CONTENTS

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BEGINNERS GRASS IDENTIFICATION WORKSHOP
University of Arizona Herbarium
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WHAT IS A GRASS?

Viridophytes (Green Plants) >> Embryophytes (Land Plants) >> Tracheophytes (Vascular Plants) >> Spermatophytes (Seed Plants) >> Angiosperms (Flowering Plants) >> Monocots (one embryonic seed leaf) >> order Poales (mostly sedges, rushes and grasses) >> family Poaceae (the grass family)

Grasses have jointed stems (culms) usually having alternating leaves in the same plane (distichous) containing sheaths, ligules and blades with parallel veins. Growth is only primary with no later secondary growth. The flowers are contained within unique bracteate structures called spikelets and have no recognizable perianth parts. The fruit is a caryopsis (grain). The caryopsis is the product of one flower and contains one seed which is usually fused to the ovary wall (pericarp). Some authors disagree in calling all grass fruits caryopses but, whatever, the above fruit description is sufficient for our purposes. The anthers contain two locules (chambers) usually elongate each opening through longitudinal slits. Other closely related plant families may contain some of the same characteristics but not the entire suite.

WHY TAXONOMIC NAMES

Within the large family Poaceae are subfamilies which contain one or more tribes. There are approximately 12,000 species of grasses worldwide. Each one of those species fits within a genus having its unique characteristics which fits within a tribe etc. Species are cataloged by taxonomic names also known as scientific names, taxons, Latin names or botanical names. Generally, common names are not used scientifically because they are random names for which there is no scientific meaning, nor are they within the common language used by botanists world wide. The taxonomic name consists of two words, the first being the genus (plural-genera) and the second being the species. There are hundreds of grass genera which are groups of closely related species. Genus names can stand alone because they do not duplicate but species names cannot because they may duplicate among the various genera but not within a particular genus. Within a species there may be enough diversity to further divide it into subspecies (subsp.) or varieties (var.). There is little or no difference between subspecies and varieties. The names of persons who named the taxon follow after the species and subspecies/variety names.

Taxonomic names can tell knowledgeable persons worldwide much about the plant in question. For example, if someone mentions Genus *Aristida* it brings to mind a group of grasses with a specific set of characteristics. These groupings have been largely morphology based but that is less so in modern times being largely DNA based. Information in the DNA provides a more accurate assessment of relationships in the tree of life than does just morphology. This has resulted in a number of taxonomic name changes; however in most cases morphologically similar species are also found to be genetically closely related. In the Some S. Arizona Grasses section below are listed many synonyms (the old names) which likely will still occur in the print media.

More information on taxonomic names is found below in the Nomenclature section.

IDENTIFICATION OF GRASS SPECIES--GETTING STARTED

There are two basic ways to identify the species of a specimen. The first method, trial and error, such as looking at plant "mug shots" to make a selection often does not work too well. In this class we teach a more scientific approach.

In order to use a scientific approach one first must have some knowledge of the plant including its morphology plus the terminology associated with it. With this knowledge one will be able to navigate through most dichotomous keys that are prepared to aid taxonomic name resolution. In this class we will study basic grass morphology, discuss other information that can be helpful in identifying a species, and use dichotomous keys.

To ease beginners into identifying some of our local grasses, I have provided a hybrid approach. It starts with a key to the various grass tribes found in Arizona. After determining the tribe (refer to the Arizona tribe key below) that best matches your specimen you can look through descriptions of a majority of the species/genera found locally in the Some S. Arizona Grasses section below. Here the featured genera/species are arranged by tribe. In most cases you should be able to determine the genus or perhaps species, hopefully with just a 10x or more hand lens.

GRASS MORPHOLOGY

In this section is basic morphological information that one needs to understand in order to identify most grass species in Arizona and throughout the region. The basic morphological plan stays fairly uniform for all grass species, but be prepared to find much variation within the individual parts that is unique to a given genus, species etc. Among other things, texture, shape, size and vestiture (pubescence) of various structures are usually quite species specific. In some species various structures may be undeveloped (missing). It is important to note that any of the grass structures may play a role in identifying a species.

Bamboos are omitted because they have some unique characteristics for which a specialized language has been developed, nor are bamboos native to Arizona.

Roots – Roots, as do those of all monocots, do not develop from the embryonic tap root. The embryonic tap root soon becomes irrelevant leaving only fibrous roots to develop from the base of the stem (culm). In some species, roots may form from above ground nodes if they come in contact with the soil. Grass roots play a minor role in grass identification but indirectly provide some evidence in determination of grass life span (annual or perennial). See Collecting and Preservation Issues below for tips on how to determine whether annual or perennial.

Culm – This, the stem of grasses, contains three major features, the nodes, internodes and generally the inflorescence (seed head). Nodes are obvious bands from which leaves, and in some species culm branches or sometimes spikelets, roots, rhizomes and stolons grow. Culm branches bud from within the base of a leaf sheath and either exit the sheath at the top (intravaginal) or burst through the sheath (extravaginal). A leaf like structure with two major

veins and smaller veins located in the axil between a culm and culm branch is called a prophyll. It plays no role in identification of most species.

Culms that do not terminate with an inflorescence are called innovations or tillers. Most authorities state that innovations are limited to perennial species. You might occasionally find some limited exceptions, but I believe you will find that the great majority of species follow the rule.

Culms may be tightly bunched (bunch grasses) and are termed cespitose (caespitose). Others that are spread by rhizomes (underground stems) are generally thought of as the sod formers which tend to form more dense patches unlike the more randomly spaced bunch grasses.

Leaf – Grass leaves usually have three major parts. See plate I. Starting at a node the sheath envelops the culm. Sheaths are either open or closed. Open sheaths are similar to a sheet of paper rolled to form a tube. One edge overlaps the other. Closed sheaths have edges fused such as a metal or plastic pipe. Sheaths may be closed for their entire length or a portion of their length. Bending away from the sheath is the blade. Across the top of the sheath is usually a small flap of membrane or a line of hairs called a ligule. Sheaths usually have a v-shaped opening at the top. Here, reaching around the top of the vee are in some species small often finger like projections, auricles, that clasp the culm.

The terms throat and collar refer to the area where the sheath and blade meet. The terms should be strictly defined but after reviewing the works of several authorities they are not. The throat should refer only to adaxial surfaces while collar should refer only to abaxial surfaces. In general the terms adaxial and abaxial refer to the relation of a plant part or plant part surface to an axis. Adaxial is the side or surface facing the axis and abaxial is the side or surface away from the axis. For example, the usual upper surface of a leaf blade is adaxial while the underside is the abaxial side. In this case, the culm is understood to be the axis. The terms dorsal and ventral are sometimes used in place of the terms abaxial and adaxial respectively.

Most important words to remember—sheath, ligule, blade, auricle, collar, abaxial/adaxial

Inflorescence – This is the part of the culm which physically supports the sexual reproductive units (spikelets which contain the flowers) of grasses. Plates I, II and III illustrate the three inflorescence types and features of each. Branching arrangements determine the type of inflorescence. The peduncle is a bare unbranched stem that supports the remainder of the inflorescence. Its lower end is at the node of the most distal leaf. Its distal end is at the lowest node of the inflorescence. At this node will either be a spikelet or spikelets or a branch or branches. Distal to the peduncle the central stem or axis of the inflorescence is called the rachis. Along the rachis at various points are nodes where spikelets or branches attach. Terminal inflorescences are most common but some species may have an axillary inflorescence that starts from nodes of the culm below the terminal leaf bud.

Grass inflorescences (spikes, racemes or panicles) are determinate. This means that the most distal spikelets mature earlier than those lower. This is contrary to what you might have learned about these inflorescence types. They are stated as being indeterminate for most or all other angiosperms.

Most important words to remember—spike, panicle, raceme, rame, rachis, pedicel.

There are three basic inflorescence types: spike, raceme and panicle.

Spike – This is the most simple inflorescence. The spikelets attach directly to the rachis (sessile) without any supporting stem between the spikelet and the rachis.

Raceme – Slightly more complex than the spike is the raceme. If any of the **individual** spikelets have a supporting stem called the pedicel that attaches to the rachis the inflorescence is a raceme. A raceme cannot have more complex branching. Pedicels by definition support only one spikelet. Racemes are uncommon in grasses although "spikes" in some tribe Triticeae species are truly racemes. They have been called spikes probably as a matter of convenience because with their very short-pedicellate spikelets they appear to be spikes.

Panicle – Most complex is the panicle. If **any** branches of the rachis contain more than one spikelet the inflorescence is a panicle the most common grass inflorescence. At the base of panicle branches in some species are swellings called pulvini (singular pulvinus). The pulvini may play a role in increasing the angle between the rachis and the branch as might a wedge. See plate II for some panicle branching patterns.

Rame – Here I will follow the Flora of North America (FNA) treatment of the term rame which is applied specifically to the Andropogoneae tribe. Various species of the tribe may have common racemes, rames or panicles with rame branches. Though not specifically stated, the term rame is applied to disarticulating racemes or panicle branches. Plate III shows details of the Andropogon tribe inflorescences. In paniculate species, rames branch from a rachis such as in locally common *Bothriochloa barbinodis*. *Trachypogon secundus* has an inflorescence of common racemes. *Heteropogon contortus* has just one rame, which might also technically be called a raceme.

In the FNA treatment the disarticulating stem of a rame is called the rame axis. As the axis disarticulates it carries with it the arrangement of usually two spikelets called spikelet units as illustrated in plate III. Within individual spikelet units depending upon the species are various spikelet size arrangements (hetero – different or homo – similar —morphic) and sex arrangements (homo – same or hetero – different –gamous). For example *Bothriochloa barbinodis* has spikelet units with two spikelets that are heterogamous. The sessile spikelet is bisexual but the pedicellate spikelet is asexual (sterile). The spikelet unit is also heteromorphic, the sessile spikelet being larger than the pedicellate spikelet.

Old vs New Terminology – The term *rame* likely is not found in older references or floras, so it may be confusing to students. These older publications likely refer to the rames as racemes. FNA, vol. 25, has a thorough explanation of the Andropogoneae inflorescence.

There are also other changes for describing grass inflorescences. The newer terminology may or may not be more wordy but hopefully it better characterizes how the inflorescences really appear. For example in older references one might see "a panicle of spikes." Now it might be stated as "a panicle with spikelike or spikate branches." It is only one inflorescence—a panicle,

not both a spike and a panicle. Another example in Hitchcock and Chase "racemes racemose along the main axis." We know it must be a panicle because there are branches of the "axis" (rachis) with more than one spikelet. It might now more properly be stated as "a panicle with raceme like branches."

