving them the proper accenting can render the person's name unrecognizable. The epithet *jamesii* should be pronounced "ja-**me**-se-i," not "j**amz**-e-i." Most American botanists ignore this rule.

There is a somewhat less scholarly approach that you might find useful.

- ☼ Pronounce all of the syllables.
- ☼ Say them as you would any English syllables.
- ☼ Put the accent where you think it sounds best.
- ☼ Try to be consistent.

A LITTLE ETYMOLOGY

PREFIXES

a- without
angusti- narrow
apo- separate
bi- two
brachy- short
brevi- short
chori- separate
cleisto- closed, hidden
con- with
echino- spiny
eu- true, typical, good
ex- without
gyno- female
halo- salt
homo- the same
hyper- above
hypo- below
in- in, within
inter- between
lati- broad, wide
longi- long
macro- large, great
meso- in the middle
micro- small
mono- one

multi- many
neo- new
ob- inverse, upside down
parvi- small
pauci- few
penta- five
peri- around, about
phyllo- leaf
poly- many
pseudo- false
sub- below, somewhat
sym- with
syn- growing together
tetra- four
tri- three
uni- one
xero- dry

SUFFICES

-aceus likeness, resemblance
-chloa grass
-flora flowered
-formis having the form of
-ifera bearing or yielding
-oides resembling
-phylla relating to leaves
-pogon beard
-seta bristle, stiff hair
-stachys an ear of grain

EPITHETS

alba - white
***arenaria* -** growing in sandy places
aristata - bearing an awn or bristle
***arundinacea* -** reed-like
***arvensis* -** of cultivated lands
***canadensis* -**
***fasciculatus* -** clump or bundle
***filiformis* -** thread-shaped
***foliosa* -** leafy
***formosus* -** handsome
***glauca* -** bluish–green; gray
***gracilis* -** slender
***inermis* -** without spines or prickles
***miliacea* -** millet-like (a minor cereal)
***mollis* -** pubescent
***nigra* -** black
***occidentalis* -** west, western
***orientalis* -** east, eastern
***palustris* -** growing in swamps and marshes
***pilosa* -** hairy
pratensis- growing in meadows
***pumila* -** dwarf
***repens* -** creeping
***rubra* -** red
***sativa* -** sown or planted
***speciosa* -** showy
***tenuis* -** thin, fine, slender
***verticillata* -** a whorl or circular arrangement
***virginica* -**
***vulgaris* -** common, ordinary

WRITING SCIENTIFIC NAMES

There are a few simple rules that must be followed in writing scientific names. The genus is always capitalized; the specific epithet should not be. The rules of nomenclature allow them to be if they are commemorative, as in *Elymus smithii* (a relative, no doubt) or if the epithet was once itself a generic name, as in *Arundo Donax*, the giant reed grass. Even in such instances, however, the rules discourage capitalization.

The generic name and specific epithet are underlined when they appear in handwritten or typed material. They are put in italics or bold-face in printed text. The authority is always capitalized, but it is not underlined or otherwise set off from the remainder of the text.

THE TAXONOMIC HIERARCHY

The taxonomic hierarchy is the series of categories that have been arranged in a particular sequence to show relationships with one another. The names of these categories and their sequence are set by the ICBN. It is the official list of groups into which plants are classified. Any one of these categories, at any level, is called a **taxon** (plural, **taxa**). The sequence of taxa and their standard endings is as follows:

Category	Ending	Example
Division or Phylum	-phyta	Magnoliophyta
Class	-opsida	Liliopsida
Subclass	-idae	Commelinidae
Order	-ales	Poales
Family-aceae		Poaceae
Subfamily	-oideae	Panicoideae
Tribe	-eae	Andropogoneae
Subtribe	-inae	Tripsacinae
Genus *		*Zea*
Subgenus	*	*Zea*
Section	*	*Zea*
Species	*	*Zea mays*
Subspecies	*	*mexicana*
Variety	*	*mexicana*

* No standard ending

There are no standardized endings for taxa at or below the rank of genus. There are, however, grammatical consid-erations. Their terminations must agree in gender and in number. This explains why *Tridens pulchellus* becomes *Erioneuron pulchellum* when the epithet is transferred from one genus to the other.

My reason for including this brief discussion of the taxonomic hierarchy is that the generic and species names are two levels of this hierarchy. In this course, we will use the names of subfamilies, tribes, genera, and species frequently.

GRAMINEAE VERSUS POACEAE

Before leaving the subject of the naming of grasses, an explanation of the family name of the true grasses is in order. In older references, grasses seem to belong to a family called Gramineae, while in more recent publications the family name is Poaceae. This might suggest that the "old name" Gramineae has been replaced by the "new name" Poaceae, probably because Poaceae is considered the correct name and Gramineae is now incorrect for some reason.

One of the basic principles of botanical nomenclature is that we are to use the first validly and effectively published name for a plant or group of plants (genus,

family, etc.). The name Gramineae was published by A. L. Jussieu in 1789; Poaceae by Barnhart in 1895. Therefore, following this principle of priority of publication, Gramineae is the correct name for the grass family.

The problem arises because another section of the International Code of Botanical Nomenclature (ICBN) requires that family names end in the suffix -aceae, which Gramineae obviously does not. Nor do Compositae, Cruciferae, Labiatae, Leguminosae, Umbelliferae, and Palmae. What do all of these families have in common? They are among our best known, most easily recognized, and most economically important plant families. These names were in use long before we had any international rules to govern such matters.

Which name, Gramineae or Poaceae, is correct? They are both correct and they may be used interchangeably. The ICBN makes an exception in these cases and allows two valid names for the same group. Article 18.5 of the ICBN states, "The following names, sanctioned by long usage, are treated as validly published: ... Gramineae (Poaceae; type *Poa* L.)...." Article 18.6 then goes on to say that, "The use, as alternatives, of the names in parentheses in Art. 18.5 is authorized."

The same holds for these first published family names and their equivalents with an -aceae ending:

Compositae/Asteraceae
Cruciferae/ Brassicaceae
Guttiferae/Clusiaceae
Labiatae/ Lamiaceae
Leguminosae/Fabaceae
Umbelliferae/Apiaceae
Palmae/Arecaceae.

My personal preference is to use Gramineae. It was the first name to be legally published for the family. It is the name used in the Code itself. Poaceae is the alternate name for Gramineae, and not the other way around.

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6.02 - GREAT MOMENTS IN AGROSTOLOGY

1703 J. Ray publishes *Methodus Graminum, Juncorum et Cyperorum Specialis*

1709 J. Scheuchzer publishes *Agrostographiae Helveticae Prodromus*

1737 C. Linnaeus publishes *Genera Plantarum*

1753 C. Linnaeus publishes *Species Plantarum*

1811 A. J. Gaudin publishes *Agrostologia Helvetica*

1812 P. de Beauvois publishes *Essai d'une Nouvelle Agrostographie*

1822 C. B. Trinius publishes *Clavis Agrostographiae*

1829 C. G. Nees von Esenbeck publishes *Agrostologia Brasiliensis*

1835 C. S. Kunth publishes *Distribution Methodique de la Famille des Graminees.*

1855 Charles Darwin identifies his first grass!

1855 E. G. Steudel publishes *Synopsis Plantarum Glumacearum*

1881 G. Bentham publishes "Notes on Gramineae"

1881 E. Hackel publishes "Untersuchungen über die Lodiculae der Gräser"

1883 C. S. Kunth publishes *Agrostographia...*

1883 G. Vasey publishes *Grasses of the United States*

1883 G. Bentham publishes treatment of Gramineae in *Genera Plantarum*

1884 G. Vasey publishes *Agricultural Grasses of the United States*

1887 W. J. Beal publishes *Grasses of North America*

1887 E. Hackel publishes treatment of Gramineae in Engler & Prantl's *Die Natürlichen Pflanzenfamilien*

1891 G. Vasey publishes *Grasses of the Southwest*

1892 G. Vasey publishes *Grasses of the Pacific Slope*

1892 G. Vasey publishes *Monograph of the Grasses of the United States and British America*

1892 E. Bruns publishes "Der Grasembryo"

1896 W. J. Beal publishes *Grasses of North America, Vol. II*

1896 A. Grob publishes *Bieträge zur Anatomie der Epidermis der Gramineenblätter*

1897 F. Scribner publishes *American Grasses*

1903 G. V. Nash publishes treatment of Gramineae in J. K. Small's *Flora of the Southeastern United States*

1910 A. S. Hitchcock & A. Chase publish "The North American Species of *Panicum*"

1913 E.-G. Camus publishes *Les Bambusées*

1917 E. A. Bessey publishes "Phylogeny of the Grasses"

1917 O. Stapf publishes first installment of Gramineae in *Flora of Tropical Africa*

1922 A. Chase publishes *First Book of Grasses*

1927 C. Niles publishes *Beauvois' Agrostographie*

1929 J. W. Bews publishes *The World's Grasses*

1931 N. P. Avdulov publishes "Kario-sistematicheskoye Issledovaniye Semeystva Zlakov"

1932 H. Prat publishes "L' épiderme des Graminées..."

1932 M. K. Elias publishes "Grasses and Other Plants from the Tertiary Rocks of Kansas and Colorado"

1934 A. Arber publishes *The Gramineae*

1935 P. Weatherwax publishes "Phylogeny of Maize"

1935 A. S. Hitchcock publishes *Manual of the Grasses of the United States*

1936 H. Prat publishes "La Systématique des Graminées"

1939 P. Mangelsdorf & R. G. Reeves publish *The Origin of INdian Corn and Its Relatives*

1939 G. W. Beadle publishes "Teosinte and the Origin of Maize"

1939 R. Pilger publishes "Zur Morphologie des Ahrchens der Gramineen"

1951 A. Chase publishes revised edition of *Manual of the Grasses*

1954 R. Pilger publishes "Das System der Gramineae"

1954 T. Tateoka publishes "On the Systematic Significance of Starch Grains of Seeds in Poaceae"

1955 A. Beetle publishes "The Four Subfamilies of the Gramineae"

1956 G. L. Stebbins publishes "Cytogenetics and Evolution of the Grass Family"

1956 G. L. Stebbins publishes "Taxonomy and Evolution of Genera, with Special References to the Family Gramineae"

1958 W. V. Brown publishes "Leaf Anatomy in Grass

Systematics"

1960 C. R. Metcalf publishes *Anatomy of the Monocotyledons, Vol. I. Gramineae*

1960 H. Prat publishes "Vers une Classification Naturelle des Graminées"

1960 W. V. Brown publishes "The Morphology of the Grass Embryo"

1960 T. Tateoka publishes "Cytology in Grass Systematics: a Critical Review"

1960 N. L. Bor publishes *Grasses of Burma, Ceylon, India and Pakistan*

1961 G. Ledyard Stebbins & Beecher Crampton publish "A Suggested Revision of the Grass Genera of Temperate North America"

1961 H. T. Clifford publishes "Floral Evolution in the Family Gramineae"

1961 H. J. Conert publishes *Die Systematik und Anatomie der Arundineae*

1962 Agnes Chase & Cornelia Niles publish *Index to Grass Species*

1966 F. A. McClure publishes *The Bamboos: a Fresh Perspective*

1968 F. W. Gould publishes *Grass Systematics*

1972 G. L. Stebbins publishes "The Evolution of the Grass Family"

1973 F. A. McClure publishes "Genera of Bamboos Native to the New World..."

1975 F. W. Gould publishes *The Grasses of Texas*

1976 N. N. Tsvelev publishes *Zlaki SSSR*

1978 F. W. Gould & C. A. Clark publish "*Dichanthelium (Poaceae) in the United States and Canada*

1978 R. W. Pohl publishes *How to Know the Grasses*

1979 H. E. Conner publishes "Breeding Systems in the Grasses: a Survey"

1979 H. H. Iltis et al. publishes "*Zea diploperennis* (Gramineae): a new Teosinte from Mexico"

1980 C. E. Calderón & T. R. Soderstrom publish "The Genera of Bambusoideae (Poaceae) of the American Continent..."

1980 R. W. Pohl publishes treatment of Gramineae in *Flora Costaricensis*

1981 L. Watson & M. J. Dallwitz publish "An Automated Data Bank for Grass Genera"

1983 H. H. Iltis publishes "The Catastrophic Sexual Transmutation Theory..."

1986 Derek Clayton & S. Renvoize publish *Genera Graminum: Grasses of the World*

1987 Thomas Soderstrom et al. publish *Grass Systematics and Evolution*

1989 N. N. Tzvelev publishes *The System of Grasses ... and Their Evolution*

1992 L. Watson & M. J. Dallwitz publish *The Grass Genera of the World*

1996 L. G. Clark & R. W. Pohl publish *Agnes Chase's First Book of Grasses (4th edition)*

1998 R. J. Soreng & J. I. Davis publish *Phylogenetics and Character Evolution in the Grass Family*

1999 E. J. Rudziewicz et al. publish *American Bamboos*

2000 Jacobs & Everett publish *Grass Systematics and Evolution*

2001 Grass Phylogeny Working Group publishes new system of subfamilies and tribes

2003 Second volume of the treatment of Gramineae published in *Flora of North America north of Mexico*

6.03 - WHO WERE HITCHCOCK & CHASE?

Albert Spear Hitchcock was born in Michigan in 1865, grew up in Kansas and Nebraska, and went to Iowa State Agricultural College (now Iowa State University), where he graduated in 1884. [1865 to 1884 = 19 years!] While there he studied under the eminent American botanist, Charles Edwin Bessey. He was then a faculty or staff member at Iowa State, the State University of Iowa, the Missouri Botanical Garden, Washington University, and Kansas State Agricultural College (now Kansas State University). In 1901 he moved to Washington, D. C. as the Assistant Chief of the Division of Agrostology in the U. S. Department of Agriculture. He would spend the remainder of his career working there, becoming the head of the grass collection of the United States National Herbarium, and one of this country's most respected systematic botanists. Willis Lynn Jepson, the distinguished University of California botanist and pre-eminent expert on the state's flora, once inscribed a book to Dr. Hitchcock, calling him an "*eager explorer, far-seeing botanist, and wise promoter of scientific research in America*." Dr. Hitchcock died in 1935, on board a ship returning from an International Botanical Congress in Europe.

His best known work, the " Manual of the Grasses of the United States," was published only months before his death. The first printing sold out in a matter of weeks. I have been told that the two editions of The Manual are the top-selling government publications in history. The U. S. Government Printing Office finally had to give up on reprinting the second edition because the plates had worn out! The comprehensive nature of the work, its keys and illustrations, made it the "Bible" for people needing to know about grasses. Its system of subfamilies and tribes, and the names of individual grasses, would dominate regional and state floras for decades.

One year after A. S. Hitchcock moved to Washington, D. C., so did Mary Agnes Chase, as a scientific illustrator for the Department of Agriculture. In 1905, she started to work for Dr. Hitchcock. Being a person of great intelligence and sensitivity, she fell in love with grasses. She became Hitchcock's scientific collaborator and was a major force behind the publication of The Manual in 1935. She retired as Senior Botanist at the Smithsonian in 1939, having become the successor to A. S. Hitchcock. She stayed on as an unsalaried research scientist until her death in 1963. One of her greatest accomplishments was the revision of The Manual, which appeared in 1951. Many of us, wanting to give her the recognition that she richly deserved, always call it "Hitchcock and Chase."

In her later years, Mrs. Chase could have been the type specimen of the little old granny. But as a young woman she was an activist for women's causes – not at all the shy and retiring lady botanist. On one or two occasions she was put in jail for her political beliefs.

