

AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA
Part 6. POACEAE – GRASS FAMILY

RICHARD STEPHEN FELGER

Herbarium, University of Arizona
Tucson, Arizona 85721

&

Sky Island Alliance

P.O. Box 41165,

Tucson, Arizona 85717

*Author for correspondence: rfelger@ag.arizona.edu

SUSAN RUTMAN

90 West 10th Street

Ajo, Arizona 85321

JIM MALUSA

School of Natural Resources and the Environment

University of Arizona

Tucson, Arizona 85721

malusa@email.arizona.edu

ABSTRACT

A floristic account is provided for the grass family as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona. This is the second largest family in the flora area after Asteraceae. A total of 97 taxa in 46 genera of grasses are included in this publication, which includes ones established and reproducing in the modern flora (86 taxa in 43 genera), some occurring at the margins of the flora area or no longer known from the area, and ice age fossils. At least 28 taxa are known by fossils recovered from packrat middens, five of which have not been found in the modern flora: little barley (*Hordeum pusillum*), cliff muhly (*Muhlenbergia polycaulis*), *Paspalum* sp., mutton bluegrass (*Poa fendleriana*), and bulb panic grass (*Zuloagaea bulbosa*). Non-native grasses are represented by 27 species, or 28% of the modern grass flora. No other large family in the region has such a high percentage of non-natives. Buffelgrass (*Cenchrus ciliaris*), fountain grass (*Cenchrus setaceum*), and *Schismus* spp. are invasive species of major concern.

The most diverse grass genera in the flora are *Muhlenbergia* (10 species), *Bouteloua* (6 species), and *Aristida*, *Eragrostis*, *Panicum*, and *Sporobolus* (4 species each). *Eragrostis pectinacea* var. *miserrima* is treated as a synonym of *E. pectinacea* var. *pectinacea* and *Muhlenbergia alopecuroides* (*Lycurus setosus*) as a synonym of *Muhlenbergia phleoides* (*Lycurus phleoides*). The modern, established grass flora includes 49 perennials and 37 annuals or ephemerals, of which 20 are summer or hot-season taxa, 12 winter-spring or cool-season taxa, and 5 are non-seasonal. This floristic treatment includes brief descriptions, illustrations, identification keys, common names (when available in English, Spanish, and the local O'odham language), local and global distributions, fossil records from packrat middens, and specimen citations.

POACEAE – Grass Family

This publication is an account of the grasses as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona (Fig. 1). This is the sixth

contribution to our flora, published in a series in *Phytoneuron* and also posted open access on the website of the University of Arizona Herbarium (ARIZ). The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Explanation of the format for the flora is provided in part 3 (Felger et al. 2013c).