Spikelet – This normally small structure consists of a series of bracts, each usually having parallel veins and usually being symmetrical, within which are found the reproductive parts (stamens and pistol). Spikelets are most often found in normal terminal or axillary inflorescences but in some cases they may also be found in other locations such as within leaf sheaths eg. *Muhlenbergia microsperma* and on rhizomes eg. *Enteropogon chlorideus* both found in Arizona.

Major spikelet parts include three types of bracts (glumes, lemmas and paleas) reproductive parts and an axis (rachilla). Here is an aid to remembering the location of the three types of bracts- **GULP;** proximal are the **G**lumes which are **U**nder the **L**emma then the **P**alea.

Plates II, IV and V all illustrate the various spikelet parts. Keep in mind that the distances shown between bracts and reproductive parts in the exploded views in plate II are greatly exaggerated. Also be aware that in some species specific bracts may never develop, most commonly the paleas or one or both glumes.

The presence or absence of awns, bristle like structures, and their qualities may be important in species identification. They may be found on any of the three bracts, but most commonly on the lemmas. Most awns are terminal on the bracts. In some species lemma awns may arise from lower on the back.

Most important words to remember – glume, lemma, palea, rachilla, floret and awn.

Glumes – The lowest bracts subtending the entire spikelet are the upper and lower glumes. The glumes may appear opposite but are alternate. In many species the upper glume is longer than the lower, but usually the lower glume somewhat partially clasps the base of the upper.

Lemma, Palea and the **Floret –** In most cases the lemma, a bract growing from the rachilla immediately below the floral axis, along with the palea located on the floral axis enclose the reproductive parts—usually three stamens and one pistol ie. a flower termed a floret. When the grasses "go to seed" the floret often stays intact. In most species the lemma partially clasps the palea which in turn clasps the reproductive parts. Paleas of most species are two veined while venation of lemmas is variable depending upon the species. Being the largest and most visible of the two floral bracts in most spikelets, the lemma is usually the most important for species identification.

Florets in spikelets that are found within leaf sheaths or underground as mentioned above are self-pollinated. Others in the more normal locations sometimes also are self-pollinated because the lemma and palea do not open. In this situation the anthers may be smaller than those in open wind pollinated florets. These are termed cleistogamous florets while opening wind pollinated florets are chasmogamous. Lodicules are tiny mostly ephemeral structures of the floret that swell during anthesis and are thought to pry open the lemma and palea which exposes the

reproductive parts to wind pollination. They usually play a minor role in species identification and we will not deal with them.

Depending upon the tribe, genus and species the number of florets may vary from one to 10+. On those with multiple florets they alternate along the rachilla which may be visable or not. One might relate the spikelet to a small inflorescence (spike), but unlike the grass inflorescence the typical spikelet with multiple florets is indeterminate meaning the uppermost often smaller florets develop last or perhaps are sterile. Spikelets with multiple florets usually break apart (disarticulate) at various locations including below or above the glumes, at each floret or in some cases one of the bracts may fall with the fruit but not the other. In some species the disarticulation point (callus) may be hardened and sharp pointed.

Reproductive Parts – Stamens arise from below the pistol and may not be found long after anthesis, but often some anthers may be found being clasped by the palea. Stigmas are also usually ephemeral. Anthesis with fully exposed stamens, as shown in plate V 2., is fleeting lasting only a few days at most. Also shown in the drawing is a somewhat fuzzy stigma, typical of many grass species reminding one of a smoker's pipe cleaner.

The ovary (fruit) type is a caryopsis, a thin walled dry fruit with one ovule (seed). Some grasses do have fruits variously termed berries, achenes or utricles though there is disagreement on whether or not they are all caryopses. Generally the seed and ovary are tightly bonded but in some species, including the local *Sporobolis* species, the bond may break when the fruit is moistened. This can separate the seed from the fruit. Occasionally the size and/or shape of the fruit is important in species identification.

Vegetative reproduction and other types of asexual reproduction are also fairly common in some grass genera. In addition to new plants forming along nodes in rhizomes and stolons, some grasses may develop new plants when lower culm nodes of the parent plant contact the soil and produce roots, particularly in those species with geniculate culms. Some species reproduce by developing tiny plantlets within the spikelet (vivipary) rather than caryopses. *Poa fendleriana* is dioecious but some populations without male plants produce viable fruits. This type of reproduction is called apomixis.

Major Spikelet Types - In order to avoid redundancy you are directed to my Arizona tribe key. Note the major differences in the lead 2 couplet. Species in the Paniceae and Andropogoneae tribes contain spikelets with basic differences from the other tribes which I will term the Cynodonteae spikelet types.

> **Paniceae Type** and **Andropogoneae Type –** These might be thought of as being opposites. Each has spikelet bracts that are usually of different textures within the individual spikelets. Couplet 3 in the Arizona tribe key explains the differences. Extreme modification is found in some Andropogoneae species with thickened inflorescence axes such as found in genera *Zea* (corn), *Tripsacum* and *Hackelochloa.*
>
> **Cynodonteae Type** – We will use the term "Cynodonteae Type" just for convenience, because that is the most important tribe in Arizona. All of the tribes other than those of the Paniceae and Andropogoneae tribes possess this general type of spikelet. All of the

spikelet bracts are of the same or nearly the same texture, though often the palea is slightly more flimsy. Depending upon the tribe, genus and species the number of florets is highly variable.

THE BIG PICTURE

Now that you should know a little about grass morphology the next step is to work towards identifying your species of interest. After identifying the basic structures of the specimen in hand the next step is to look at those structures closer because each species contains its own unique imprint on the basic structures. You should now understand that out of the thousands of possible combinations of traits available our mystery species has a specific combination unique only to that species. Fortunately some of the traits that define a species are usually obvious enough in most individual plants to easily identify their genus or species. There are, however, some species and of course specimens that will be very hard to identify not only for us "commoners" but also for the bonafide experts.

Other than basic morphology other issues to consider are very important and are covered in the sections below. Be aware too that unfortunately, there is often some subjectivity involved in identifying a species. What differentiates one species from a very similar one may be somewhat arbitrary and dependent upon the thoughts of the naming authority. That continuum between similar species may also be complicated by hybridization. Some grasses are notorious for hybridization.

It might best be stated that some specimens may just be so "on the edge" of a species description that they are impossible to identify. That's just the nature of the beast along with the human element that just cannot encompass all specimens in a tidy little pigeon hole. Accept this but don't be discouraged, because those on the edge specimens are uncommon perhaps rare given that you have a good specimen.

In the section "Collecting and Preservation Issues" is a discussion of points to consider when collecting a specimen.

MEASUREMENTS

In some instances measurements found in botanical descriptions are vague about what is included in the measurement. For example, different regional floras often have widely varying ranges for culm length of identical species. Some variation might be explained by environmental factors but the question of what is included persists. Does culm length include the terminal inflorescence or not? This is usually not indicated but after examination of numerous floras I believe most authors do include it. M. Barkworth, editor of the FNA grass volumes (personal communication) agrees. Some authors for the various genera found in the grass volumes of Flora of North America make mention of how some measurements of various parts are made.

Other instances of uncertainty include width and/or length measurements of curved structures such as the lemmas, glumes and paleas of most grasses. Unless otherwise stated, I believe the measurement of a curved structure should be made in the natural condition rather than pressed (flattened). Width should be measured at the widest point.

Spikelet length normally does not include the awns; however, in genus *Eriochloa* spikelet length noted in some local floras state that awn length in included. This is stated to be the case in Gould and Shreve and Wiggins (Vegetation and Flora of the Sonoran Desert, Stanford U. Press, 1964). Measurements given in FNA for *Eriochloa* sp. are similar but without explanation.

Leaf blade width is often problematic. Some blades are naturally curled or curl upon drying while some fold along the midrib. There is no easy answer on how width is measured unless specified in the description or key. In dealing with curled blades, some authors state that measurements are of the diameter. For folded (conduplicate) blades, some mention width is from the folded edge to the blade edge.

Unfortunately unless stated there may be no way to resolve such questions about measurements, but there may be clues found among the various floras including drawings to scale etc. Perhaps there are other definitive characteristics that allow one to work around some measurement problems.

REFERENCES

The primary goal of this class is to expose participants to basic grass structure plus provide some information about a number of local genera/species which may be identified with a hand lens. Mentioned in the Some S. Arizona Grasses.....handout are some other simple tools that would be helpful. Some beginners may become more interested in serious identification work. For more advanced work the herbarium is open to the public and provides assistance if requested. Also found here are many references featuring not only local species but those found in many parts of the world. You are always welcome to bring in specimens and use the scopes and reference materials.

The best references that include all or many local species are as follows:

Grasses of the Southwestern United States; Gould, F.; University of Arizona Press, Tucson; 1973; Somewhat betraying its title this flora covers only Arizona. Since publication more species have been found here and there have been a number of name changes but this is still a good handy reference.

Intermountain Flora, Vascular Plants of the Intermountain West, U.S.A. Vol. 6; Cronquist, A. et. al. New York Botanical Garden; 1977. Though not covering southern Arizona this volume has excellent illustrations and good keys and descriptions of many of the northern species that enter our area.

Manual of Grasses for North America; Barkworth, M. et al editors; Intermountain Herbarium and Utah State University Press, Logan, Utah; 2007. This flora is essentially a condensed paperback version of Flora of North America volumes 24 and 25 with a few revisions. FNA keys, drawings and maps, all reduced in size, are used. Space was also saved by eliminating species descriptions and using abbreviations extensively in the keys and genus descriptions.

Floras of New Mexico by Kelly Allred are good and they cover most species in our area. Two editions are available. One without illustrations is more compact than the other.

Manual of the Grasses of the United States; Hitchcock, A.S.;second revised edition by Agnes Chase; U.S. Government Printing Office, Washington D.C.; 1950. This has been the long established standard for the United States until the publication of volumes 24 and 25 of Flora of North America. The publication may still be available reprinted in two volumes by Dover. Even with the many changes that have occurred since publication this reference still has value.

Flora of North America, volumes 24 (2007) and 25 (2003) covering North America north of Mexico; Barkworth, M. et al. editors; Oxford University Press, New York and London; these volumes are the "gold standard" of today. Published after year 2000, they generally have the most complete species descriptions, excellent illustrations, good range maps and generally good keys. Taxonomic changes in grass species have occurred since publishing and there are occasional errors but overall the volumes are the best available.