ALBERT SPEAR HITCHCOCK

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6.04 - EVOLUTION OF GRASSES

"In my opinion, the climax of flowering-plant evolution is represented by the grasses.."(G. Ledyard Stebbins)

EVOLUTIONARY TRENDS IN THE GRASSES*

VEGETATIVE FEATURES

Habit: perennial →	annual
Elongate rhizome: absent →	present
Seedling leaves: short →	elongate
Ligule: membranous →	hairs
Pseudopetiole: absent →	present
Bicellular hairs: present →	absent
Silica cells: quadrate/elongate →	dumbbell-shaped
Stomates: lozenge-shaped →	oblong
Kranz anatomy: absent →	present

SPIKELET AND INFLORESCENCE

Panicle branches: single →	pairs, trios, clusters
Peduncle: well developed →	short/absent
Florets per spikelet: several →	one
Disarticulation below glumes: no →	yes
Glumes: awnless →	awned
Glumes: shorter or equal to →	longer than lemmas
Sterile basal lemmas: absent →	present
Lemma callus: blunt →	elongate, pointed
Lemma texture: similar →	dissimilar
Lemmas: awned →	awnless
Awn: straight, single →	bent, twisted or trifid
Awn: terminal →	dorsal or basal
Lemma apex: tapering →	notched, bilobed, toothed
Lemma veins: convergent →	parallel

FLORET AND CARYOPSIS

Florets: bisexual/mixed →	unisexual
Palea: 2-partite →	1-partite
Lodicule number: 3 →	2
Lodicules: vascular →	nonvascular
Lodicule apex: thin →	thick, truncate
Stamen number: six →	three
Style branches: three →	two
Stigmas: elevated →	sessile
Embryo/caryopsis ratio: <1/3 →	>1/3
Embryo internode: short →	elongate/absent
Starch grains: compound →	simple

NUMBER OF ADVANCED CHARACTER STATES IN REPRESENTATIVE GRASSES

Tribe	Genus	# Advanced States
Bambuseae	*Bambusa*	02
Streptochaeteae	*Streptochaeta*	04
Oryzeae	*Oryza*	09
Ampelodesmeae	*Ampelodesmos*	11
Eragrosteae	*Eragrostis*	11
Ehrharteae	*Ehrharta*	11
Danthonieae	*Danthonia*	12
Poeae	*Festuca*	12
Arundineae	*Arundo*	13
Chlorideae	*Chloris*	14
Olyreae	*Olyra*	16
Stipeae	*Stipa*	16
Triticeae	*Hordeum*	17
Paniceae	*Panicum*	17
Aveneae	*Avena*	18
Agrostideae	*Agrostis*	18
Andropogoneae	*Schizachyrium*	19

*From Stebbins, G. L. Major trends of evolution in the Poaceae and their possible significance. In, Estes, J. R., R. J. Tyrl, & J. N. Brunken (editors). Grasses and grasslands. Univ. Oklahoma Press. Norman. Pp. 3-36.

MAJOR CLADES

Evidence is presented to support the recognition of several major clades within the family:

- *Streptochaeta* & Phareae (early-diverging lineage)
- PACC clade (Panicoideae, Arundinoideae, Chlorid-oideae, Centothecoideae)
- BOP clade (Bambusoideae, Oryzoideae, Pooideae)

[Source: Grass Phylogeny Working Group, 2000]

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6.05 - DOMESTICATION OF GRASSES

"History celebrates the battlefields whereon we meet our death, but scorns to speak of the plowed fields whereby we thrive; it knows the names of the King's bastards, but cannot tell us the origin of wheat. That is the way of human folly." (Jean Henri Fabre)

"The value of the grasses to the human race is incalculable; they affect and support virtually every facet of human existence." (Richard W. Pohl, 1987)

The great civilizations, both past and present, have been based upon agriculture. These agricultural systems, in turn, have been founded upon a handful of cereals or grains. The great civilizations of the Near and Middle East, notably those of Greece, Rome, and Egypt, were based primarily on wheat; as were those of Europe and later North America. The well-developed agriculture of the Maya, Aztecs, and Incas rested on maize. The great societies of China, India, and the Far East were based upon rice. While all of the great civilizations cultivated many different kinds of plants for a variety of purposes, it is almost impossible to overestimate the importance of the cereals. We devote 70% of our farmland to growing cereals and we derive about 50% of our calories from them. As a group they are, without question, the most important source of our food and they have been throughout our entire cultural history.

All of the **true cereals** belong to Gramineae. It is common to recognize maize (corn), rice, and wheat as the major cereals. Barley, rye, and oats are the best known of the minor cereals. In addition to the true cereals is an artificial group of plants called the **false cereals**. They are characterized by small, grain-like fruits. Sunflower and buckwheat "seeds" are perhaps the best known examples.

There are several features of cereals that make them useful to us. They are annuals, which means that we can rely on getting a crop in a relatively short time. They are also adaptable and efficient producers of food. Cereals are very nutritious. Grains can be easily harvested, cleaned, and processed.

The most important part of the cereal plant is its fruit, the seed-like **caryopsis**. It is more commonly known as a **grain** or a **berry**. It contains a single seed whose outer coat is fused to the inner wall of the fruit. The outer layer of the grain (ovary wall and seed coat) are often called **bran**; the embryo within the grain is the **germ**.

THE PROCESS OF DOMESTICATION

The monumental event that is often called the single most significant occurrence in human cultural evolution happened a scant 10,000 years ago. That event is the domestication of plants and animals. To emphasize how recent this was in the scheme of things, I will switch time scales. Assume that the entire history of the universe can be collapsed into a single year.

Jan. 01: Creation of the Universe
Sep. 25: Origin of life on earth
Dec. 20: Plants colonize the land
Dec. 28: First flowering plants appear
Dec. 31: 10:30 p.m. - First humans
Dec. 31: 11:00 p.m. - Use of tools
Dec. 31: 11:59 p.m. - Domestication (agriculture)

What do we mean by cultivation and domestication of plants and what are the processes involved? To **cultivate** means to care for a plant; to till the soil, water, weed, and prune. To **domesticate** means to bring into the household; to alter, especially genetically from the wild state. We have domesticated a hundred or so plants and 50 or so animals, such as the dog, pig, cattle, horse, water buffalo, goat, sheep, and chicken.

Domestication is really directed evolution, which in turn is based upon two basic phenomena: **variation**, the concept that not all individuals are the same and that some are better adapted for survival than others, and **natural selection**, the view that nature selects for those individuals that are best adapted to reproduce the species. Natural selection has been largely replaced by **artificial selection** -- by people selecting those individuals that we want to preserve. This has been done consciously and unconsciously.

Domestication involves three important steps:

- moving seeds, grains, etc. from their native habitats and planting them in new areas;
- removing selective pressures and thereby allowing more variants to survive; and
- selecting for characteristics that are useful to us, but not necessarily for the plant under its natural conditions.

THE CHANGES

Some changes in plants that have occurred as a result of domestication include:

- spread into a greater diversity of environments and a wider geographic range;
- flowering and fruiting simultaneously;
- reduction or loss of dispersal mechanisms;
- conversion from perennials to annuals;
- absence of normal pollinators;
- loss of defense mechanisms (thorns, awns, etc.);

- ☼ increased palatability;
- ☼ development of seedless fruits;
- ☼ reproduction by vegetative means;
- ☼ increase or decrease in plant size;
- ☼ change in chromosome number;
- ☼ increased susceptibility to disease;
- ☼ loss of seed dormancy;
- ☼ loss of photoperiod controls;
- ☼ change from self-incompatability to self-compatability
- ☼ conversion of flower parts from one series to another.

WHERE DID IT OCCUR?

The Near East Complex

Avena sativa	oats
Hordeum vulgare	barley
Secale cereale	rye
Triticum aestivum	bread wheat
Triticum monococcum	einkorn wheat
Triticum turgidum	emmer wheat

The Asian Complex

Brachiaria ramosa	anda horra
Coix lacryma-jobi	Job's tears
Digitaria cruciata	raishan
Digitaria sanguinalis	manna
Echinochloa colona	shama
Echinochloa frumentacea	Japanese millet
Oryza sativa	rice
Panicum miliaceum	Proso millet
Panicum sumatrense	sawan
Paspalum scrobiculatum	khodo millet
Setaria glauca	korali
Setaria italica	foxtail millet

The African Complex

Brachiaria deflexa	animal fonio
Digitaria exilis	fonio
Digitaria iburua	black fonio
Eleusine coracana	finger millet
Eragrostis tef	teff
Oryza glaberrima	African rice
Pennisetum americanum	pearl millet
Sorghum bicolor	sorghum

The New World Complex

Bromus mango	mango
Bromus unioloides	tuca
Panicum sonorum	sauwi
Setaria geniculata	brittle grass
Zea mays	maize (corn)

[After deWet, J. M. J., 1981]

WHEN WERE THEY DOMESTICATED?

9000	Barley
9000	Emmer wheat
7500	Rice
7500	Rye
7000	Einkorn wheat
7000	Sugar cane
7000	Durum wheat
6000	Bread wheat
6000	Finger millet
5500	Maize
5500	Foxtail millet
4500	Sorghum
1500	African rice
1000	Millets
1000	Oats
1000	Maize (larger ears)
1972	Wild rice

Why Did It Take So Long?

The overriding question about the domestication of plants is why did it take so long for us to make so simple a "discovery" or to take this step. A number of theories have been put forth:

- ☼ While we lived by hunting, fishing, and gathering we had too little time for such cultural luxuries.
- ☼ Domestication became a necessity after dramatic shifts in climate.
- ☼ For thousands of years, we would be satisfied just to meet our basic needs for food, shelter, and clothing. Domestication occurred as the culmination of an ever increasing differentiation and specialization of human communities.
- ☼ Some plants and animals may have been domesticated as parts of religious ceremonies.
- ☼ No particular motive or advance was required; only the revelation that seeds can be sown to produce plants when and where desired ("The Eureka! Model").
- ☼ There is no single explanation; all of them have contributed to our understanding of the problem ("The No-Model Model").

The Worst Mistake in History?

You should be aware that not everyone is convinced that the domestication of plants and animals has been such a fine thing. But certainly we are now better off than the people in the Middle Ages? The cavemen? The apes? Jared Diamond (1987) argues the following:

- We are now much more dependent upon a few high carbohydrate crops, such as rice and the potato.
- We are more susceptible to famine and crop failure.
- Studies show an increase in tooth enamel defects associated with malnutrition, an increase in iron-deficiency anemia, an increase in bone lesions, and until recently a decrease in life expectancy.
- The population densities that are now possible with agriculture encourage the spread of parasites and infectious disease.
- Agriculture and led to deep class divisions and accentuated the inequality of the sexes.

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6.06 - THE MAJOR & MINOR CEREALS

First, a short detour into the field of economic botany. There is a convention of long standing that calls for recognizing two groups of cereals – true and false. **True cereals** are the grains derived from plants of Gramineae. All others, such as buckwheat, sunflower, grains-of-paradise, etc., are **false cereals** or **pseudocereals**. We will ignore the false cereals.

It is also customary to distinguish two groups of true cereals – major and minor. The **major cereals** are wheat, rice, and maize (corn). The **minor cereals** are all of the remaining true cereals such as barley, oats, and rye.

WHEAT

This is most widely cultivated crop plant and also one of our oldest. Archeological remains dating to 6700 B. P. have been found in Jarmo, Iraq. These were relatively primitive wheats. But, even the advanced bread wheat is known from 5000 B. C. from the Nile Valley. Wheat was brought to the New World by the Spanish in 1529. It has been in cultivated in the United States since about 1602.

There are about 14-16 commonly recognized species of wheat. They fall easily into three groups, differing in chromosome number and morphology. In *Triticum*, x = 7. Two of the wheats are diploid (2x = 14); eight are tetraploids (4x = 28); and six are hexaploids (6x = 42). A more detailed summary is presented below. The diploid and tetraploid wheats are of little economic importance; it is the hexaploids that we use. The evolution of these 6X wheats is a fascinating story of hybridization between primitive wheats and weedy relatives (goat grasses of the genus *Aegilops*), followed by what was described for many years as a "spontaneous doubling of chromosome number". It always seemed to me that there was something mystical in that phrase. Most researchers now believe that the change from diploid to tetraploid came about through the union of unreduced gametes. This process occurred without our assistance. We just took advantage of the results. I will go into this in more detail in lecture.

Today there are many different cultivars of wheat available. They are classified in several ways. The **winter wheats** are planted in the fall, remain dormant during the winter, and then mature in the early summer. Winter wheats are grown from Texas to South Dakota. **Spring wheat** is planted in the spring and matures that same summer. It is adapted for growing seasons as short as 90 days. Spring wheat is used in the northern regions of the U. S. and Canada.

Wheat is the most important cereal for bread making because of the nature of the protein in its grains. Glutenin and gliadin are sticky proteins that can hold a paste or dough together in a mass. Together they form **gluten**. If a mixture of wheat flour and water is exposed to the air for any length of time, it will become infected by naturally occurring microorganisms, including yeasts. They produce gases as part of their life cycle. The proteins in wheat flour have the ability to trap these gas bubbles within the dough. The result is leavened bread.

WILD AND DOMESTICATED WHEATS

Ploidy: Scientific Name	Genome(s)
Diploids [2n = 2x = 14]	
Triticum boeticum (wild einkorn)	AA
Triticum monococcum (einkorn)	AA
Tetraploids [2n = 4x = 28]	
Triticum dicoccoides (wild emmer wheat)	AABB
Triticum dicoccon(emmer wheat)	AABB
Triticum durum (durum or macaroni)	AABB
Triticum turgidum (poulard or rivet)	AABB
Triticum polonicum (Polish wheat)	AABB
Triticum carthlicum (Persian wheat)	AABB
Triticum timopheevii	AAGG
Triticum araraticum	AAGG
Hexaploids [2n = 6x = 42]	
Triticum spelta (spelt wheat)	AABBDD
Triticum macha (macha wheat)	AABBDD
Triticum vavilovii (Vavilov's wheat)	AABBDD
Triticum compactum (club wheat)	AABBDD
Triticum sphaerococcum (shot wheat)	AABBDD
Triticum aestivum (bread wheat)	AABBDD

This summary is modified after Simmons, N. W. (editor). 1976. Evolution of crop plants. Longman. London, England. P. 121. The nomenclature for the various wheat species follows Terrell, et al. (1986).

EVOLUTION OF MODERN HEXAPLOID WHEATS

PHASE I: DIPLOID TO TETRAPLOID

Triticum boeoticum (Wild einkorn wheat) [2n = 2x = 14] [Genome: AA]	X	*Aegilops speltoides* (Goat grass) [2n = 2x = 14] [Genome: BB]

▽
▽
▽

Sterile F_1 Hybrid
[2n = 2x = 14]
[Genomes: AB]

▽
Unreduced Gametes
("Chromosome Doubling")

▽
▽
Triticum dicoccoides
(Wild emmer wheat)
[2n = 4x = 28]
[Genomes: AABB]

▽
▽
Domestication

▽
▽
Triticum dicoccum
(Cultivated emmer wheat)
[2n = 4x = 28]
[Genomes: AABB]

PHASE II: TETRAPLOID TO HEXAPLOID

Triticum dicoccum		*Aegilops squarrosa*
(Cultivated emmer wheat)		(Goat grass)
[2n = 4x = 28]		[2n = 2x = 14]
[Genomes: AABB]	X	[Genomes: DD]

▽
▽
Sterile Hybrid
[2n = 3x = 21]
[Genomes: ABD]

▽
▽
Unreduced Gametes
("Chromosome Doubling")

▽
▽
Triticum aestivum
(Bread wheat)
[2n = 6x = 42]
[Genomes: AABBDD]

▽
▽
Domestication

▽
Hulled/Free-threshing cultivars

▽
Recent domestication/genetic engineering

RICE

Rice is the principal food for about 60% of the world's population. It has been cultivated in southeast Asia for at least 5000 years. Literally thousands of cultivars have been developed, 8000 of them in India alone. Rice was introduced into America in 1647.

Unlike wheat, most kinds of rice are diploid (2n = 2x = 24). It is usually grown in a swampy field known as a paddy. This helps to explain why so much rice is raised in the monsoon belt where heavy seasonal rainfall is used. In most instances, rice seeds are not planted directly in the paddies. Instead there are nurseries where seedlings are started and then transferred. The seedlings are planted in small bunches, each clump about 4-16" from the next one. Most cultivated strains require flooding, this being accomplished by taking advantage of the monsoons and by the skillful manipulation of dikes in the paddies.

At maturity, most rice plants are 4-6 ft. tall. In the Mekong Valley, some deep water varieties reach 20 ft. Once the plants have flowered, the water level is reduced and finally the supply is shut off entirely and the fields allowed to dry. When the plants begin to wither, it is time to harvest the crop. In the Old World, the harvesting and threshing processes are done by hand. In the U.S. and other technologically advanced countries, much of this is done by machine. In this country, Arkansas, Louisiana, and California are the main rice growing states.

