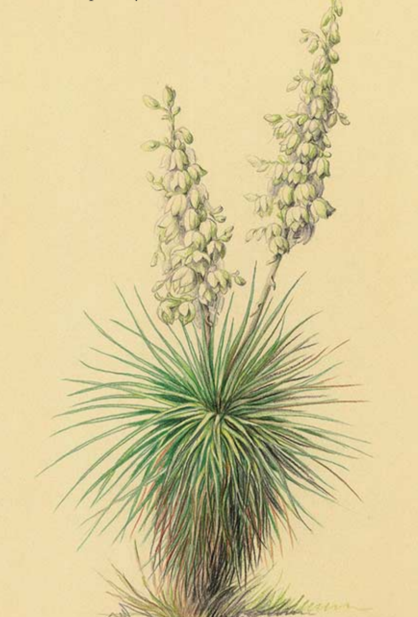
Soap tree yucca (*Yucca elata*)



Cora Estelle Mosher

Plant Press Arizona

THE ARIZONA NATIVE PLANT SOCIETY

Volume 45, Number 2 **Winter 2022**

In this Issue: The Grasses

With Regular Features

Above and inset: Wheat (*Triticum aestivum*): Smoky Hills, Kansas. *Credit: Doug Ripley*

The Grasses

by Ries Lindley and Douglas Ripley, Co-Editors, Plant Press Arizona

Ubiquitous is one adjective that can be used to describe the grasses. But by itself it is completely inadequate to describe the incredible diversity, complexity, distribution, beauty, economic significance, and overwhelming impact that members of the Grass Family (Poaceae) have, either directly or indirectly, on nearly every aspect of life on earth. Notwithstanding the incredible importance of grasses, and their presence nearly everywhere in our environment, they are often taken for granted by the general public and even occasionally plant lovers. That is a shame, and that is the reason we decided to devote most of this issue of *Plant Press Arizona* to a review of the significance of these members of the Plant Kingdom.

Scope and Range of the Grasses

Consisting of approximately 800 genera and 12,000 species, Poaceae is the most commonly occurring plant family. In the United States, over 80 genera and approximately 1,000 species of grass occur, while approximately 460 grass species occur in Arizona. Grasses occur on every continent, even Antarctica where the Antarctic Hairgrass (*Deschampsia antartica*) is one of only two vascular plants native to the continent.

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President's Note *by Douglas Ripley* jdougripley@gmail.com

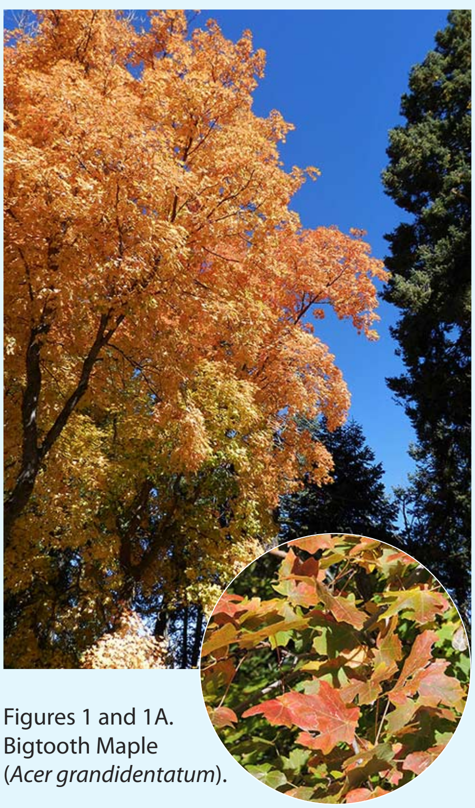
Winter greetings to Arizona Native Plant Society members! I hope all of you were able to savor the exceptional monsoon rains that we received in most parts of Arizona this summer. For me the exceptional rains during the much longer than usual monsoon season provided many opportunities to observe our beautiful native flora in bloom in a number of locations throughout the state. Now that the flowering season is largely over, I have found new botanical enjoyment in visiting the higher elevations of some of our Sky Islands to observe the wonderfully colored autumn foliage. An October trip to the Pinaleño Mountains in Graham County definitely charged my botanical batteries with views of spectacularly colorful aspen, maples, and oaks.

I think it is safe to say that throughout the year the Arizona Native Plant Society continaued to address its primary mission in fine form. Many of our chapters held monthly meetings or sponsored interesting field trips and other activities. One especially nice sponsored activity was the resumption of the long weekend workshop held at the Southwestern Research Station in the Chiricahua Mountains, the first after a three-year hiatus due to COVID restrictions.

The Society continues to receive recognition for some of its notable native plant cooperative work. Most recently, we joined with the Bureau of Land Management to celebrate the unveiling of interpretive signs at the Waterman Restoration Site in the Ironwood National Forest. Thanks to the tireless efforts of the Society's Conservation Committee, led by John Scheuring, this former highly degraded, buffelgrass-infested site has been restored to a thriving and sustainable Sonoran Desert habitat. For conservation work such as this, the Coronado National Forest recently recognized the Society and John Scheuring with an award in a special ceremony.

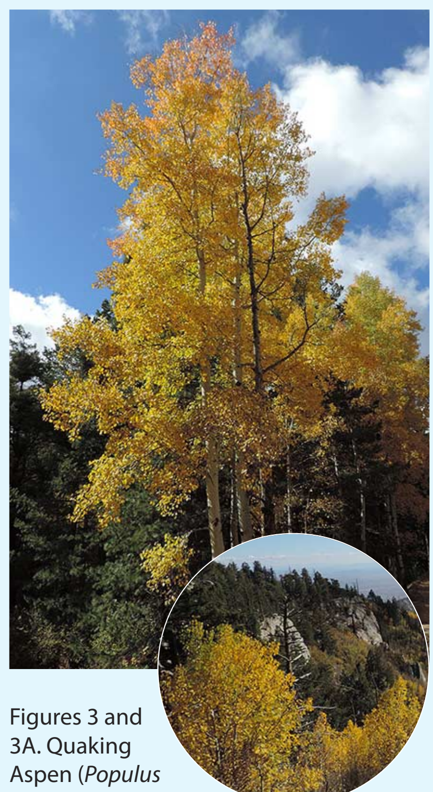
We held our annual Botany Conference remotely via Zoom on December 3, 2022. The theme this year was: "Native Plants of Arizona: Exploring the unique plants and ecosystems of our botanically diverse state." As with previous meetings, the entire program may be viewed on the YouTube link on our website. A committee will soon start planning the 2023 conference which we hope will be held in person at some interesting Arizona location.

Thanks to all of our members for their participation in the Arizona Native Plant Society. We look forward to your continued participation and support in the New Year.



Figures 1 and 1A. Bigtooth Maple (*Acer grandidentatum*).

Figures 2 and 2A. Gambel's Oak (*Quercus gambelii*).



Figures 3 and 3A. Quaking Aspen (*Populus tremuloides*).

All figures from the Swift Trail, Pinaleño Mountains, Graham County. *Photo credit: Doug Ripley*

The Grasses

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Importance of the Grasses

It is undoubtedly safe to say that the grass family is of more overall importance than any other family of flowering plants. Among the more important qualities and uses of grasses are:

- Food crops for human consumption: rice, wheat, barley, rye, corn, milo, millet, oats, and sugarcane
- Domesticated animal forage and grain
- Alcoholic beverages
- Wildlife forage
- Range forage
- Construction (bamboo and thatch)
- Industrial uses
- Soil conservation
- Turf and landscaping

Morphology of the Grass Flower
by David Thayer, *Wild Grasses of Arizona*

The grass flower is a highly evolved structure significantly modified from typical angiosperm flowers. Therefore it has been described with special terms, an understanding of which is necessary to appreciate the overall life cycle of the grasses. Specific flora terminology is illustrated in the following diagrams.

The spikelet is the basic unit of grass identification. A single plant will have many spikelets attached to the seed head. Each spikelet has two tiny leaf-like glumes at bottom and one to many florets above the glumes. Florets are held to each other by an axis called the rachilla. Each complete floret consists of two tiny leaf-like structures called the lemma (lower) and palea (upper). These enclose the reproductive parts as shown next. Many glumes and lemmas have needle-like projections called awns.

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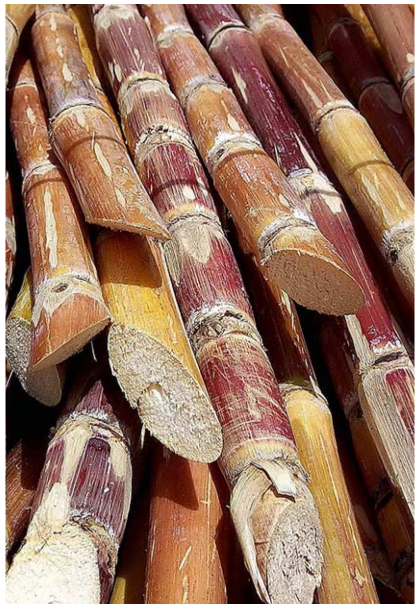
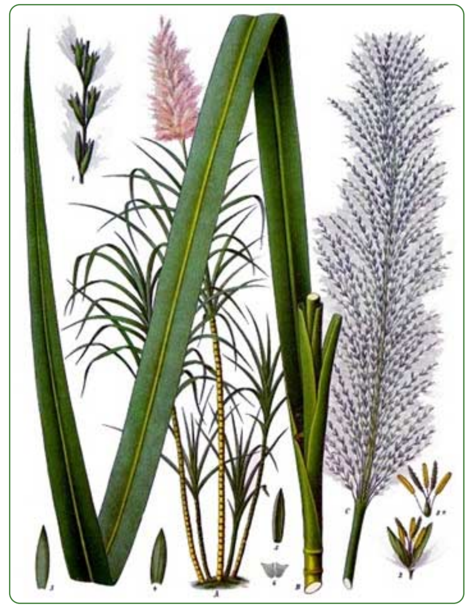
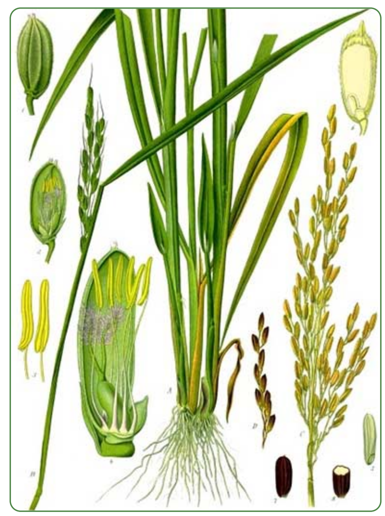
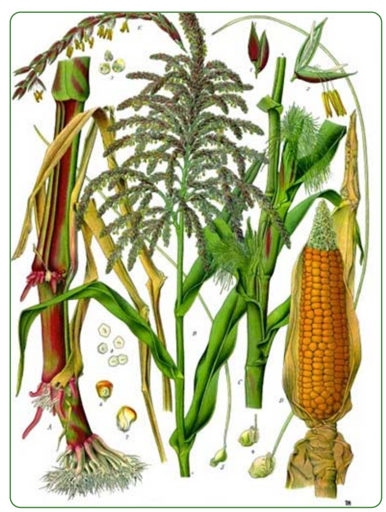
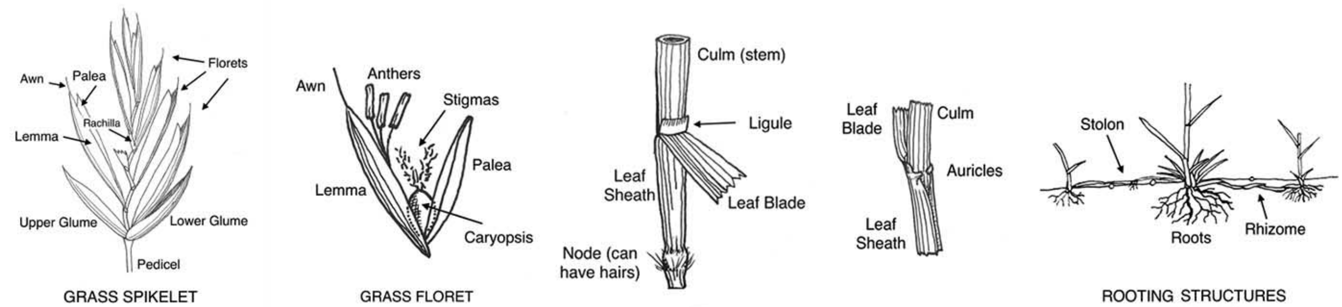



Above, from left. Cut sugarcane. *Wikipedia Commons.* Illustration of sugarcane from Franz Köhler's *Medicinal Plants* (1887). *Wikipedia Commons.*



Left column: Rice cultivation in Taiwan. *Photo credits: Doug Ripley.* Right column: Illustrations of rice and corn from Franz Köhler's *Medicinal Plants* (1887). *Wikipedia Commons.*



Grass Structure: *Illustrations: Dave Thayer*, Wild Grasses of Arizona (**https://azgrasses.org/**), **dave.canyondave@gmail.com**

The Grasses *continued*

After the floret develops, the lemma and palea usually open a bit and the beautiful female *stigmas* protrude. Pollen is ejected from the extended male *anthers* and blown in the wind in a process called *anthesis*. The pollen sticks to the stigmas, fertilizes the ovary, and a seed called a *caryopsis* grows. Be aware that all these parts can be very tiny; usually a hand lens is needed to see them.

The main grass stem below the seedhead is called the *culm*. Each grass leaf has two main parts, the *blade* and the *sheath*. The sheath is wrapped around the culm, so it looks like part of the stem, while the grass blade extends from the culm and is the thing that makes a lawn. Each sheath extends down to the next lower *node* at the top of the next stem segment.