ANATOMY

This class will not look at anatomical structures which can only be viewed from material mounted on glass slides prepared for higher power light transmitting microscopes.

Some grass keys do mention anatomical structures, so they deserve brief mention here. Sclerenchyma patterns in leaf blades help identify many species of genus *Festuca.* Sclerenchyma cells are normally thick walled cells which run longitudinally in leaf blades to provide strengthening of the blades. Kranz anatomy refers to a particular arrangement of cells surrounding veins in the leaf blades of carbon four (C^4) plants. C^4 refers to a type of photosynthesis process common in many plants subject to hot and drought conditions. More temperate climate grasses are generally C^3; therefore many of our Arizona grasses are C^4 with Kranz anatomy.

WORKING WITH DICHOTOMOUS KEYS

This class will provide enough information so that you can use most of the dichotomous keys found in the above publications for species identification. It is best to start with keys in publications dealing with more local species in order to narrow the number of species you are dealing with.

When using the keys, one has to read the couplets very carefully. Ideally the keys are all objective but in many cases subjectivity is necessary leaving gray areas in which the user needs to try to interpret the author's thoughts. Of course, this raises the possibility (or probability?) of reaching a dead end. One can usually know when this happens because further leads or species descriptions just don't match the characteristics of the specimen. When this happens it might be time to take a break or go backwards through the key to a couplet where you believe you might have selected the wrong lead then proceed; still no satisfactory identification?--then it's time to try another key. Don't think that the newer floras are always the best references. Earlier botanists

may have noted details that may have been "lost" over time.

The specimen being identified presents another variable. There is enough variability within a species that either lead in a key may not always quite match the specimen in hand. In this case, as mentioned earlier, one may need to follow both leads. The correct lead usually soon becomes obvious.

After a determination is made it is then time to go to a description of the plant and see if it fits the specimen in question. Keep in mind that you will rarely obtain a perfect fit. At times some measurements may be out of range or some characteristics may not quite fit the specimen. If in doubt, you can always compare your specimen with others at the herbarium. I have found that spikelet parts of numerous fairly local specimens often have measurements on the low end or slightly less than the ranges mentioned in various references.

One last caveat: "haste makes waste." Preformed ideas rather than careful observation are a good recipe for shoddy work. Read the keys and descriptions thoroughly and don't "see" what you want to see but **see what is there**!

Questions regarding anatomical features do appear in some of the FNA grass keys but the couplets also mention other characteristics allowing one to proceed without knowledge of the anatomy.

COLLECTING AND PRESERVATION ISSUES

If you are absolutely certain of the species that you are looking at in the field you may or may not want to collect a specimen. For beginners, I recommend that in most cases you will want to collect a specimen to examine more carefully later.

Prior to collecting there may be some things to consider if you are not on your own private property. Anyone who plans to collect specimens must follow some ethical considerations:

1. Follow the regulations if collecting on public lands. Various land management agencies from city/county to federal probably all have regulations regarding removal of plants.
2. Respect private property.
3. Use discretion; for example there may be no regulation prohibiting collecting along a popular national forest trail such as in Madera Canyon but it would be best not to start grubbing out grasses for collection along the trail in front of others even if special permission were granted.
4. Practice good land ethics. In Arizona there are some grass species of concern and perhaps needing special management due to their being uncommon or rare, so don't be a hog and grub out the only specimen of a plant you see in a particular area. If you believe it is important to identify the specimen off site, consider writing good field notes (see below) and perhaps removing only a small portion of the plant without harming it.

When collecting, always select average appearing specimens. If possible, I try to keep specimens

hydrated and carefully handled until I get home. Then I wash the roots and remove foreign matter such as soil, stones or parts from other plants that may be mixed in with the specimens. Then I blot off excessive water with old towels or rags prior to pressing. After a couple of days or so in the press especially for more moist specimens it is desirable to move them to dry plant press sheets in order to keep them mold free. The damp sheets should be thoroughly dried before reusing.

Some information needs to be noted in the field. Without it identification of a species may be impossible or at least more difficult. Presence or absence of rhizomes or stolons must be noted especially if they were not collected as part of the specimen. In some cases it is important to note how the culms grow such as caespitose, geniculate, prostrate etc. Perhaps even noting the character of an inflorescence while the plants are still in the ground may be helpful. Plate II shows some shapes such as nodding, ascending branches etc.

Being able to compare a number of specimens in the field should make it fairly easy to correctly determine annual/perennial status. Otherwise it may be difficult. Live (green) annuals normally pull out of the ground quite easily. Perennials are generally well anchored. Annuals are often short (<0.5m), but a number of annuals reach 1-2 m. height, eg. corn. Often local annuals have small tight root crown areas compared to perennials which may have a fairly large base that expands over its life. Annuals may have a few dead leaves near the base but usually don't have a mass of older dead material at the base which is often gray colored. All or nearly all culms of annuals should bear inflorescences; therefore they should have very few or no innovations (tillers). Some species stated as annuals may not die after producing a fruit crop but may live long enough to produce a second crop, though these plants may be diminished in size.

This may sound like a no brainer, but if you are travelling afar you should definitely note where the specimen was collected and the habitat in which it was found. For example, you are travelling in Montana and you key out your specimen "satisfactorily" and then look at its geographical range to find it is a native species with a different known range. Oops, back to the drawing board!

Some species have fragile ligules and leaf tips so care must be taken to treat them gently. Careful examination should be made to determine the presence of auricles which may also be quite fragile. If you have species with complex inflorescences the branching patterns are sometimes useful in identification, so if you press the specimens it will be helpful to not press them into a tangled messy blob of tissues. The lesson, therefore, is to attempt to press complex specimens so that the patterns can best be later seen. This may be difficult, so it is often wise to collect one or two extra specimens or at least the more complex parts that can be later mutilated if necessary for examination. Lightly pressed specimens should show less distortion of the spikelets than heavy.

You should now understand that a good specimen is not just the physical plant but also includes other supporting information mostly obtained in the field. For small grasses it is best to include the entire plant or at least a few culms including all parts from roots to inflorescence. Innovations should be included if present. For large species that cannot be collected in their entirety, the collected parts must be such that an identification could reasonably be made. This

might mean including the inflorescence, portions of a culm complete with a node, or nodes, and complete leaves. Large or small the good specimen is one that can be identified to species by a person with basic knowledge of grass morphology having pertinent reference materials.

For beginners some of the following information may not be applicable, but I provide it for those who wish to collect specimens for themselves or for herbarium contributions. A number of folks with little or no botanical background have become very interested in not only learning more about local plant species but in being important contributors to the U. of A. Herbarium (ARIZ). These volunteer contributions are becoming more valuable in aiding research especially in light of limited research budgets, changing environment conditions due to climate change and other increasing human impacts on the environment. We humans need to know what is out there in order to manage, save or in some cases eradicate it.

To be of value for a herbarium collection, in addition to knowing the genus and species plus the naming authority other information must include the date of collection, name(s) of collector(s), and location of the collection. The best location description would allow others to relocate the collection site. For research purposes, relocation of collection sites may be valuable. Relocation is usually difficult without GPS coordinates (latitude and longitude—WGS 84 or NAD 83 datums are probably best and most often seen with herbarium specimens). Many herbarium specimens have insufficient location data. For example descriptions such as "Madera Canyon" or "highway such and such east of Payson" are of no value when trying to relocate a population.

ONLINE RESOURCES

The most complete reference is the online version of FNA. The key words "flora of north america grasses" or "grass manual on the web" should open the website. It is easy to use and it has all of the keys and botanical descriptions found in the printed volumes. Some new information has been added for some genera and species. For keys to the tribes, enter Poaceae; for genera enter the correct tribe and for species enter the correct genus. The keys follow the descriptions of each taxonomic group.

Seinet has some interesting keys, species descriptions, location data and photographs of specimens.

Phytoneuron www.phytoneuron.net, is an online publisher. Prominent local botanist and author, Richard Felger, has published a coauthored document *Ajo Peak to Tinajas Altas; A Flora of Southwestern Arizona Part 6. Poaceae-Grass Family,* 2014.

NOMENCLATURE

Brief mention of taxonomic names was made in the "Why taxonomic names" section above. In many cases individual species may have had name changes with the old names becoming synonyms of the new names. We need not state why because there are many possible reasons. Just know that synonyms appear in the literature and can cause much confusion. For example are *Sitanian hystrix* (Nutt.) J.D. Smith and *Elymus elymoides* (Raf.) Seezey the same plant? Yes, but if the synonyms are not listed in the publication you are using how do you know they are the same plant? You might go to another reference with a better list of synonyms or check web sites

that list synonyms. We use the website Tropicos of the Missouri Botanical Garden extensively at ARIZ. If a species has synonyms you will likely find them in Tropicos. It also has a wealth of other nomenclature information for every species.

To access the lists just enter Tropicos in your web browser. On the homepage enter a taxonomic name. It will then show the naming authorities, when the name was published and the publication in which it was published. Click on synonyms for a list of them. If you click on accepted names you may be surprised. In the thousands of published floras throughout the world covering areas from the size of, for example, a sky island mountain range to those that cover perhaps a continent, you may see many names for the same plant; however the accepted names listed in Tropicos are those accepted only by a few of the usually more prominent floras, data bases etc. More on accepted names later.

A little background is in order at this point. Though perhaps not necessary information for the beginner it is passed on to help explain the perplexities of nomenclature. Perhaps the best way to explain some of the basics is to start with a plant that seems different from any named species. After studying the situation, a knowledgeable person (naming authority) determines it is different from named species, subspecies, varieties etc and decides it should be named, for this example, a species. In order to receive recognition as a bonafide species the protocol found in the International Code for Botanical Nomenclature must be followed. The naming authority will select a type specimen (type) that should be representative of the population and publish details of this plant in a manner consistent with the code. In our hypothetical case, if the rules in the code are followed our new species name is accepted. If you see the words “illegitimate” and “invalid” mentioned our naming authority did not follow the rules in the code.

An illegitimate name means that the naming authority did not follow the exacting protocols of the code. The same might be said about “invalid” but more specifically it means that the name was not validly published. Reasons are normally unspecified in Tropicos. Illegitimate and invalid names are shown because they may be found “hanging around” in old floras and old herbariuim specimens. It is important to be aware of them for the simple reason that they may affect today’s proper identification of a specimen.