THE PROCESS

Oryza rufipogon
Wild: Asia
Perennial
2n = 2x = 24
Genome: AA

▽
Oryza nivara
Wild: India, Asia, Oceania
Annual
2n = 2x = 24
Genome: AA

▽
Domestication

▽
Oryza sativa
Cultivated: widespread
Annual
2n = 2x = 24
Genome: AA

We commonly recognize three types of rice based upon the length of the grain:

- **long**: tropical rices; not too soft nor starchy; grains 7-8 mm long, the length prized by the connoisseur

- **medium**: commonly grown in the U. S.; somewhat softer; grains averaging about 6.6 mm long

- **short**: grown in the more northern climates, often planted in Japan; even more starchy; grains averaging about 5.5 mm long

MAIZE

First, a word about the common name of *Zea mays*. In this country, we usually call this plant corn or Indian corn. Maize is a better common name (and a perfectly legitimate one) because corn is used by English-speaking peoples around the world for several other cereals.

There are three features of maize that make it different from wheat, rice, or any other cereal. It is the only important cereal that is native to the New World. Second, maize as we known it today is considerably different in appearance from its wild ancestors. The progenitors of the other cereals are basically the same in general appearance as their modern derivatives. Maize is strikingly distinct. And third, maize is unique among the major cereals in having separate male and female flowers borne on entirely different parts of the plant. The male flowers are found on the branches of the tassel, while the female flowers are clustered in the ear, the complex fruiting structure that bears an even number of rows of caryopses, or kernels as they are commonly called.

There are six main types of maize in use today:

- **flint**: kernel made of hard starch; in use by Native Americans at the time of Columbus; widely used in the northern corn belt;

- **dent**: kernel of hard starch, capped by soft starch that dries to leave a small depression in the top of the grain; economically the most important maize; much used in the corn belt;

- **flour**: kernel consists almost entirely of soft starch; used by the Native Americans of the Southwest and those in South America for hand grinding;

- **sweet**: kernels with high sugar content, consumed while immature; most widely grown for human consumption here and in Europe;

- **pop**: kernels lacking soft starch, cells burst upon heating because of high water content of central cells; related in flint corn;

- **pod**: peculiar type with comparatively little economic importance; kernel enclosed by bracts; considered by some to be the ancestor of modern maize.

Maize has many uses. About 90% of the crop goes into livestock food. In this country, maize is relatively unimportant as a food for humans. This is not the case in many other areas of the world, especially Africa. It is inferior to wheat and to some other cereals in its protein content. This means that maize flour products are less tasty than those made from rye or wheat. Maize flour, however, has been the mainstay of many peoples in Central and South America. Other important products from maize include corn starch, corn oil, alcoholic beverages, and silage.

HYBRID MAIZE

One of the great developments in modern agricultural genetics is hybrid corn. The basic principle involved is that stable inbred lines can be crossed with one another to produce uniform plants with higher yields that combined the desirable features of the two parental lines. Modern hybrid corn involves a double crossing. During the first year, inbred line A is crossed with line B. Self-pollination is prevented during these crosses by removing the male flowers from one strain (detasseling), thereby rendering the plants effectively female. The manual emasculation of plants, once a common summer job for young people living in the Corn Belt, has all but disappeared because of another important advance -- genetically controlled male sterility in maize. In separate fields, lines C and D are similarly crossed. The seeds from the A x B and from the C x D crosses are planted. These mature into AB and CD individuals. These are then crossed during the second year, yielding the double cross ABCD hybrid seed. It is planted the third year to produce tremendous yields of high-quality seed. The ABCD seed is not true-breeding and must, therefore, be purchased regularly.

CYTOPLASMIC MALE STERILITY

In 1938, Paul Mangelsdorf, a Harvard botanist who devoted his life to the study of maize, discovered a sweet corn variety in Texas that was male sterile. The male flowers of its tassel had shriveled anthers that did not produce fertile pollen grains. Investigation of this plant revealed that the sterility was under genetic control, as opposed to some short-lived environmental problem, such as drought. Sterile sex cells typically result from chromosomal abnormalities, either in their number or structure. However, in this case the corn plant produced sterile pollen when a sterility factor [S] in the cytoplasm of the cell was present at the same time that it had a double recessive gene [rf] in its nucleus. This same kind of phenomenon was first found in onions, and is now known to occur in several crop plants. One possible explanation is that the cytoplasmic sterility is caused by viruses that can survive only if the rf rf condition exists. If the gene is

present in the Rf state, fertility is restored. Cytoplasm without the sterility factor is designated N, for "normal." The cytoplasmic factor passes from one generation to the next only via the egg. To summarize:

S rf rf = male sterile plants
S Rf rf = male fertile plants
S Rf Rf = male fertile plants
N rf rf = male fertile plants
N rf rf = male fertile plants

Therefore, by using an inbred line that contains the S rf rf genetic combination, male sterile plants are produced. The corn plants are rendered functionally female. The difficulty in finding enough workers and their cost made the male-sterile strains a very attractive alternative to manual detasseling. Within twenty years, practically all of the maize grown in the United States incorporated the male sterility factor first found in the Texas corn plants. Once again we had made one of our major crop plants more genetically similar to one another, with all of the advantages and disadvantages associated with that uniformity. The bill came due in the summer of 1970. Our corn fields were invaded by a fungus (*Helminthosporium maydis*), which causes the southern leaf blight. The disease spread rapidly, moving from Florida northward at about 150 km per day. By the end of the summer, the blight had covered much of the eastern and central United States. It devastated the Texas male-sterile hybrids, causing more than a $1 billion loss in the corn crop. Today's maize cultivars are based upon normal cytoplasm and are detasseled by hand.

"JUMPING GENES"

James Watson, who shared the Nobel Prize with Francis Crick for their discovery of the structure of DNA, said, *"There are really three main figures in the history of genetics -- the three M's: Mendel, Morgan, and McClintock."* Gregor Johann Mendel (1822-1884), an Austrian monk, is often called the father of genetics. His work on the changes that he observed from one generation to the next in pea plants that he grew in the monastery garden is well known -- a standard fixture in all highschool and college texts in biology and genetics. Thomas Hunt Morgan (1866-1945), of Columbia University, along with his wife (Lillian) and his students did his research on the fruit fly (*Drosophila melanogaster*). His lab was the first to demonstrate that genes were located on chromosomes in the cell nucleus, that genes were located at specific sites on a chromosome, and that traits were passed from parent to offspring through genes. Morgan won the Nobel Prize in 1933 for these fundamental discoveries.

The third "M" is Barbara McClintock (1902-1992). She earned her bachelor's degree in botany from Cornell University, where she was also awarded her master's and doctorate. In 1931, McClintock identified the ten chromosomes of maize, and she co-authored with Harriet Creighton the first paper to describe the genetic phenomenon of crossing-over. In 1944, McClintock identified the seven chromosomes of the bread mold, *Neurospora*, and began her research on mobile genes and controlling elements in maize. She had observed that some plants have leaves with different patterns of pigment in them. In maize, some kernels were white, some solid purple, and some had speckles of purple on otherwise white kernels.

After years of detailed study, McClintock developed a theory to explain what she had seen. The differences in pigmentation of corn kernels was caused by some genes moving from one site on a chromosome to another location, or from one chromosome to another. Further, it appeared to her that other genes acted as switches that turn a gene on and off during plant development. McClintock presented the results of her work in 1951 at a Cold Spring Harbor Symposium. The reaction was mixed. Most of her colleagues failed to understand her work, others rejected it outright, and others thought that poor Barbara had been out in the sun too long playing her corn plants. One said, that *"... he had never heard anything as ridiculous."* Another, *"I understand that you're doing something that's very strange. I don't want to hear a word about it."* At the other end of the spectrum, the distinguished Caltech geneticist Alfred Sturtevant said, "*I didn't understand one word she said, but if she says it is so, it must be so!"*

What Barbara McClintock had proposed was heresy! Everyone knew that a chromosome was like a necklace and the beads were genes. This bead is always next to that bead in a necklace; this gene is always next to that gene on a chromosome. And she was saying that it ain't necessarily so. In her now classic paper, McClintock concluded that the best explanation for what she was seeing was that a gene did, in fact, actually move from one site on a chromosome to the site of the gene that controlled pigment color. She called it Ds, the dissociator gene. Ds would instruct the color gene. The Ds gene, in turn, was controlled by an activator, Ac.

McClintock called these mobile genetic units **transposons**. Time Magazine called them "jumping genes." It explained McClintock's theory in terms of three characters -- a painter, a boss, and a policeman. The painter is the structural gene that makes a kernel have a particular color. The boss (Ds or dissociator gene) can tell the painter to paint or not to paint. The boss must follow the directions of the police officer (Ac or activator gene), who can tell the boss to let the painter do his job or not. The officer can tell the boss to have the painter stop and then later resume painting. Depending on the interaction of the painter, boss, and policeman, the kernel will be pigmented, speckled, or colorless.

On 10 October 1983, McClintock learned from the radio that she had won the Nobel Prize in Physiology

or Medicine. The folks in Stockholm had tried to call her at home, but she didn't have a telephone. She, Marie Curie in 1911, and Dorothy Hodgkin in 1964 are the only three women to receive an unshared Nobel in any field.

McClintock's long-time friend and champion, Marcus Rhoades, said of her work:

"One of the remarkable things about Barbara McClintock's surpassingly beautiful investigations is that they came solely from her own labors. Without technical help of any kind she has by virtue of her boundless energy, her complete devotion to science, her originality and ingenuity, and her quick and high intelligence made a series of significant discoveries unparalleled in the history of cytogenetics. A skilled experimentalist, a master at interpreting cytological detail, a brilliant theoretician, she has had an illuminating and pervasive role in the development of cytology and genetics."

Transposable elements have since been found in many plants and animals. They are best known in maize, fruit flies, yeasts, and humans.

MAIZE RELATIVES

It is also important not to over emphasize the uniqueness and remoteness of maize. It does have close relatives, although you might not recognize them as such on casual inspection.

Gama grass (*Tripsacum* ssp.). There are about seven species of gama grasses found from the central United States to southern Brazil. All of them are perennials. The male and female flowers are separated from one another, but do not occur in the tassel/ear configuration in corn.

Teosinte. There are three kinds of teosinte, all occurring in Mexico and Central America. Traditionally, teosinte has been placed in its own genus (*Euchlaena*), but in more recent works the species have been put in *Zea*. The male flowers are borne in a tassel at the top of the plant; the female flowers are borne on a spike on the lower parts of the plant.

POSSIBLE ANCESTORS

A great deal of research and speculation has been focused on the ancestor or ancestors of modern maize. Here are the major players.

Corn Grass. This plant is an anomalous grass with numerous slender leaves, numerous tillers, and small ears. There is a long spathe, more characteristic of *Coix* than of maize. These differences are supposedly the result of a single dominant gene. The plant really does not look like maize, but it was once proposed as an ancestor. It has few, if any, proponents these days.

Teosinte. When first proposed by Ascherson, the hypothesis was that maize was a domesticated form of teosinte. The theory was later modified by Harshberger and Collins to say that one parent of maize was teosinte, but that it had a second parent of unknown identity. George Beadle discovered that teosinte kernels will pop; a reason to preserve it as a food plant. The polystichous nature of the maize ear could be the result of fusion of teosinte spikes. The advocates of teosinte provided the only real challenge to the pod corn theory as the leading explanation of corn's ancestor.

Common Ancestry. According to this theory, maize originated from a perennial, wild, maize-like ancestor. This plant is now extinct. The pre-maize, in turn, had an ancestor in common with both teosinte and gama grass. That grandparent is also now extinct. This theory is largely untestable because the principal players are extinct. They cannot be tested or measured.

Pod Corn. This theory was developed about sixty years ago by Paul Mangelsdorf and R. G. Reeves, two of the great names in this area. Pod corn is still very much with us today. It is a peculiar, primitive looking maize with well-developed papery bracts surrounding the individual kernels. We grow it in this country as a curiosity; in South America it remains a food plant of limited importance. The pod corn theory has three basic premises:

- modern maize originated from a wild form of pod corn indigenous to the lowlands of Central or South America;
- teosinte is the product of natural hybridization between maize and gama grass; and
- many of the strains of maize that we see today are the result of past hybridization between *Zea* and *Tripsacum*.

NATURE OF EVIDENCE

Archeological/ethnobotanical remains. Although archeological remains of maize are fairly common in the New World, they have never been found in the Old World. This fact helps us to conclude that maize is indigenous to the New World. Several of the important digs are:

Bat Cave (New Mexico). The floor of this cave is littered with six feet of garbage, coprolites (fossil poop), debris, and tiny cobs of maize about 5600 years old. The cobs are 2-3 cm long, with kernels partly enclosed by bracts. Anatomically, it is a pod corn or a pop corn.

Swallow Cave (New Mexico). At the lowest levels are tiny cobs similar to those in the Bat Cave. The prehistoric context of the cobs indicates their great age.

Coxcatlán Cave (Tehuacán Valley of Mexico). The cave system consists of 28 superimposed levels. The upper 14 have well-preserved cobs. The cave was occupied from 10,000 to 2300 B. C. and then again from 900 B. C. to A. D. 1500. The cave faces a broad alluvial plain where wild and cultivated maize could have grown. The oldest remains bridge the gap between wild maize and the earliest stages of domesticated maize.

La Perra Cave (Tamaulipas, Mexico). The oldest remains are from about 2500 B. C. They show the signs of crossing with gama grass at the lower levels, but show "tripsacoid" features at the upper levels.

Purron Cave (Tehuacán Valley of Mexico). This cave was inhabited from about 200 B. C. to A. D. 1500. The surrounding soils ar fertile and there was an abundance of water.

Pollen. During the excavations required for a new office building in Mexico City, grass pollen was discovered in cores taken at a depth of about 70 meters. The pollen was about 80,000 years old. Detailed studies made by Elso Barghoorn, a paleobotanist at Harvard University, showed that the pollen was that of maize. Above the six meter level was copious pollen of modern, cultivated maize. Barghoorn's work again provides support for the New World origin of maize. The plants that produced this pollen were alive and well thousands of years before we migrated into the Valley of Mexico. Second, this discovery tended to support the pod corn theory of Mangelsdorf and Reeves. The ancestor of modern maize as a more primitive kind of maize.

Genetic. On the fourth longest chromosome of pod corn is a gene designated Tu. In pure pod corn the gene is present in the homozygous dominant state (TuTu). It is heterozygous in modern pod corn (Tutu) and it is homozygous recessive (tutu) in modern maize. The change from TuTu to tutu is associated with many changes in pod corn, including a number that have made the plant much more useful to us. These have also rendered it unable to live in the wild. The changes include:

- ☼ reduction in prominence of the tassel;
- ☼ increase in the development of the ear;
- ☼ changing the tassel from principally female to male;
- ☼ decrease in the length and weight of the bracts surround the kernels; and
- ☼ increase in the size and weight of the axis of the ear.

Walter Galinat (1983, 1985) reports that the gene Tr controls the two- versus four-ranked ears. The gene Pd controls single versus paired spikelets. Ab determines the presence or absence of abscission layers in the ear. The gene Tu codes for soft outer glumes and a soft rachis.

Molecular. John Doebley of the Univ. of Minnesota has studied isozyme variation in maize and teosinte. He has looked at 13 enzyme systems encoded by 21 loci. If teosinte were the ancestor of maize, we would expect to find considerable similarity at the molecular level. His studies show that maize and teosinte are indistinguishable.

TEOSINTE VERSUS MAIZE

- ☼ In teosinte the female spikelets are solitary; they are paired in maize;
- ☼ In teosinte the central spike of the female inflorescence is two-ranked; it is many-ranked in maize;
- ☼ In teosinte the rachis shatters at maturity; it is non-shattering in maize;
- ☼ The caryopsis is encased in teosinte; naked in maize.

At first, the differences seem striking. As Paul Mangelsdorf noted, "If maize has originated from teosinte, it represents the widest departure of a cultivated plant from its wild ancestor which still comes within man's purview...