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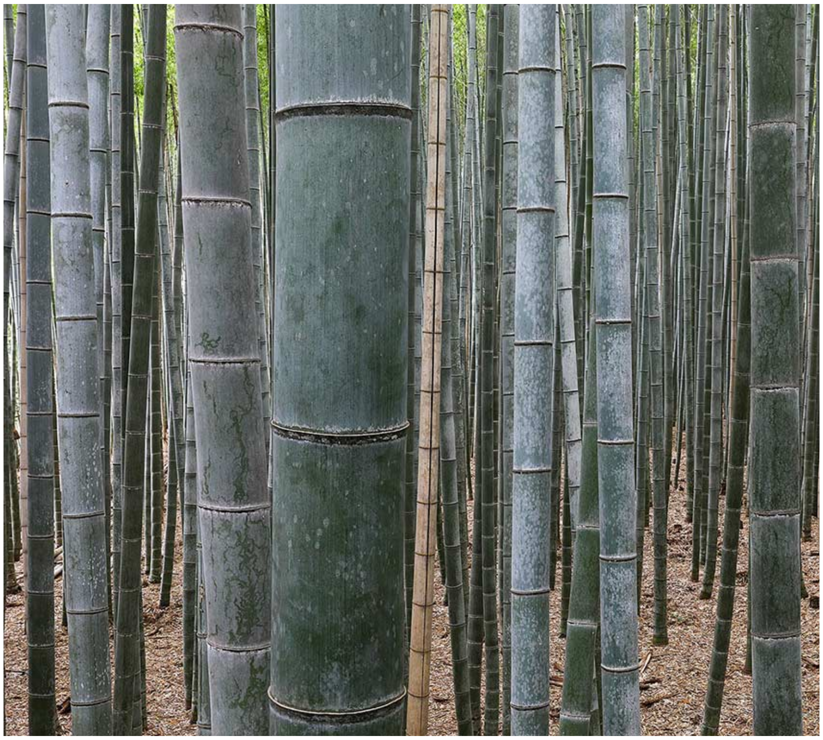
Above and inset: Antarctic Hairgrass (*Deschampsia antartica*) growing with mosses, Cierva Cove, Antarctica. *Photo credits: Doug Ripley.*



Above, clockwise from left. Bamboo forest in Arashiyama, Kyoto, Japan. Giant dragon bamboo, China. Bamboo scaffolding can reach great heights, Hong Kong. *Wikipedia Commons.*

Left column. Scenes from the Jack Daniels Distillery in Lynchburg, Tennessee. *Photo credits: Doug Ripley.*

The Grasses *continued*

Sometimes, at the junction of blade and sheath, there might be little ear-like structures called *auricles.*

The *ligule* is often used as an identification feature. It is a thin structure attached to the leaf at the inside junction of sheath and blade. The ligule may be *membranous* (usually white and very thin) or *ciliate* (hairy).

In addition to its roots, a perennial grass plant may have aerial root-like stems called stolons which look like above-ground roots but are actually stems. These creep along the ground, at intervals putting down true roots and starting a new grass plant. Similar structures called rhizomes grow underground in shallow horizontal paths, and sprout new plants at the nodes.

A Note to the Reader

It wasn't that long ago when our world was centered on agriculture. A vast majority of the people on the planet grew the food they ate and lived with nature on a day-to-day basis. As a result, art and nature were of a piece to them. They found beauty in the very same places they found hard work and disappointment. There are still people like that among us, and we asked some of them to contribute their thoughts on grasses. We hope you will enjoy the articles presented here. Each one is written by someone who feels a deep kinship with grasses and a responsibility to the earth and the people that live on it.

Figures 1–3. Kentucky bluegrass (*Poa pratensis*). Muttongrass (*Poa fendleriana*). Cheatgrass (*Bromus tectorum*). *Photo credits: Max Licher.*

Bring On the Grasses

by Debbie Allen[1] Photos courtesy the author unless otherwise indicated.

Around 6 million years ago there was a dramatic change in life on Earth. It was not as catastrophic as the moment when a meteor hit the Yucatan Peninsula and ended the reign of the dinosaurs. This change was the result a revolution that had been slowly brewing for several million years during the Miocene epoch. It started when a number of plants, mostly grasses, decided to experiment with the way they did photosynthesis. Photosynthesis — that magical process where plants snatch carbon dioxide (CO_2) from the air, water from the ground, and in the presence of sunlight create sugars and release oxygen (O_2) — has been around for over a billion years. And yet these upstart plants decided to try something new.

Life is always experimenting to come up with something better. It is not surprising that even after a billion years there would be plants seeing how they could improve photosynthesis. It is unusual that this new Miocene photosynthesis evolved independently over 60 times, making it a remarkable case of convergent evolution. Monocots, primarily grasses and to a lesser extent sedges, make up 80 percent of what turned out to be a very successful adaptation.

Strangely, the new photosynthetic path these plants chose made the process more complex, not simpler. It added an extra step and required more energy. BUT — it also required much less water. Suddenly barren, open areas that had plenty of sunlight but not much rainfall were ripe for colonization. The pampas of Argentina, the great savannas of Africa, central Australia, the steppes of central Asia, and, of course, what is now Mexico up into the southwestern United States, were hot and dry with little competing vegetation, all perfect for plants with this new type of photosynthesis.

Scientists are not known for devising easy-to-remember descriptive names, but in this case they did. The "old" method photosynthesis is called C3 because the first molecules produced in the process contain 3 carbon atoms. The "new" method is called C4 because it initially produces molecules containing 4 carbon atoms. In general, C3 grasses are considered "cool season" grasses and C4 are "warm season" grasses.

As grasses spread rapidly into new areas, animals followed. Small mammals and birds ate the seeds. Larger carnivores and raptors found new prey. Large herbivores ate the grass leaves, although at a cost. Grasses are not particularly easy to chew and digest, and C4 grasses are especially challenging. It is probably not by chance that of the 13 different members of the horse family that evolved at different times in the Miocene, only one survived at the end, our modern genus *Equus*. Equids have the largest teeth with the most enamel of any Miocene predecessor, and so are the best equipped to eat grasses.

Most plants have retained the tried-and-true C3 method of photosynthesis. Only about 3 percent of the flowering land species of plants use C4. A third type of photosynthesis, CAM (for crassulacean acid metabolism) is even more complicated, evolved in the Miocene, and offers advantages in drier climates. The CAM process allows a plant to photosynthesize during the day, but only exchange gases at night which typically results in significantly less water loss. CAM plants make up seven percent of land plants, primarily epiphytes like orchids and bromeliads or succulent xerophytes like cacti. Grasses have been especially enthusiastic about adopting C4. Over 40% of all grass species use C4 photosynthesis. These

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Figure 4. Red Brome (*Bromus rubens*). *Photo credit: Sue Carnahan.* Figure 5. Smooth brome (*Bromus inermis*). *Photo credit: Max Licher.* Figure 6. Cultivated barley (*Hordeum vulgare*). *Photo credit: Sue Carnahan.*

Bring On the Grasses *continued*

species are primarily found in lower latitudes in arid regions where they thrive in the abundant sunlight.

In the United States, it is estimated that 80 percent of the native grasses in the southwest, including Arizona and New Mexico, are C4 grasses and only 20 percent are C3 grasses. Those percentages are reversed if you travel north to Montana, which has only 20 percent native C4 grasses.

What does this actually mean if you are looking at grasses in Arizona? "Our" grasses have two distinct seasons. The pattern of these seasons will be different in different parts of the state. I live in Prescott, in the Central Arizona Highlands. By mid-March we start to see the C3 cool season grasses set their seedheads. Some of the first to bloom are the bluegrasses and muttongrasses (*Poa)*. The genus *Poa* is large and complex, but here we only have two main species. Kentucky bluegrass (*Poa pratensis)* (Figure 1), is a common introduced perennial used in lawns as well as for pastures and reclamation. Muttongrass (*Poa fendleriana)* (Figure 2), is our native equivalent to bluegrass and its common name indicates its value as pasture for sheep as well as horses, cattle, and elk. One of the important differences between the two is that Kentucky bluegrass has short rhizomes and makes a nice lawn turf, while mutton grass is a bunchgrass, growing in clumps with deep roots. Bunchgrasses are more suitable to our arid climate but not great for lawns.

Other early cool season grasses include the annual bromes. Cheatgrass (*Bromus tectorum)* (Figure 3) and red Brome (*Bromus rubens*) (Figure 4) are among the earliest grasses to flower. There will be negatives to share about cheatgrass later, but at this point in its life it can form lovely, nodding, purplish swaths next to roads.

The perennial bromes are very different from the annual species, to the degree that they are sometimes put into a separate genus. Generally, the annual bromes are introduced, short, and invasive. Perennial bromes are usually tall, excellent forage, and mostly native. Smooth brome (*Bromus inermis)* (Figure 5) is an introduced exception. Perennial bromes, being larger plants, tend to flower later in the season.

One last common cool season genus found blooming here in early spring is *Hordeum*, the barleys. While there are often outliers of the cultivated barley plants, *Hordeum vulgare*, occurring near old homesteads, is the most commonly found (Figure 6). The most widespread *Hordeum* species is wall barley, or more correctly "mouse" barley (*Hordeum murinum*) (Figure 7), according to Kelly Allred. If you have ever seen barley or wheat, mouse barley looks like a miniature version popping up between cracks in the sidewalk or in areas of weedy growth. Mouse barley has its native equivalent in little barley (*Hordeum pusillum)* (Figure 8). Seeds from little barley have been found in North American archaeological sites dating from 2,800 to 3,000 years ago, indicating that it was cultivated for its tiny seeds before the arrival of maize.

C3 grasses begin to grow when the temperature is between 40°F and 45°F and grow best at 75°F to 85°F. C4 grasses do not begin to grow until the temperature reaches 60°F to 65°F and they thrive at 90°F to 95°F. All grasses like some rain, but C3 are more demanding. When our dry period hits in May and June, often with zero precipitation, the C3 grasses start to die back.

Our C4 grasses generally do not get serious about growing until after the monsoon rains start in early July, giving the perfect combination of heat, sun, and water. Some of the

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Bring On the Grasses

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Figures 7–8. Wall or "Mouse" barley (*Hordeum murinum*). Little barley (*Hordeum pusillum*). *Photo credit: Max Licher.*

earliest on the scene are the threeawns, genus *Aristida.*

Threeawns are distinctive because they have, well, three awns. These awns are usually obvious and easy to see just walking by. One of the most common of the threeawns is purple threeawn (*Aristida purpurea)* (Figures 9a and b). Purple threeawn is for botanists like juncos are for birdwatchers.

At one time, there were several very distinctive species of juncos, and birders would carefully list the Oregon, pink-sided, slate-back, and white-winged. DNA studies have subsequently showed that these are just some of the seven interbreeding varieties of what is now called the dark-eyed junco species. Similarly, thirty years ago botanists identified seven species of threeawns that DNA has shown are intergrading varieties of purple threeawn.

Figures 9a–b. Purple threeawn (*Aristida purpurea*). *Photo credit: Max Licher.*

As summer progresses, more C4 grasses start to flower, peaking here in Prescott in September.

There are many genera of C4 grasses here, so I will just mention two notable ones: the grama grasses and the muhlys.

Grama grasses, genus *Bouteloua*, are on the top of everyone's list of favorite grasses. Blue grama (*Bouteloua gracilis)* (Figures 10a and b), has a distinctive "eyelash" seedhead which graciously provides good forage both in summer and winter. One clever adaption is that it slowly grows out into small circles, as the older grasses in the center die, thus providing its own little catch basin for the summer rains. An indication of the importance of blue grama is that it has been designated the state grass of both New Mexico and Colorado. There are several *Bouteloua* species that have a similar appearance, including a charming little annual called mat grama (*Bouteloua simplex*) (Figure 11), which looks like a miniature blue grama.

Sideoats grama, (*Bouteloua curtipendula*) (Figure 12), is a *Bouteloua* with a very different appearance from blue grama. Imagine a tall staff with short pennants on each side. The pennants are the seed heads, suspended on delicate pedicels. For some reason, the pedicels sometimes all swing to one side, giving the seedhead a one-sided appearance. Sideoats grama is more widespread through the country than blue grama, but shares the same desirable traits. It is the state grass of Texas.

Muhly grass is the casual term for the genus *Muhlenbergia.* There are several muhly grasses that are found across the United States, but the genus is mainly concentrated in the southwest. There are more species of *Muhlengbergia* in the southwest than any other genus. Muhlys range widely in appearance. At one end, we have deergrass (*Muhlenbergia rigens)* (Figure 13). It is a large, coarse grass that gets its name not because deer eat it, but because it provides good cover for mule deer fawns. Deergrass forms clumps up to six feet across and sends up its compact, spikelike seedheads on four-foot-tall stems. Its extensive root system is excellent at preventing erosion.

At the other end of the spectrum of muhly grasses is the small delicate muhly (*Muhlenbergia fragilis*) (Figure 14). This short annual grass is barely noticeable until fall when it creates delicate clouds of pink inflorescences. Someone mentioned

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Bring On the Grasses

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that they call it "fairy grass," and when it sparkles with dew, it truly looks magical.

Like many plants, our native grasses are threatened by several aggressive introduced species. Often these plants have been introduced intentionally. In the case of grasses, there is always a search for high-quality forage, primarily for cattle. Grasses are also important for erosion control, so varieties with rhizomes are often imported for slope stabilization. Unfortunately, the rhizomes give these grasses the potential to become invasive.