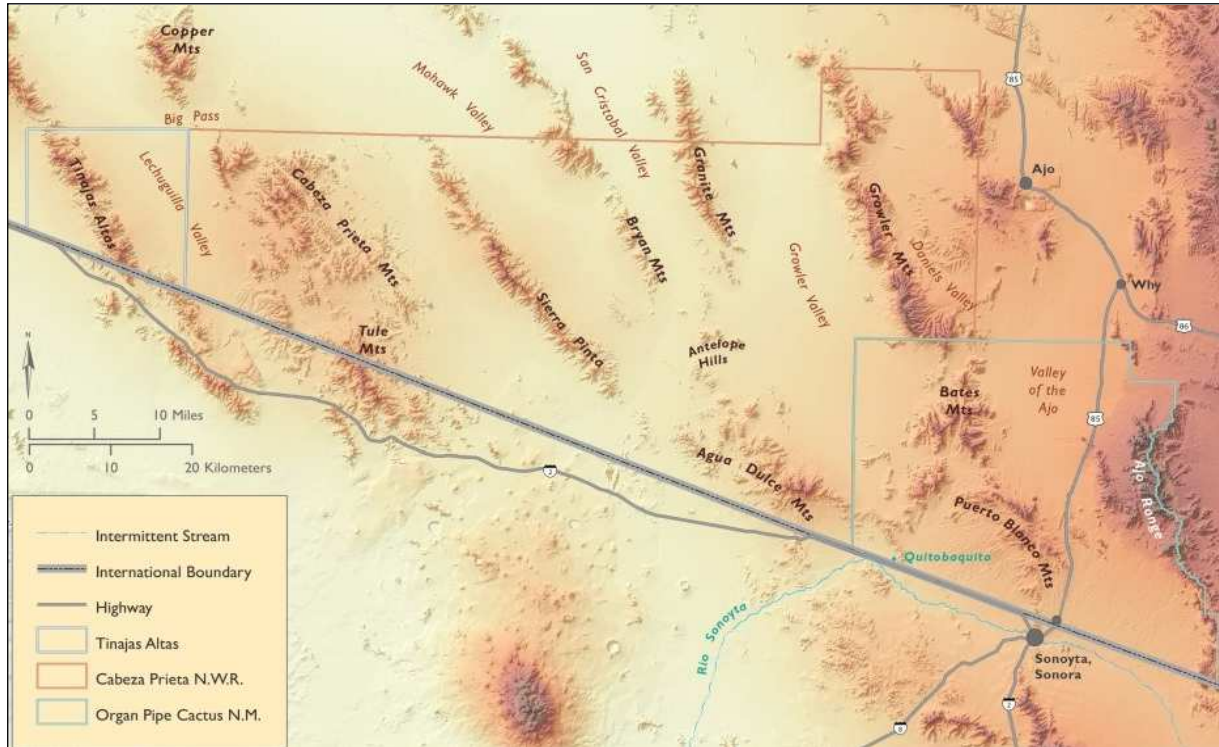


Figure 1. Flora area in southwestern Arizona. Map prepared by Ami Pate of Organ Pipe Cactus NM, 2013.

The following generalized descriptions include the grasses in the flora area and not necessarily the same grasses in other regions. There are many variations and not all can be covered in this brief description.

Annual/ephemeral and perennial herbs and some reed- or bamboo-like (*Phragmites*). Roots fibrous; rhizomes and stolons sometimes present. Culms hollow between the nodes and solid at nodes, or less often also solid between the nodes. Leaves basal or cauline (on the culm), 2-ranked, consisting of the sheath, ligule, and blade. Leaf sheaths are partially to fully enclosing the stem, and either open (margins overlapping, not fused) or closed (margins fused). Junction of the leaf sheath and blade called the collar, usually with a ligule, often a scale-like or hairy extension at the top of the leaf sheath and blade and facing the culm (membranous throughout, membranous at the base and topped by cilia, or entirely of hairs). Leaf blades linear with parallel veins, flat or variously folded or inrolled (involute).

In grasses there are several kinds of stems, including culms, rhizomes, and stolons. Technically, “stem” is a general term that can be applied to all of these. The aerial stem of a grass is termed a culm. Inflorescences generally are terminal, sometimes on lateral branches from the culm. (Measurements for culms therefore do not include inflorescences.)

Flowers small, bisexual, or unisexual and the plants monoecious or dioecious. Flowers in spikelets. Terminology for grass inflorescences treats the spikelet as the basic unit in the way the flower is treated in general terminology for flowering plants. Spikelets are in spikes, panicles, or rarely racemes. Panicle branches may be racemose (spikelets with pedicels), spicate (spikelets sessile), or rames (spikelets in pairs, one sessile, one pedicellate), or unilateral (spikelets all on one side of the branch) or not. Spikelets of bracts and 1 or more florets, the bracts and floret(s) 2-ranked (alternate on opposite sides of the rachilla). Bracts variously awned or not; lowermost bracts (glumes) paired or sometimes reduced to 1. The floret includes 2 bracts, the lemma below and the palea above, these enclosing the actual flower (the palea sometimes reduced or absent). In spikelets of more than one floret the lowermost or uppermost floret or florets sometimes staminate or reduced and sterile. Perianth segments (lodicules) of greatly reduced scales, mostly 2 (3 in *Aristida* and *Pappostipa*), often swelling and spreading the floret open at anthesis, or sometimes absent. Pistil single, superior (of 3 united carpels, but functionally with 1 carpel containing 1 ovule). Stamens usually 3, sometimes 1 or 2. Stigmas generally 2 and feathery (plumose). Fruits of specialized achenes (1-seeded) called a caryopsis (caryopses, plural), where the seed is fused to the fruit wall (pericarp), or an actual achene in which the seed separates from the pericarp (*Dactyloctenium* and *Sporobolus*). The caryopsis (including the tightly enclosing fertile lemma and palea in panicoids) or the achene is conveniently referred to as the “grain.”