However, according to Doebley (1990), perhaps as few as five genes account for 50-80% of the differences between maize and teosinte. "If you took those five regions from maize and put them into teosinte, the thing you'd have in front of you would be called maize." He estimates that these dramatic changes could have occurred in less than 1000 years.

An alternative explanation, wonderfully entitled the "Cataclysmic Sexual Transmutation Theory," was advanced by Hugh Iltis of the Univ. of Wisconsin. He thinks of an ear of corn as "... that magnificently monstrous enigmatic anomaly...." His argument builds on the fact that the maize ear and the central spike of the maize tassel are homologous. Both are polystichous and both are governed by the same genes. The central spike of the tassel is often feminized into an ear by abnormal environments or by disease, such as corn smut. Iltis argues that the maize ear is a feminized tassel reduced to its terminal spike. Therefore, the teosinte tassel could be transformed into a maize ear in one giant step. This would explain the lack of connecting links in the archaeological record.

PUTTING IT ALL TOGETHER

The salient points appear to be:

- ☼ Maize is native to the New World, probably Mexico or Central America.

- The direct ancestor of maize is teosinte.
- "... teosinte is not a hybrid of maize and *Tripsacum*. Perhaps I may be permitted to enjoy some degree of satisfaction in the fact that it is colleagues and not my critics who have shown that this part of our tripartite hypothesis is no longer tenable." (Paul Mangelsdorf, 1974)
- The transformation of teosinte into maize began about 8000 B. P.
- Archaeological evidence suggests that we first began to cultivate maize about 5200-3400 B. C.
- "The mystery of maize is not such a mystery after all, and the romance has been exaggerated." (Jack Harlan, 1992)
- Early Native Americans discovered that they could accelerate the forces of natural selection by physical separation of selected plant types.
- Use of irrigated garden plots or isolated plots meant that these forms would not be genetically swamped by wild populations.
- They selected the most useful variants out of large populations of teosinte.
- "... American Indians had already developed two or three hundred races of corn, essentially all we have today. Theirs was the most extraordinary achievement in plant breeding in all of man's existence, including his most recent history.... Perhaps most remarkable of all were the earliest steps when man (or, more likely, woman) first began to influence the evolution of what I believe to be the wild ancestor of corn." (George W. Beadle, 1972)

THE PROCESS

Mangelsdorf & Reeves

Pod corn
▽
Wild maize
▽
Domestication
▽
Modern maize

*****

Maize x grama grass
▽
Teosinte

Beadle & Galinat

Teosinte
▽
Domestication
▽
Primitive maize
▽
Domestication
▽
Modern maize

THE MINOR CEREALS

BARLEY

Hordeum vulgare ranks number fourth in terms of world-wide annual production. Along with wheat, it was one of the first plants that we domesticated. All of the cultivated species are diploids (2n = 2x = 14). Barley differs from wheat, maize, and rice in having three spikelets per node. If all three develop, the spike has the appearance of having six rows of grains (the 6-rowed barleys); if the two lateral spikelets are rudimentary, then the spike appears to have two rows of spikelets (the 2-rowed barleys). The two bracts immediately surrounding the grain are fused to it. The grain is pearled, rubbed against abrasive disks to remove the hulls and some of the outer layers of the grain, during the processing for human consumption. The chief use of barley is as animal food. It is a relatively unimportant food for humans. About one-third of the crop is used for making malt used in brewing, flavoring, cereals, icings, coffee substitutes, infant foods, flours, medicinal syrups, candies, and industrial fermentations.

THE PROCESS

Hordeum spontaneum
Wild barley
Fertile Crescent
▽
Domestication
▽
Hordeum vulgare var. *distichum*
2-rowed barley
▽
Domestication
▽
Hordeum vulgare var. *hexastichum*
6-rowed barley

RYE

Secale cereale is a plant of cool, non-humid regions. It is grown chiefly in northern Europe. In the United States, North and South Dakota and Nebraska grow

the most rye. The species is diploid (2n = 2x = 14). It is now unknown in the wild. Most rye is fed to cattle. We use it to make flour for "rye bread" or the famous black bread (Schwartz brot) of Germany, Poland, and Russia. Most of our U. S. rye bread has a very high wheat flour content. Rye is also used to make whisky and industrial alcohol. Ergot *(Claviceps purpurea)* is an important fungal parasite of rye. It causes tremendous crop losses and poisoning in both cattle and humans. Consumption of contaminated grain over a period of time leads to a gangrenous loss of tissues because of constriction of blood vessels, especially in the extremities of the body. Larger doses can have pronounced effects on the central nervous system.

THE PROCESS

Secale montanum	X	*Secale ancestrale*
Wild rye		Wild rye
S. Europe/SW Asia		Anatolia/Armenia
	▽	
	Secale cereale	

OATS

The origin of oats (*Avena* spp.) is obscure. There are few references to it in the ancient literature; none, for instance, in the Old Testament. It may have become domesticated in the cultivated fields of barley or of some other crop. It is now grown in temperate regions, chiefly Europe and North America.

As in wheat, there are diploid, tetraploid, and hexaploid oats. We use the hexaploids more than the others. The diploids include *A. brevis* (slender oats), *A. strigosa* (sand oats), *A. wiestii* (desert oats), and *A. nudibrevis*. The tetraploids are *A. barbata* (slender oats) and *A. abyssinica* (Abyssinian oats). The hexaploids include *A. fatua* var. *fatua* (wild oats), *A. fatua* var. *sativa* (cultivated oats), *A. sterilis* (wild red oats), *A. byzantina* (red oats), and *A. nuda* (naked oats).

Until quite recently, oats were not widely appreciated, even though they are very nutritious (protein content of 13.8%). Oats are used to make flour, rolled oats, and even as a beverage (avena). The crop is often rotated with corn. Iowa is the leading U. S. producer.

SORGHUM

The U. S. is the leading producer of sorghum (*Sorghum bicolor* + other spp.). Annual world-wide production now stands at 57 million metric tons of this increasingly popular grain. The species are believed to be Asian or African in origin. Sorghum was introduced into the U. S. in the mid-1800's. The grains are small and difficult to process. We use the various species mostly for forage and silage, but in the Old World the grains are often eaten like rice or made into an unleavened bread. All of the species are diploids (2n = 2x = 40), except for Johnson grass, a very aggressive tetraploid weed.

There are four commonly recognized groups of sorghum species, based upon their use:

- ☼ syrup or sorgos, whose stem juices are abundant and sweet;
- ☼ broomcorn, used to make old-style commercial brooms;
- ☼ grain sorghums, such as kaffir, milo, and durra; and
- ☼ grass sorghums, such as Sudan grass, Tunis grass, and Johnson grass, grown for forage and silage.

WILD RICE

Zizania aquatica is native to North America. The common name is confusing, because it is not really a kind of rice (*Oryza*). The plants are robust aquatics. As in maize, the two sexes are found in separate spikelets on different parts of the plant. Native Americans gathered the grains by boat. Until recently, wild rice has eluded cultivation with most of the crop coming from Minnesota. It is now being cultivated, including in some of our northern California counties.

T' EF OR TEFF

This popular grain, derived from *Eragrostis abyssinica*, is native to northeastern Africa. Its major production site is Ethiopia, where it is more popular than all other cereal grains combined. The very small grains (1/32 in. in diameter) are typically fermented for a day or so and then made into pancakes. Teff has become popular among natural food enthusiasts in this country in recent years. The plants are also an excellent source of fodder.

JOB'S TEARS

Although native to southeastern Asia, *Coix lacryma-jobi*, named after the righteous sufferer in the Old Testament parable, is now very common through all of the tropical and subtropical regions of the world where its grains are used as food. It is not highly regarded, even though it has a very high protein content. Many of you will have seen these grains because they are also used to make rosaries and tourist trinkets.

MILLETS

This is a group name for an artificial assemblage of grasses that have very small grains. Most of the common ones belong to the genera *Pennisetum, Setaria, Panicum,* and *Eleusine*. For the most part, the various species are native to tropical and subtropical areas of the Old World. They are especially well

adapted to poorer soils. Most of us in Europe or North America have never eaten any of the millets (unless, of course, we frequent hippie cooperative food stores) and probably do not appreciate the role that they play in the diet of about one-third of the world's people. We see millet relatives as roadside weeds or as constituents in bird seed mix. They are also used for forage.

TRITICALE

Both its common name and generic name (X *Triticosecale*) suggest the origin of this cereal. It is a human-mediated hybrid between wheat (*Triticum*) and rye (*Secale*). Natural hybrids had been known for many years, but their offspring were usually sterile. Genetic work began in the late 1930's to produce a synthetic hybrid that would combine the useful features of these two important cereals. In 1965, the Centro Internacional de Mejoramiento de Maize y Trigo launched a major effort to make triticale a major food crop. It is the only artificial cereal to date that has had a major impact.

THE PROCESS

Secale cereale Rye RR	X	*Triticum durum* Durum wheat AABB
	∇ *Triticosecale* ABR	
Secale cereale Rye RR	X	*Triticum aestivum* Breadwheat AABBCC
	∇ *Triticosecale* ABCR	

THE MINOR CEREALS

Common Name [Scientific Name]	Comments
acha *[Digitaria exilis]*	African; quite palatable and nutritious
Adlay *[Coix lacryma-jobi]*	See Job's tears
African millet *[Eleusine coracana]*	Widely used in China, India, and Africa
barley *[Hordeum vulgare]*	Old World; one of the ancient cereals
barnyard grass *[Echinochloa crus-galli]*	Known to us also as an agricultural weed
broom millet *[Panicum miliaceum]*	Cultivated especially in the Old World
browntop *[Brachiaria ramosa]*	A relative of the *Panicum* cereals
bulrush millet *[Pennisetum americanum]*	A relative of elephant and Napier grass
channel millet *[Echinochloa turnerianum]*	A relative of our barnyard grass
club wheat *[Triticum compactum]*	Grown mostly in Chile, USA, and India
common millet *[Panicum miliaceum]*	In use since prehistoric times; Eurasia
durum wheat *[Triticum durum]*	High in gluten; used to make spaghetti
einkorn wheat *[Triticum monococcum]*	Primitive diploid, 1-seeded wheat
emmer wheat *[Triticum dicoccon]*	Ancient Mediterranean wheat; still used
finger millet *[Eleusine coracana]*	Important cereal in Africa and India
fonio *[Digitaria elixis]*	Used in tropical Africa
foxtail millet *[Setaria italica]*	Native to India; Near East & China
German millet *[Setaria italica]*	See foxtail millet
guinea grass *[Panicum maximum]*	A perennial grass of tropical areas
hog millet *[Panicum miliaceum]*	See common millet
Hungarian millet *[Setaria italica]*	Old World; now widely cultivated
Hungry-rice *[Digitaria eximis]*	West Africa; now unknown in wild
Italian millet *[Setaria italica]*	See Hungarian millet
Japanese millet *[Echinochloa crusgalli]*	See barnyard grass
Job's tears *[Coix lacryma-jobi]*	SE Asia; ornamental use in jewelry
kans *[Saccharum spontaneum]*	Sugar cane relative grown in Africa
koda millet *[Paspaum commersonii]*	Old World; relative of Dallis and bahia grass
little millet *[Panicum sumatrense]*	Grown extensively in India
manna grass *[Glyceria* spp.*]*	Used especially in North America
naked oats *[Avena nuda]*	Upland regions of China
oats *[Avena* spp.*]*	Hexaploids most important
pearl millet *[Pennisetum glaucum]*	Highly nutritious; hybrids grown in USA
perennial teosinte *[Zea mays* ssp. *diploperennis]*	Recently discovered in Mexico
Polish wheat *[Triticum polonicum]*	S. Europe and n. Africa, not Poland
proso millet *[Panicum miliaceum]*	Ancient; grown mostly in USSR and Asia
ragi *[Eleusine coracana]*	See finger millet
rye *[Secale cereale]*	Probably native to southeast Asia
sanwa millet *[Echinochloa frumentacea]*	Used primarily as cereal in Far East
shama millet *[Echinochloa colona]*	Old World; now also a widespread
sorghum *[Sorghum bicolor]*	Ancient cereal of Asia and Africa
tartarian oats *[Avena orientalis]*	One-sided spikelet clusters
teff *[Eragrostis abyssinica]*	Ethiopia and African highlands
teosinte *[Zea mays* ssp. *mexicana]*	A close relative of maize
triticale *[X Triticosecale* spp.*]*	Artificial wheat/rye hybrid
wild rice *[Zizania* spp.*]*	Native to North America; recently domesticated

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6.07 - GRASSLANDS OF THE WORLD

Grasslands are plant communities in which grasses are dominant. Major grassland areas occur in North America, South America, Africa, Asia, and Australia. Most of them are associations with more than one dominant species. Grasslands are often found in the interior of continents, where rain falls mainly in the summer months. The distribution of grasslands is dependent upon certain climatic, edaphic, and human-generated factors.

There are three major kinds of grasslands, with many subdivisions and transitional types:

- **Savannas** are dominated by high, coarse grasses and more or less widely scattered, low trees. Turf is seldom formed. They are often found in the tropical and subtropical regions, often in areas characterized by a short dry season. Typical examples include the llano of Venezuela, the Campo of Brazil, and the vast grasslands of much of Africa.

- **Steppes** are treeless grasslands of low relief. They may be arid or semiarid and occur in warm or cool climates. Steppes are dominated by sod-forming grasses, tufted tall grasses, or short grass vegetation. They are characterized by a protracted cold season. Typical examples include the grasslands of the southern republics of the former Soviet Union and the Great Plains east of the Rocky Mtns. in the United States.

- **Prairies** are treeless grasslands of low relief, climatically and vegetationally intermediate between savannas and short-grass steppes. Prairies are less humid that savannas and are less arid than steppes. They are usually absent from tropical/subtropical regions. Their deep, dark soils are covered with sod-forming tall-grasses. Typical examples include the Trans-Mississippi Valley in the United States, the Black Earth Belt of Russia, and the Pampa of Argentina.

THE EARTH'S COVER (mi^2)

Water	139,150,000
Ice caps	5,830,000
Forests:	
Tropical Rain Forest	3,800,000
Temperate Rain Forest	550,000
Deciduous Forest	6,500,000
Coniferous Forest	7,600,000
Dry or Monsoon Forest	2,000,000
Thorn Forest	340,000
Sclerophyll Brushland	1,180,000
Total	21,970,000
Deserts:	
Desert Shrub/Grass	10,600,000
Salt Desert	30,000
Desert (Hot & Dry)	2,400,000
Tundra (Cold)	4,400,000
Total	17,430,000
Grasslands:	
High Grass Savanna	2,800,000
Tall Grass Savanna	3,900,000
Tall Grass	1,580,000
Short Grass	1,200,000
Desert Grass Savanna	2,300,000
Total	12,570,000

[After Shantz, 1954]

Forests are 42% of the earth's vegetation cover, deserts are 34%, and grasslands are 24%. With adjustments to recognize the extent of grasslands in forests and deserts: forests = 40%; grasslands = 27%; and deserts = 33%.