In the southwest, the recognition that C4 grasses are well-adapted to our climate has resulted in the introduction of buffelgrass (*Cenchrus ciliaris*) (Figure 15), from South Africa. In 1953, the Department of Agriculture noted that buffelgrass is "Readily established; roots grow as much as an inch a day; high protein content. Provided a large amount of palatable forage on relatively poor soils." Bufflegrass has now become the bane of southern Arizona. Bufflegrass can out-compete native grasses by forming dense stands, and has changed the fire regime in desert areas. The closely spaced, dense plants can carry a fire where widely spaced native desert plants cannot. Desert plants that never needed to develop a resistance to hot, wide-spread fires are now at risk.

Bufflegrass can't take cold temperatures, but further north in Arizona we have another South African C4 grass that is spreading enthusiastically. Weeping lovegrass (*Eragrostis curvula)* (Figure 16) is a large bunchgrass with deep roots that was imported for pasture and erosion control. In 1981, Frank Gould in *Grasses of Southwestern United States* reported that weeping lovegrass was found in Graham and Pima Counties. Now it is widespread throughout the central Arizona highlands.

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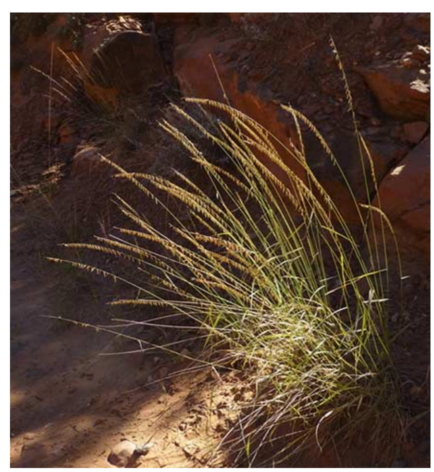
Figure 10a–b. Blue grama *(Bouteloua gracilis). Photo credits: Max Licher (closeup, 10a), Paul Rothrock (inset, 10b).*



Figures 11–12. Mat grama (*Bouteloua simplex*). Sideoats grama (*Bouteloua curtipendula*). *Photo credit: Max Licher.*

Bring On the Grasses

continued

Figures 13–14. Deergrass (*Muhlenbergia rigens*). Delicate muhly (*Muhlenbergia fragilis*). *Photo credit: Max Licher.*

It is not surprising, at least in retrospect, that C4 grasses would be imported into Arizona with the best of intentions and then become invasive. What is surprising is that a pair of C3 grasses, poorly suited for living here, would arrive uninvited and proceed to take over not only the southwest but millions of acres of the high plains. These grasses are cheatgrass brome, *Bromus tectorum,* mentioned earlier, and red brome, *Bromus rubens*. In the west, cheatgrass first appeared next to the railroads, probably from contaminated seed or the fleece of sheep. Cheatgrass has developed a successful playbook for outcompeting native grasses:

Figures 15–16. Buffelgrass (*Cenchrus ciliaris*). *Photo credit: Sue Carnahan.* Weeping lovegrass (*Eragrostis curvula*). *Photo credit: Max Licher.*

- Come up early in the season with abundant viable seeds.
- Die early, drying out and making perfect tinder.
- Burn. Spread your seeds. Take out the competition during the high fire season, especially C4 plants that are just getting started before the monsoons.
- Get all those seeds germinating in the winter rains, sucking up all the water possible.
- Repeat until you have removed the competition.

Using this formula, cheatgrass has managed to become the dominant species in more than 100 million acres of the high plains. Unfortunately, the result is a barren monoculture, devoid of the food sources a grassland normally supports.

Red brome has followed a similar playbook while focusing on the desert southwest. Red brome was intentionally introduced (by the University of Arizona) for evaluation as a forage plant and then escaped. Like bufflegrass, red brome spreads into areas where the widely spaced desert plants have not developed fire survival strategies.

Ironically, after the evolutionary success of C4 grasses spreading into arid, sunny areas, they are now being threatened by the C3 plants they originally replaced. What will evolution bring next?

"Food" for thought. The most invasive monoculture grasses in our country include corn (90 million acres), wheat (47 million acres), and lawns (40 million acres).

"Grass is What Holds the Earth Together"

Agnes Chase, Agrostologist — 1869-1963

by Debbie Allen[1] *Photo: Smithsonian Institution Archives*

If you have one reference book for grasses in your library, it is probably Albert Spear Hitchcock's *Manual of the Grasses of the United States* published in 1935. More likely, you have the second edition, revised by Agnes Chase and first published in 1950. The book covers nearly all the grasses found in the United States. Remarkably, almost every grass in its 800 pages has a pen and ink illustration. Because the book is a government publication, all the illustrations are in the public domain and can be used without copyright infringement. For that reason, these wonderful line drawings show up online and in many grass publications.

The group of women illustrators (and they were all women) included Agnes Chase, who claimed credit for many illustrations and most of the spikelet drawings. The *Manual of Grasses* shows her progression from a talented illustrator to a masterful editor. A comparison of the 1935 book and the 1950 revision shows changes in descriptions, organization of the illustrations, and even maps showing species distributions. It was clearly done by someone with an in-depth knowledge dealing with the complexities of grasses.

Mary Agnes Meara (or Mera) was born in 1869 in Iroquois County, south of Chicago. In the 1870 census she was the youngest in the family of five, living on a farm valued at $2,400 with four farm laborers. The following summer her father Martin, an Irishman known to have a violent temper, burned and whipped her 11-year-old brother to death. Martin was subsequently lynched by an outraged community. Her mother, Mary, lost her newly born 2-week-old baby girl during the incident. Mary moved her family, a son and three

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girls including Agnes, to Chicago and changed their last name to Merrill.

Agnes (she used her middle name, perhaps to avoid confusion with her mother), went to elementary school and then joined the workforce to help support the family. She worked as a typist and proofreader and discovered a passion for science and botany that filled her spare time. At age 18 she married William Ingraham Chase, the editor of the newspaper where she worked. He died of tuberculosis a year later, in 1889, leaving her a widow at age 19.

Ten years later, in 1900, Agnes was living on her own in Chicago. The rest of her family was still there. Her older brother was married and had a wife and an 8-year-old daughter. Her mother was living with her two unmarried older sisters. But things were about to change for Agnes. It had been a busy decade since her husband died. She had been working as a proofreader, taking botany classes at the University of Chicago, learning botanical illustration, and collecting plant specimens. A specimen of *Woodwardia virginica* on vPlants (Virtual Herbarium of the Chicago Region) was collected by Agnes Chase in 1891. She enjoyed collecting trips with her husband’s nephew, Virginius Chase. Virginius eventually collected 15,000 botanical samples and his herbarium was purchased by the University of Illinois. He remained close to his aunt, who was on his herbarium sheet as determiner for a sample of *Elymus virginicus* that he collected in 1951.

Chase met two valuable mentors in the 1890s. Ellsworth Jerome Hill was a botanist specializing in mosses and liverworts. He encouraged her interest in botany and taught her how to use a microscope. In return, she illustrated the new species he discovered. The Hill herbarium collection of 16,000 species is now at the University of Illinois.

Chase also started working with Charles Frederik Millspaugh, who was curator of botany for the Field Museum of Natural History. She illustrated (for free) his publications *Plantae Utowanae* (1900) and *Plantae Yucatanae* (1904). In the second publicatio, he named a plant *Encelia chaseae* “for Mrs. Agnes Chase, whose careful drawings illustrate this publication.”

In 1903, with Ellsworth Hill’s encouragement, Chase obtained a position as a botanical illustrator for the USDA Bureau of Plant Industry. She had the highest score of all the entrants on the qualifying test. She moved to Washington D.C., where she worked as an illustrator. In 1907 she became the scientific assistant to Albert Spear Hitchcock. The two worked together for the next 27 years, collecting and classifying grasses. She evolved from being an illustrator to a valued collaborator. *The Genera of Grasses of the United States*, published in 1920, presaged the much more complete *Manual of Grasses of the United States*. The first had 288 pages in the main text; the second 796 pages.

Hitchcock died in 1936, the year after the *Manual* was published, and Chase replaced him as senior Botanist in charge of systematic agrostology at USDA. She took mandatory retirement three years later at the age of 70. She held the honorary role as custodian of grasses at the U.S. National Herbarium until her death. At age 91 she wrote her goddaughter “If I had any sense I’d quit the herbarium and grasses, but it would be easier to stop breathing.”

Chase wrote her own book in 1922, *First Book of Grasses: The Structure of Grasses Explained for the Beginners*. “The purpose of this primer is to give those with little or no knowledge of botany such an understanding of the structure of grasses… that our native grasses may become better known and their worth and beauty be more fully appreciated.”

Even though Chase spent her life focused on grasses, she was also active in social issues. She was a suffragist and was jailed twice. While in jail, the women had a well-publicized hunger strike and were force-fed. The USDA, unhappy with the publicity, told Hitchcock to fire her. Hitchcock refused, saying that her skills were imperative for their research.

Chase built up a large circle of friends among women and co-workers. When she was refused official funds to go on a collecting trip in Brazil, she raised her own money and stayed with female missionaries. In Brazil, she and local fellow botanist Dona Maria Bandeira climbed Mount Itatiaia, the second highest peak in the country. They descended “with skirts filled with plant specimens.”

By 1920, Chase owned a three-bedroom house on 41st Street in Washington D.C. where she lived for the next 43 years. People were welcome to stay. The 1930 census shows that she had a co-worker, Egbert Walker, and his wife Elsie living with her. Elsie was an editor who worked at the Red Cross, so Chase had much in common with both the husband and wife.

Agnes Chase died in 1963 on the day she moved into a nursing home. She is buried with her husband, William Ingraham Chase, in Chicago’s Rosehill Cemetery.



Trailing grama (*Bouteloua diversispicula*). *Photo credits: Sue Carnahan (Figures 1 and 2) and John Scheuring (Figure 3).*

SPOTLIGHT ON A NATIVE PLANT

by John Scheuring, Chairman, Conservation Committee, Arizona Native Plant Society

Trailing Grama Grass (*Bouteloua diversispicula* J.T. Columbus)

Family: Poaceae

Trailing grama is a short (4–10 inches), perennial, heavily stolonizing grass that is native and common in Sonora, Mexico. In Arizona it has been found in wild stands in the eastern Ragged Top foothills of Pima County and recently in Oracle Road/AZ 77 rights-of-way, probably planted inadvertently in a 2016 hydroseed mix with stray seed from Sonora.

The trailing grama populations along Oracle/AZ 77 have been remarkably resilient in their opportunistic response to dry and wet conditions. When we first discovered the plants in the very dry September of 2020, they were quite green and robust from road runoff that came from a few isolated, modest rains that year. During the 2020/2021 megadrought months, the plants went into hard dormancy, and many appeared gray and dead. But the historic July/Aug 2021 rains greened up even the deadest appearing plants in a matter of days. In Monsoon 2022, we witnessed a veritable explosion of trailing grama along Oracle/AZ 77, due to last year's extensive dispersal of broken-off runners (stolons) carried along by vehicles as well as significant seed dispersal.

We estimated in 2020 the trailing grama population extended two miles along Oracle/AZ 77. This year the population stretches six miles along both sides of that same road, an increase in area almost double since last summer.

The spread is evidenced as little toeholds on the edge of the pavement followed by the spread of plantlets and runners (stolons) growing down the slopes and the roadway runoff gradient. The trailing grama plants opportunistically fill in empty spaces, especially in the wetter areas near the pavement edges. The spread stops when there is insufficient residual moisture to support it. The plants knit the soil together and provide ideal resistance to soil erosion.

The good news is that this year, for the first time, there is clear evidence that trailing grama is outcompeting Bermudagrass (*Cynodon dactylon*). As it closes in, the Bermudagrass goes from prostrate to erect growth in a peculiar way.

Trailing Grama could be a viable option for roadside vegetation, restoration, and urban landscaping. But there is a lot to learn:

- We have no idea of its seed production or producibility.
- We have no idea how to intentionally establish it, even by stolons.
- We know that it can be mowed but have no idea how much foot traffic it can tolerate in urban landscapes.
- We have no idea about the establishment and care of trailing grama in urban landscapes.

The use of this grass in land restoration has never been tried. With additional study it may be found that trailing grama could be used for roadside vegetation, restoration, and urban landscaping.

Trailing grama plants are available for sale to the public at Desert Survivors Nursery in Tucson. The Pima County Native Plant Nursery has done an excellent job propagating plants for use in Pima County projects.

Figure 1. Big sacaton (*Sporobolus wrightii*). *Photo credit: Sue Carnahan*. Figure 2. Loamy slopes, desert grassland, mesquite—native grass, SRER. *Photo credit: Dan Robinett*.

Grasslands and Rangeland Management in Arizona *by Dan Robinett[1]*

Introduction

When I was a young man at the University of Arizona in 1968, I initially majored in wildlife management. My wildlife professor, Dr. Hungerford, liked me, knew I was working my way through school, and needed a job when I got out. He also knew I loved plants and our rugged landscapes as much as I did the animals that used them. He suggested I instead pursue a major in range management as the program was small compared to wildlife management and the jobs more plentiful. It was the best advice I received during my college career.

After graduation and a two-year stint in the US Army, I embarked on a career with the United States Department of Agriculture (USDA) Soil Conservation Service, later to become the Natural Resources Conservation Service (NRCS). I spent my entire NRCS career in southern Arizona. My job as a range conservationist consisted of working in partnership with ranchers to apply the latest knowledge in rangeland management to the business of producing livestock in Arizona. I retired in 2007, started a company and consulted in rangeland management for another 12 years. I could not have had a better career.

Rangelands are described as lands on which the native vegetation is predominately grasses, grass-like plants, forbs, shrubs, and dispersed trees (savannah). Rangelands comprise about 30% of the entire land cover of the U.S., totaling about 770 million acres. A dominant use of rangelands in the US and around the world is livestock grazing. In Arizona, grasslands form the backbone of the ranching industry.