Some grasses, including species of *Bromus*, *Festuca*, and *Sporobolus*, produce mostly or only cleistogamous florets. These are florets that remain closed and produce seeds without exposing the stamens and stigmas and thus are self-fertilized. Cleistogamous grasses tend to occur in dry areas with erratic rainfall, sparse vegetation, and lighter soils (Lord 1981). Five grasses in the flora area produce cleistogenes at the stem bases or in leaf axils: *Cottea pappophoroides*, *Disakisperma dubium*, *Enneapogon desvauxii*, *Muhlenbergia appressa*, and *M. microsperma*. The cleistogenes are modified cleistogamous inflorescences or spikelets, lacking glumes and awns, and the grain is typically larger (heavier) than the grain from “normal” (chasmogamous) florets. Cleistogenes provide a reproductive strategy in addition to that of the usual terminal (chasmogamous) inflorescences, such as when those inflorescences are lost to herbivores or do not develop due to drought.

Grasses in the flora area are distributed among six subfamilies following the classification in Sorong et al. (2013) and the Grass Phylogeny Working Group (2012):

Subfamily Aristidoideae: *Aristida*

Subfamily Arundinoideae: *Phragmites*

Subfamily Danthonioideae: *Schismus*

Subfamily Chloridoideae:

Tribe Eragrostideae:

Subtribe Cotteinae: *Cottea*, *Enneapogon*

Subtribe Eragrostidinae: *Eragrostis*

Tribe Zoysieae:

Subtribe Sporobolinae: *Sporobolus*

Tribe Chlorideae:

unplaced genus: *Dactyloctenium*

Subtribe Boutelouinae: *Bouteloua*

- Subtribe Eleusininae: *Chloris*, *Cynodon*, *Dinebra*, *Diplachne*, *Disakisperma*, *Leptochloa*
- Subtribe Hilariinae: *Hilaria*
- Subtribe Gouiniinae: *Tridentopsis*
- Subtribe Monanthochloinae: *Distichlis*
- Subtribe Muhlenbergiinae: *Muhlenbergia*
- Subtribe Pappophorinae: *Pappophorum*
- Subtribe Scleropogoninae: *Dasyochloa*
- Subfamily Panicoideae
 - Tribe Paniceae
 - Subtribe Anthephorinae: *Digitaria*
 - Subtribe Boivinellinae: *Echinochloa*
 - Subtribe Cenchrinae: *Cenchrus*, *Setaria*, *Zuloagaea*
 - Subtribe Melinidinae: *Eriochloa*, *Urochloa*
 - Subtribe Panicinae: *Panicum*
 - Tribe Paspaleae: *Hopia*, *Paspalum*
 - Tribe Sacchareae
 - Subtribe Anthistiriinae: *Heteropogon*
 - Subtribe Sorghinae: *Bothriochloa*, *Sorghum*
 - Subtribe Tripsacinae: *Zea*
- Subfamily Pooideae
 - Tribe Bromeae: *Bromus*
 - Tribe Hordeae
 - Subtribe Hordeinae: *Elymus*, *Hordeum*
 - Subtribe Triticinae: *Triticum*
 - Tribe Meliceae: *Melica*
 - Tribe Poeae
 - Subtribe Agrostidinae: *Polypogon*
 - Subtribe Aveninae: *Avena*
 - Subtribe Poinae: *Poa*
 - Subtribe Loliinae: *Festuca*
 - Subtribe Phalaridinae: *Phalaris*
 - Tribe Stipeae: *Pappostipa*