GRASSLANDS OF NORTH AMERICA

Grassland Type	%	Hectares
Tallgrass Prairie	19	57,351,100
Mixed-grass Prairie	19	56,617,400
Shortgrass Prairie	21	61,522,300
Coastal Prairie	01	3,800,000
California Grassland	03	9,200,000
Palouse Prairie	22	64,471,600
Fescue Prairie	08	25,500,000
Desert Grassland	07	20,756,500
Total		*299,222,900*

[After Sims & Risser in Barbour & Billings, 2000]

TALL GRASS PRAIRIE

The Tall Grass Prairie, True Prairie, or Bluestem Prairie occurs at the eastern edge of the grassland formation, from southern Manitoba to south-central and eastern Texas, and eastward into Ohio. Characteristic grasses include:

Andropogon gerardii	Big bluestem
Sorghastrum nutans	Indian grass
Panicum virgatum	Switch grass
Schizachyrium scoparium	Little bluestem
Spartina pectinata	Prairie cord grass
Sporobolus heterolepis	Prairie dropseed
Koeleria macrantha	June grass
Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Stipa spartea	Porcupine needle grass

MIXED GRASS PRAIRIE

The Mixed Grass Prairie or Mixed Prairie is the largest grassland association. It occurs from Canada to south-central Texas; from western Nebraska to the Rocky Mountains. Rainfall (10-27") comes mainly in the spring and in the early summer. A summer drought is expected periodically. The characteristic grasses include:

Elymus smithii	Western wheat grass
Elymus dasystachys	Thickspike wheat grass
Schizachyrium scoparium	Little bluestem
Stipa spartea	Porcupine needle grass
Stipa comata	Needle-and-thread grass
Koeleria macrantha	June grass
Calamovilfa longifolia	Prairie sandreed
Sporobolus cryptandrus	Sand dropseed
Bouteloua gracilis	Blue grama
Carex spp.	Sedges

The Sandhills of Nebraska is a recognizably distinct component, characterized by:

Redfieldia flexuosa	Blowout grass
Stipa hymenoides	Indian rice grass
Eragrostis trichoides	Sand love grass
Stipa comata	Porcupine needle grass
Calamovilfa longifolia	Prairie sandreed
Schizachyrium scoparium	Little bluestem
Andropogon hallii	Sand bluestem
Muhlenbergia pungens	Sandhill muhly

SHORT GRASS PRAIRIE

The Short Grass Prairie or Short Grass Steppe occupies about 280,000 sq. km in the Central Plains of the United States. Its northern limit is close to the Colorado-Wyoming boundary, extending south into Texas; from the foothills of the Rocky Mtns. on the west to the Oklahoma Panhandle on the east. Rainfall is from about 300-500 mm annually. The characteristic grasses include:

Bouteloua gracilis	Blue grama
Stipa comata	Needle-and-thread grass
Elymus smithii	Western wheat grass
Buchloë dactyloides	Buffalo grass
Aristida purpurea	Purple three-awn grass
Hilaria mutica	Tobosa
Bouteloua hirsuta	Hairy grama

DESERT GRASSLAND

The Desert Grassland occurs in the American Southwest and in adjacent north-central Mexico. It is the hottest, driest of our grasslands, receiving 11-17" of precipitation each year. Snow is a factor at higher elevations. Characteristic low-elevation grasses include:

Bouteloua eriopoda	Black grama
Hilaria mutica	Tobosa
Aristida divaricata	Poverty three-awn
Aristida purpurea	Purple three-awn
Muhlenbergia porteri	Bush muhly
Sporobolus cryptandrus	Sand dropseed

At higher elevations:

Hilaria belangeri	Curly mesquite
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Bouteloua eriopoda	Black grama
Hilaria mutica	Tobosa
Stipa neomexicana	New Mexico feather grass
Bouteloua curtipendula	Sideoats grama

CALIFORNIA PRAIRIE

The California Prairie or Pacific Prairie covers about 10 million hectares in California and Baja California. It occurs as open grassland and as an understory. It consists of two elements – one occurring along the North Coast at medium and higher elevations and the other in the Great Central Valley, southern Coast Range, and extending into Mexico.

Northern Component: pre-European settlement

Danthonia californica	California oat grass
Deschampsia cespitosa	Tufted hair grass
Festuca occidentalis	Western fescue
Festuca idahoensis	Idaho fescue
Festuca rubra	Red fescue
Calamagrostis nutkaensis	Pacific reed grass

Northern Component: post-European settlement

Festuca arundinacea	Tall fescue
Holcus lanatus	Velvet grass
Anthoxanthum occidentale	Sweet vernal grass
Lolium multiflorum	Italian rye grass
Arrhenatherum elatius	Tall oat grass
Dactylis glomerata	Orchard grass

Central Valley: pre-European settlement

Stipa pulchra	Purple needle grass
Stipa cernua	Nodding needle grass
Elymus glaucus	Blue wild rye
Poa scabrella	Pine bluegrass
Muhlenbergia rigens	Deer grass

Central Valley: post-European settlement

Avena fatua var. *fatua*	Wild oat
Avena barbata	Slender oat
Bromus mollis	Soft cheat grass
Bromus diandrus	Ripgut grass
Bromus rubens	Foxtail brome
Hordeum murinum	Mouse barley
Hordeum pusillum	Little barley
Festuca myuros	Foxtail fescue
Festuca megalura	Foxtail fescue
Erodium cicutarium	Filaree
Erodium botrys	Filaree

PALOUSE PRAIRIE

The Palouse Prairie, named after a Native American people, occurs from southern British Columbia southward to central Oregon and eastward into Idaho and Montana. Minor examples are found in Utah and in Nevada. The Palouse Prairie is a relatively arid grassland with about 8-25" of precipitation each year, much of it as snow. It occupies sites between sagebrush steppe on the drier side and ponderosa pine or Douglas-fir on the wetter side. Characteristic grasses include:

Elymus spicatus	Bluebunch wheat grass
Festuca idahoensis	Idaho fescue
Elymus cinereus	Ashy wild rye
Poa secunda	Sandberg's bluegrass
Stipa comata	Needle-and-thread grass
Stipa occidentalis	Western needle grass
Koeleria macrantha	June grass
Elymus pauciflorus	Pacific wild rye
Elymus smithii	Western wild rye

FESCUE PRAIRIE

The Fescue Prairie is found on the northern and northwestern sides of the Mixed Grass Prairie, from central Saskatchewan into Alberta and southward into northern Montana. Its sole dominant is *Festuca scabrella*, which can account for 50% or more of the vegetative cover. It is richer in forbs than is the adjacent Mixed Grass Prairie. Characteristic grasses include:

Festuca scabrella	Rough fescue
Elymus subsecundus	Bearded wheat grass
Danthonia intermedia	Timber oat grass
Helictotrichon hookeri	Spike-oat
Stipa	Porcupine needle grass
Festuca idahoensis	Idaho fescue

COASTAL PRAIRIE

The Coastal Prairie occurs along the Gulf of Mexico, from southwestern Louisiana through Texas, into northeastern Mexico. It is a region of high humidity and rainfall (26-34"). The mild climate and long growing season favor the growth of subtropical grasses. There has also been an influx of taxa from the Short Grass Prairie. Characteristic grasses include:

Bothriochloa saccharoides	Silver blustem
Stipa leucotricha	Texas needle grass
Schizachyrium scoparium var. *littorale*	Seacoast bluestem
Andropogon gerardii	Big bluestem
Heteropogon contortus	Tanglehead
Sorghastrum nutans	Indian grass
Paspalum plicatulum	Brownseed paspalum
Spartina spartinae	Gulf cord grass

THE KÜCHLER CLASSIFICATION

A. W. Küchler (1964) drew a distinction between **real vegetation**, which comprised all of the types of vegetation present at the time observations were made and **potential natural vegetation**, which he defined as "the vegetation that would exist today if man were removed from the scene and if the resulting plant succession were telescoped into a single moment." He recognized 116 vegetation types in the conterminous United States (i. e., the lower 48 states). The following contain one or more grasses as dominants.

Juniper Steppe Woodland. Dominants: *Elymus spicatus, Artemisia tridentata, Juniperus occidentalis.* Other components: *Artemisia, Balsamorhiza, Elymus, Festuca idahoensis, Lithospermum, Lupinus, Poa secunda, Purshia.* Occurrence: East of Cascade Range.

Fescue-Oatgrass. Dominants: *Carex tumulicoa, Danthonia californica, Deschampsia holciformis, Festuca idahoensis.* Other components: *Agrostis hallii, Brodiaea, Calamagrostis nutkaensis, Calochortus, Chrysopsis, Grindelia, Iris, Lupinus, Pteridium, Ranunculus, Sanicula, Sisyrinchium, Stipa lepida.* Occurrence: Western slopes of northern Coast Ranges, California.

California Steppe. Dominants: *Stipa cernua, Stipa pulchra.* Other components: *Aristida divaricata, Elymus glaucus, Elymus triticoides, Eschscholzia, Gilia, Lupinus, Orthocarpus, Plagiobothrys, Poa scabrella, Sisyrinchium, Stipa coronata, Stipa lepida,* and introduced annual species of *Avena, Bromus, Festuca*. Occurrence: Central Valley of California and some coastal regions south of San Francisco.

Fescue-Wheatgrass. Dominants: *Elymus spicatus, Festuca idahoensis.* Other components: *Achillea, Artemisia, Collinsia, Hieracium, Lupinus, Potentilla, Rosa, Symphoricarpos.* Occurrence: Eastern Washington and northwestern Idaho.

Wheatgrass-Bluegrass. Dominants: *Elymus spicatus, Festuca idahoensis, Poa secunda.* Other components: *Achillea, Astragalus, Chrysothamnus, Draba, Festuca microstachys, Lithophragma, Lupinus, Plantago, Stellaria.* Occurrence: Washington, Oregon, and northwestern Idaho.

Alpine Meadows and Barren. Dominants: *Agrostis, Carex, Deschampsia cespitosa, Festuca viridula, Luzula spicata, Phleum alpinum, Poa, Trisetum spicatum.* Other components: *Achillea, Antennaria, Aquilegia, Arenaria, Castilleja, Draba, Erigeron, Oxyria, Penstemon, Phacelia, Phlox, Polemonium Polygonum, Potentilla, Salix, Saxifraga, Selaginella, Sibbaldia, Sieversia, Solidago.* Occurrence: Rocky Mtns., Cascade Range, Sierra Nevada.

Grama-Galleta Steppe. Dominants: *Bouteloua gracilis, Hilaria jamesii.* Other components: *Andropogon hallii, Schizachyrium scoparium, Artemisia, Astragalus, Atriplex, Bouteloua curtipendula, Bouteloua hirsuta, Ephedra, Opuntia, Stipa hymenoides, Tetradymia, Yucca.* Occurrence: Northern Arizona and New Mexico.

Grama-Tobosa Prairie. Dominants: *Bouteloua gracilis, Hilaria mutica.* Other components: *Bouteloua curtipendula, Bouteloua eriopoda, Bouteloua hirsuta, Erioneuron pilosum, Gutierrezia, Muhlenbergia, Opuntia, Yucca.* Occurrence: Western Texas.

Sagebrush Steppe. Dominants: *Elymus spicatus, Artemisia tridentata.* Other components: *Artemisia, Balsamorhiza, Elymus, Festuca idahoensis, Lithospermum, Lupinus, Phlox, Poa nevadensis, Poa secunda, Purshia, Stipa hymenoides.* Occurrence: Pacific Northwest, eastward to Rocky Mtns.

Wheatgrass-Needlegrass Shrubsteppe. Dominants: *Elymus smithii, Artemisia tridentata, Poa arida, Stipa comata.* Other components: *Artemisia, Atriplex, Carex, Elymus spicatus, Eurotia, Koeleria macrantha, Sarcobatus.* Occurrence: Montana and Wyoming.

Galleta-Three Awn Shrubsteppe. Dominants: *Aristida longiseta, Artemisia filifolia, Ephedra viridis, Hilaria jamesii.* Other components: *Aster, Berberis, Bouteloua gracilis, Chrysopsis, Chrysothamnus, Ephedra, Euploca, Franseria, Helianthus, Mentzelia, Muhlenbergia pungens, Munroa squarrosa, Oenothera, Poliomintha, Quercus, Sphaeralcea, Sporobolus cryptandrus, Stephanomeria, Stipa hymenoides.* Occurrence: Southeastern Utah.

Grama-Tobosa Shrubsteppe. Dominants: *Bouteloua eriopoda, Hilaria mutica, Larrea divaricata.* Other components: *Acacia, Andropogon barbinodis, Aristida divaricata, Aristida glabrata, Aristida hamulosa, Aristida longiseta, Astragalus, Baileya, Bouteloua, Gutierrezia, Hilaria belangeri, Hilaria jamesii, Mentzelia, Muhlenbergia porteri, Opuntia, Prosopis, Sphaeralcea, Sporobolus airoides, Sporobolus cryptandrus, Sporobolus flexuosus, Yucca, Zinnia.* Occurrence: Southeastern Arizona and southern New Mexico.

Mesquite Savanna. Dominants: *Hilaria belangeri, Hilaria mutica, Prosopis juliflora.* Other components: *Acacia, Andropogon barbinodis, Aristida glauca, Aristida purpurea, Aristida wrightii, Bouteloua curtipendula, Bouteloua rigidiseta, Buchloë dactyloides, Juniperus, Quercus.* Occurrence: Western Texas.

Mesquite-Acacia Savanna. Dominants: *Acacia rigidula, Andropogon littoralis, Prosopis juliflora, Setaria macrostachya.* Other components: *Acacia, Bothriochloa saccharoides, Aristida, Bouteloua filiformis, Buchloë dactyloides, Cenchrus myosuroides, Chloris, Condalia, Heteropogon contortus, Hilaria belangeri, Opuntia, Pappophorum bicolor, Paspalum, Quercus, Schizachyrium scoparium* (eastern part). Occurrence: Southern Texas.

Mesquite-Live Oak Savanna. Dominants: *Andropogon littoralis, Prosopis juliflora, Quercus virginiana* var. *maritima.* Other components: *Aristida roemeriana, Brachiaria ciliatissima, Heteropogon contortus, Panicum virgatum, Paspalum, Sorghastrum nutans, Trachypogon secundus.* Occurrence: Southern Texas.

Foothills Prairie. Dominants: *Elymus spicatus, Festuca idahoensis, Festuca scabrella, Stipa comata.* Other components: *Achillea, Agropyron, Artemisia,*

Bouteloua gracilis, Carex, Elymus smithii, Eriogonum, Koeleria macrantha, Penstemon, Poa secunda. Occurrence: Western Montana.

Grama-Needlegrass-Wheatgrass. Dominants: *Elymus smithii, Bouteloua gracilis, Stipa comata.* Other components: *Artemisia, Carex, Chrysopsis, Elymus spicatus, Gutierrezia, Koeleria macrantha, Liatris, Poa secunda, Muhlenbergia cuspidata, Schizachyrium scoparium, Sporobolus cryptandrus, Stipa viridula.* Occurrence: Montana and Wyoming.

Grama-Buffalo Grass. Dominants: *Bouteloua gracilis, Buchloë dactyloides.* Other components: *Aristida purpurea, Bouteloua curtipendula, Bouteloua hirsuta, Elymus elymoides, Elymus smithii, Gaura, Grindelia, Haplopappus, Lycurus phleoides, Muhlenbergia torreyi, Opuntia, Plantago, Psoralea, Ratibida, Senecio, Sphaeralcea, Sporobolus cryptandrus, Yucca, Zinnia.* Occurrence: Eastern parts of New Mexico and Colorado, southeastern Wyoming, western parts of Nebraska, Kansas, Oklahoma, and Texas.

Wheatgrass-Needlegrass. Dominants: *Bouteloua gracilis, Elymus smithii, Stipa comata, Stipa viridula* (not in Colorado). Other components: *Antennaria, Artemisia, Aster, Echinacea, Elymus trachycaulus, Koeleria macrantha, Liatris, Psoralea, Solidago, Stipa spartea.* Colorado only: *Chrysothamnus, Festuca, Muhlenbergia, Tetradymia.* Occurrence: Western North Dakota and South Dakota, eastern Montana and Wyoming, and Colorado.

Wheatgrass-Bluestem-Needlegrass. Dominants: *Andropogon gerardii, Elymus smithii, Stipa spartea.* Other components: *Elymus trachycaulus, Schizachyrium scoparium, Artemisia, Aster, Bouteloua curtipendula, Bouteloua gracilis, Echinacea, Koeleria cristata, Liatris, Psoralea, Rosa, Solidago, Stipa comata, Stipa viridula.* Occurrence: North Dakota, eastern South Dakota, and Nebraska.

Wheatgrass-Grama-Buffalo Grass. Dominants: *Bouteloua gracilis, Buchloë dactyloides, Elymus smithii.* Other components: *Schizachyrium scoparium, Artemisia, Aster, Bouteloua curtipendula, Carex, Echinacea, Juniperus, Liatris, Solidago, Stipa comata.* Occurrence: South Dakota.