Grasslands in Arizona

Grasslands are plant communities where the vegetation is dominated by perennial grass species. In the US, the terms grassland and prairie are used interchangeably. Grasslands occur in Arizona between the deserts at lower elevations and woodland /forest at higher elevations. Grasslands adjacent to the four deserts in Arizona (Sonoran, Chihuahuan, Mohave, and Great Basin) contain floral elements of each, making distinctive and unique plant communities.

Desert grasslands occur at elevations higher than Sonoran, Chihuahuan, and Mohave Desert shrub lands in southern and western Arizona where average annual precipitation is above 300 mm (12 in). Desert grasslands also occur in Northern Arizona above the cold desert of the Colorado Plateau. They occur at higher elevations than in the southern part of the state, more northerly latitudes, and where average annual precipitation is above 150 mm (6 in).

Plains grasslands occur throughout the state at elevations above desert grasslands. These grasslands resemble the short and mid-grass plant communities of the Great Plains but have a greater affinity to Madrean plant communities in Arizona and Mexico.

Northern Arizona grasslands contain both warm and cool season perennial grasses while those in Southern Arizona are dominated by warm season perennial grasses. The warm season photosynthetic pathway (C4) results in higher rates of

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Figure 3. Loamy uplands, plains grasslands, native grasses. Elgin, AZ. Figure 4. Sandy uplands, Colorado Plateau. *Eriocoma hymenoides* and *Penstemon ambiguous*. *Photo credits: Dan Robinett.*

Grasslands and Rangeland Management in Arizona *continued*

photosynthesis and greater water use efficiency at higher temperatures than the cool season photosynthetic pathway (C3) (McClaran and Van Devender 1995).

Unique grasslands occur throughout the state, some considered quite rare in North America. One example is riparian floodplains of big sacaton (*Sporobolus wrightii*) (Figure 1). These plant communities are nourished by shallow water tables and water received as runoff from adjacent watersheds. They have almost complete soil cover of grass canopy and litter. Aboveground annual production ranges from 2,000–4,000 kilograms per hectare (air dry). Sacaton roots can reach depths of 7 meters in loamy textured soils and individual plants can live to 100 years.

Grasses and Grazing

Grasslands provide food and cover for a wide variety of animals and habitat for other plants. Grasslands protect soils from erosion by wind and water, reduce evaporation of soil moisture, and enrich soil horizons with organic matter.

Like all living things, perennial grasses have lifespans, some are short (2–3 years), others can be quite long. In one study on the Santa Rita Experimental Range (SRER), Arizona cottontop (*Digitaria californica*) (Figure 5) plants had an average annual lifespan of seven years, and a maximum age over 30 years. Black grama (*Bouteloua eriopoda*) (Figure 6) plants on the SRER had a maximum age of 14 years (McClaran and Van Devender 1995). If a grass species cannot reproduce in a plant community for whatever reasons it will soon be lost at some scale on the landscape.

Grass species in Arizona evolved under a variety of impacts including drought, fire, and grazing by herbivores ranging in size from wooly mammoth to termites. A megafauna of herbivores existed throughout the Pleistocene in Arizona, waxing and waning with glacial and interglacial periods over the past two million years (Betancourt et al. 1990). Many grass species present today were shaped by the grazing pressure of these animals. Perennial grass species have special morphological and physiological characteristics making them well-adapted to partial defoliation by grazing animals. Grass shoots (tillers) begin growth in the spring and summer from axillary buds produced at ground level around the root crown of the plant. The axillary bud (growing point) is a

Figure 5–6. Arizona cottontop (*Digitaria californica*). Black grama (*Bouteloua eriopoda*). *Photo credits: Max Licher.*

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Figure 7. Vine mesquite (*Hopia obtusa*). Figure 8. Bush muhly (*Muhlenbergia porteri*). Figure 9. Black grama (*Bouteloua eriopoda*). *Photo credits: Max Licher.*

Grasslands and Rangeland Management in Arizona *continued*

secondary meristem (area of cell division and growth) that can produce new shoots, roots, rhizomes, and stolons. The growing points remain at ground level until the new shoot reaches some level of maturity and produces an inflorescence (flowers). The removal of shoot tissue (by grazing or clipping) before the shoot elevates does not remove the growing point and the shoot can continue to grow. However, close grazing after flowering can remove most of the growing points and the shoot may not recover (McClaran and Van Devender 1995).

Some grasses protect their growing points completely. Vine mesquite (*Hopia obtusa*) (Figure 7) is a good example. Vine mesquite's root crowns, basal buds and growing points are entirely below ground. Vine mesquite produces an extensive system of rhizomes below ground and stolons above ground which store water and energy for plant growth and spread to form new plants. Vine mesquite is well-adapted to swales and alluvial fans where sedimentation and erosion occur that could either cover up or expose the root crowns of less well-adapted grass species.

Arizona grasslands in the Holocene (previous 10,000 years) evolved in the absence of large numbers of large grazing animals. Instead, small numbers of mid-size herbivores like deer, pronghorn, and elk occurred. Some desert grassland species like bush muhly (*Muhlenbergia porteri*) (Figure 8) and black grama (*Bouteloua eriopoda*) (Figure 9) are suffrutescent (shrub-like) in growth form. The stems of these species are perennial, growing points form aboveground, and stolons (shoots that bend over and root at the nodes) are important for reproduction. Close grazing and fire can remove growing points and stolons and negatively affect the reproduction, cover, and productivity of these two species. Due to their unique character, desert grasslands especially present challenges for rangeland management.

History of the Use of Grasslands in Arizona

Human occupation of the land over the past 20,000 plus years has had an impact upon Arizona grasslands. Humans and a warming climate at the end of the Pleistocene interacted to cause the extinction of native species of horse, ass, antelope, camelids, mammoth, and sloth. In the past ten thousand years these large animals no longer occur in the fossil record of Arizona (Betancourt et al. 1990).

For Native Americans, grasslands in Arizona provided game animals from grasshoppers and cotton rats to deer, elk. and pronghorn. Seeds, shoots, and roots of plant species in the grasslands provided food, medicine, dyes, clothing. and building materials important to Native Americans. Native people also used fire to hunt and enhance habitat for game animals and food plants (Bahre 1991).

European peoples first came to Arizona in the late 1600s and found un-grazed grasslands and sparse populations of native people. The first were Spanish explorers like Father Kino who saw the possibilities of the new territory. He and others brought old-world plants and animals like cattle, sheep, and horses to graze the abundant forage. Later came Mexican families who learned the husbandry of livestock in northern Mexico and brought herds with them into the Arizona territory. Native Americans resisted the newcomers, and it was not until after the Gadsden Purchase (1854) and the Civil War in the United States that large-scale settlement by European people began in earnest. Homesteading accelerated and people accustomed to the more humid climates of eastern and southern states brought an old-world mentality of agriculture and grazing into an arid environment. The results were not good. Livestock numbers increased quickly and soon the grasslands were degraded and

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soils eroded (Bahre 1991, Turner et al. 2003). Drought in the late 1880s caused the death of over half of the livestock on the land. By 1900, large areas of public domain in the Southwest had been negatively affected. Government representatives of the Public Land Office realized that actions were needed to prevent the tragedy of the commons. Anyone could put livestock on the public domain, and no one had responsibility for the care of the land. The US Forest Service (USFS) began in 1905 to manage wood-cutting and overgrazing on the newly formed Forest Reserves. Severe drought in the early 1920s and the collapse of beef markets after WW1 led to further deterioration of the rangelands (Bahre 1991, Turner et al. 2003).

The dust bowl drought of the 1930s brought about the creation of agencies such as the US Grazing Service, later to become the Bureau of Land Management (BLM), and the Soil Conservation Service, later to become the Natural Resources Conservation Service (NRCS). Severe drought in the 1950s continued the decline in condition of rangelands in the southwest. With newly enacted environmental legislation in the 1960s and 70s, federal land management agencies were forced to evaluate grazing as a land use on public lands. During and after this period, livestock numbers were reduced, grazing systems put in place, and vegetation monitoring implemented to refine grazing management.

The Development of a New Profession, Rangeland Management

A new professional field took shape, rangeland science. Land Grant Universities in western and mid-western states began to offer programs to train rangeland managers in the art and science of managing rangelands to produce livestock. Rangeland science evolved in modern times to recognize and embrace change over time and at different scales. The theory of rangeland science is still evolving as more and more information is gleaned from basic research, rangeland vegetation monitoring, and studies of change (climate, ecosystem) over time (Sayre 2017).

The 20,000-hectare Santa Rita Experimental Range, south of Tucson in the Santa Cruz River Valley, was established in 1903 and was the first of its kind in the United States. It was administered by the USFS until 1987, since then by the University of Arizona, which is charged with rangeland research designed to restore and conserve grassland resources used for livestock production. The SRER is the longest continuously active rangeland research facility and among the five oldest biological field stations in the US. (McClaran and Van Devender 1995, McClaran 2003).

Research facilities like SRER and the USDA ARS (Agricultural Research Service) Southwest Watershed Research Center in Tucson have contributed greatly to our understanding of the function, use, and management of rangelands in the arid southwest. Rangeland managers work for federal and state agencies, Native American Tribes, on private ranches, and for other landowners. The Society for Range Management represents this group of professionals in rangeland science, use, and management (McClaran 2001 and 2003, Sayre 2017).

Modern Day Management of Grasslands in Arizona

The most important tool in rangeland management is stocking rate, the number of animals placed on the land in a given year. Precipitation varies from year to year, resulting in considerable differences in forage production on an annual basis. Flexibility in stocking rates is critical to match the available forage to animal numbers in any given year. Grazing systems are currently employed on most ranches. Livestock are grazed in a rotation through several pastures in an annual cycle. In the best of these systems, grazing periods are brief and rest periods are long. Resting pastures during the growing seasons allows forage species to recover and reproduce.

A system employing adaptive management works best in arid environments. Rangeland management specialists help ranchers monitor vegetation, precipitation, assess forage and water supplies, and plan grazing for the coming year (Figure 10). As the year progresses and seasons change, grazing plans are modified to better match plant growth, physiology, and forage production. Over time, grazing systems evolve to meet the needs of the ranch operation and the land management agencies involved.

Many challenges face users and managers of Arizona rangelands/grasslands in the future. Increasing temperature results in increased evaporation and transpiration from soils and plants. Shrubs continue to increase on grasslands for a variety of reasons all exacerbated by increasing temperatures. Studies using repeat photography and long-term vegetation monitoring show the extent of shrub encroachment on Arizona rangelands, especially desert grasslands (McClaran 2003, Turner et al. 2003). Over the past 25 years of drought in Arizona, the amount of cool season (October–March) moisture has declined and the variability of cool season moisture has increased. Recent research by ARS and studies by BLM and The Nature Conservancy on the Empire Ranch, showed that in years when cool season moisture was less than two inches, perennial grass mortality was significant. In years like 2006 and 2011, when only an inch or

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Figure 10. Vegetation monitoring, Empire Ranch, Key Area #3, Las Cienegas NCA. *Photo credit: Dan Robinett.* Figure 11. Lehmann lovegrass (*Eragrostis lehmanniana*). *Photo credit: Max Licher.*

Grasslands and Rangeland Management in Arizona *continued*

less of cool season moisture was received, between 50% and 90% of the perennial grass basal cover died (Hamerlynck et al. 2013, Bodner and Robles 2017). In years where cool season precipitation is very low, perennial grasses run out of moisture and die in May–June before the onset of the summer monsoon. Increasing temperatures allow grasses to use soil moisture longer into the fall and allow grass plants to green up earlier in the spring, further reducing the availability of cool season moisture for use by perennial grasses in late spring–early summer.

Urban development of open spaces continues unabated and fragments habitat for wildlife, results in increased wildfire, introduction and spread of invasive plants, and depletion of water supplies. As human populations in the region grow, increased recreation on public rangelands places additional pressure on the soil, and plant, and animal resources. Non-native plant species like Lehmann lovegrass (*Eragrostis lehmanniana*) (Figure 11) continue to increase at the expense of native grasses and forbs on both grazed and un-grazed rangelands in Arizona.

Summary

Grasslands in Arizona are an incredible natural resource. Their native plant and animal diversity is amazing. The challenge in the future will be for all of us to adapt to a rapidly changing environment and help the people and agencies who use and manage rangelands be successful in conserving these resources for future generations.

Resources

UA CALS, Rangelands West, **https://rangelandsgateway.org/collections/rangelands-west**

Society for Range Management, **http://www.rangelands.org**

Santa Rita Experimental Range, **https://cals.arizona.edu/srer/.**

Southwest Watershed Research Center USDA ARS, **https://www.ars.usda.gov/pacific-west-area/tucson-az/southwest-watershed-research-center/**

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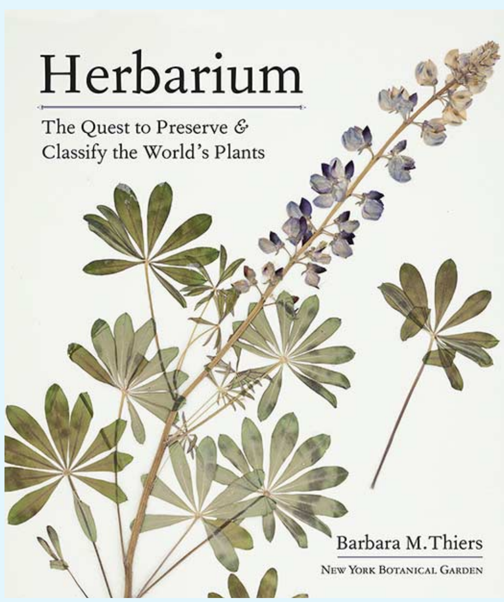
Preparing herbarium specimens, from left: Specimen being prepared for press. Specimen mounting view from above.