The type specimen is said to “fix” the application of the new name. The naming authority may use as a type specimen (type) a physical specimen or an illustration of the plant. This original type specimen is called the holotype. The code establishes other categories of type specimens that may augment the holotype or replace it should it be lost, destroyed or for various other reasons. These other types are designated only by publication and in most cases must be accepted by the original naming authority. Alternative types include lectotypes, isotypes, syntypes among others each having its own definition.

Besides synonyms you may encounter other 'nyms—basionyms, homonyms and autonyms. The basionym is the original name given by the naming authority to the group of plants represented by the type. All later names for that group of plants might be considered to be synonyms. Yes, some species etc. may have more than one basionym. This would seem impossible in a perfect world, but one reason may be that back in the 18th and 19th centuries due to poor communications. The same species, variety etc. may have been validly published by authors in

widely separate locations each, of course, giving it a different name and each name becoming a basionym.

It is fairly common to see the word homonym in Tropicos. This is often but not always the same name or a very similar name given to two or more different species, obviously causing problems. I have seen some cases where the same authority named the same species twice but one name is a homonym. In these cases, the authority violated the rules in the code, but may have later validly republished the name to legitimize it. Most homonyms are either invalid or illegitimate.

One more 'nym and we are done with them-autonym. Autonyms are default names. If a **new** variety or subspecies of a species is named, it must be named other than the species name because the species name at this point also becomes the variety or subsp. name of the group of plants that are not included in the new variety or subspecies. *Aristida purpurea,* a common local species has many varieties. By default *Aristida purpurea* var. *purpurea* becomes the name of that group of plants represented by the type of *Aristida purpurea* and which is not identified as being of one of the later named varieties. *Aristida purpurea* var. *purpurea* does not have to be validly published because it **is** the validly published *Aristida purpurea.*

Hopefully this will answer most of your questions about synonyms and give you an idea of the big picture regarding the naming of plants. Bear in mind though that it only scratches the surface of a very complex subject governed by pages and pages of protocol. Similar to the English Language, there are many rules but also many exceptions for certain situations.

Now, to choose an accepted name for that plant you just collected realizing that there may be many depending upon the references you are using. At ARIZ our updating of names is a work in progress. For grass names we currently almost exclusively refer to three references: Flora of North America; the website Catalog of New World Grasses and for some old world species the website The Plant List. For our collection that includes numerous Latin American species we usually use the name accepted in the Catalog. It is easy to use, is more up to date than the Flora of N.A. and includes the entire new world (the Flora only covers North American species north of the U.S.-Mexico boundary). The Catalog is tied to the grass lists in Tropicos. It is maintained by some of the leading agrostologists in the U.S. and Latin America.

The Plant List is also easy to use. It is based at Kew Gardens in England.

With the current very time consuming updating process underway for our grass collection there is some disarray; therefore we advise most users to seek the help of staff when trying to locate specimens. Don't let this discourage you from asking questions and using the collection. We believe that outreach is one of our most important jobs. Remember also that there may be a story behind those specimens you bring in that may teach us something too. I have been surprised by some of the specimens that folks have brought in.

CITATIONS

Flora of North America was used throughout this document for small details about some genera and species. It was the sole source for information both for the plates and narrative concerning the unique inflorescences of tribe Andropogoneae.

The glossary was reproduced from the second edition of the Manual of Grasses of the United States. Both of these publications are more fully referenced above in the references section above.

The publication Grass Systematics and Evolution edited by Soderstrom et.al., Smithsonian Institution Press, Washington and London, undated, provided some clarification on certain morphological details. In particular is section 3 by H. Clifford, Spikelet and Floral Morphology; section 4 by T. Sendulsky et. al., Fruits, Embryos and Seedlings and section 5 by L. Clark et. al., Vegetative Morphology of Grasses: Shoots and Roots.

Plant Identification Terminology, An Illustrated Glossary by Harris and Harris, second edition, 2001; Spring Lake Publishing, Spring Lake, Utah, provided good information when drawing the various shapes illustrated in the plates.

Michael M. Bauer revised 2018

ARIZONA TRIBES, FAMILY POACEAE

M. Bauer

The following key was developed for folks who wished to have a tribe key more easy to use for beginners than the key in Flora of North America. Eliminated were tribes that include species that are not known to occur within Arizona. You may note that two tribes, Cynodonteae and Poeae, occur twice. These are very large tribes with species of widely varying characteristics that could not satisfactorily be located at only one location in the key. With the great number of similar characteristics shared among many tribes, it is important to read through the entire descriptions in the couplets before proceeding. Remember also that some of the information necessary to proceed in this key may need to be determined in the field

1. Very large, tall culms with large much branched plumose panicles; spikelets long pubescent; rhizomatous; grows in very wet areas. .....Tribe **Arundineae**

1. Plants of various heights of various habitats; inflorescences of spikes, racemes or panicles; combination of characteristics not as above. .....**2**.

2. Spikelets with 2 florets; glumes of different texture than at least one of the florets; spikelets usually dorsally compressed or terete. .....**3.**

    3. Spikelets usually somewhat obovoid (egg shaped) to nearly spherioidal (globose); spikelets may be subtended by bristles, in disarticulating groups (fascicles) subtended by bristles and/or indurate spines or without bristles or spines; glumes and lower lemma usually somewhat herbaceous; upper floret usually cartilaginous, shiny, rugose or dull (usually not green and mostly enclosed by the lower lemma and upper glume). .....Tribe **Paniceae**

    3. Spikelets usually somewhat ovate in outline and paired-one mostly sessile, the other pedicellate; often on a disarticulating axis called a rame axis; in a few other species the spikelet pairs on conventional non disarticulating rachises; inflorescences in some with highly modified thickened axes into which usually the female spikelets may be partially embedded; the paired spikelets often different in size (heteromorphic) and different sexually (heterogamous); usually only one spikelet of the pair with awns; glumes somewhat indurate (chartaceous to cartilaginous glumes usually completely enclosing the small hyaline fragile florets which are difficult to dissect; in Arizona genus *Tripsacum* monoecious.Tribe **Andropogoneae**

2. Spikelets with one to many florets usually with all bracts of the same texture; spikelets in most species laterally compressed to terete in some; reduced florets usually above the fertile. .....**4.**

    4. Florets usually greater than one. .....**5.**

        5. Sheaths usually partly open or mostly open; branches often spike like. .....**6.**

            6. Sheaths usually open; inflorescences mostly panicles, some with racemes (Genus *Microchloa* with spikes?); lemmas usually with 1-3 or 7-13 often conspicuous veins; hairs often seen in the blade-sheath junction area. .....Tribe **Cynodonteae**

6. Combinations usually not as above. .....**7.**

7. Sheaths open; paleas 3 veined; glumes no more than a ring or lobes.....Tribe **Oryzeae**

7. Paleas 2 veined. .....**8.**

8. Inflorescences spikes or very spike like racemes; one or more spikelets per node; some with disarticulating rachises; spikelets usually long and narrow conjested, or not, on the rachises; glumes 1-5 veined, lanceolate often tapering into an awn; see also Genus *Lolium* in lead 10 below. .....Tribe **Triticeae**

8. Inflorescences usually panicles, less often racemes and spikes in Genus *Lolium* (see couplet 10 below) .....**9.**

9. Culm internodes solid, not hollow; most small to moderate sized plants with the exception of Genus *Cortaderia*, a large caespitose perennial with large plumose inflorescences; ligules of culm leaves of hairs or ciliate membranes, the cilia being longer than the membranous basal portion; glumes usually exceed the distal florets; lemmas with 3-11 usually somewhat obscure veins and often bilobed or bifid with a mucro or awn between the lobes; awns usually twisted and geniculate; rachilla usually extends beyond the distal floret..... Tribe **Danthonieae**

9. Culm internodes usually hollow.....**10.**

10. Lemmas awned or not; some with multiple short awns/mucros [Genus *Lolium* some with spikes, the edge of the spikelet laying against the rachis (radial)]; spikelets usually pedicellate; culms not branching above the base; lemmas usually with 1-7 (9) inconspicuous veins; no hairs at the blade sheath junction. ……..Tribe **Poeae**

10. Lemmas with multiple awns and/or teeth often giving the panicles a plumose appearance. ..... Tribe **Pappophoreae**

5. Sheaths closed for most or all of their length. .....**11.**

11. Lemmas mostly awned, often with bifid or bilobed tips, the veins usually convergent distally; panicles, some congested but mostly open, often with nodding branches or spikelets; florets usually numerous; palea usually adnate to the caryopsis; ovaries (prior to much development into a mature caryopsis) pubescent tipped. .....Tribe **Bromeae**

11. Lemmas of our species mostly unawned with veins that are usually somewhat parallel and not converging; lemma apicies entire or bilobed or bifid and usually non green, fragile (scarious).
.....Tribe **Meliaceae**

4. Spikelets nearly always with one floret and no infertile florets above or below. .....**12.**

12. Sheaths usually partially closed; see lead 10 above. .....Tribe **Poeae**

12. Sheaths usually entirely open. .....**13.**

13. Usually awned, the point of awn attachment to the lemma usually quite distinct (stark); lemma usually inconspicuously veined, the edges often tightly surrounding or partly surrounding the palea; lemma often hairy and the distal end often having a chopped off appearance; awns from short to extremely long (>5 cm.), often twisted and plumose, especially the basal segment, and geniculate; calluses usually well developed, often short and strigose; glumes usually longer than the floret; spikelet (floret) usually laterally compressed to terete. .....Tribe **Stipeae**

13. Characteristics usually not as above. .....**14.**

14. Usually with an awn column that divides into 3 branches, the branches of varying lengths, often the central branch being the longest; lateral branches may be suppressed in two local species (*Aristida schiedeana* and *A. ternipes ternipes*) but usually rudiments may be found; spikelets usually long and narrow with the glumes, lemma and palea tightly enclosing the long linear caryopses; glumes shorter or longer than the florets but not exceeding the awn column; palea may be adnate to the caryopsis; one genus-*Aristida*;. .....Tribe **Aristideae**

14. Characteristics usually not as above; see lead 6 above.....Tribe **Cynodonteae**

Key based mostly on tribal information contained in Flora of North America, volumes 24 and 25.