Bluestem-Grama Prairie. Dominants: *Schizachyrium scoparium, Bouteloua curtipendula, Bouteloua gracilis.* Other components: *Ambrosia, Amorpha, Andropogon gerardii, Buchloë dactyloides, Clematis, Dalea, Echinacea, Elymus smithii, Erysimum, Heodeoma, Liatris, Oenothera, Panicum virgatum, Paronychia, Psoralea, Scutellaria, Sorghastrum nutans, Sporobolus asper, Stenosiphon.* Occurrence: Central and western Kansas, extending into adjacent areas of Nebraska, Colorado, and Oklahoma.

Sandsage-Bluestem. Dominants: *Schizachyrium scoparium, Andropogon hallii, Artemisia filifolia, Bouteloua hirsuta.* Other components: *Bouteloua gracilis, Buchloë dactyloides, Calamovilfa longifolia, Eragrostis trichodes, Helianthus, Hordeum jubatum, Panicum virgatum, Redfieldia flexuosum, Sporobolus cryptandrus, Stipa comata, Yucca.* Occurrence: Southwestern Nebraska, western Kansas, eastern Colorado, and northwestern Oklahoma.

Shinnery. Dominants: *Schizachyrium scoparium, Quercus mohriana.* Other components: *Acacia, Andropogon hallii, Aristida, Artemisia, Bouteloua gracilis, Bouteloua hirsuta, Buchloë dactyloides, Celtis, Cenchrus, Eriogonum, Juniperus, Prosopis, Prunus, Quercus, Rhus, Sorghastrum nutans, Sporobolus cryptandrus, Yucca.* Occurrence: Panhandle of Texas and adjacent parts of New Mexico and Oklahoma.

Sea Oats Prairie. Dominants: *Andropogon littoralis, Uniola paniculata.* Other components: *Batis, Carex, Croton, Elionurus tripsacoides, Ipomoea, Juncus, Lycium, Paspalum monostachyum, Sesuvium, Xanthoxylum.* Occurrence: Islands off southern Texas coast.

Northern Cordgrass Prairie. Dominants: *Distichlis spicata, Spartina alterniflora, Spartina patens.* Other components: *Gerardia, Juncus, Limonium, Plantago, Salicornia, Triglochin.* Other components: Along Atlantic coast from New England southwards to North Carolina.

Bluestem Prairie. Dominants: *Andropogon gerardii, Schizachyrium scoparium, Panicum virgatum, Sorghastrum nutans.* Other components: *Amorpha, Antennaria, Aster, Baptisia, Bouteloua curtipendula, Erigeron, Galium, Helianthus, Koeleria macrantha, Liatris, Panicum leibergii, Panicum scribnerianum, Phlox, Psoralea, Ratibida, Rosa, Silphium, Solidago, Sporobolus heterolepis, Stipa spartea.* Occurrence: North Dakota and Minnesota southward to Oklahoma.

Nebraska Sandhills Prairie. Dominants: *Andropogon gerardii, Andropogon hallii, Schizachyrium scoparium, Calamovilfa longifolia, Stipa comata.* Other components: *Artemisia, Asclepias, Carex, Eragrostis trichodes, Erigeron, Gilia, Panicum virgatum, Dalea, Sporobolus cryptandrus, Stipa hymenoides.* Occurrence: Nebraska and southern South Dakota.

Blackland Prairie. Dominants: *Schizachyrium scoparium, Stipa leucotricha.* Other components: *Andropogon gerardii, Bothriochloa saccharoides, Aristida purpurea, Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Buchloë dactyloides, Panicum virgatum, Sorghastrum nutans, Sporobolus asper.* Occurrence: Texas.

Bluestem-Sacahuista Prairie. Dominants: *Andropogon littoralis, Spartina spartinae*. Other components: *Andropogon glomeratus, Andropogon virginicus, Aristida purpurea, Aristida roemeriana, Buchloë dactyloides, Carex, Paspalum monostachyum, Paspalum plicatulum, Schizachyrium tenerum.*

Occurrence: Coastal plains of Texas and Louisiana.

Southern Cordgrass Prairie. Dominants: *Spartina alterniflora.* Other components: *Carex, Distichlis spicata, Juncus, Mariscus, Panicum hemitomon, Panicum repens, Phragmites australis, Sagittaria, Scirpus, Spartina cynosuroides, Spartina patens, Spartina spartinae, Typha, Zizaniopsis miliacea.* Occurrence: Southeastern Texas and southern Louisiana.

Palmetto Prairie. Dominants: *Aristida stricta, Serenoa repens.* Other components: *Andropogon, Aristida spiciformis, Axonopus compressus, Axonopus furcatus, Lyonia, Paspalum distichum, Sabal, Vaccinium.* Occurrence: Central Florida.

Oak Savanna. Dominants: *Andropogon gerardii, Schiza-chyrium scoparium, Quercus macrocarpa.* Other components: *Amphicarpa bracteata, Calamovilfa longifolia, Carya, Comandra, Euphorbia, Fraxinus, Monarda, Panicum leibergii, Quercus, Rosa, Sorghastrum nutans, Sporobolus heterolepis, Stipa spartea.* Occurrence: Wisconsin, Minnesota, North Dakota.

Cedar Glades. Dominants: *Celtis laevigata, Juniperus virginiana, Quercus stellata, Sporobolus neglectus, Sporobolus vaginiflorus, Ulmus alata.* Other components: *Andropogon gerardii, Arenaria, Bouteloua curtipendula, Bumelia, Carya, Celtis, Cercis, Cheilanthes, Croton, Forestiera, Leavenworthia, Palafoxia, Dalea, Pleurochaete, Psoralea, Quercus, Rhus, Schizachyrium scoparium, Sedum, Symphoricarpos.* Occurrence: Tennessee, Alabama, Missouri, and Arkansas.

Cross Timbers. Dominants: *Schizachyrium scoparium, Quercus marilandica, Quercus stellata.* Other components: *Andropogon gerardii, Bouteloua curtipendula, Bouteloua hirsuta, Carya, Celtis, Elymus canadensis, Eragrostis spectabilis, Eragrostis trichodes, Panicum scribnerianum, Panicum virgatum, Sorghastrum nutans, Sporobolus asper, Stipa leucotricha, Ulmus.* Occurrence: Texas to Kansas.

Mesquite-Buffalo Grass. Dominants: *Buchloë dactyloides, Prosopis juliflora.* Other components: *Acacia, Aristida purpurea, Aristida roemeriana, Bouteloua gracilis, Bouteloua hirsuta, Bouteloua trifida, Condalia, Juniperus, Quercus, Schedonnardus paniculatus, Yucca.* Occurrence: Northwestern Texas and sw. Oklahoma.

Juniper-Oak Savanna. Dominants: *Schizachyrium scoparium, Juniperus ashei, Quercus virginiana.* Other components: *Andropogon gerardii, Aristida glauca, Aristida intermedia, Aristida purpurea, Bouteloua curtipendula, Bouteloua hirsuta, Buchloë dactyloides, Cercis, Erioneuron pilosum, Fraxinus, Hilaria belangeri, Leptochloa dubia, Panicum obtusum, Quercus, Sorghastrum nutans, Sporobolus.* Occurrence: Central Texas.

Mesquite-Oak Savanna. Dominants: *Schizachyrium scoparium, Prosopis juliflora, Quercus.* Other components: *Aloysia, Andropogon barbinodis, Aristida intermedia, Aristida purpurea, Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Brayodendron, Buchloë dactyloides, Juniperus, Quercus, Ulmus.* Occurrence: Central Texas.

Fayette Prairie. Dominants: *Schizachyrium scoparium, Buchloë dactyloides.* Other components: *Aristida purpurea, Aristida roemeriana, Bothriochloa saccharoides, Bothriochloa tenerium, Paspalum dilatatum, Paspalum plicatulum, Stipa leucotricha.* Occurrence: Southern Texas.

Live Oak-Sea Oats. Dominants: *Quercus virginiana* var. *maritima, Uniola paniculata.* Other components: *Baccharis, Cenchrus tribuloides, Croton, Ilex, Iva, Juncus, Myrica, Opuntia, Panicum amarum, Sabal, Salsola, Serenoa, Spartina alterniflora, Spartina patens, Yucca.* Occurrence: Eastern and Gulf coasts from North Carolina to Alabama.

Cypress Savanna. Dominants: *Aristida affinis, Aristida patula, Taxodium distichum.* Other components: *Acer, Annona, Blechnum, Cyperus, Hypercium, Ilex, Leersia hexandra, Magnolia, Mariscus, Myrica, Persea, Rhynchospora, Salix, Saururus, Spartina bakeri, Stillingia aquatica, Taxodium, Tillandsia, Utricularia.* Occurrence: Southwestern Florida.

NATIONAL GRASSLANDS

California:

Butte Valley National Grassland Macdoel, CA	18,000 acres

Colorado:

Comanche National Grassland Springfield, CO	435,028 acres
Pawnee National Grassland Greeley, CO	193,060 acres

Idaho:

Curlew National Grassland Malad, ID	47,749 acres

Kansas:

Cimarron National Grassland Elkhart, KS	108,175 acres

Nebraska:

Oglala National Grassland Chadron, NE	94,316 acres

New Mexico:

Kiowa/Rita Blanca National Grasslands Clayton, NM	136,417 acres

North Dakota:

Little Missouri National Grassland	525,000 acres

Medora Ranger District
Dickinson, ND

Little Missouri National Grassland 503,000 acres
McKenzie Ranger District
Watford City, ND

Cheyenne National Grassland 70,000 acres
Lisbon, ND

Oklahoma:

McClellan Creek/Black Kettle Natl. Grasslands
Cheyenne, OK 32,749 acres

Oregon:

Crooked River National Grassland 111,379 acres
Madras, OR

South Dakota:

Buffalo Gap National Grassland c. 600,000 acres
Fall River Ranger District
Hot Springs, SD

Buffalo Gap National Grassland 591,727 acres
Wall Ranger District
Wall, SD

Cedar River/Grand River National Grasslands
Lemmon, SD 161,809 acres

Fort Pierre National Grassland 115,997 acres
Pierre, SD

Texas:

Lyndon B. Johnson/Caddo Natl. Grasslands
Decatur, TX 38,095 acres

Wyoming:

Thunder Basin National Grassland 572,211 acres
Douglas, WY

GRASSLANDS OF SOUTH AMERICA

Grasslands cover about 2 million sq. mi. (or about one-third) of the continent. There are three well-defined and separate regions. The **llano** and savanna of the Orinoco Basin occur mostly in Venezuela and in the Guianas. The common grasses include *Andropogon condensatus, Cymbopogon rufus, Sporobolus junceus, Trachypogon plumosus, Panicum maximum,* and *Aristida* spp. The **campo** and savanna of upland Brazil is a region of extreme wet and dry seasons. The grasses are typically tall and coarse. Common species include *Melinis minutiflora, Panicum maximum,* and *Hyparrhenia* spp. The **pampa** and prairies of Uruguay and Argentina are broad, level plains and plateaus. The regions may be subhumid, semiarid, or arid. The grass flora is rich. Various species of *Stipa, Poa, Sporobolus, Bromus, Paspalum, Bothriochloa, Panicum, Aristida, Hordeum, Melica, Eragrostis, Briza, Axonopus,* and *Cortaderia* are typical.

GRASSLANDS OF AFRICA

Grasses cover about 20% of the continent. Two very different kinds of grasslands are present. The **high-grass savanna** is characterized by tall grasses and low trees. It occurs next to the tropical rain forests centered in the Congo Basin. Common grasses include *Andropogon schimperi, Hyparrhenia rufa, Pennisetum benthamii, Imperata cylindrica,* and *Pennisetum purpurascens*. Sorghum, millets, and rice are also widely cultivated in the region. The **tall-grass savanna** is characterized by tall grasses and various species of *Acacia*, a shrubby legume. The grasses are about 1-2 m tall; the trees are scattered. It occurs in the eastern and southern parts of the continent. Common grasses include various species of *Andropogon, Hyparrhenia, Themeda,* and on the drier sites *Aristida, Chloris, Melinis,* and *Digitaria* are found.

GRASSLANDS OF ASIA

The Asian grasslands are mostly steppes. They are similar to those found on this continent in their general climatic features, and soils. The steppe region lies on either side of ca. 50° N latitude and extends in an east-west direction. The soils vary from deep, dark fertile soils to sandy, hard clays and to sterile alkaline soils in the South and in the East. The region west of the Volga River, including the Republic of Ukraine, is a rich agricultural area. Common native grasses include various species of *Stipa, Koeleria, Festuca, Poa, Hierochloë, Agropyron, Elymus, Calamagrostis, Aegilops, Haynaldia, Hordeum,* and *Setaria*.

GRASSLANDS OF AUSTRALIA

A huge interior desert with thinly populated grasslands making up a large portion of its rim occurs here. There are also important agricultural areas in New South Wales, Victoria, and in Queensland. The common grasses there (and probably the least well known to us at the generic level) include *Astrebla, Dichanthium, Danthonia, Themeda, Iseilema, Poa, Eulalia, Spinifex, Triodia, Imperata, Melinis, Bromus, Festuca, Avena,* and *Hordeum*.

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6.08 - TOXIC GRASSES

Because the grass family is the source of so many important food plants, it may come as a surprise to learn that it is also the source of a number of poisonous plants. The victims of grass toxicity are wild and domesticated animals, humans, and even other plants. Symptoms range from those that are mildly irritating to death. Mechanisms of poisoning include:

- plant parts that cause mechanical injury;
- absorption of toxins from the soils where grasses are growing;
- manufacture of one or more toxins by the grass itself;
- acting as a host to a fungus that makes the toxins.

MECHANICALLY INJURIOUS*

Some grasses are toxic only in the broadest sense because they are armed with stout awns that can cause mechanical injury. The sites of penetration, often around in eyes, snout, or the soft parts of the mouth cavity, can become infected and then further complications may occur. Such grasses do not actually produce toxic substances.

Scientific (Common) Name	Cause
Aristida spp. (three-awns)	awns
Avena fatua (wild oat)	awns
Bromus spp. (bromes)	awns
Cenchrus spp. (sand burs)	spines
Hordeum spp. (barleys)	awns
Leersia spp. (cut grasses)	leaf margins
Setaria spp. (foxtails, bristle grasses)	awns
Spartina spp. (cord grasses)	leaf margins
Stipa spp. (needle grasses)	awns

NITRATE/NITRITE INTOXICATION*

Others species, especially cereal crops and agricultural weeds are toxic not because they contain a poison, but because they absorb it from fertilizer-rich soils and then sequester in the plant body.

Scientific Name	Common Name
Avena sativa	Oat
Cynodon spp.	Bermuda grasses
Echinochloa frumentacea	Sanwa millet
Hordeum jubatum	Foxtail barley
Hordeum vulgare	Barley
Lolium spp.	Rye grasses
Pennisetum glaucum	Pearl millet
Sorghum spp.	Sorghums
Triticum aestivum	Bread wheat
Zea mays	Maize, corn

CYANOGENIC GLYCOSIDES*

√ General Features:

- ☼ Found widely in plant kingdom
- ☼ Common in roses, grasses, legumes, spurges
- ☼ HCN glycoside (sugar + toxic component)
- ☼ Intact glycoside harmless
- ☼ Activated by chewing, crushing, freezing, etc.
- ☼ Pure HCN very toxic
- ☼ Readily absorbed on skin; dangerous when inhaled

√ Symptoms:

- ☼ Acts at cellular level
- ☼ Blocks release of oxygen from red blood cells
- ☼ Instantaneous collapse (large doses)
- ☼ Weakness, giddiness, headache
- ☼ Nausea & vomiting
- ☼ Coma
- ☼ Death from cellular asphyxiation

Scientific Name	Common Name
Agrostis stolonifera	Creeping bent grass
Andropogon spp.	Bluestems
Avena sativa	Oat
Bambusa spp.	Bamboos
Bothriochloa spp.	Old World bluestems
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Briza spp.	Quaking grasses
Catabrosa aquatica	Brook grass
Chloris truncata	Australian finger grass
Cortaderia spp.	Pampas grasses
Cymbopogon spp.	Lemon grasses
Cynodon spp.	Bermuda grass, star grasses
Dactyloctenium aegyptium	Egyptian crowfoot
Danthonia semiannularis	Oat grass
Eleusine coracana	African millet
Eleusine indica	Goose grass
Elymus spp.	Wild ryes
Festuca spp.	Fescues
Glyceria canadensis	Canadian manna grass
Glyceria grandis	American manna grass
Glyceria septentrionalis	Eastern manna grass
Holcus lanatus	Velvet grass
Hordeum vulgare	Barley
Lagurus ovatus	Hare's-tail grass
Lamarckia aurea	Goldentop
Leersia hexandra	Clubhead cutgrass
Leptochloa dubia	Green sprangletop
Lolium perenne	Perennial rye grass
Melica altissima	Onion grass
Molinia caerulea	Purple moor grass
Oryza sativa	Rice
Panicum maximum	Guinea grass
Panicum muticum	Para grass
Poa pratensis	Kentucky bluegrass
Secale cereale	Rye
Sorghastrum nutans	Indian grass
Sorghum x *almum*	Columbus grass
Sorghum bicolor	Sorghum, Sudan grass
Sorghum halepense	Johnson grass
Stipa robusta	Sleepy grass
Tridens flavus	Purpletop
Triticum aestivum	Bread wheat
Zea mays	Maize, corn

PHOTOSENSITIZATION*

Several grasses are implicated in this syndrome. Sensitive animals are poisoned when they eat grasses that contain certain pigments that react with sunlight to form toxins that can cause damage to their skin and underlying tissues. Probably the best known example of this phenomenon is found in our local weedy Klamath weed or St. John's wort (*Hypericum perforatum*), a member of Guttiferae.