Spikelets in the subfamily Panicoideae are generally paired (sometimes in triplets on terminal branchlets), the members of a unit usually with pedicels of different lengths or one spikelet sessile, or reduced, or sometimes absent. The individual spikelets detach below the glumes and have 2 florets, the lower one staminate or sterile, often reduced to just a lemma, the upper floret usually bisexual. Many other grasses have spikelets with 2 florets, but rarely have the lower floret staminate or sterile and the upper one bisexual. Two major kinds of spikelets are notable among the subfamily Panicoideae, the andropogonoid and the panicoid spikelets.

Andropogonoid spikelets are seen in *Bothriochloa*, *Heteropogon*, and *Sorghum* in the tribe Sacchareae. There is a basic pattern, but a daunting array of variation. The spikelets are in pairs (triplets often at branch tips—the descriptions that follow are for the paired spikelets). The pairs have 1 sessile/subsessile spikelet and 1 stalked (pedicelled) spikelet. Among those in the flora area the pedicelled spikelet is smaller than the sessile/subsessile one or reduced or absent. The sessile/subsessile spikelet has a staminate or sterile (reduced) floret below and a bisexual or pistillate floret above. The spikelet pair or unit falls with its rachis segment as the dispersing unit. A branch of the inflorescence with such pairs of sessile and pedicelled spikelets is called a rame.

In the panicoids the spikelets in an inflorescence are similar to each other and may be paired or not; pedicels of paired spikelets are of different lengths or one is sessile. What often appears to be a spikelet with one floret is actually a spikelet with two florets. Like the andropogonoids, the lower floret is staminate or sterile, and most panicoid plants in the flora area have the sterile floret reduced to a just a lemma. The sterile lemma generally resembles the upper glume. The upper floret is bisexual, with a lemma, palea, stamens, and pistil. Panicoid spikelets are seen in *Cenchrus*, *Digitaria*, *Echinochloa*, *Eriochloa*, *Panicum*, *Setaria*, *Urochloa*, and *Zuloagaea* in Paniceae and *Hopia* and *Paspalum* in Paspaleae. In *Eriochloa* the lower glume is modified as a cup-like structure. The panicoid spikelets in *Cenchrus* are hidden in burs or fascicles. Others, such as *Hopia*, *Panicum*, and *Urochloa*, have a hard, smooth and shiny fertile lemma with inrolled margins tightly clasping the palea and enclosed fruit.

DIVERSITY, DISTRIBUTION, AND NATURAL HISTORY

The grass flora of the region is large and diverse (Table 1). Grasses established and reproducing in the modern flora include 86 taxa in 43 genera, which is 12% of the total modern flora of approximately 740 taxa (Felger et al. 2013a, b). Poaceae is the second largest plant family in the flora, following the composites (Asteraceae, 112 taxa). At least 28 species of grasses are represented by fossil specimens, 5 of which are no longer present in the flora area. Non-native grasses include 27 species. We also include some modern grasses documented for flora area but not established or reproducing or apparently no longer present and found at the margins of the area. A total of 97 taxa in 46 genera are included in this publication. Organ Pipe Cactus National Monument (OP, or Organ Pipe) supports a modern grass flora of 79 taxa including 24 non-natives; Cabeza Prieta National Wildlife Refuge (CP, or Cabeza Prieta) has a modern flora of 50 taxa including 18 non-natives, and the Tinajas Altas Region (TA, Tinajas Altas) has 18 species including 4 non-natives. The most diverse grass genera in the flora are *Muhlenbergia* (10 species), *Bouteloua* (6 species), and *Aristida*, *Eragrostis*, *Panicum*, and *Sporobolus* (4 species each).