BOOK REVIEW *Douglas Ripley, Arizona Native Plant Society, Cochise Chapter*

Herbarium: The Quest to Preserve & Classify the World's Plants by Barbara M. Thiers

2020. 279 pp. ISBN 978-1-604469-930-2. Available from Amazon.com ($23.50).

Most professional botanists and many amateur native plant enthusiasts have used an herbarium at some point in their lives. Some dedicated souls wind up spending half of their lives in those venerable and useful scientific plant repositorties. That is because the herbarium is an invaluable resource for the permanent storage and curation of scientific plant specimens. As such it is a priceless place to conduct research in support of all manner of biological studies or to serve as a safe repository for specimens from scientific field work.



I think it is safe to say that most people are not aware of the long and storied history of herbaria, the locations and features of the major herbaria in the world, or even how they operate and maintain the integrity of their holdings. Fortunately for those who wish to know more about all things relating to herbaria, as well as a good deal about general botanical history, there is the recently published *Herbarium: The Quest to Preserve & Classify the World's Plants* by Barbara Thiers that fills those needs wonderfully in a meticulously researched and beautifully illustrated book. As the long-time director of the William and Lynda Steere Herbarium at the New York Botanical Garden, one of the three largest herbaria in the world, Thiers is uniquely qualified to document the history, importance, and operations of herbaria throughout the world.

Tracing the origin of the first herbarium to the 16th century Italian physician Luca Ghini, Thiers presents a fascinating account of the establishment of subsequent herbaria through the age of botanical exploration and then to developments in the United States and eventually throughout the world. In each section, Thiers presents a description of the important botanical personalities and their accomplishments, all illustrated with beautiful images of relevant plants, places, or portraits of individuals.

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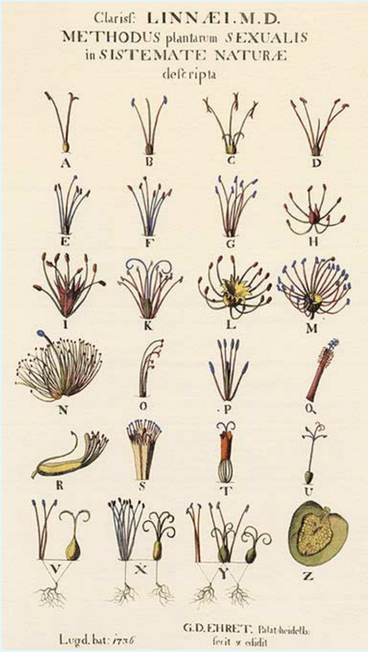

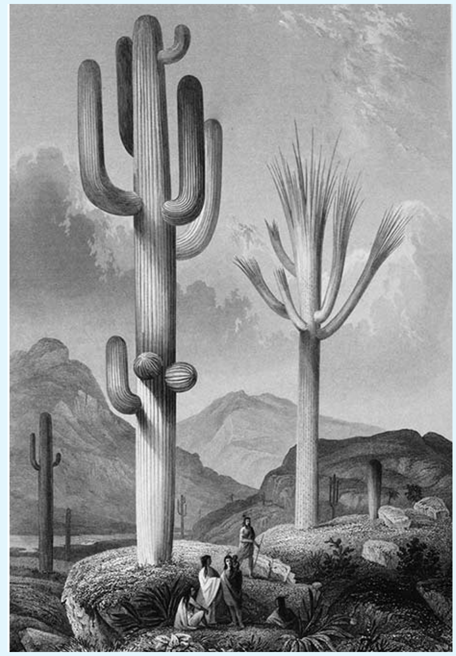

Left: George Dionysius Ehret's illustration of Linnaeus' sexual system of plant classification. This diagram appeared in the first edition of *Systema Naturae* (1735); the original watercolor is held in London's Natural History Museum.

Center: Drawing of *Mutisia dem*atis (Asteraceae) by Salvador Rizo. Genus named in honor of the Spanish botanical explorer José Celestino Mutis (1732-1808).

Right: "View along the Gila" by Paulus Roetter, from George Engelmann's *Cactaceae of the Boundary* (1859).

Below: *Lewisia rediviva* (Montiaceae) from Curtis's Botanical Magazine (1863). Genus named for Meriwether Lewis who collected the plant during the Corps of Discovery 1806 at Lolo Creek, in the mountain range that became known as the Bitterroot Mountains.

BOOK REVIEW **Herbarium: The Quest to Preserve & Classify the World's Plants**

continued

The book concludes with a discussion of the future of herbaria that includes an impressive review of the many new contributions to science that herbaria are making now and additional contributions they will be able to provide in the future. These include using herbarium specimens for the analysis of gene sequences, pollution detection, and remediation through analysis of heavy metals deposits, documenting past atmospheric conditions, predicting changes in biodiversity, ecological niche modeling, providing a history of phenology, and analysis of invasive species distributions.

In summary, this book is a remarkable and beautifully illustrated accomplishment that will appeal to any native plant enthusiast wishing to learn more about the history of botanical exploration, the efforts taken to conserve the plant collecting records since the 15th Century, and what the future holds for herbaria throughout the world

How to Spend a Nice Quiet Evening with *Scleropogon*[1]

by Kelly W. Allred[1] *All photos are by the author except those credited otherwise.*

You can hear them sometimes, usually on a quiet, warm night under a full moon in October, well after the rains. They skitter across the baked clay of the playa, only if the wind is soft, a breath of a breeze really. Anything stronger sends them tumbling roly-poly, head-over-heels. Shh, listen: tchka-tchka-tchka-tchka, their spindly spider legs scratching along but barely touching the soil, their spear-heads poised to catch and drive deep. Later, you find them all lined up in the cracks and fissures, seeds planted deep, awns shriveled and decaying. Later still, every 20th one or so sends up a leaf and sends out an exploring stolon, colonizing the playa, holding the soil, readying for next season's adventure.

Inset: Figure 1. Rodolfo Amando Phillipi. *Wikipedia Commons.*

Scleropogon brevifolius Phillipi[2] is a walking (skittering?) lesson in the botany of grasses, providing ample material for the novice and expert alike. Let's start with the name: *Sclero-pogon* means "hard beard" in Greek, referring to the hard seed case beset with stiff hairs at the pointed end; *brevi-folius* means short-leaved, which they are; and Phillipi is the person who coined this interesting name in 1870 [Rodolfo Amando Phillipi (1808–1904), a German-Chilean paleontologist-zoologist-botanist] for these plants growing in the region of Mendoza, Argentina. These grasses obviously also grow in North America, in the southwestern deserts from Texas and Oklahoma to California and Nevada. Mendoza is at approximately 33° south latitude, and the North American plants grow in similar habitats at 33° north latitude. Botanists refer to this as an amphitropical disjunction, growing on both sides of the tropics, but not between. In fact, there is an entire cadre of desert plants with this distribution. If we were to pick you up from your home in the north horse latitudes, and magically plop you down in the deserts of the south horse latitudes, you would be right at home, knowing most of the genera of grasses you see and many of the species: *Bouteloua aristidoides*, *Bromus catharticus*, *Trichloris crinita*, *Cottea pappophoroides*, *Enneapogon desvauxii*, *Leptochloa dubia*, *Muhlenbergia asperifolia*, *Muhlenbergia torreyi*, *Panicum hirticaule*, *Schedonnardus paniculatus*, *Scleropogon brevifolius*, *Nasella tenuissima*, and *Trachypogon secundus* all find themselves on both sides of the tropics. The grass genus *Bothriochloa* (Greek, pitted-grass, alluding to the little hole or pit in the lower glume of many species) is especially rich in New World amphitropical disjuncts, with at least eight species displaying an amphitropical distribution.

Scleropogon brevifolius also provides a primer in evolutionary modification: reduction of reproductive organs and elaboration of accessory structures. Your typical flower parts, sepals and petals, are almost completely gone in most grasses and hardly seen. Each flower, typically composed of *stamens* and *pistil*, is protected by a pair of modified leaves, termed *lemma* and *palea*, and these alternate up the sides of the short flowering stem. *Scleropogon* takes reduction a step further, eliminating stamens in one set of flowers, and pistils in another set. The result is easily seen in the flower clusters (termed *spikelets*): female spikelets have long, bristly *awns*, and male spikelets lack these awns.

The awns of the female spikelets are outgrowths of the veins of the lemma, the modified leaf structure enclosing the pistil. As the spikelet matures and dries, the awns bend outward and downward and stiffen. At full maturity, the spikelet is released from the plant and blown about on the soil surface, the awns holding the seed case more-or-less upright at just the right angle for its spear-point base to catch in the drying cracks.

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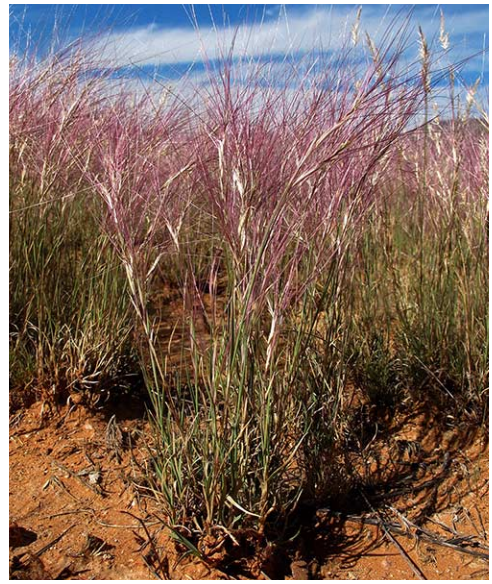
[1]I happily acknowledge Edgar Anderson's (1897–1969) delightful essay, "How to Spend a Nice Quiet Evening with a Potato" [*Missouri Botanical Garden Bulletin* 43: 50-53. 1955.] for inspiring my title.

[2]I am eschewing our over-reliance on so-called "common names." It's time we stop lying to ourselves, saying the Latin/Greek names are too strange, too unpronounceable, or too hard to remember. Ask any group of seven-year-olds about *Tyrannosaurus rex* or any of a host of other dinosaur names; they'll not only remember them and pronounce them correctly, they'll most likely be able to spell them all, too. *Rosa, Yucca, Iris, Chrysanthemum, Amaranthus, Ambrosia, Cosmos, Stevia, Zinnia, Nasturtium, Dalea, Lotus, Mimosa, Geranium, Hibiscus, Penstemon, Veronica,* and *Phlox* are all part of our every-day conversations. If you're self-conscious about pronunciation, just say every letter; you'll be close enough.



Above: Figure 2. *Scleropogon brevifolius* community, Chihuahuan Desert.
Right: Figure 3. *Scleropogon brevifolius,* female plants. *Photo credit: Frankie Coburn.*

How to Spend a Nice Quiet Evening with *Scleropogon* *continued*

This base has a hard point with stiff, upward-pointing hairs. The seed is easily pushed into the soil crack, and the hairs prevent it from being extracted as it wiggles back-and-forth from little puffs of wind, driving the seed deeper into the ground.

This same suite of features for enhancing propagation by seed can be seen in other grasses, notably species of *Aristida*. In *Aristida*, each seed is protected by a seed case with three awns. When the seed case is released at maturity, they are blown about by the wind and eventually find a landing spot on a plot of bare ground. No matter which way the seed case lands, the awns hold the case with its base touching the soil, much like a three-legged stool always being steady. This promotes implantation of the seed into a soil crevice, and also enhances water uptake by the seed and rapid penetration of the embryonic root into the soil. Indeed, studies have shown that when the three awns are excised from the seed case, germination of the seed and eventual establishment of the seedling decreases markedly.

Let's return to the topic of footnote 2, so-called common names. I say so-called, because the English names we see listed as "common names" are often anything but common, and many of them are obviously contrived to fit some sort of

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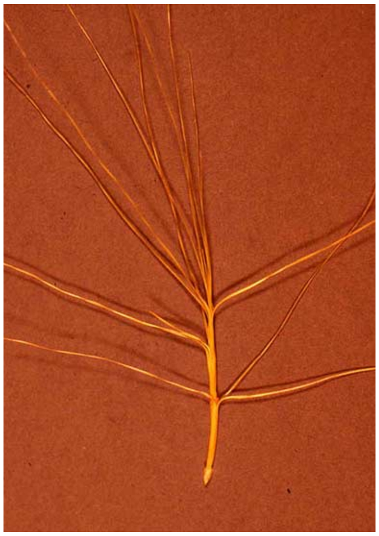
Figure 4. *Scleropogon brevifolius,* female plants. *Photo credit: Frankie Coburn.*

Figure 5. *Scleropogon brevifolius,* awnless male spikelets. *Photo credit: Russ Kleinman.*



Left: Figure 6. *Scleropogon brevifolius*, awned female spikelet.