Scientific Name	Common Name
Avena sativa	Oat
Cenchrus incertus	Southern sandbur
Echinochloa crusgalli	Barnyard grass
Eriochloa contracta	Prairie cup grass
Hordeum murinum	Wall barley
Hordeum vulgare	Barley
Secale cereale	Annual rye
Setaria italica	Foxtail millet
Sorghum spp.	Sorghum
Triticum aestivum	Bread wheat

GRASS TETANY*

Also known as grass staggers, this syndrome appears to be associated with ionic imbalances in the blood serum after eating large amounts of lush growth. Low magnesium levels are typical. Animals suffering from grass tetany first show signs of excitement, poor coordination, and anorexia, followed by cardiovascular involvement, convulsions, coma, and death.

Scientific Name	Common Name
Agropyron spp.	Wheat grasses
Avena sativa	Oat
Bromus spp.	Bromes
Dactylis glomerata	Orchard grass
Elymus spp.	Wild ryes
Festuca spp.	Fescues
Hordeum spp.	Barleys
Lolium perenne	Perennial rye grass
Phalaris spp.	Canary grasses
Phleum pratense	Timothy
Secale cereale	Annual rye

Triticum aestivum	Bread wheat

ERGOTISM*

√ Chronic or Gangrenous Ergotism

- ☼ Small amounts over long period of time
- ☼ Constriction of blood vessels
- ☼ Death of tissues
- ☼ Loss of extremities

√ Acute or Convulsive Ergotism

- ☼ Larger amounts quickly consumed
- ☼ Central nervous system
- ☼ Crawling sensation on skin
- ☼ Tingling of skin; fingers
- ☼ Tinnitus aurium
- ☼ Headache
- ☼ Vertigo
- ☼ Vomiting & diarrhea
- ☼ Hallucinations
- ☼ Painful muscular contractions
- ☼ Epileptiform seizures

Scientific Name	Common Name
Agrostis spp.	Bent grasses
Bromus spp.	Brome grasses
Dactylis glomerata	Orchard grass
Elymus spp.	Wild ryes
Koeleria spp.	June grasses
Phalaris spp.	Canary reed grasses
Poa spp.	Bluegrasses
Secale cereale	Rye

GRASSES + ENDOPHYTIC FUNGI

Interestingly, the best known cases of poisoning from ingesting grasses are caused by parasitic fungi that live on the plants. It is the fungus that makes the toxin, not the grass. The so-called endophytic fungi are the subject of much recent research, particularly those that infect fescue grasses. The following grasses have been found to serve as hosts to such fungi.

Scientific Name	Common Name
Agropyron spp. (s. l.)	Wheat grasses
Agrostis spp.	Bent grasses
Andropogon spp.	Bluestems
Cynodon spp.	Bermuda grass, star grasses
Elymus spp.	Wild ryes
Festuca spp.	Fescues
Glyceria spp.	Manna grasses
Holcus spp.	Velvet grasses
Hilaria spp.	Tobosas, galletas
Hystrix spp.	Bottlebrush grasses
Lolium spp.	Rye grasses
Paspalum spp.	Paspalum, water grasses
Poa spp.	Bluegrasses
Sphenopholis spp.	Wedgescales

*After Burrows, G. E. & R. J. Tyrl. 2001. Toxic plants of North America. Iowa State Univ. Press. Ames. Pp. 872-888.

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SECTION 7.0 - G L O S S A R Y

- A -

abaxial: the side of a structure facing away from an axis

achene: a dry, single-seeded indehiscent fruit whose seed coat and fruit wall separate from one another, as in the sedges

acicular: needle-shaped, as in the leaves of *Monanthochloë*

acuminate: gradually tapering to an extended point

acute: sharp-pointed

adaxial: the side of a structure facing toward an axis

adnate: the fusion of unlike parts

adventitious: originating from mature tissues rather than meristematic ones, as in aerial roots that arise from a location other than the primary root system or aerial bulbs

adventitious embryony: a type of apomixis (q. v.) in which the embryo arises in the nucellus or in the integument, rather than within the embryo sac

adventive: a plant that is introduced accidentally

aerial: growing above ground, rather than in the soil

agamospermy: the production of seed without the prior fusion of gametes

aleurone: the outermost protein-rich layer(s) of endosperm

allopolyploid: a type of polyploid that contains genomes that are different from one another, often from two or more species

amphiploid: an allopolyploid that behaves as though it were a diploid

androecium: the male portion of a flower, consisting of one or more stamens

andromonoecious: the condition of having both bisexual and male flowers in the same inflorescence, as in most panicoid spikelets

anemophily: wind-mediated pollination

aneuploid: the condition of having a chromosome number that is not an exact multiple of the base number for that organism

annual: living for a single growing season

anther: the sac-like, pollen-producing part of a stamen

anthesis: the phase during which a flower is fully opened and pollination occurs

anthoecium: the collective term for the lemma and palea

antrorse: directed upwards, as in barbs on an awn

apex: the upper or distal end of a structure; plural, apices

aphyllopodic: the condition of having bladeless lower leaves, as in some sedges

apiculate: an apex that bears a short, typically flexible point

apomixis: a type of reproduction that involves the organs and processes typically associated with sexual reproduction, but which does not involve the actual fusion of egg and sperm nuclei; used more loosely as a synonym for asexual reproduction

apospory: a type of apomixis in which the embryo sac is derived from a cell of the inner integument

apposed: when similar parts occur close to one another or side by side

appressed: lying against a surface or, in the case of inflorescence branches, against a central or principal axis

arista: an awn or beard

aristate: an apex that tapers to a very narrow, elongate, bristle-like point; awned

arm cell: a leaf mesophyll cell type, characteristic of bambusoid grasses, in which the internal partitions or septae are incomplete

ascending: growing upward, obliquely at first and then erect, as in certain grass stems

asexual: any form of reproduction that does not involve the union of egg and sperm

attenuate: gradually narrowed to a slender point

auricles: the paired, ear-shaped appendages at the apex of the sheath in some grasses

autopolyploid: an organism with three or more chromosome sets that are ± identical to one another; often the result of doubling of chromosomes or through unreduced gametes

awl-shaped: the leaf or bract shape characterized by a gradual taper from the base to a sharp point

awn: a substantial hair or bristle that arises from the apex or back of glumes or lemmas [very rarely paleas]; awned, having awns

axile: the interior angle formed by a stem and the petiole or pedicel that it bears

axillary inflorescence: an inflorescence that arises from a lateral position on a culm, as opposed to one that is terminal

axis: the central stem of an inflorescence

- B -

balanced: having spikelets ± equally inserted on both sides of a central axis

basifixed: said of an anther that is attached to a filament by its base, as opposed to being attached at its midpoint

beak: a prominent sterile elongation of a caryopsis

beard: a line or tuft of hairs

beautiful: of or pertaining to grasses, especially native ones

berry: a multi-seeded, indehiscent fruit in which the fruit wall is fleshy throughout; common examples include the tomato and grape; in the grass family, berries are found in certain bamboos

bifid: two-cleft or two-lobed, as in the apex of a lemma or glume

bisexual: a flower, floret, or spikelet that bears both male and female reproductive structures; the term perfect is also used for this condition

blade: the flattened, expanded portion of a leaf

body: the portion of a glume, lemma, or palea, exclusive of awns or teeth

B. P.: Before Present

bract: a reduced leaf; glumes, lemmas, and paleas are all considered bracts

bractlet: a small bract

bran: the outer layers of a cereal grain that are removed during the grinding process

bristle: a short, stiff hair; a sterile branch

bulb: an underground plant structure consisting of a series of overlapping leaf bases attached to a much-reduced stem axis; many bulbs are actually corms (q. v.)

bulbils: small axillary bulbs that replace more typical florets or spikelets, as in *Poa bulbosa*

bulblet: a small bulb

bulliform cells: the comparatively large, thin-walled, colorless epidermal cells of the intercostal zone of the grass leaf blade

bundle sheath: the layer of tissue that surrounds the vascular bundle; not all grasses have bundle sheaths

- C -

C_3 grasses: those grasses, often found in the cooler, temperate regions, whose photosynthetic pathway has a 3-carbon compound (3-phosphoglycerate) as its first detectable sugar precursor

C_4 grasses: those grasses, often subtropical and tropical, whose photosynthetic pathway has a 4-carbon compound (malate or aspartate) as its first sugar precursor

caducous: falling off early

caespitose: occurring in clumps or tufts; also spelled cespitose

callus: a hardened, often pointed, base of a lemma or floret

canescent: a vestiture type characterized by gray pubescence

capillary: hair-like, as in delicate panicle branches or awns

capitate: aggregated into a dense, head-like cluster, as in an arrangement of spikelets

capsule: a dry, dehiscent fruit that opens by means of slits, lids, pores, or teeth as in the rush family

carinate: having a longitudinal ridge on the dorsal surface, as in the keel of a ship

cartilaginous: having a hard, tough cartilage-like texture

caryopsis: a dry, single-seeded, indehiscent fruit whose seed coat and fruit wall are inseparable; the fruit type of the grasses

cauline: pertaining to a stem, as in cauline leaves that are inserted along a stem, as opposed to its base

chartaceous: having a papery or tissue-like appearance, as in certain leaf and bract margins

chasmogamous: characterized by pollination and fertilization of open flowers or florets

chorology: the study of the distribution and composition of the components of a flora

ciliate: fringed with marginal hairs

ciliolate: as in ciliate, but the hairs minute

cleistogamous: the condition in which flowers or florets remain closed and are typically self-pollinated

cleistogene: a spikelet with self-compatible flowers that remains hidden within basal leaf sheaths

closed sheath: a sheath in which the two edges are fused with one another to form a continuous cylinder around the culm, as in brome grasses and orchard grass

coleoptile: the sheath that covers the shoot apex in the monocot embryo

coleorhiza: the sheath that covers the primary root in the monocot embryo

collar: the band of tissue located at the junction of the blade and sheath of the grass leaf; sometimes differentiated by its lighter color

column: the lower, sometimes twisted portion of an awn; the fused bases of awns, as in *Aristida*

coma: a tuft of hairs; comose, having a coma

complex: a group of closely related, difficult to differentiate, taxa, as in the *Festuca microstachys* complex

compound raceme: an inflorescence in which the peduncle bears two or more branches, each bearing a raceme of spikelets

compound rame: an inflorescence type in which the peduncle bears two or more branches, each bearing a rame of spikelets

compound spike: an inflorescence type in which the peduncle bears two or more branches, each bearing a spike of spikelets

compressed: flattened, as if pressure had been applied to a structure from the back or sides

continuous: not breaking apart; remaining intact, as in the central axis of an inflorescence at maturity

contracted: narrowed, as opposed to open or spreading

convolute: rolled longitudinally, with one edge completely within the other, as in a rolled up leaf blade

cordate: heart-shaped, as in the shape of certain leaf bases

coriaceous: leathery, as in the texture of certain lemmas or glumes

corm: a dense, vertical, underground stem surrounded by dry, papery leaf bases; often loosely called a bulb

corrugated: wrinkled

cosmopolitan: common to all or to most of the world

costal: the region on a grass leaf that is above the strands of vascular tissue (nerves)

culm: the stem of a grass plant

cultivar: a cultivated variety; a cultivated strain of a crop plant or of an ornamental

cuneate: wedge-shaped

cv.: cultivar

- D -

deciduous: falling from a plant at the end of a season

decumbent: said of stems that lie on the ground, but whose ends are upturned

denticulate: minutely toothed

depauperate: not fully developed, stunted; often the result of growing on an impoverished site

diaspore: from the Greek word for dispersion, a unit of plant dispersal; examples include caryopses, grains with husks remaining attached, groups of spikelets, etc.

diffuse: widely or loosely spreading, as in inflorescence branches

digitate: having parts that radiate from a central point, as do the fingers of a hand

dimorphic: having two different shapes, as in the glumes of *Koeleria*

dioecious: a species in which staminate and pistillate flowers or spikelets occur on separate plants, as in buffalo grass

diploid: the chromosome complement found in vegetative cells of the plant body; typically expressed in terms of "2n," as in 2n = 14

disarticulation: the separating or disjoining of spikelet parts from one another or of portions of an inflorescence axis from one another

distal: at the end opposite the point of attachment, as opposed to proximal (q. v.)

distichous: attached in two vertical rows, as in leaves on a stem or spikelet bracts on a rachilla

divaricate: spread very far apart, as in inflorescence branches

divergent: spread apart from one another, as in divaricate, but less so

dorsal: relating to or attached to the back of an organ, the side that is turned away from the axis

dorsally compressed: flattened, as if pressure had been brought to bear on the back of bract

- E -

elliptical: in the form of a flattened circle

emarginate: a leaf or bract with a shallow notch at its apex

endemic: confined to a particular region, applied especially when the area is relatively small

endosperm: the nutritive tissue within the seed that originates from the fusion of polar nuclei and sperm nucleus

entire: said of a margin of a leaf or bract that lacks lobes or teeth

entomophily: insect-mediated pollination

epiblast: the small, nonvasculated flap of tissue that occurs on the side opposite the scutellum in some, but not all, grass embryos

erose: said of a margin that appears to have been gnawed or worn away

euploid: having a chromosome number that is an exact multiple of the base chromosome number

exserted: protruding beyond or out of another structure, as in an inflorescence from a sheath

extirpate: to eliminate or destroy; literally, to pull up by the roots

extravaginal branching: a type of branching in which the shoot breaks through the leaf sheath

- F -

fascicle: a tight cluster or clump, as in leaves, axillary stems, or spikelets

fertile lemma: a lemma that encloses a flower

filament: the delicate stalk that supports an anther

filiform: thread-like

fimbriate: fringed, as in a bract margin

flabellate: fan-shaped

floret: a subunit of a spikelet, consisting of a lemma, palea, and flower; sometimes incorrectly defined as only the flower itself

forb: any herbaceous plant that is not a grass or does not appear grass-like

fusoid cells: the large, colorless mesophyll cells found in the leaves of most bambusoid grasses

- G -

gamete: a sex cell; the egg or sperm

gametophytic apomixis: a kind of reproduction in which a diploid embryo sac is produced because reduction division did not occur during the meiotic cycle

geniculate: said of structure that is bent sharply, as in certain grass stems and awns

genome: all of the genetic information found in a single complete set of chromosomes in an organism

genus: a group of related species; the first component of a scientific name

gibbous: having a pouch-like enlargement on one side of a structure, as at the base of a glume

glabrous: without hairs

gland: a secretory structure; used more broadly for any warty protuberance; glandular, having or bearing glands

glaucous: having a blue-gray or sea-green color; also used for a whitish waxy covering that can be easily rubbed off
globose: almost spherical

glume: a sterile bract at the base of a spikelet; most grasses have two such structures, some have one, a few have none

glutinous: covered with a sticky exudate

grain: the fruit of the grass family; see caryopsis

graminoid: grass-like

gynoecium: the female portion of a flower, consisting of the seed-producing components (carpels)