Aristida californica var. *californica* and *Cenchrus palmeri* are essentially endemic to the Sonoran Desert but also extend southward into thornscrub in northwestern Sinaloa, Mexico. Thus, although grasses are successful in the flora area as well as in the Sonoran Desert as a whole, there is no endemism in the flora area and few endemics within the Sonoran Desert (Felger 2000, 2007; Gould & Moran 1980; Malusa et al. 2013; Pearlstein et al. 2012).

Non-native grasses are represented by 27 species, or 28% of the total grass flora (97 taxa), in contrast to 11% non-natives in the total vascular plant flora. No other large family in the region has such a high percentage of non-natives. The non-natives are largely from the Old World and tend to annuals found in disturbed habitats. Six Old World grasses are widespread and common even in undisturbed, natural habitats: red brome (*Bromus rubens*), Bermuda grass (*Cynodon dactylon*), stink grass (*Eragrostis cilianensis*), wild barley (*Hordeum murinum*), and Arabian and Mediterranean grasses (*Schismus arabicus* and *S. barbatus*). Buffelgrass (*Cenchrus ciliaris*), fountain grass (*C. setaceum*), and *Schismus* spp. are invasive species of major concern. Others, such as soft-feather pappus grass (*Enneapogon cenchroides*) and Lehmann love grass (*Eragrostis lehmanniana*) are potentially serious invasives in the flora area. See discussion of non-native and invasive species in the introduction to this flora series in Felger et al. (2013a) and also Felger (1990, 2000) and Felger et al. (2007a).

Table 1. Local distributions and growth forms of grasses. † = modern taxon also represented by a fossil specimen. †† = fossil taxon not found in the modern flora area. * = non-native and reproducing in the flora area. ** = non-native and not established (not reproducing) in the flora area. OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region. Growth forms: PR = perennial, NS = non-seasonal annual/ephemeral, S = summer or hot-season annual/ephemeral, W = winter-spring or cool-season annual/ephemeral. Totals are for the modern, established flora.

Taxon	Region			Growth form			
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Perennial	Non-seasonal	Summer	Winter
†Aristida adscensionis	OP	CP	TA		NS		
Aristida californica var. californica		CP		PR			
Aristida californica var. glabrata	OP			PR			
†Aristida purpurea var. nealleyi	OP	CP	TA	PR			
Aristida purpurea var. parishii	OP	CP		PR			
Aristida purpurea var. purpurea	OP			PR			
Aristida ternipes var. gentilis	OP	CP		PR			
Aristida ternipes var. ternipes	OP	CP		PR			
*Avena fatua	OP						W
†Bothriochloa barbinodis	OP	CP	TA	PR			
†Bouteloua aristidoides	OP	CP	TA			S	
Bouteloua barbata var. barbata	OP	CP	TA			S	
Bouteloua barbata var. rothrockii	OP			PR			
(†Bouteloua barbata var.?)	OP		TA				
†Bouteloua curtipendula	OP			PR			
†Bouteloua repens	OP			PR			
†Bouteloua trifida	OP	CP		PR			
Bromus arizonicus	OP	CP					W
*Bromus rubens	OP	CP	TA				W
**Bromus tectorum	OP						W
*Cenchrus ciliaris	OP	CP	TA	PR			
**Cenchrus echinatus	OP					S	
(Cenchrus palmeri)						(S)	
*Cenchrus setaceus	OP	CP		PR			
*Cenchrus spinifex		CP				S	
Chloris virgata	OP	CP				S	
Cottea pappophoroides	OP	CP		PR			
*Cynodon dactylon	OP	CP		PR			
*Dactyloctenium aegyptium	OP					S	
†Dasyochloa pulchella	OP	CP	TA	PR			
†Digitaria californica	OP	CP	TA	PR			
Dinebra panicea	OP	CP				S	
Dinebra viscida		CP				S	