Some S. Arizona Grasses Arranged by Tribes

Michael M. Bauer

Some southern Arizona tribes, genera and species are shown below. Selected are more common taxa and/or those with unique easily seen features. Although "easily seen," grass parts are **tiny!** and a 10x or higher power (higher is better) hand lens is an important aid for field identification. Other tools that might be helpful for the beginner include a magnifying hood, forceps and a probe. These tools would be helpful for hands free manipulation of spikelets or other small parts in order to see them better with the higher power hand lens. In this document unless otherwise stated, floret texture, vestiture etc. usually refers to the lemma which is usually the most prominent and readily seen structure of the floret. Note that the tribe must be determined prior to genus and/or species identification.

Bromeae sheaths closed most of the length; disarticulation above the glumes; multiple florets usually in a fairly long more or less lanceolate spikelet; often a fairly open lax to nodding panicle; lemma usually bilobed to bifid and with a straight awn.

Bromus carinatus (mountain brome) and *B. arizonicus* (Arizona brome) species are fairly difficult to distinguish; mountain brome, annual to short term perennial, is found above the desert while Arizona brome, an annual, is found in the low to mid elevations; both have conspicuously keeled lemmas unlike many of the other bromes; panicles various with few spikelets; see *B. catharticus.*

Bromus catharticus naturalized, sometimes annual or perennial, exotic of mostly mid elevations similar to the above species but often the hyaline to whitish lemma margins are quite easily visible; 9-13 lemma veins often forming ribs contrasts with 7-9 flatter veins of *B. carinatus*.

Bromus rubens (red brome) exotic short to midsized annual of the low to mid elevations; may form dense patches; panicle usually of dense, reddish and awned vertically aligned spikelets on short appressed branches that obscure the short rachis.

Most other S. Arizona brome species hard to differentiate in the field.

Triticeae usually with auricles; usually spikes or spike like racemes with very short pedicels; often more than one spikelet at each inflorescence node; glumes often subulate or narrowly lanceolate tapering into an awn; lemmas usually tapering into an awn**.**

Hordeum species (barley) glumes awn like; lemma with 5 veins usually awned; rachis usually disarticulates with the spikelets.

H. murinum common weedy annual in the Tucson area along local roadsides; 3 spikelets at each node and 1 floret per spikelet; awns usually ascending; see plate IV; compare with *Elymus elymoides.*

Elymus species (rye) perennial, some rhizomatous or stoloniferous; may have auricles; spikes with 1-3 spikelets per node; species often tough to identify; species id often includes length of inflorescence internodes, venation and texture of glumes, awn lengths, disarticulation points and orientation of awns (straight, or curved etc); species more of the riparian, woodland and grassland areas.

E. elymoides (squirrel tail) most common of the genus in Pima County; inflorescence similar to *H. murinum* but prior to disarticulation the awns at maturity flare outward similar to bristles of a bottle brush; common at mid elevations above the desert.

Poeae usually open sheaths; collars without hairs on the sides (see Cynodonteae); usually panicles; spikelets laterally compressed; usually with multiple florets with asexual florets above the sexual.

Vulpia octoflora small winter or early spring low to mid elevation annual; inflorescence with appressed spikelets or panicle branches; spikelets with numerous florets; lemmas short awned and notably scabrous or pubescent; this probably the most common local *Vulpia* sp.

Agrostis species mostly montane and/or riparian; inflorescence branches often in whorls; spikelets with one delicate usually hyaline floret; glumes as long or longer than the florets; lemmas awned or not; disarticulation above the glumes.

Polypogon species mostly riparian to aquatic; panicle branches ascending to appressed, dense; spikelet detail similar to genus *Agrostis* except disarticulation below the glumes.

P. monspeliensis (rabbitfoot grass) annual*;* panicle dense (obscuring the rachis), spike like oblong with yellow awns.

P. viridis perennial; disarticulates with stipe attached to the spikelet.

Festuca species (fescues) mostly montane; perennial; most species narrow leaved, caespitose; panicles usually with few branches at the lower nodes; spikelet with numerous florets; disarticulation above the glumes; lower glume 1 (3) nerved; upper 3 (5) nerved; lemmas mostly rounded proximally with 5 (7) veins usually awned from at or near the acute tip.

Festuca arizonica lemma short awned; ovary (grain) apices “densely pubescent”--FNA <1/2 of sheath closed

Lolium species (rye grass) non-natives probably not well established locally but might be seen in wetter areas and those under cultivation; inflorescence a spike with awned or unawned spikelets laterally flattened and positioned so the flat side is not tangent to the rachis but oriented radially to it; spikelets missing a lower glume; a few species that may be difficult to identify; see also *Schedonarus arundinaceus* below.

Schedonarus arundinaceus (*Festuca arundinacea, Lolium arundinaceum*) (tall fescue) is most likely to <u>not</u> be found in references under its latest name (*Lolium a.);* morphologically

the inflorescences are more fescue like rather than what most references indicate for genus *Lolium* having spikes; an introduced old world perennial caespitose species that would most likely be found here in more moist disturbed areas; can be fairly tall with broad leaves (4-12 mm) and auricles with a few cilia; inflorescences with ascending to appressed branches; spikelets fescue like; lemmas fairly short awned or unawned; although there are significant morphological differences among the species, genera *Festuca, Lolium* and *Schedonarus* are closely related.

Phalaris species (canary grasses) ours annuals of various habitats; panicle dense (obscuring the rachis), spike like; spikelets tightly compressed laterally with glumes keeled or winged; upper floret fertile usually shiny pubescent; lower florets sterile and reduced to needle like structures curling around the edge of the upper floret.

P. minor exotic annual; glumes winged in cross section and with one sterile floret; see plate V, 4-6.

P. caroliniana annual, probably exotic; winged or not with 2 sterile florets (one on each side of the fertile floret).

Avena species (oats) ours most likely to be *A. fatua*, an alien annual, often seen along local roadsides; panicles with branches usually nodding and with large, awned spikelets (to approx. 3 cm); glumes usually exceed the 2-3 florets; calluses long bearded; lemmas strigose with reddish hairs; long awns stout, geniculate and twisted arising from upper portion of the bifid lemmas.

Poa species (bluegrasses) here mostly montane species, the genus being of northern origins; prow shaped blade tips and grooves on both sides of the blade midrib (adaxial surface) are common; spikelets usually notably laterally compressed and small; lemmas unawned, often keeled and with hyaline margins distally; calluses blunt and many species with tufts of tangled hairs in the callus area; 2-5+ florets common; paleas often hyaline or milky shaded with green veins.

P. bigelovii a small to moderate height native annual reaching the desert floor here. Lowest 1/4-1/2 of sheath closed.

P. fendleriana (mutton grass) here a higher elevation native perennial; a widespread species exhibiting both sexual and asexual production; distal cauline leaves with sheath only or with very short blades; caespitose to somewhat rhizomatous; narrow panicle; calluses glabrous but lemmas glabrous to pubescent; compare with *Koeleria macrantha.* Sheaths open to closed in lower third.

P. pratensis (Kentucky bluegrass) a higher elevation perennial species here but extremely widespread over the northern hemisphere; in S. Arizona a rhizomatous species with wooly callus hairs is probably *P. pratensis.* Lower 1/4-1/2 of sheath closed.

Koeleria macrantha (June grass) most publications still have this name but now included within *K. pyramidata*; looks similar to *Poa fendleriana* but flag leaf blades fully developed; leaf blade tips are boat prow shaped similar to those of *Poa* sp.; rachis and panicle branches puberulent compared to being glabrous or scabrous in *P. fendleriana*; here found at higher elevations; lemma often shiny and sometimes with a mucro; compare also *Sphenopholis obtusata.*

Sphenopholis obtusata (wedgegrass) also similar to *P fendleriana* and *K. macrantha;* it is also found at higher elevations; narrow panicle with ascending branches with closely spaced spikelets with 2-3 florets; the notable difference from the other species is that disarticulation is below the glumes and the lower glume is **much** narrower than the somewhat oblanceolate upper glume.

Cynodonteae Flora of North America states: recognized by two or more of the following characteristics: 1-3 or 7-13 veined lemmas; laterally compressed spikelets; spike like inflorescence branches; long hairs in the collar area**;** locally our largest group of desert plants; probably evolved in areas of water stress of the tropics and subtropics; noted here are mostly genera common to the local low and mid elevations..

Eragrostis species (lovegrasses) plants caespitose; panicles with usually ascending to spreading branches; glabrous and unawned spikelets often with many imbricate florets; many species with dark lead colored spikelets prior to curing; glumes usually one veined and not exceeding adjacent florets; palea on some species winged eg. *E. echinochloidea* and *E. superba;* many species with persistent paleas and deciduous lemmas; some species with non green glandular tissue or pits in various locations, such as on the leaves, pedicels or lemma midribs (look closely-they may be tiny); native and many alien species, some quite invasive; local species often best determined with the aid of a dissecting scope; determining whether annual or perennial is best done in the field.

E. echinochloidea (tick grass) rapidly locally increasing exotic invasive medium sized perennial; culms often geniculate; small spikelets (usually <5 mm. long) mostly pendant and light colored; winged paleas and crateriform glands on the glumes may be difficult to see with a hand lens; see also *E. superba.*

E. superba (saw tooth lovegrass) medium sized invasive exotic perennial found at moderate elevations locally; the somewhat triangular shaped flat spikelets with individual florets appearing like saw teeth are quite distinct, hence the common name; the individual florets (lemmas) may show distinct green veins; like *E. echinochloidea,* the winged paleas may or may not be readily seen if they are hidden beneath the lemma edges.

E. barrelieri (Mediterranean lovegrass) here in the desert areas a rather short invasive exotic annual of the disturbed areas; although said to be annual it may produce small inflorescences a second time late in the year; spikelets usually narrow (linear) and 5-10 mm. long, often dark colored; spots often of colored tissue found in random locations of the panicle branches and below the culm nodes are fairly definitive for this species here.

E. cilianensis (stink grass) medium height annual invasive exotic locally; inflorescence fairly compact with numerous spikelets; spikelets usually 5-12+ mm. long, ovate to lanceolate; spikelets may be dark colored; lemmas with green veins and crateriform glands on the midribs; spots or bands of glandular tissue on the panicle branches and culms missing, unlike in *E. barrelieri.*

The above *Eragrostis* species are all fairly easily identified. Two native annual species more of the mid elevations may be hard to differentiate. Often caryopses of *Eragrostis* species aid in identification and at maturity may be teased out of the florets. Both species (*E. mexicana and pectinacea*) have fairly dark reddish brown opaque to slightly translucent caryopses. *E. mexicana* caryopses are striate and have a grooved side that should be easily seen with a hand lens. The groove may be pronounced or fairly shallow. *E. pectinacea* caryopses are not grooved but round edged and are smooth or faintly striate.