- H -

H & C: an abbreviation for Hitchcock & Chase, the authors of the Manual of the Grasses of the United States

habit: the general appearance of a plant

haploid: the chromosome complement found in the nuclei of gametes; often expressed by the letter n, as in n = 7

herb: an annual, biennial, or perennial plant whose stems die back to the ground at the end of the growing season because they lack the firmness of sufficient secondary growth

herbaceous: having the features of an herb

hirsute: having coarse, ± erect hairs

hispid: having long, rigid, bristly hairs; hispidulous, minutely hispid

hulls: the bracts of the grass spikelet, especially the lemma and palea

hyaline: having a colorless, thin, translucent or transparent texture

hybrid: a plant or animal that is the offspring of a cross between two or more strains, breeds, varieties, species, or genera; hybrids occur spontaneously in nature and they are created in the garden and laboratory
hybridization: the natural or artificial methods by which hybrids are created

hygroscopic: absorbing or attracting water; water sensitive, as in the grass lodicules

- I -

imbricate: overlapping one another, as in bracts of the spikelet

included: occurring within, as opposed to protruding from

indigenous: native to a region

indurate: hard, as in texture

inflorescence: the flowering portion of a grass plant; the arrangement of spikelets on a culm

innovation: a basal, typically vigorous offshoot

inserted: joined to or placed on, as in leaves on a stem or bracts on the spikelet axis

intercostal: the region between the nerves or veins of vascular tissue on a leaf or bract

internode: the region between two consecutive nodes on a stem

intravaginal branching: a type of branching in which the side shoot emerges from the top of the leaf sheath, as opposed to breaking through the side of the sheath

introduced: purposefully brought into a region, as in the case of a crop plant or an ornamental

involucre: an organized set of bracts or of branchlets that surrounds or forms a series or set beneath a spikelet, group of spikelets, or floret

involute: with both edges rolled longitudinally inward toward the midpoint of a leaf or bract

- J -

joint: the node of a grass stem; a point where articulation or disarticulation occurs

- K -

keel: a prominent ridge or rib, as seen in some glumes, lemmas, or paleas

kranz syndrome: the set of anatomical and physiological traits that are found in those plants that have the C_4 photosynthetic pathway

- L -

lanceolate: a leaf blade or bract that is narrow and tapers on both ends and that is widest above the middle; not to be confused with Lancelot, the most famous of King Arthur's knights

laterally compressed: flattened, as if pressure had been brought to bear on the sides of a bract, as opposed to the back (dorsally compressed)

lemma: one of the two bracts enclosing the grass flower, the other being the palea; the lemma is typically the larger bract

lenticular: lens-shaped, as in the appearance of certain seeds or fruits

leptomorph rhizome: the type of slender rhizome found in certain bamboos, in which each node as a bud and a whorl of roots

lignified: woody

ligule: the membranous flap or series of hairs at the junction of the sheath and blade of the grass leaf

linear: several to many times longer than wide, as in the typical blade of a grass leaf

lodicule: the reduced perianth of the grass flower; these tiny, mitten-shaped structures are all that remains of the calyx

- M -

macrohair: any of the larger, easily seen surface hairs on a plant structure

malt: germinated cereal grain, often barley, used as an enzyme source in brewing and distilling

membranous: soft, thin, and pliable, as in the texture of a glume or lemma

meristem: the region of actively dividing cells of the stem or root apex; the meristematic region of the grass leaf occurs at its base, thereby permitting the plants to survive grazing, fires, and lawn mowers

mesocotyl: that portion of the grass embryo axis that occurs between the node where the scutellum and the coleoptile are attached

metabolically challenged: dead

microhair: any of the more or less microscopic hairs that occur on the surface of plant parts; in the grasses, they are of diagnostic significance

midrib: the central rib of a leaf or bract

minute: small, as in the size of your vocabulary if you had to use the glossary for this term

monoecious: said of a species in which the staminate and pistillate flowers or spikelets occur on the same plant, as in maize or Job's tears

monotypic genus: a genus of only one species

mucro: a short, sharp point or extension, as seen at the tip of lemma or glume; mucronate: bearing a mucro

muricate: a surface characterized by short, hard, tubercular outgrowths

- N -

n: the chromosome number found in the nuclei of sex cells; in diploid organisms n equals the haploid chromosome number

native: originating naturally in a particular region; occurring in an area before the arrival of humans, especially European explorers, traders, etc.

naturalized: not native to a particular area, but now well established and maintaining itself without our assistance

nerve: a vein or strand of vascular tissue, appearing as ridges on the surface of glumes, lemmas, or paleas

neuter: lacking reproductive structures; sterile
node: the point or region on a stem where a leaf or bract is attached

nut: a dry, hard, indehiscent, 1-seeded fruit

- O -

oblique: slanting or unequal-sided

oblong: much longer than broad, with the sides ± parallel, as in the shape of certain leaf blades

obovate: of the shape of an inverted egg

obtuse: blunt in form; also dull in perception or intellect, as in the people who find grasses ugly and boring

oides: a suffix meaning resembling

open sheath: a sheath in which the two edges touch one another or overlap, but are not fused to form a collar or cylinder

ovary: the seed-bearing portion of a flower

- P -

pachymorph rhizome: the short, thick type of rhizome found in some bamboos, in which lateral buds typically produce only additional rhizomes

palea: one of two bracts enclosing the grass flower, the other being the lemma; typically the smaller and more delicate of the two

pampas: the vast open grasslands of South America, especially those in Argentina and Uruguay, dominated by taller bunch grasses in the east and by shorter grasses and shrubs in the drier southern and western portions

panicle: an elongate or rounded, much-branched inflorescence in which the spikelets are attached on the outermost branchlets

papillate: bearing small pimple- or nipple-like protuber-ances; also papillose

parallel: extending in the same direction and equidistant, as in the veins of most grass blades

parthenogenesis: meaning "virgin birth," a kind of apomixis in which the embryo develops from an egg cell that was not fertilized

pearl: to remove the outer layer(s) of a grain by exposing them to abrasive surfaces that grind away the tissues

pectinate: having units, such as spikelets, closely inserted next to one another, as in the teeth of a comb

pedicel: the stalk that supports a spikelet; see also peduncle

pedicellate: borne on a stalk (pedicel)

peduncle: the stalk that supports an inflorescence of spikelets; see also pedicel

pendent: hanging down

perennial: living for several to many years, often blooming and dying back at the end of each growing season; see also annual

perfect: a flower, floret, or spikelet that bears both male and female reproductive structures; the term bisexual is also used for this condition

pericarp: the fruit wall

perigynium: the membranous sac or sheath that surrounds the gynoecium or achene in some sedges

persistent: not breaking apart, as in an inflorescence axis or rachilla that remains intact at maturity

petiole: the stalk that supports a leaf blade

plano-convex: a structure that is flat on one side and rounded on the other, as in the fertile floret of certain panicoid grasses

Pohlstoffe: a distilled water, methanol, detergent (Aerosol OT) mixture used to soften dried plant specimens to facilitate their being examined; named after the late R. W. Pohl, the eminent and eccentric American agrostologist

pilose: covered with soft distinct hairs

pistillate: a flower, floret, spikelet, or plant that bears only female reproductive structures

pitted: having small cavities or depressions; also referred to as punctate

plicate: folded into pleats, typically lengthwise

plumose: feather-like, as in the awn of certain needle-grasses with prominent hairs

polygamous: a plant that bears both bisexual and unisexual flowers or spikelets

polyploid: an organism whose nuclei contain three or more sets of chromosomes

p. p.: the abbreviation of the Latin phrase *pro parte*, meaning "in part;" often used to mean some, but not all species in a genus, as in *Panicum* p. p.

prairie: the extensive level or somewhat undulating grasslands of central North America, characterized by rich soils and tall, sod-forming grasses

prophyllum: the first leaf of a lateral branch; also spelled prophyll

proliferated: the term applied to a spikelet or an inflorescence when some portion has been modified into bulblets or other vegetative structures

prop roots: the aerial roots at the base of a maize plant that provide mechanical support for the stem

prostrate: lying flat on the ground

pseudogamy: a kind of apomixis in which the embryo develops without the egg cell being fertilized, but which requires sperm nuclei to fertilize the polar nuclei for the embryo and the endosperm to develop

pseudospikelet: literally a "false spikelet," it is the structure found in some bamboos in which a single true spikelet is subtended by several bracts

puberulent: minutely pubescent; downy, the hairs soft, straight, and erect

pubescent: said of any plant structure that is hairy, especially if the hairs are short and soft

pulvinus: the swollen or enlarged base of a leaf sheath or of an inflorescence branch in some grasses; pulvini are associated with the movement of these structures

- Q -

q. v.: the abbreviation of a Latin phrase meaning "which see," which is the author's way of telling you that the word or topic is explained elsewhere in the text

- R -

raceme: an elongate arrangement of stalked spikelets attached along an unbranched central axis

rachilla: the unbranched central axis of a spikelet; not the central axis of an inflorescence of spikelets; rhachilla is the English spelling

rachilla extension: the portion of a rachilla that extends beyond the insertion of the uppermost floret; often appearing as a bristle

rachis: the unbranched central axis of a spike, raceme, or rame; the primary axis of a panicle

rame: an elongate arrangement of stalked and unstalked spikelets borne in repeating pairs or trios along an unbranched axis; the inflorescence type characteristic of the bluestem grasses and their relatives

rank: a vertical row, as seen when looking down on a plant; often expressed in terms of 2-ranked, 3-ranked, etc., which would indicate the number of rows

reflexed: turned or bent abruptly downward or backward

repent: creeping or sprawling plants or stems, often rooting at the nodes; also referred to as trailing; when the accent is placed on the other syllable, you feel sorry or contrite about a past action

retrorse: directed backward or downward, as in barbs on a bristle

rhizomatous: rhizome-bearing

rhizome: an underground, horizontal stem that bears reduced, scaly leaves

rosette: a dense, circular cluster of basal leaves

rudiment: a small, very poorly developed floret

rugose: wrinkled, as in the surface of a bract

runner: a stolon (q. v.), especially a slender one

- S -

savanna(h): a type of subtropical or tropical grassland characterized by coarse grasses and scattered trees

scabrous: covered with short, stiff hairs, so as to be rough to the touch

scarious: thin, dry, membranous, and non-green, as in margins of certain leaves and bracts

scutellum: the organ of the grass embryo that is located between the endosperm and the embryo axis; it is often interpreted as the grass cotyledon

secund: with florets or spikelets turned toward one side only, usually as a result of torsion along an axis

segmental allopolyploid: a polyploid of hybrid origin in which the chromosome sets of the parents are not identical, nor are they that different from one another, such that the plants sometimes behave as though they are autopolyploids and sometimes as allopolyploids

sessile: not stalked; seated on or attached directly to another plant part

seta: a bristle; setaceous means bristle-like

sheath: the lower portion of a grass leaf that surrounds the stem

silica bodies: crystals of silicon dioxide that occur in specialized epidermal cells of the grass leaf; their shape is of diagnostic significance

silica cells: the shorter epidermal cells of the grass leaf and stem that contain silica deposits

s. l.: the abbreviation of the Latin phrase *sensu lato,* meaning "in the broad sense"

somatic cells: the vegetative cells of the plant body, as opposed to the gametes or sex cells

sp.: species, in the singular

spathulate: having a large bract that is attached beneath and that often ± surrounds an inflorescence, as in the bracts of certain bluestems

species: a kind of plant or animal whose distinctiveness is seen in morphological, anatomical, cytological, chemical, and genetic discontinuities presumably brought about by reproductive isolation; thought by many zoologists to be real biological entities and by many botanists to be convenient constructs of the human mind

species name: a binomial consisting of the genus and the specific epithet, as in *Zea mays*

specific epithet: the second element of a binomial (the *mays* of *Zea mays*)

spike: an elongate arrangement of sessile spikelets borne on an unbranched central axis

spikelet: the basic unit of the grass inflorescence, typically consisting of two glumes and one or more florets

spp.: species, in the plural

spreading: oriented outward and more or less diverging from the point of origin

s. s.: the abbreviation of the Latin phrase *sensu stricto*, meaning "in the narrow or restricted sense"

ssp.: abbreviation for subspecies; sspp., plural

stamen: the pollen-producing organ of a flower, consisting of an anther and a filament

staminate: said of a flower, floret, spikelet, or plant that bears only stamens

stem: the plant axis that bears leaves, flowers, and fruits; principally aerial, but sometimes subterranean in the form of rhizomes, bulbs, etc.

steppe: any of the extensive, often tree-less, semi-arid grasslands of Eurasia, Africa, and the Americas dominated by short bunch grasses

sterile: lacking reproductive parts

sterile lemma: a lemma that does not enclose a flower; often all that remains of a reduced floret

stigma: the region of the female reproductive structure (carpel) that is receptive to pollen; in grasses, the feathery portion that sits atop the ovary

stipe: a stalk

stipitate: stalked, as in the florets of certain grasses

stolon: an aerial, horizontal stem, often rooting at the nodes, that bears ordinary foliage leaves, as in Bermuda grass; often called runners

stoloniferous: stolon-bearing

striate: marked with fine, longitudinal, parallel lines, grooves, or ridges

strict: close together, straight, and upright, as in certain stems

strigose: characterized by short, stiff, appressed hairs

sub: Latin prefix, meaning below, inferior to, almost, or somewhat

subglobose: almost spherical, as in the shape of a floret or a grain

suborbicular: almost circular in outline

subtend: to be below another plant part in point of attachment, as in a set of bracts attached beneath a spikelet

sucker: a vegetative shoot that originates from below ground

- T -

tabashir: silica deposits within the culms of certain bamboos; the term is little known outside the world of crossword puzzles

tawny: dull brownish-yellow

taxon: a taxonomic group of any rank; plural, taxa

terete: round, as seen in cross-section; spherical is not a synonym

terminal: uppermost, as in a floret in a spikelet or an inflorescence on a stem

tetraploid: a cell or an organism in which the nuclei contain four sets of chromosomes

throat: the adaxial surface at the junction of the sheath and blade of the grass leaf

tiller: a ± erect basal branch or sucker shoot

tomentose: covered by dense, soft, woolly hairs

transverse: in a cross-wise direction, as across the face or surface of a plant part

trichome: any hair-like outgrowth of the epidermis

truncate: with a squared-off or chopped-off apex or base, as in the appearance of certain leaves or bracts

tubercule: a warty protuberance

tufted: in bunches or clumps, as in the stems of a grass plant

turgid: swollen

- U -

uncinate: hooked, as in certain hairs

unilateral: one-sided; situated on one side only

unisexual: a flower, spikelet, or plant that bears either stamens or carpels, but not both

utricle: an indehiscent, 1-seeded, bladdery fruit; found in certain bamboos

- V -

var.: variety

vein: a strand of vascular tissue in a leaf or bract, seen as a ridge on the surface; in the grasses, veins are also called nerves

veld: a type of tree-less grassland best developed in southern Africa

venation: the arrangement of veins on a leaf or bract

ventral: pertaining to or attached to the inner side of an organ; the side that faces toward a central axis

verrucose: a surface, as on a lemma, covered by warty protuberances

versatile: said of an anther that is attached at its midpoint, such that it moves ± freely on the apex of the filament

verticil: a whorl or circular arrangement of parts around a central axis; verticillate, whorled

vestigial: rudimentary, poorly developed, much-reduced in size

vestiture: any surface feature on a plant, such as hairs, spines, scales, wax, etc.

villous: covered with shaggy, soft, but unmatted hairs

vivipary: in grasses, the term is restricted to a form of asexual reproduction in which bracts of the spikelet are modified into leafy or tailed bulb-like structures, as in certain blue grasses, fescues, and wheat grasses

viscid: sticky, gummy

- W -

wanting: lacking, missing

weed: an undesirable, worthless, aggressive kind of plant that has a set of biological features that often allows it to out-compete native species and crop plants in a particular area

winged: having a wing, a membranous lateral extension of an organ, as in a winged glume or inflorescence branch

- X -

x: the designation of the number of chromosomes that constitutes the basic set for a particular organism, as in x = 5

- Z -

zygote: the fertilized egg

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