<i>Diplachne fusca</i> ssp. <i>uninervia</i>	OP				NS		
<i>Disakisperma dubium</i>	OP			PR			
<i>Distichlis spicata</i>	OP			PR			
* <i>Echinochloa colona</i>	OP	CP				S	
* <i>Echinochloa crus-galli</i>		CP				S	
<i>Elymus elymoides</i>	OP			PR			
* <i>Enneapogon cenchroides</i>	OP				NS		
<i>Enneapogon desvauxii</i>	OP	CP		PR			
(* <i>Eragrostis barrelieri</i>)	(OP)				(NS)		
* <i>Eragrostis cilianensis</i>	OP	CP	TA			S	
<i>Eragrostis intermedia</i>	OP			PR			
* <i>Eragrostis lehmanniana</i>	OP	CP		PR			
† <i>Eragrostis pectinacea</i>		CP				S	
* <i>Eriochloa acuminata</i>	OP					S	
<i>Eriochloa aristata</i>	OP	CP				S	
† <i>Festuca microstachys</i>	OP						W
† <i>Festuca octoflora</i>	OP	CP	TA				W
† <i>Heteropogon contortus</i>	OP	CP	TA	PR			
<i>Hilaria belangeri</i>	OP			PR			
<i>Hilaria rigida</i>	OP	CP	TA	PR			
<i>Hopia obtusa</i>	OP			PR			
* <i>Hordeum murinum</i>	OP	CP					W
†† <i>Hordeum pusillum</i>	OP						W
<i>Leptochloa crinita</i>	OP			PR			
<i>Melica frutescens</i>	OP			PR			
<i>Muhlenbergia appressa</i>	OP						W
<i>Muhlenbergia dumosa</i>	OP			PR			
† <i>Muhlenbergia emersleyi</i>	OP			PR			
† <i>Muhlenbergia fragilis</i>	OP					S	
† <i>Muhlenbergia microsperma</i>	OP	CP	TA		NS		
<i>Muhlenbergia phleoides</i>	OP			PR			
†† <i>Muhlenbergia polycaulis</i>	OP			PR			
<i>Muhlenbergia porteri</i>	OP	CP		PR			
<i>Muhlenbergia rigens</i>	OP			PR			
<i>Muhlenbergia tenuifolia</i>	OP			PR			
<i>Panicum alatum</i>		CP				S	
* <i>Panicum antidotale</i>	OP			PR			
† <i>Panicum hallii</i>	OP			PR			
† <i>Panicum hirticaule</i>	OP	CP				S	
<i>Pappophorum vaginatum</i>	OP			PR			
<i>Pappostipa speciosa</i>	OP		TA	PR			
†† <i>Paspalum</i> sp.	OP			?			
* <i>Phalaris caroliniana</i>		CP					W

* <i>Phalaris minor</i>	OP	CP					W
<i>Phragmites australis</i>	OP			PR			
** <i>Poa annua</i>	OP						W
† <i>Poa bigelovii</i>	OP	CP					W
†† <i>Poa fendleriana</i>	OP			PR			
* <i>Polypogon monspeliensis</i>	OP	CP			NS		
* <i>Polypogon viridis</i>	OP			PR			
* <i>Schismus arabicus</i>	OP	CP	TA				W
* <i>Schismus barbatus</i>	OP	CP					W
† <i>Setaria grisebachii</i>	OP					S	
<i>Setaria liebmannii</i>	OP					S	
† <i>Setaria macrostachya</i>	OP	CP		PR			
* <i>Sorghum halepense</i>	OP	CP		PR			
<i>Sporobolus airoides</i>	OP	CP		PR			
<i>Sporobolus cryptandrus</i>	OP	CP	TA	PR			
<i>Sporobolus flexuosus</i>	OP			PR			
<i>Sporobolus pyramidatus</i>	OP					S	
<i>Tridentopsis eragrostoides</i>	OP			PR			
† <i>Tridentopsis mutica</i>	OP	CP	TA	PR			
** <i>Triticum aestivum</i>	OP						W
<i>Urochloa arizonica</i>	OP	CP				S	
†† <i>Zuloagaea bulbosa</i>	OP			PR			
Total established taxa in modern flora area: 86	79	49	18	49	5	20	12
Region and growth form	Organ Pipe	Cabeza Prieta	Tinajas Altas	Perennial	Non-seasonal	Summer	Winter