E. intermedia (plains lovegrass) widespread medium height native perennial of the grasslands; panicles widespreading, not dense; many of the pedicels longer than the spikelets which are somewhat lanceolate 3-6 or 7 mm.

E. curvula (weeping or Boer lovegrass) medium to tall invasive exotic perennial of low to probably mid elevations; panicles oblong somewhat narrow early, more open when mature; spikelets similar to *E. intermedia*; long (to 50+ cm.) narrow blades differentiate this species from other local *Eragrostis* species.

E. lehmanniana (Lehman lovegrass) an extremely invasive mid height perennial species of the mid elevation grasslands which is becoming more common locally at the lower elevations; culms often geniculate; panicles fairly compact and oblong; spikelets somewhat linear 5-12 mm. long; many of the pedicels are shorter than the spikelets.

Dasyochloa pulchella (*Erioneuron pulchellum*) (fluff grass) very low growing stoloniferous somewhat mat forming perennials; inflorescence light colored with pubescence; leaves with prickly tips; common locally; see plate I.

Leptochloa species (sprangletop) many species in this genus have been relocated taxonomically into new, or in some cases old generic names; panicle branches with spikelets on one side in 2 rows; multiple mostly unawned florets; the two most common local species:

L. dubia (*Disakisperma dubia*) (green sprangletop) usually a fairly tall perennial with a few digitate or subdigitate long panicle branches; unawned lemmas.

L panicea subsp. *brachiata* (*Dinebra panicea* subsp *brachiata*) (red sprangletop) weedy usually medium height annual with many shorter (usually <10 cm) racemosely arranged spreading panicle branches; lemmas unawned.

Enteropogon chlorideus (*Chloris chloridea*) a somewhat tall native of low to mid elevations

with a panicle that is similar to *Leptochloa dubia;* panicle with a few racemose branches; spikelets awned with two florets, the upper being small and sterile; uncommon and in the U.S. only known from Pima County and Texas; included here due to its unique underground cleistogamous spikelets which terminate rhizomes.

Sporobolus/Muhlenbergia species these genera are closely related but also with some significant differences; both have spikelets with single florets in wide spreading to narrow panicles; genus *Sporobolus* (dropseed or sacaton) has one veined lemmas and ligules of hairs; glumes 0 –1 veined; "muhly" species have 3 veined lemmas and membranous ligules or membranous ligules with a ciliate fringe; glumes usually one veined; Genus *Muhlenbergia* is the largest in Arizona;

S. wrightii and airoides these large moisture loving caespitose species are the famed sacaton of Arizona history; some suggest they are one species; *S. wrightii* normally has a long narrower inflorescence while the latter normally has an inflorescence about as long as wide.

M. microsperma short to moderate height much branched annual of the low to mid elevations; culms often geniculate; panicle usually with ascending branches; spikelets often purplish and awned; often with cleistogamous spikelets forming a bulge within the lower leaf sheaths.

M. porteri (bush muhly) perennial of the low to mid elevations locally; similar to *M. microsperma* but much more bushy with tangled geniculate culms and larger (to almost 1 meter high); culms narrow but wiry; panicle open with relatively few spikelets which may blend with the foliage; no cleistogamous spikelets.

M. rigens (deer grass) a large species of the wetter areas of the mid elevations locally; panicle extremely narrow and long (up to about 0.5 meter); this native species is sold in the nursery trade and often seen locally in yards.

M. straminea (screwleaf muhly) moderate to large sized perennial of the mid to higher elevations; flattened and coiled lower leaf sheaths (similar to wood shavings) should be easy to see underneath the younger foliage; lemmas with 12–27 mm long delicate awns; upper glume 3 veined, the veins sometimes extending into mucros; upper glume equal to or exceeding the floret.

M. montana (mountain muhly) quite similar to *M. straminea* but the 3 veined upper glume is shorter than the floret and the leaf sheaths, though flattening do not coil as frequently.

Bouteloua species (gramma grasses) annual and perennial natives with two types of distinctive inflorescences; common to both are spikelets with 1-3 florets, the lower one being bisexual and usually short awned while the upper may be male or rudimentary with long awns; spikelets are fairly tightly spaced in two rows along one side of a panicle branch; one inflorescence type has relatively short disarticulating branches with few spikelets while the

other type has longer non disarticulating branches with many pectinate and tightly spaced spikelets; in both inflorescence types the branches normally align to one side of the rachis;

B. aristidoides (six weeks gramma) a small annual which may form dense patches here in the desert; with very short scabrous disarticulating branches patches may be irritating to walk through when the branches penetrate one's socks.

B. curtipendula (side oats gramma) a moderate height usually caespitose perennial with a large number of disarticulating branches; see also *B. repens.*

B. repens (slender gramma) another common moderate height local perennial species with disarticulating panicle branches; distinguished from *B. curtipendula* by having much fewer panicle branches (4-12).

B. barbata (also six weeks gramma) common small local annual with 4-9 pectinate non disarticulating inflorescence branches; var. *rothrockii* is a short term mid-sized perennial more common at the mid elevations usually with 4 or more panicle branches.

B. gracilis (blue gramma) a moderate height perennial widespread species of North American grasslands with usually about 3 non disarticulating pectinate inflorescence branches; spikelets mostly glabrous; commonly with short rhizomes allowing the plant to expand in size often into a ring after the inner culms die.

B. hirsuta (hairy gramma) locally a moderate height perennial of the mid elevations with non-disarticulating branches; distinct from *B. gracilis* and *B. barbata rothrockii* with its papillose hairy spikelets and obvious naked extension of each panicle branch axis, ("stinger"), beyond the distal spikelets.

Lycurus species (wolf's tail) two very closely related native mid sized perennial species now included in genus *Muhlenbergia;* most common at slightly higher elevations; both with narrow spikelike panicles; both species with mostly 2 unequal awns on lower glumes and one awned upper glumes; leaf tip and ligule characteristics of our two species are fragile and best examined prior to drying and pressing.

L. setosus (*Muhlenbergia alopecuroides*) has fragile hair like tips on blades of upper leaves and long acute to acuminate membranous ligules.

L. phleoides (*Muhlenbergia phleoides*) without the hair like leaf tips and shorter [1.5-3 (4) mm.] membranous ligule with evident triangular lobes.

Hilaria species ours perennials of the desert and higher elevations; rhizomatous or stoloniferous so may form patches; inflorescences spikelike with 3 spikelets tightly held together in disarticulating groups called fascicles.

H. belangeri (curly mesquite) a short low to mid elevation stoloniferous perennial;

H. mutica (tobosagrass) probably the most common of three larger *Hilaria* sp.in S. Arizona; identification of species difficult in these three species; mid-size rhizomatous perennial with wiry culms which may form thickets; glumes tend to be fabellate only in *H. mutica*; very gray coloration of plants contrast with other local grasses..

Tridens muticus (slim tridens) locally a common medium height perennial of the desert scrub; panicle narrow but spikelets not severely congested; spikelets often purplish with 5+ florets; glumes and lemmas somewhat thin-hyaline; lemmas with prominent hairs on the veins; hairs of the midrib occur on the lower half; lemma often notch tipped; palea with marginal hairs.

The following five species all have largely digitate panicles with spike like branches:

Chloris virgata (feather fingergrass) locally weedy medium height annual of the lower to moderate elevations; often found in disturbed areas; panicles digitate with usually numerous <10 cm. long spikate branches; spikelets closely spaced in 2 rows; spikelet with one fertile floret and usually just one sterile floret above; lower lemma awned and showing obvious long hairs distally.

Cynodon dactylon (Bermuda grass) a mid to low elevation exotic weed locally and of concern as a serious invader in seasonally wet areas including roadsides where road surface runoff is heavy; being stoloniferous and/or rhizomatous, it is capable of forming a dense ground cover; panicles digitate with usually <6 spikate branches which are triangular in cross section; spikelets tightly spaced in two rows; spikelets usually with one floret; see plate I.

Eleusine indica (goose grass) exotic caespitose annuals of moderate height; sometimes 1 or 2 panicle branches seen below the digitate branches; panicle branches fairly flat and ending with a spikelet; spikelets with 5-7 florets; occasionally seen around Tucson.

Dactyloctenium aegyptium (crow foot grass) small to moderate height exotic annual that may be increasing around Tucson; panicle branches 2 to about 6 cm. long with the branches projecting beyond the distal spikelets; spikelets with a few florets; see also *D. radulans.*

Dactyloctenium radulans similar to *D. aegyptium* but with very short panicle branches (to about 1.5 cm.) in which "most spikelets touching those of an adjacent branch"--Flora of North America; few or no spikelets touch in *D. aegyptium.*

Danthonieae rachilla extends beyond the last floret; lemma apices bilobed to bifid; lobes sometimes bristle like (setaceous); lemma often with a mucro or awn (awn usually geniculate) emerging between the lobes; lemma of fertile florets with 3-11 inconspicuous veins and pubescent**;** only one genus of local importance.

Schismus species two very similar species, S. *barbatus and arabicus,* of late winter to early spring; ephemeral exotic generally small annuals of low to mid elevations; locally the plants are characteristically vee shaped with a large number of culms radiating from a small basal area; inflorescences usually <6 cm. long with ascending panicle branches; lemmas glabrous or

pubescent with bifid tips and often mucronate.

Aristideae one floret per spikelet; awn with 3 digitate branches, the lateral branches sometimes greatly reduced; spikelets usually long and narrow; often the lemma tapers into the awn**;** this tribe contains 3 genera with only genus, *Aristida,* being in the new world; a number of mostly perennial species throughout Arizona often on harsh sites; below are three fairly easy to identify local species.

A. purpurea (purple three awn) a widespread medium height native with many varieties which are often hard to differentiate; fine examples are seen along local roads where it thrives on runoff from the roads; very striking with its reddish purple inflorescences that glisten in the sun light prior to curing; inflorescences with rachises straight to somewhat bowed and branches mostly ascending; varieties are based mostly upon variation of the inflorescence branching and spikelet and awn dimensions; older publications may show as species that are now considered to be varieties of *Aristida purpurea; A. longiseta, glauca , fendleriana, wrightii* and *parishii* are all now varieties of *A. purpurea; A. glauca is* now *A. pur.* var. *nealleyi.*

A. adscensionis very similar to *A. purpurea* but it is a smaller annual; only other major difference between the two species is that the central awn of this species is winged, the wings being about as wide as the central axis; the translucent wings may be best seen while holding it against a bright sky and observing with a hand lens.