Above: Figure 7. *Scleropogon brevifolius*, female spikelets. *Photo credit: Patrick Alexander.*

Right: Figure 8. *Scleropogon brevifolius* spikelets embedded in cracks. *Photo credit: Patrick Alexander.*

How to Spend a Nice Quiet Evening with *Scleropogon* *continued*

preconceived system. This is what usually happens: someone (typically an over-zealous proponent of "standardized common names" because scientific names are too difficult) decides that some genus (let's say *Muhlenbergia*) should all be called "muhly" or "muhly-grass." Then they decide that all species of *Muhlenbergia* should be some sort of "muhly," and proceed to make up names to fit their system. (Does this sound familiar? Think binomial nomenclature!) They do this by "translating" (as they suppose) the scientific name and adding that to the word muhly. Thus, we have Andean muhly (*M. andina*), sand muhly (*M. arenacea*), rough-leaved muhly (*M. asperifolia*), Bush's muhly (*M. bushii*), Emersley's muhly (*M. emersleyi*), filiform muhly (*M. filiformis* — that's a big improvement!), few-flowered muhly (*M. pauciflora*), Porter's muhly (*M. porteri*), smelly muhly (*M. pungens*), and Schreber's muhly (*M. schreberi*). Never mind that each one of these already has a perfectly good, and commonly used, English name: in the same order — foxtail grass, ear muhly, scratchgrass, nodding muhly, bull-grass, pull-up muhly, New Mexico muhly, bush muhly, blowout grass, and nimble-will. Even worse, their "translations" are often misconstrued. Thinking *pungens* has something to do with odor (as in a pungent odor), they come up with "smelly muhly." In fact, *pungens* comes from the verb to puncture, referring to the sharp-tipped leaves; it has nothing to do with smell. We find a similar linguistic error in the common name of another grass, *Hordeum murinum*, a little spring annual from Eurasia. Thinking *murinum* comes from *murus*, a wall, standardized name propogandists have dubbed it wall barley. But, *murinum*

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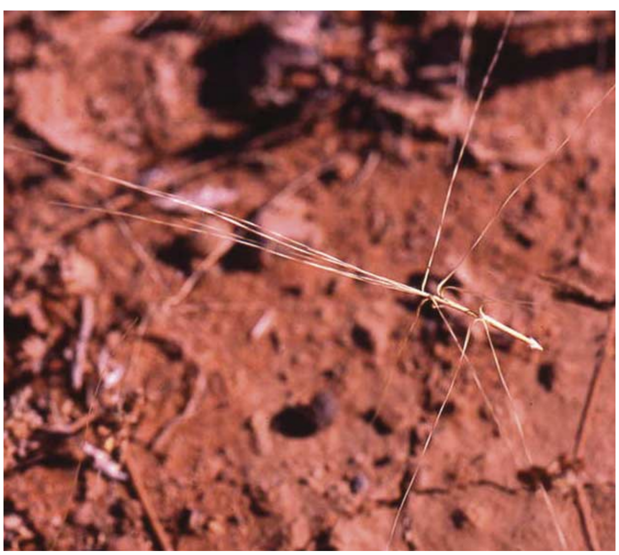


Figure 9. *Scleropogon brevifolius*, female spikelet.

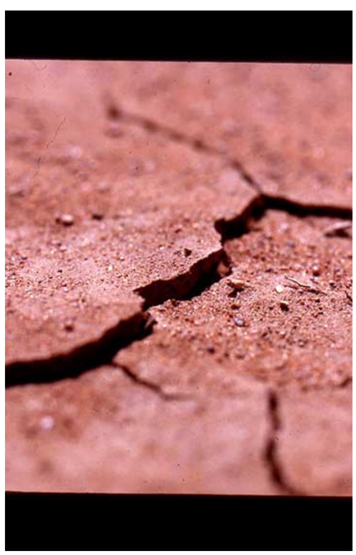


Figure 10. Clay fissure.

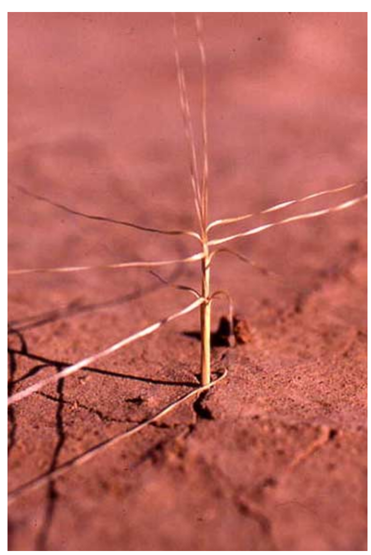


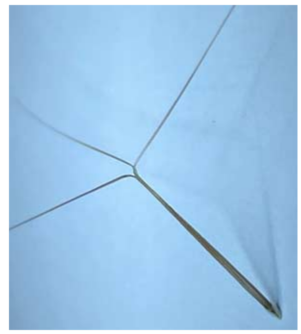
Figure 11. *Scleropogon brevifolius* spikelet embedded in clay fissure.

How to Spend a Nice Quiet Evening with *Scleropogon* continued

derives from *murinus*, meaning mouse-like, and a much-better common name would be mouse barley. We could go on and on…

That said, the common name for *Scleropogon brevifolius* — burrograss — is both commonly used and naturally derived, and I welcome it wholeheartedly. Nevertheless, it has not been without controversy. At the turn of the 20th century, burrograss was called needlegrass, along with numerous species of *Aristida* and *Achnatherum*. Indeed, our bush muhly was then called mesquite grass, along with sideoats grama and vine mesquite, our bristlegrass was called foxtail, foxtail was called squirreltail, alkali sacaton was called saltgrass, saltgrass was called alkaligrass, tobosagrass was called black grama, black grama was called wooleyfoot, blue grama was called white grama, western wheatgrass was called bluestem, and bluestem was called sage grass.

The next time you're out on a desert playa, under a full moon, with only a gentle breeze wafting across the plain, listen carefully for the scritch-scratch of *Scleropogon brevifolius* skittering across the clay. But, look closely, too. You'll likely find a look-alike grass intermingled with it, *Muhlenbergia arenacea*, also known as ear-grass. Now, there's a story…



From left: Figure 12. *Scleropogon brevifolius* offsets from stolons. Figure 13. *Aristida purpurea*, with awns raising base of floret at angle to enhance germination. Figure 14. *Aristida purpurea*, with awns excised and floret lying flat.

Resources

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Grasses: An Ecological Perspective *by Elizabeth Makings*[1]

Figure 1. Sorghum (*Sorghum bicolor*). *Photo credit: Sue Carnahan.* Figure 2. Barley (*Hordeum vulgare*). *Wikipedia Commons.*

A special issue of the journal *Science* came out in August 2022 entitled "GRASS — Essential and overlooked biomes." Several papers are presented including (Archibald, et al. 2022) and (McSteen and Kellogg 2022), a brief introduction on the "Unrecognized value of grass" and a reminder of how fast we are losing them. It comes with a plea to overcome our grass blindness and catalogs the many reasons why grasses and grasslands are important. If you don't know the facts, allow me … grassy ecosystems are the principal component of at least 20% of the earth's vegetative cover and grasses are among the top four plant families in terms of species diversity. Grasses (Family Poaceae) are the only family of plants distributed on every continent — yes, even Antarctica. Grasslands store carbon, generate oxygen, stabilize soil, and provide habitat for wildlife, all of these on a scale unparalleled in any other biome. Oh yeah, and they are pretty important to humans, too. Domestic grasses including rice, wheat, and corn, provide most of our calories. They are fodder and forage for our animals, building materials for our houses, biofuels for our cars, turf for our playgrounds, ornamental beauties, *and* proof that God loves us — the source of our most globally important alcoholic beverages.

The grass grain is a miracle. From rice comes sake; rum is fermented sugar cane (I know, it's not from the grain smarty pants, I was just seeing if you were paying attention); corn alcohol comes in many forms including bourbon and chicha, *Sorghum* (Figure 1) is used to make a number of distilled liquors, rye can be made into whiskey, and then… <dramatic pause, punctuated by the suspenseful three notes sequence, dun dun duuun!>… there's barley. The genus *Hordeum* (Figure 2) is one of the first plants to be cultivated in the Fertile Crescent and remains of barley have been found from as much as 11,000 years ago in modern day Turkey, Iraq, and Iran. Barley grains are typically toasted first to add flavor, then ground into flour when making breads, but above all, they are the main ingredient in beer and whisky. Beer consists of fermented barley grains and whisky is made from fermented and distilled barley grains. In whisky, the germination of the grain (malting) is halted with heat and smoke, then the distilled product is aged in oak — giving us smokey-oaky whisky. I'm not a big fan, but I do home brew and it's a lot of fun. There's nothing like enjoying your own beer. It really does taste better.

Sorry, I got distracted there thinking about my next recipe. I'm supposed to talk about the ecology of grasses, but I'm finding it impossible not to nerd out on my way there. Go ahead, pick a topic. Grasses do not disappoint. They are a well-studied group and there are a lot of smart people working on them. Naturally. They are incredibly interesting organisms, and it is serves us to advance the science of their genomes, anatomy, evolutionary history, and agricultural potential. There are so many fun facts to annoy your friends with at your next dinner party.

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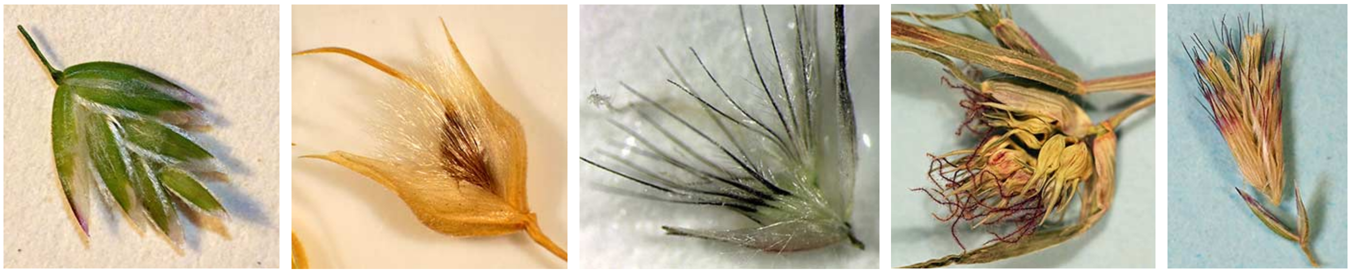

Figure 3a. Bigelow's Bluegrass (*Poa bigelovii*). Figure 3b. Indian Rye Grass (*Eriocoma hymenoides*). Figure 3c. Soft Feather Pappus Grass (*Enneapogon cenchroides*). Figure 3d. Buffalo Grass (*Bouteloua dactyloides*). Figure 3e. Cotta Grass (*Cottea pappophoroides*). *All photos courtesy the author.*

Grasses: An Ecological Perspective *continued*

Grasses are an evolutionary success story, demonstrated by their dominance over large areas of the world and in every ecological niche. But how did they become the world's most successful angiosperms? What are their tricks? Answer: they do it all, and they do it well. Grasses have advantages when it comes to dispersal and establishment, are highly competitive, and have successfully adapted to every type of environment.

Grass anatomy? Holy cow! Grass anatomy and morphology are evolutionary marvels with key innovations in many structures. The reproductive unit is the spikelet, a sort of botanical shorthand where simple bracts have replaced showy calyces and corollas. And while the basic arrangement of this tiny inflorescence remains consistent, there are a mind-blowing number of ways the grasses have modified those bracts. For the most part, the *spikelet,* not the seed, is the dispersal unit so the spikelet is the star of the show employing all manner of awns, hairs, bristles, burs, spikes, teeth, and Velcro to help with dispersal. Some even inflate themselves to "float" over large, windblown areas (Figures 3a–3e).

There are several important traits that contribute to their establishment success. First, many grasses have a short generation time. They germinate, mature, make seeds, disperse, and die, all within a year. Short life cycles increase the possibility of a rapid response to a spatial or temporal opportunity. Translation: grasses are agile. While a saguaro may take 50–100 years to even be reproductive, grass traits can be selected for over short periods of time. Drought-tolerant individuals survive in drought-prone landscapes. Duh. And of course, people noticed grasses were special and we selected for those traits that served us, such as more starch content, seed heads that don't shatter, short wheat, tall corn, larger ears, six row barley, etc. And we now know their lofty status among plants has to do with their genetics. Plants with multiple compliments of chromosomes (polyploids) are not only more easily manipulated agriculturally, but ecologically more successful if new niches become available.

So, let's talk genomes: A duplication event which occurred in the grass common ancestor about 90 million years ago is among the many pieces of molecular evidence supporting the monophyly (a group of taxa composed only of a common ancestor and all of its lineal descendants) of grasses. But they are far from uniform. Polyploidy has figured prominently in grass evolution and approximately 80% of grasses have this condition (compared to 50–70 % in the rest of the angiosperms) (Cheng et al. 2022). Common Bermuda grass (*Cynodon dactylon*) (Figure 4), for example, has ploidy levels ranging from diploid to hexaploid throughout its range. The grass family has species with some of the smallest genomes. *Zingeria biebersteiniana* (Figure 5) is one of only five angiosperms known with two chromosomes (2n=4); and some of the largest genomes. Common or bread wheat (*Triticum aestivum*) (Figure 6) has about 16 Gb base pairs, or five times as many as humans. One Gb = 1,000,000,000 pairs of those remarkable little A, T, C, and G nucleotides bases that make up the backbone of the DNA molecule. Indeed, the wheat tribe (the Triticeae) continues to be an excellent model for studying polyploid evolution due to its ridiculously large genome and high ploidy level. Interdisciplinary research involving the increasingly accessible grass genomes has the potential to move us toward food security (Paterson et al. 2009).

The grass embryo is another remarkable innovation, and unique in the Plant Kingdom. Within the seed, the embryo is already differentiated into primary root, shoots and leaves — giving it a head start when it germinates by reducing the time to establishment.

The physiological adaptations of grasses are just as impressive. Though grasses evolved in frost-free tropical environments, they have acquired frost tolerance several times in multiple clades, opening up vast regions to colonize. Grasses have continuously shifted their photosynthetic pathway from C3 to C4 allowing them to be highly productive over a wide climatic range. C3 photosynthesis is generally associated with cool growing seasons

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Grasses: An Ecological Perspective *continued*

Figure 4. Bermuda Grass (*Cynodon dactylon*). *Photo credit: Max Licher*. Figure 5. *Zingeria biebersteiniana. Wikipedia Commons.* Figure 6. Bread Wheat (*Triticum aestivum*). *Wikipedia Commons.*

and wetter conditions (thus temperate climates and shady tropical forests), and C4 with hot, and often arid, growing seasons, like, lucky for us, Arizona.