Grasses in the flora area known from fossil packrat middens include at least 28 species (Table 1). Five species, from the Ajo and Puerto Blanco Mountains, are not known in the modern flora: *Hordeum pusillum*, *Muhlenbergia polycaulis*, *Paspalum* sp., *Poa fendleriana*, and *Zuloagaea bulbosa*. *Paspalum* is a wetlands grass and the nearest modern occurrences are near the Colorado and Gila Rivers. The nearest modern occurrences of the other four are mostly at elevations above the desert, such as the Baboquivari and Coyote Mountains. The fossil records indicate wetter ice age conditions. The fossils were identified by fragments of the inflorescences and reproductive structures that often included spikelets or even spikes or spikelet clusters, florets, caryopses or “grain,” or combinations or pieces of these parts (see Felger et al. 2013a).

Non-native plants established as reproducing populations in the flora area are indicated with an asterisk (*) and non-native taxa not established as reproducing populations are marked with two asterisks (**). Fossil specimens and modern taxa also represented by fossils are indicated with a dagger symbol (†) and fossil taxa no longer known to occur in the flora are indicated with two dagger symbols (††).

Grasses dominate some high elevation, north-facing slopes of the Ajo Mountains. Relatively few excursions have documented these grasslands due to their remoteness and difficulty of access,

especially during the summer season. Additional explorations are likely to produce new records. At least 58 taxa of grasses occur in the Ajo-Diablo Mountain complex (Felger et al. 2013a). Within the flora area 18 species are known only from the Ajo–Diablo Mountain complex, and *Bouteloua barbata* var. *rothrockii* is known elsewhere in the flora area only from the Bates Mountains. These grasses, listed below, generally extend no farther into the desert and are like sky island populations.

<i>Bouteloua barbata</i> var. <i>rothrockii</i>	<i>Muhlenbergia emersleyi</i>
<i>Bouteloua curtipendula</i>	<i>Muhlenbergia fragilis</i>
<i>Elymus elymoides</i>	<i>Muhlenbergia phleoides</i>
* <i>Enneapogon cenchroides</i>	<i>Muhlenbergia rigens</i>
<i>Eragrostis intermedia</i>	<i>Muhlenbergia tenuifolia</i>
<i>Festuca microstachys</i>	<i>Pappophorum vaginatum</i>
<i>Hilaria belangeri</i>	<i>Setaria grisebachii</i>
<i>Melica frutescens</i>	<i>Setaria liebmannii</i>
<i>Muhlenbergia appressa</i>	<i>Tridentopsis eragrostoides</i>
<i>Muhlenbergia dumosa</i>	

Perennial grasses in the established modern flora are represented by 49 taxa (Table 1). However, many or perhaps most of these perennials can be reproductive in the first year or season. Several perennials are not truly herbaceous, e.g., *Hilaria rigida*, *Muhlenbergia dumosa*, and *Phragmites australis*. Annuals (ephemerals) are represented by 37 taxa, summer ephemerals by 20 taxa, cool-season or winter-spring ephemerals by 12 taxa, and non-seasonal ephemerals include 5 species.

Seven species, only two of them native, are restricted to wetland habitats, which are often characterized by highly alkaline or saline soils. *Phragmites australis* and **Polypogon viridis* are highly localized and limited to habitats with permanent water. The others are *Distichlis spicata*, **Echinochloa colona*, **E. crus-galli*, ***Poa annua*, and **Polypogon monspeliensis*.

Five grasses are common on the dunes of the Pinta Sands and nearby sand soils and interdune troughs: *Aristida californica* var. *californica*, *Bouteloua aristidoides*, *B. barbata* var. *barbata*, *Hilaria rigida*, and **Schismus arabicus*. However, all occur elsewhere although *A. californica* var. *californica* is mostly restricted to sandy soils.