A. ternipes (spidergrass) this species is common locally in the low to mid elevations; this medium to large perennial may or may not have the 3 awns found in most *Aristida* sp.; var. *gentilis* has 3 awns while var. *ternipes* has a long central awn with normally suppressed lateral awns; looking closely one can usually find the short rudiments of the lateral awns; the inflorscence of *A. ternipes* has wide spreading branches, naked on the lower portion and with few spikelets.

Paniceae spikelet with two florets, the lower reduced, sterile or male depending upon the species and the upper usually bisexual; lower glume may be missing but usually present; if present, usually shorter than the spikelet; lower lemma and upper glume usually similar and membranous; upper florets (lemma and palea) "indurate, coriaceous, or cartilaginous..." --Flora of North America...often glabrous, dull or shiny or rugose; most of the time the florets are appressed to appear as one; most genera of the "bristle clade" have individual spikelets or groups of spikelets subtended by one to numerous bristles or spines; "bristle clade" genera normally having bristles subtending individual spikelets include genus *Setaria;* those with groups of spikelets termed fascicles subtended by bristles or spines include genus *Pennisetum (Cenchrus)*; see plates II and V, 9-14 for details of a somewhat typical Paniceae spikelet.

Setaria species (the bristlegrasses) most with one bristle under each spikelet in dense spikelike panicles; spikelets tend to be somewhat globose, so the inflorescence appears as beads on a stick with protruding bristles; common locally are the medium to large height perennials, *S. leucopila and macrostachya*; both are similar and occur locally from low to mid elevations; smaller annual species are also found locally and may be difficult to identify.

S. leucopila fairly common locally; blades usually <5 mm. wide; spikelets usually somewhat elliptical; lower palea usually much smaller than the upper palea.

S. macrostachya blades often >5 mm. wide; spikelets more often subglobose; lower palea nearly the same size as the upper palea.

Cenchrus species panicles with short branches spike like; branches terminate in a fascicle containing one or more spikelets surrounded by subtending ranks of bristles and/or spines; unlike in most panicoids, the lemma and palea of upper florets tend to be fairly similar in texture to the glumes and lower lemma; indurate spines on some form burs; the fascicles including the bristles/spines of both genera disarticulate intact; for non bur type fascicles see plate V, 7.

Traditionally genus *Cenchrus* has been applied to the bur producing species and genus *Pennisetum* applied to species with bristles. Recently the two genera have been combined under genus *Cenchrus.*

C. spinifex (*C. incertus* and *pauciflorus*) (common sandbur) medium height annual locally on more moist sites; most common of the bur forming species; easily determined by the pain one will feel if grabbing a bur with its indurate spines; spines wide based, somewhat triangular in shape, are very randomly placed and protrude at various angles from an indurate cup surrounding a few spikelets; beneath the spines may be a few bristles.

C. echinatus (southern sandbur) locally less common annual than *C. spinifex*; most spines somewhat more orderly ascending from the cup than in *C. spinifex*; a number of bristles beneath the cup.

C. ciliaris (*Pennisetum ciliare*) (buffelgrass) this low to lower mid elevation invasive exotic caespitose perennial may reach maturity at any size between 10-100 cm+ height; freely branching culms with fairly short blades give the larger plants a weedy look; fascicles with many bristles in two ranks plus one longer primary bristle; inner bristles ciliate as is the primary bristle; panicle 2-20 cm long and green, brownish to purple; fascicles with more than one spikelet and including the bristle length up to approx 1 cm.

P. setaceum (*C. setaceus*) (fountain grass) another large caespitose invasive exotic perennial with long arching leaf blades and long (to approximately 30 cm) narrow spikelike inflorescences that are plumose; low to mid elevations; fascicles usually with more than one spikelet; inner bristles plumose 20 or more mm. long; panicles silvery often somewhat pink or purplish; unfortunately often cultivated as an ornamental.

P. advena (purple fountain grass) a very large caespitose exotic ornamental seen and sold locally; its very large size and often burgandy foliage differentiate it from similar *P. setaceum*; not supposed to set viable fruits but.....

P. villosum a rhizomatous invasive exotic seen around Bisbee; fascicles very plumose;

spikelets longer (about 1 cm.) than in fountain and buffel grasses.

Melinis repens (*Rhynchelytrum repens*) (natal grass) invasive caespitose medium sized annual to short lived perennial of low to mid elevations; inflorescence with spreading to ascending panicle branches notably shiny pink-silvery colored due to the many long glassy hairs of the spikelets; spikelets greatly laterally compressed so that the outer bracts appear to be folded.

Urochloa species small to medium height annual caespitose natives of the low to mid elevations; panicle branches usually few and somewhat spike like; two local closely related species with rugose upper florets and usually some cross venation evident in the upper glumes.

U. arizonica (*Brachiaria arizonica*) (Arizona signal grass) cross venation confined to the upper half of the glume; spikelets hairy; panicle branches hairy with papillose based hairs; upper glumes may be pubescent.

U. fusca (*Brachiaria fasciculata*) (brown top signal grass) probably less common than *U. arizonica;* panicles mostly scabrous, somewhat hairy but with few or no papillose based hairs; upper glumes glabrous with cross venation, if evident, throughout; spikelets may be somewhat yellow to somewhat rusty colored.

Digitaria species inflorescences various from simple branched/rebranched panicles to subdigitate or digitate panicles with spikelike branches; lower glumes may be missing, tiny or to no more than approx ¼ the length of the spikelet; in local species the upper floret is unique due to the hyaline margins of the lemma.

D. californica (cottontop) fairly common local native extending up to mid elevations; medium sized caespitose perennial; panicles with ascending branches (5-15 cm. long) are usually easily spotted during the summer due to the dense long white pubescence of the upper glumes and edges of the lower lemmas; no awns (*Bothriochloa barbinodis* looks similar but it has awns).

D. insularis similar to *D. californica* but spikelet hair color renders the inflorescence a gold to light brown color; upper floret is dark brown; uncommon in SE Arizona.

D. sanguinalis and *ciliaris* (crabgrasses) two very similar species with mostly spreading subdigitate to digitate branches; may occasionally be seen here but the two species are difficult to differentiate.

Eriochloa species (cup grasses) annual natives of moderate size of low to mid elevations locally; narrow inflorescence a panicle with racemosely arranged rather short spikelike ascending to appressed branches; the lower glume and the glabrous callus are modified to form (in ours) a donut shaped ring around the base of the spikelet.

E. acuminata spikelet normally somewhat acute but with a short awn; most common

locally.

E. aristata spikelet long tapering (aristate) into a short awn, though the difference with *E. acuminata* may be subjective in some specimens;

E. lemmonii similar to *E. acuminata* but with easy to feel velvet like pubescence on the adaxial blade surfaces.

Echinochloa species (barnyard grasses) fairly narrow racemosely branched panicle with spikelike branches; spikelets tightly spaced on the branches; our most common species have no ligule; in its place is an area of non-green coloration; the inflorescences are usually covered with stiff papillose hairs; low to moderate elevations; probably seen mostly on disturbed sites.

E. colona annual exotic; branches short (usually < 4 cm.) and never rebranched; unawned; upper floret has a somewhat herbaceous tip that withers as the fruit matures.

E. crus-galli annual exotic; longer branched than *E. colona*; branches may rebranch but the secondary branches are very short; look closely for rebranching on the side of the stem not obscured by spikelets; some or all of the spikelets with awns of varying length to about 5 cm.; upper florets also with a withering tip.

Dichanthelium species an interesting genus similar to and formerly included in genus *Panicum* but with unique growth habits; ours are two small to moderate sized species of the mid elevations; perennials with a basal rosette of leaves in the winter; spring brings typical culm growth with terminal, mostly exserted, panicles but in summer-fall the culms branch; these branches are short, leafy and bear small terminal panicles partly included within the leaf sheaths; ours native species.

D. oligosanthes ours with spikelets about 3 mm. long; upper glumes with a prominent colored spot at the base.

D. acuminatum spikelets up to 2 mm. long without a colored spot at the base of the upper glume.

Paspalum species inflorescence usually with one to a few either digitate, subdigitate or racemosely arranged spike like flattened branches; spikelets dorsally compressed with the lower lemma side being fairly flattened the other side convex (spikelet plano-convex); lower glumes absent or found only on some spikelets and may be tiny;

P. distichum (knotgrass) moderate sized perennial native mostly of wet areas; some may have rhizomes; spikelets mostly solitary (sometimes paired) in two rows, one on each side of the branch midvein; usually two panicle branches; upper glumes 3-veined, short pubescent on the back; lower glume absent or tiny; spikelets 2.4 – 3.2 mm long.

P. dilatatum (dallisgrass) mid-size to large exotic perennial of mostly wet areas; panicles of usually 3–5 flattened spikelike branches racemosely arranged; spikelets usually 3–4 mm long; upper glumes and lower lemmas pubescent on the margins, 5–7 veined; short rhizomes form a knotty base.

P setaceum (sand paspalum) medium to large size perennial may be short rhizomatous forming a knotty base; said to prefer sandy not necessarily wet soils; spikelets about 2 mm long mostly paired along mostly 2–3 racemosely arranged panicle branches; lower glume absent; ours var. *stramineum* without an evident lower lemma midvein.

Panicum species by default if a local grass with the paniceae spikelet is not one of the aforementioned genera it is probably a *Panicum* species.

P. hirticaule (witchgrass) an annual usually of moderate to large size mostly found in the wetter areas locally and to mid elevations; inflorescence from fairly small to large and often rebranched; branches usually naked along to lower half; herbage from glabrous to usually papillose pubescent; sheath said to be ciliate on one margin; spikelets with prominent veins, glabrous often rust colored with tips somewhat abruptly acuminate; lower glumes ½ to ¾ spikelet length; lower florets sterile.

P. hallii (Hall's witchgrass) moderate sized perennial of low to mid elevations with often crowded basal leaves; leaves tend to coil like wood shavings; leaf margins cartilaginous; plant somewhat glaucous; lower florets sterile.

P. obtusum (now *Hopia obtusa*) (vine mesquite) somewhat uncommon medium to large perennial of more moist habitats; low to fairly high elevations; inflorescences with a few spikelike branches; spikelets somewhat ellipsoid; stoloniferous and/or rhizomatous; lower florets staminate.