Grasses have flexible growth forms and amazing phenotypic plasticity including the ability to alter culm height, structure, branching, and rooting characteristics. Grasses can make above-ground stems (stolons), below-ground stems (rhizomes), and clonal offshoots (tillers) from each node. Grasses grow in a complete range of soil environments from standing water to sand, and importantly, grasses tend to concentrate their roots in the top few centimeters of soil, which makes them effective at intercepting incoming water and highly effective at competing for resources. They have multiple locations for meristematic tissue allowing them to survive continuous defoliation, and disturbance such as grazing and fire. Indeed, grasses are well adapted to grazing with their ability to elongate from the base (crown) and their immense below-ground reserves.

You may have heard the phrase "grasses carry fire?" True. Their seasonality, architecture and leaf chemistry are especially important here. Grasses are high in volatile oils and resins that readily ignite, and the fine leaves, density of the leaves, low-to-the-ground habit, and dormancy cycles allow them to carry fire very efficiently. Fire is a frequent occurrence in grasslands and even when above-ground biomass is burned, grasses grow back quickly due to their underground stores. A case in point that gave me a great appreciation for this phenomenon was the Monument Fire, which swept through grasslands in the eastern foothills of the Huachuca Mountains in June of 2011. I was doing field work in the burned area in August and the grasses were already waist high. I would have been skeptical if someone had told me there had been fire just two months earlier had it not been for the charred crowns of the vegetation. But the grasses loved it. Grasslands need fire. They respond quickly and thrive while woody vegetation is less tolerant and struggles to survive with frequent fire intervals.

<Somber, pensive music> Alas, because they are one of the earth's most productive ecosystems, grasslands have been exploited by humans for millennia. Indeed, they are so important to humans their regional names imprint a specific designation to entire biotic provinces. The Eurasian "steppe," the Hungarian "puszta," the "pampas" of Argentina, the "campos" of Uruguay, the Mexican "pastizales," and the South African "veldt" all refer to vegetation types in which grasses are dominant. Their tremendous overuse has led to changes and great loss of much of this biome. For example, 99% of our pre-settlement North American tall grass prairie has been lost due to agriculture, urbanization, fragmentation, lack of fire, domestic livestock, non-native species, and other offenses. Additionally, marginally suitable grasslands with poor soils, wetlands, and drought-prone climates continue to be converted for short-term profitability. Grasslands receive less attention than forested ecosystems but are in most need of our protection. And even as we observe the frightening climatic trajectory, with the earth seemingly giving us an eviction notice, the science says we still have time. Policy makers, institutions, and individuals must take this short window of opportunity and prioritize the conservation of natural ecosystems, and grassland protection is one of the most important actions we can take to secure the well-being of our planet.

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Figure 1. University of Arizona Biosciences Research Laboratory, SE corner of Cherry Ave and Mabel Street *(planting design by Wheat Design Group, 2016)*. This project used 200 grasses, predominately the non-native *Muhlenbergia lindheimeri*, in areas that receive building runoff. The non-native *Muhlenbergia capillaris* 'Regal Mist' and the native *Muhlenbergia dumosa* are also used within the project.

Big Farma — How did THAT grass end up here?

by Jennifer Patton[1] and Ben Wilder[2] *Photos courtesy the authors.*

Have you ever wondered who was responsible for the plant selection in the Home Depot parking lot or at your favorite Starbucks? How about at the new Bioscience building on the UA Campus, or along the newly widened Grant Road between I-10 and Campbell? Planting plans for each of those projects were developed by a landscape architect, typically local, but sometimes from out of state. The American Society of Landscape Architects defines landscape architecture as, "the planning, design, management, and nurturing of the built and natural environments. Landscape architects plan and design parks, campuses, streetscapes, trails, plazas, residences, and other projects that strengthen communities." You will also hear the term "landscape designer." The roles and responsibilities are often similar, but a landscape architect has acquired the necessary years of experience and passed exams that confer registration. All local jurisdictions require planting plans to be sealed by a licensed landscape architect (Figure 1).

So a landscape architect (LA) must have a lot of plant knowledge, right? Interestingly, plant knowledge is not part of the registration exam in Arizona (licensure is conducted on a state-by-state basis). An individual can get registered in Arizona without showing any local plant knowledge (nor do they have to have local work experience). If one is lucky enough to go through the curriculum at the University of Arizona, you will have a semester class on plant materials (learning commonly used and locally available landscape plants, both native and non-native), a semester of landscape ecology, and one semester of planting design.

Landscape architects and designers rely heavily on plant information provided by the major nurseries that supply plants. The top two wholesale nurseries supplying southeastern Arizona are Civano (Tucson) and Mountain States (Phoenix). Both nurseries are active with the local society of landscape architects, sponsoring events, attending trade shows, and presenting at the annual horticultural conferences where they discuss new plant introductions, plants for shade, trees for tight spaces, etc. Plant giveaways and raffles at luncheons and conferences are a big draw.

The nurseries provide cut sheets for the plants that they sell, including photos, general plant attributes, and enticing descriptions. The *Muhlenbergia* x 'Pink Flamingo' is described as a "narrow, upright clump of thin blue-green leaves topped in the fall with dramatic arching plumes of soft pink flowers, reminiscent of headdresses worn by Vegas showgirls." The write up for *Muhlenbergia capillaris* Regal Mist'® states that this grass "can literally stop traffic during fall bloom"! How is a landscape architect to choose?

continued next page

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Big Farma — How did THAT grass end up here? *continued*

There is a reason that many ecologists and environmental enthusiasts have a very low opinion of landscape architects.

When does a landscape architect use grasses?

(Disclaimer: This article is about grasses, so we will focus on that from here forward, but the principles are the same for all plant species. There is no one way a landscape architect selects plants. Landscape architects have diverse interests and backgrounds. Many are focused foremost on design and aesthetics — how will planting bring a space together — what are the colors and textures that will make the space have an incredible wow factor? Other landscape architects have a more ecological bent and may be considering how plant material can aid in restoration, support pollinators, or benefit local wildlife.)

Grasses may be either container plants or seed. We will discuss seed first.

Seeding with grass

Grasses are used regularly in seed mixes for stabilization and erosion control; grass roots grow quickly and are great at holding soil in place. A careful designer will include annuals and perennial species, as well as cool season and warm season germinators. On large projects, there is no assurance of when the construction will occur, and schedules often change; the seed mix you thought was going to be applied in early October may actually end up being applied in May. A seed mix installed for erosion control may contain up to 50% grass species (shrubs, forbs, and wildflowers make up the remainder); more typically, grass species may constitute 20–30% of the mix (Figure 2).

All jurisdictions require ground cover for dust control and soil stabilization — any disturbed soil surface must be covered. This is typically either rock or seeding (normally hydroseed with mulch and a polymer binder). Seeding is used in areas that can be a bit more "wild"' and won't be treated with herbicide.

Seed species: some jurisdictions provide a list of species that you select from, other jurisdictions may have you conduct site releves, counting every species of plant within a certain area, and extrapolating to arrive at species diversity and density across the site. The goal is to develop a seed mix that mimics the existing plant palette. There are several challenges to this approach. Landscape architects are not celebrated for their plant ID skills, and grasses are notoriously tricky. The fastidious LA ends up at the Herbarium while George patiently IDs collected species (George Ferguson, Collections Manager, University of Arizona Herbarium). From that, a seed list is developed, which is then vetted against what species of seed can be obtained. Those

Figure 2. Hydroseeded mini-benched slope along the east side of the recently widened (2017) Oracle Road near the wildlife overpass. The ADOT landscape architect composes the seed mixes for all ADOT projects. Grass species in this seed mix included *Bouteloua curtipendula, Bouteloua rothrockii, Bouteloua gracilis, Hilaria berlangeri, Muhlenbergia porteri, Sporobolus airoides, and Sporobolus cryptandrus*. Numerous forb and shrub species were also included, such as *Plantago ovata*.

looking for a regional seed source rely on Wildlands Restoration in Tucson — Gary Maskarinec, owner of Wildlands Restoration, has helped us numerous times with species availability and appropriate quantities. However, the landscape architect typically has no control over the seed source. Often the contractor that installs the project has the ultimate selection, and project seed may be sourced from Granite Seed, one of the largest seed suppliers serving the southwest. At this point, there is no knowledge of where the seed that will be applied is grown, or whether the strain is appropriate for the site.

On residential projects where seeding may be used for restoration, considerations for grass seed selection includes the presence (or absence of) awns. People seem to hate it when their kids and dogs come in with fur and socks filled with needle gramma awns. I get calls wanting to know if that grass was intentionally put in the seed mix…And speaking of awns, we learned recently why they invented cowboy boots — solid leather and no laces means nothing to trap the awns. Try wearing your lightweight mesh hikers through a field of needle gramma and you will quickly know what I mean.

Container-grown Grasses

Common spaces where you will see grasses planted are: within detention basins that experience occasional inundation; in streetside water harvesting basins, traffic circles, and chicanes where they are valued for their ability to filter pollutants and aid in infiltration of stormwater; and in parks where their soft nature ensures they won't scratch or poke a playing child (Figure 3).

Selection of grass species often involves a review of the NRCS Soil Survey to see which species historically grew in the area; a

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Figure 3. This streetside chicane planted with native shrubs, trees, and grasses collects runoff during rain events. Grass species are emphasized as their roots are quick to establish, and they help to break up the soil, encouraging infiltration. Grasses also aid in the filtering of runoff. Grass species included in this planting are *Bouteloa gracilis, Bouteloa curtipendula,* and *Muhlenbergia emersleyi*. (Design: Tucson Clean and Beautiful. Construction: Desert Living. Maintenance: Neighbors)

Figure 4. Civano Growers sells tens of thousands of grasses every year. In recent years, Civano has reduced the number of plant species that they grow (from over 400 species to less than 80), focusing on species that people want, that are easy to grow, and that don't require a lot of maintenance. The three grass species that they currently grow (*Bouteloa gracilis 'Blonde Ambition' PP22048, Muhlenbergia capillaris, and Muhlenbergia rigens)* are shown at the Civano growing grounds, south of Tucson. The waiting semi-trucks may transport these grasses to Texas, southern California, Utah, Nevada, or New Mexico.

Big Farma — How did THAT grass end up here? *continued*

site visit can inform which plants are thriving and which aren't. And then the LA will look at the current availability lists from the plant nurseries (and for many LA's, that is where plant selection starts, because it does not matter what is on site if you cannot obtain it, in the numbers required, for the project).

These are the grasses you can get

Roughly speaking, there are 50 species of native perennial grass and 40 species of native annual grass in the Tucson area. Unfortunately, it is impossible to specify just any species of grass for a project—the LA is limited by what growers choose to grow and sell. The species growers choose to grow and sell are those that customers (designers and contractors) ask for. What do customers ask for? Grasses that make a dramatic statement, impress with their color and shape and will grow here. In other words, a very short list of species, nativity optional. For example, Civano Growers and Desert Trees Nursery, the two wholesale nurseries in southern Arizona, currently offer five species of grass between them: *Bouteloa gracilis* 'Blonde Ambition' PP22048, *Muhlenbergia capillaris, Muhlenbergia* x 'Pink Flamingo', *Muhlenbergia rigens*, and *Pennisetum setaceum* 'Rubrum' — respectively, a clone of a cultivar of a blue gramma plant originally from Santa Fe, a southeastern U.S. (Texas and eastern U.S.) native, a cloned hybrid of two non-native *Muhlenbergias*, our native deer grass, and the purple fountain grass, a species with the potential to become invasive. If we add Mountain States wholesale nursery in Phoenix, the list expands to include *Aristida purpurea* and *Bouteloua curtipendula*, along with a handful of non-native cultivars (Figure 4).

It is important to understand that contractors working on large-scale commercial and public projects will typically purchase from wholesale nurseries that can supply the quantities and species required (much more efficient to procure all the needed plants from one source). Large projects require lots of plants all at once (several hundred or more grasses is possible for a single project) and wholesale prices are less than half those of retail. While contract-growing is more common for restoration projects, we have not seen contact-growing used for private development (subdivisions, campuses, commercial, etc.).

To meet this demand, the grower needs to stock thousands of plants. There is a risk to the grower for mis-guessing what the demand will be for any particular species. Grasses root quickly, take over their container and start to look shabby within a relatively short time vs. shrubs and trees. Depending on species and time of year this shelf-life may be a season or so, but no more than a year.

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Figure 5. Desert Survivors is the local go-to for retail customers. The nursery is always fully stocked at spring, monsoon and fall plant sales, but on any given day there will be 25–40 different perennial grass species available for purchase. In the foreground are *Sporobolis airoides*, *Sporobolis wrightii*, and *Heteropogon contortus*.

Figure 6. Nighthawk Natives grows a lot of grasses — they sell over 2,000 grasses annually for restoration projects; another 1,000 or so are purchased by retailers and landscape contractors. Some native species they are currently growing include *Eragrostis intermedia*, *Hilaria berlangeri*, *Hilaria mutica*, *Hopia obtusifolia*, *Schizicarium scoparium and Tridens muticus*.

Big Farma — How did THAT grass end up here? *continued*

Keeping the species list short works well for both the contractor and the grower.

What about the designer? When our firm is working on large public or commercial projects, and we have an interest in using grass, what do we do? We often omit grass species as container plants (grass species are included in seed mixes). We don't use non-native plants in our designs, and in our experience the commonly available native grasses, *B. gracilis* and *M. rigens* don't do well in Tucson without a lot of irrigation. There are so many other native grass species that are better choices and use much less water.