P. bulbosum (now *Zuloagaea bulbosa*) (bulb panicgrass) fairly large perennial of higher elevations; usually with a corm like root crown area; lower florets sterile or staminate; lower paleas may exceed lower lemma; lower floret male or sterile.
P. capillare (witchgrass) annual of disturbed soils, wet areas; plant mostly papillose hispid; outstanding feature of the species is the large open much branched inflorescence that is about half the size of the entire plant; inflorescence may break off when mature to become a tumbleweed; glabrous spikelets not dense, generally about 2.5 mm long; lower glume generally about ½ the spikelet length.

P. antidotale (blue panicgrass) a large almost bamboo like species with thick scaly rhizomes has been found along the Santa Cruz River; lower florets staminate.

Andropogoneae most with rames; some with simple racemes that do not disarticulate; spikelets with large glumes entirely enclosing the florets; most species with sessile-pedicellate spikelet pairs or sometimes triplets; in the rame each disarticulated segment usually includes one spikelet

pair or triplet with a section of the rame axis; see plate III for various rame arrangements; spikelets with two florets, the lower often reduced; both with hyaline lemmas and paleas; upper floret often awned; after the foliage dries during fall/winter months many species have a somewhat rusty red pigmentation in contrast to the straw color of most species; some members of this tribe have become extremely modified as in the case of corn with its thickened cobs and two species briefly mentioned below-*Tripsacum lanceolatum* & *Hackelochloa granularis.*

Bothriochloa species (blue stems) this genus differs from other Andropogoneae species by having pedicels and rame axes with a hyaline longitudinal central groove so they appear somewhat barbell shaped in cross section; the hyaline portion appears translucent when held up to the light.

B. barbinodis (beard grass) quite common locally and to mid elevations; perennial, medium to large height; in summer the plumose silvery inflorescences each with many ascending rames usually about 10 cm. long are quite visible along roads; dense long hairs on the rame axes and pedicels; has long geniculate twisted dark awns contrary to somewhat similar appearing *Digitaria californica* without awns; see plate III.

Other native species, some of which are somewhat difficult to differentiate are more common in other parts of southern Arizona; one exotic increasingly seen locally is *B. ischaemum* usually with only a few subdigitate < 10 cm. long reddish pubescent rames; see also similar appearing *Dicanthium annulatum.*

The following two genera (*Heteropogon* and *Trachypogon*) that might be confused; they have single rames or racemes and look quite similar:

Heteropogon species terminal rames; pedicellate spikelet sterile or male and without an awn; sessile spikelet perfect and with an awn.

H. contortus (tanglehead) common local to mid elevation medium to large perennial; long (5-9 cm.) dark awns which are pubescent below and become entangled; culms near the soil level quite flattened somewhat lens shaped in cross section.

H. melanocarpus large uncommon annual species; may be found around Sabino Canyon; glumes of the pedicellate spikelet have a longitudinal row of pits.

Trachypogon secundus (*T. plumosus*) (crinkle awn) similar to *Heteropogon* species but has non disarticulating racemes; also different in that the long twisting lighter colored awns are on the long and perfect pedicellate spikelet; the subsessile spikelet is sterile or male; large perennial of the mid elevations.

Schizachyrium species (blue stem) three species in Arizona that may be difficult to differentiate; single rames with shorter non tangled or twisted awns than the above two genera; culms often branching, each with a single terminal rame; sessile spikelets bisexual and awned; the pedicellate spikelets sterile or male and either unawned or with awns shorter than in the sessile spikelet; species of the mid elevations; usually caespitose.

Dichanthium annulatum an exotic stoloniferous perennial that may be naturalizing in our area; looks similar to *Bothriochloa ischaemum* but without the hyaline grooves in the rame segments and pedicels; less than 10 subdigitate rames that are naked (without spikelets) at their bases.

Sorghum species two very large species of exotics; these old world plants have been associated with humans for thousands of years, so many, many cultivars exist probably genetically entwined; therefore, it may be difficult to identify the species in this continuum of cultivars; the best clue may be whether or not the specimens in hand are rhizomatous or not.

S. halapense (Johnson grass) an invasive rhizomatous weed of the more seasonally wet areas locally with large spreading terminal inflorescences of racemosely branched and rebranched rames; sessile spikelets bisexual, either awned or not; pedicellate spikelets sterile or male and unawned; glumes indurate, pubescent and shiny; under certain conditions this plant may be poisonous to livestock.

S. bicolor (sorghum) mostly a yard or crop plant; annual, or perenial in warm winters; culms resemble corn; terminal inflorescences usually more compact than in *S. halapense* and with hairy spikelets; sessile spikelets bisexual and unawned; pedicellate spikelets sterile or male; not rhizomatous.

Tripsacum lanceolatum (Mexican gama grass) a tall rhizomatous native perennial mostly found near wet areas of Cochise and Santa Cruz Counties; this strange species has a two part rame; the paired male spikelets share the rame axis with the indurate female spikelets beneath; female spikelets are embedded in the thickened axis; the male portion of the inflorescence is more typical of most Andropogoneae species having paired sessile and pedicellate spikelets.

Hackelochloa granularis (pitscale grass) another strange andropogonoid; an exotic annual of waste areas, roadsides etc. of extreme SE Arizona; rames terminal and axillary on a thickened axis; the small sessile partially embedded spikelets look like tiny hand gernades.

Pappophoreae a small tribe with multiawned florets (lemmas).

Cottea pappophoroides mid-sized perennial of low to mid elevations with ascending panicle branches; lemmas long pubescent basally and with a mix of short awns and teeth with short awns.

Pappophorum vaginatum (pappus grass) medium to fairly large perennial of lower elevations with long very narrow spikelike panicles; lemmas with numerous awns which are not plumose; awns about 2x the lemma body length and which tend to bend outward as the fruits mature; lower glumes with one vein.

Enneapogon species (also pappus grass) two local species with 9 plumose awns on each lemma; awns 2x or more the length of the lemma body; lower glumes with 5-7 veins.

E. cenchroides medium to tall (usually > 0.5 meter) invasive exotic annual of low to mid elevations; panicles usually longer than 10 cm. and fairly narrow with appressed to ascending branches; culms usually about 2 mm. in diameter.

E. desvauxii medium sized perennial (usually <0.5 meter) of the low to mid elevations; panicles usually < 10 cm. long somewhat spike like; cleistogamous spikelets are often found at or very near the base of the plant.

Stipeae most caespitose perennials including the species listed below; sheaths open; terminal panicles; spikelets with one floret and no prolonged rachilla; spikelets usually fusiform (cigar or spindle shaped) with awned lemmas that are often densely hairy which tightly wrap around the floret; distal end of lemma often with a chopped off appearance (crown) and often flared at the tip; awns twisted and once or twice geniculate, sometimes plumose below; ours mostly of the sky islands; most old references have many of our species within genus *Stipa*, but recently new world species have been placed in many different genera relegating genus *Stipa* to the old world species.

Jarava speciosa (*Stipa speciosa* or most recently *Pappostipa speciosa*) (desert needlegrass) medium height species of low to mid elevations; sheaths of basal leaves reddish brown, persistant; lower blades particularly with dense throat hairs and densely hairy ligules; blades usually rolled (involute) to about 1 mm. diameter; glumes longer than the florets; calluses long, sharp pointed; floret (lemma) densely hairy; awns >35 mm., once geniculate, the lower portion twisted with long (4-8 mm.) plumose hairs; upper portion glabrous to scabrous.

Hesperostipa neomexicana (*Stipa neomexicana*) (New Mexico needlegrass) ligules of lower leaves not densely hairy; glumes longer than the florets; florets evenly short pubescent with a long sharp pointed callus (4–5 mm long) and distally a ciliate crown; awns extremely long (>12 cm.) and twice geniculate sometimes weakly so; awns completely pubescent but with shorter hairs on the lower twisted segments.

Achnatherum species a few species in southern Arizona but most difficult to determine; the genus is also difficult to easily define; glumes longer than the floret; floret usually terete, fusiform and not compressed; lemma margins usually not or barely overlapping and uniformly hairy mostly with hairs of equal length or distal hairs slightly longer.

A. eminens (*Stipa eminens*) (southwestern needlegrass) a low to mid elevation moderate to large caespitose native; upper ligule to 4.5 mm long; florets 4–7.5 mm long; lemmas evenly hairy with 35–70 mm twice geniculate awns; panicle flexuous “relatively few flowered” (Gould) with lower branches 5-8 cm long ascending to divergent; early the lower portions of the panicle may be enclosed.

A. hymenoides (*Oryzopsis hymenoides*) (Indian ricegrass) a native mid elevation caespitose moderately sized species; the paired somewhat zigzag pedicels on the widely divergent panicle branches and rebranches are quite evident; florets obovoid 3–4.5 mm long uniformly hairy; awns to 6 mm, deciduous.

Piptochaetium species ligules decurrent (edges extending downward forming the edges of the leaf sheaths); ours with calluses blunt to acute but not with extremely sharp points; florets hairy; lemmas indurate, the lemma edges fitting into a groove in the palea which may be most easily seen in cross section (slice with a sharp instrument); see plate V, 8 for schematic cross section; the palea is longer than the lemma and may be seen as a short projection above the distal rim (crown) of the lemma; awns twice geniculate, though sometimes not prominently so; twisted below usually scabrous.

P. pringlei (Pringle needlegrass) glumes and florets > 6 mm. long; florets brown, hairy, smooth shiny or perhaps tuberculate; awns scabrous usually 20-35 mm. long; (see also *P. fimbriatum.*

P. fimbriatum (pinon ricegrass) glumes and florets <6mm. long; florets brown, hairy, shiny smooth; awns 10-20 mm. long, scabrous; dense basal leaves said mostly tightly involute and spreading to drooping contrasting with more flat ascending leaves of *P. pringlei.*

Piptatherum micranthum (*Oryzopsis micrantha* or newest name – *Piptatheropsis micrantha*) a caespitose mid-sized perennial of moderate to higher elevations; panicles with widely spaced lower nodes and few branches divergent at maturity having a few spikelets; glumes equal to or exceeding the florets; florets 1.5–2.5 mm long dorsally compressed; lemmas usually glabrous shiny with nearly straight 4–8 mm awns that are early deciduous; calluses very short (0.1–0.2 mm).

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