Imagine a more typical landscape architect or designer churning out large project plans for their firm. If they aren't careful, they will specify species they are interested in without checking availability. This means the contractor in the field will have to make a substitution. Sometimes they check with the architect, sometimes they don't. Either way, the LA will not be getting the grass they dreamed about and may get something unfortunate.

Even if *B. gracilis* was *the* Tucson basin grass, we have deep misgivings about specifying a grass that is a clone of a cultivar. Is it really wise to plant thousands and thousands of genetically identical grasses? Won't this take the *B. gracilis* gene pool in an unknown direction? Make the entire gene pool more susceptible to catastrophe? Sure, the seed heads on 'Blonde Ambition' are impressive. They look like fake eyelashes on steroids. The human need is met. But what about the rest of nature? What needs aren't being met? What in this plant has been lost in exchange for the unusual seed head?

Thinking about a blonde's ambition and her impact on wildlife led us to research work done by Douglas Tallamy. Tallamy, an entomology professor at the University of Delaware, is a passionate advocate for planting native plants in our yards as, the title of his most recent book states, "Nature's Best Hope." His research group pitted shrub and tree cultivars against their wild native relatives to see which better supported both the insect herbivore and the insect pollinator. The only clear result of their experiment was that plants that had had their leaf color altered from green to red, blue or purple, consistently inhibited insect herbivory. (See "Further reading" below for links to this study and other interesting web pages about cultivars.) Tallamy, somewhat surprisingly to us, goes on to say that cultivars, if developed solely for the needs of nature, could prove superior to wild natives. A big "if" and a big "could" in our minds. I am sure the indefatigable African grass researchers in Arizona a century ago only imagined the blessings their research would bring.

One of the rules of our practice is "first do no harm." The research that has been done on cultivars' impact to nature is very thin. There are so many variables involved, so many facets and niches of nature that humans could easily miss. The human love affair with cultivars would make it easy to justify their widespread propagation on the slenderest reeds of proof of benefit. Personally, it is easy for us to sacrifice the "enhancements" the horticulturist offers for the comfort we take in knowing our wild, native plants will never let us down.

continued next page

Big Farma — How did THAT grass end up here? *continued*

Spotlight on Native Plant Nurseries that Grow Native Grasses

'We' get the plants 'we' ask for. Civano would be happy to sell us wild, native plants if that is what we demanded, and they would do it at the scale and efficiency that they currently devote to cultivars. Put another way, if all of us with a little time on our hands donned backpack sprayers like John Scheuring, John would eventually have to find something else to do, and 'Buffelgrass National Park' would be just a bad memory. In this spirit, Desert Survivors and Nighthawk Natives are two nurseries that every native plant lover should support.

Desert Survivors

Desert Survivors caters to the retail market. Jim Verrier, Nursery Director, told us that they grow around 700 species of native plants! Jim typically grows around 60 species of native grass. When we visited the nursery in September he had 32 grasses available for purchase (more species will be available at their plant sales). Desert Survivors grows all of their grasses from seed collected onsite. No vegetative propagation of cultivars occurs. A couple of Jim's current favorite grasses are *Leptochloa crinita* and *Pappophorum vaginatum*. Both spread readily and can handle basin conditions (Figure 5).

Nighthawk Natives

Nighthawk Natives contract-grows plants for wholesale and retail nurseries, landscapers, and restoration projects. They also sell plants at seasonal sales — if you buy native plants at the Tucson Audubon or Native Seed Search plant sales, you are probably buying Nighthawk Native plants. Berni Jilka, owner of Nighthawk Natives, currently grows about 20 species of native grass from seed collected on site. No vegetative propagation of cultivars occurs. The nursery is happy to contract-grow other native grass species. If you want to try a perennial grass that is well-suited to the hot dry conditions of the Tucson basin, Berni suggests *Muhlenbergia porteri, Sporobolus contractus,* or *Sporobolus airoides* (Figure 6).

Pima County Native Plant Nursery

As an LA that loves native plants, it does not get much better than being the designer on a Pima County project that can utilize the Pima County Native Plant Nursery (City and other government agencies can also make use of the Native Plant Nursery as long as an Inter-Governmental Agreement for the project is in place).

Figure 7. The Pima County Native Plant Nursery grows out plants for specific County projects. Pima County Flood Control and Pima County Department of Transportation are primary users. Here *Bothriochloa barbinodis*, *Bouteloua curtipendula*, *Leptochloa crinite,* and *Digitaria californica* are flourishing.

The nursery is designed to grow-out plants for specific projects. The designer provides the plant list and quantities to the nursery, along with the timeframe for when the plants are needed. This works well on projects like roadways, that have an 18-month design schedule, and a 6-month or longer construction schedule – plenty of time for the plants to be grown. There are complications for the nursery when project schedules change. They can't just 'hold' plants until the project is ready, so they end up doing a lot of juggling, and species substitutions may occur. Those plants may also be used on smaller County projects where there is insufficient time to grow out plants. Currently the nursery is growing over 30 species of Pima County native grasses. Like Nighthawk and Desert Survivors, they grow their grasses from seed, typically from seed collected onsite (Figure 7).

Considerations with grasses in the landscape

As grasses are being used more frequently in street-side water harvesting plantings, we are seeing problems with the establishment of buffelgrass (*Pennisetum ciliare*), fountain grass (*Pennisetum setaceum)*, and lovegrass (*Eragrostis* spp.) species that are drawn to the disturbed soils and moist conditions. At certain times *Muhlenbergia emersleyi* can look strikingly like fountain grass, and immature *Muhlenbergia rigens* can be hard to tell apart from immature buffelgrass.

Our approach as we move forward will be to select grass species that are markedly different in appearance from these invasives. *Leptochloa crinite* (Figure 8), *Heteropogon contortus* (Figure 9), and *Tridens muticus* (Figure 10), for example, are distinctive in appearance and are not invasive look-alikes (Figure 11).

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This Public Plaza managed by Pima County Regional Flood Control District includes a number of native grasses sourced from the Pima County Native Plant Nursey. Container grasses used include *Bouteloua curtipendula*, *Sporobolis wrightii, Heteropogon contortus and Pappophorum vaginatum*. Our approach as we move forward will be to select grass species that are markedly different in appearance from invasives. Clockwise from top left: *Leptochloa crinite* (Figure 8), *Heteropogon contort* (Figure 9), and *Tridens muticus* (Figure 10), for example, are distinctive in appearance and are not invasive look-alikes. Buffelgrass (Figure 11) has volunteered among the plantings — will the maintenance staff be able to routinely identify and remove?

Big Farma — How did THAT grass end up here? *continued*

Acknowledgments

We would like to thank the following people who helped us as we prepared this article (many of whom have also assisted us over the years in improving our plant and seed understanding and identification skills): Amy Belk, Pima County Native Plant Nursery Manager; George Ferguson, Collections Manager, University of Arizona Herbarium; Berni Jilka, Nighthawk Natives Nursery; Ries Lindley, our first instructor in grass identification; Gary Maskarinec, Wildlands Restoration; Jim Verrier, Nursery Director, Desert Survivors Nursery; Stephanie Vickers, Sales Manager, Civano; and John Scheuring, State Conservation Chairman, Arizona Native Plant Society.

About the Authors: Jennifer Patton and Ben Wilder are owners of Wilder Landscape Architects in Tucson, Arizona. The firm promotes native plants in their designs to create spaces firmly rooted in their locale.

Further reading:

Do Cultivars of Native Plants Support Insect Herbivores? Tallamy et al. **https://journals.ashs.org/horttech/view/journals/horttech/28/5/article-p596.xml.**

Common misperceptions about cultivars of native plants **https://extension.umd.edu/resource/cultivars-native-plants.**

Native Species or Cultivars of Native Plants–Does it Matter? **https://piedmontmastergardeners.org/article/native-species-or-cultivars-of-native-plants-does-it-matter/.**

Questions on the Phenology of Arizona Riparian Deciduous Trees *by Frank Reichenbacher*[1]

As a University of Arizona graduate student working in the lab of ecologist Charles H. Lowe Jr. in the late 1970s, I completed a master's thesis on riparian plant communities.

One day at the lab I had a conversation with Lowe that I still think about. I was blathering on about something to do with riparian ecology when Lowe stopped me, all grizzled six-foot-four of him, leaned over a desk, puffed on his cigar and said, "So Frank, why is it that some trees (referring to broadleaf deciduous riparian trees) flower before they leaf, while other trees leaf before they flower?"

Clearly, I had been given a toy to play with so I would maybe keep quiet for a few minutes.

"Riparian" refers to the zone along the banks of a stream or river. In the arid and semiarid Southwest these zones take on heightened importance for humans and natural ecological systems to the extent they indicate, support, and nurture a key ecosystem. Wildlife, human and otherwise, actively seek out the cooling, shaded environment created by deciduous trees, which are nothing like the dominant plants of surrounding non-riparian habitats along precious flowing streams of water.

I've thought about Lowe's question, of course, but beyond that I've thought a lot about the way it forces one to think about being a plant from the perspective of a plant, and then how the answer(s) might nudge one toward the realization that being a human being (at least, a pre-industrialized subsistence farmer or hunter-gatherer human being) is not that different.

I want to revisit this question — more than forty years after Lowe asked it — although, I now realize there are really two questions. First, there is one dangling detail that must be clarified before we should attempt to answer the original question, namely: is it true that some riparian trees leaf before they flower, while others flower before they leaf? I've wondered about that and I'm not sure it's true, or at least, it may not be completely true. Maybe some individual trees in an area do one thing, while others of the same species do the opposite in another area. Maybe it changes from year to year. Or maybe nature is always more complex than we give her credit for and Lowe didn't even ask the right question.

To support or refute the first question, I'll have to visit some trees in the spring hoping to get there at the moment leaves or flower begin to emerge from buds on the twig and record the date. While I'm at it, I'll also want to document the whole phenological progression of flowering, leafing, and seed dispersal for the season because, quite frankly, we do not have enough on-the-ground observations of these key events in phenology (i.e., the study of cyclic and seasonal events in nature). Furthermore I can't get enough of our riparian forests, so I'm going to visit them as often as I can from late January through April.

I think I just volunteered myself for a lot of work. I could probably use a little help, like maybe from members of the Arizona Native Plant Society?

All members in the several chapters that are somewhere near at least some of our deciduous riparian plant communities. Even downtown Phoenix has the Tres Rios Wetlands. Gilbert has a dedicated riparian park.

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But which trees, exactly, are we interested in? To be clear, I'm thinking about the broadleaf deciduous trees that drop leaves in the fall and spend the winter mostly naked. These are trees that dominate the wetter soils adjacent to streams and rivers, providing habitat for so many species of wildlife. Here they are, the broadleaf riparian deciduous trees of Arizona. It's not many:

Common Name	Scientific Name
Fremont Cottonwood	*Populus fremontii*
Narrowleaf Cottonwood	*Populus angustifolia*
Goodding Willow	*Salix gooddingii*
Bonpland Willow	*Salix bonplandiana*
Arizona Sycamore	*Platanus wrightii*
Velvet Ash	*Fraxinus velutina*
Arizona Black Walnut	*Juglans major*
Arizona Alder	*Alnus oblongifolia*
Box Elder	*Acer negundo*

[1]University of Arizona. **frankr1@arizona.edu**.

Questions on the Phenology of Arizona Riparian Deciduous Trees *continued*

If you want to participate, please consult the instruction page for this project on the AZ Native Plant Society website:(**https://aznps.com/tracking-flower-and-leaf-emergence-in-the-riparian-trees-of-arizona/**). Or, you can email me at **frankr1@arizona.edu** and I'll send a list of procedures including what data to record, how to collect them, and suggestions about where to go for most members. There are numerous field guides that can help you identify trees of Arizona but send me your questions and pictures of trees if you need help identifying to species. I'll collate the responses I receive and then perhaps we will talk the editors into publishing a report to the membership. While you are out there in your riparian forest, keep in mind the question: Is it true some trees flower before they leaf while others leaf before they flower? When you have answered this to your satisfaction think about why. There is a reason, or, more likely, there are probably several reasons.

I should probably mention that all the trees listed above possess reproductive systems that are not typical of most flowering plants. They are either dioecious (male and female flowers on different individual plants) or monoecious (male and female flowers separate on the same plant). Most flowering plants are hermaphroditic, i.e., male and female parts are found in the same flower. I wonder why *all* our riparian trees would have these atypical reproductive systems?

See the adjacent photograph taken in early October 2022. Alders have an adaptation with which they metaphorically thumb their noses at other competing deciduous broadleaf trees. Their flower buds emerge in the fall, spend the winter fully exposed to the elements on the naked tree, and then flower in the spring. Why do you think this might be a good idea? Or is it a good idea? In this photo the plump female buds are at the top and the slender male buds are below.

Good luck! Stay safe, and maybe we'll run into each other someplace leafy, green, and cool next spring.

Arizona Alder, *Alnus oblongifolia*, October 3, 2022, on Big Bug Creek. *Photo credit: Frank Reichenbacher.*

CORRECTION TO *SPOTLIGHT ON A NATIVE PLANT* ARTICLE FOR VOL 45(1):

The individual for whom the Shindagger was named was incorrectly identified. George Engelmann named this plant in honor of the German immigrant Arthur Carl Victor Schott, a surveyor with the United States–Mexico Boundary Survey (1849–1857). In addition to his dedicated assistance to the survey's leader, Major William H. Emory, Schott made numerous collections of plants, animals, fossils, and minerals as well as borderlands drawings.

THE ARIZONA NATIVE PLANT SOCIETY

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