Following years of favorable rains in late summer and early fall, extensive ephemeral grass-dominated meadows may develop on certain low-lying habitats, such as the large playas and sandy loams of the lower bajadas. Characteristic grasses in these places include *Aristida adscensionis*, *Bouteloua aristidoides*, *B. barbata* var. *barbata*, *Chloris virgata*, *Dinebra (Leptochloa) panicea*, *Dinebra (Leptochloa) viscida*, **Eragrostis cilianensis*, *Eriochloa aristata*, *Muhlenbergia microsperma*, *Panicum alatum*, and *P. hirticaule*.

Sandy plains in the northern part of Organ Pipe provide favorable conditions for grasses—in particular lower bajada and floodplain deposits of sandy loams along flat reaches of drainages in the Valley of the Ajo. In fact this area has the highest concentration of grass species known for the region. This dense growth of grasses supports large rodent populations, so that during years of favorable rainfall it is best to wear legging as protection from the numerous unseen rattlesnakes that feed on the rodents (Phil Rosen, pers. comm. to R. Felger 2006). In this area 21 grasses have been recorded in less than one hectare:

<i>Aristida adscensionis</i>	* <i>Eragrostis cilianensis</i>
<i>Aristida purpurea</i> var. <i>nealleyi</i>	<i>Festuca octoflora</i>

Bouteloua aristidoides
Bouteloua barbata var. *barbata*
Bromus arizonicus
 **Bromus rubens*
Cottea pappophoroides
Dasyochloa pulchella
Digitaria californica
Dinebra panicea
Eriochloa aristata

Hilaria rigida
Muhlenbergia microsperma
Muhlenbergia porteri
Panicum hirticaule
Poa bigelovii
 **Schismus barbatus*
Setaria macrostachya
Sporobolus flexuosus

Economic grasses have played an important role in regional agriculture and food resources. Maize (*Zea mays*) has been cultivated in the region since prehistoric times. In 1701, Padre Kino and his companions found O'odham people cultivating maize (corn) along the river at Sonoita (Burrus 1971) and brought wheat (*Triticum aestivum*) and other crops to the area (Bolton 1919). The missionaries also introduced cattle, which thrived on grasses and other forage, which undoubtedly contributed to the ultimate demise of some local grasses and wetland habitats (Felger 2000, 2007).

Most grasses produce edible grain. Native Americans in the flora area harvested grain from grasses that was large enough and/or abundant enough to make the effort worthwhile. Even those with very small grain were harvested for food by Sonoran Desert people, including the annual grama grasses (e.g., *Bouteloua aristidoides*) and even little-seed muhly (*Muhlenbergia microsperma*) and many perennials such as bull grass (*Muhlenbergia emersleyi*). Although these and other common grasses have very small grains, they can be so abundant that significant quantities could be collected in a relatively short time. Others have substantially larger and perhaps more readily harvested and prepared grain, such as vine mesquite (*Hopia obtusa*), plains bristlegrass (*Setaria macrostachya*), and alkali sacaton (*Sporobolus airoides*). These grains were often basket winnowed to separate chaff, parched, ground into flour, and cooked or stored for later use. The flour was mixed with other foods or consumed as porridge. Pertinent references include Castetter (1935), Castetter and Bell (1942, 1951), Castetter and Underhill (1935), Childs and Dobyns (1954), Felger (2007), Felger and Moser (1985), Felger et al. (1992), Gasser (1982), Hodgson (2001), Lumholtz (1912), and Rea (1997).

KEY TO THE GRASS GENERA OF SOUTHWESTERN ARIZONA

In the various keys we make use of annual (ephemeral) vs. perennial growth forms mainly in an attempt to produce keys as user-friendly as possible. The drawback is that many or most of the perennials may, on occasion, become reproductive in their first year or season. Even so, these occasional first year/season plants generally have more extensive root systems than the truly annual/ephemeral grasses, and in such cases perennial individual plants are generally far more numerous than the occasional first season/annual individuals. We use the terms ephemeral and annual almost interchangeably and nearly all annual grasses in the flora area are ephemerals, although ephemerals are plants that can grow and mature in a single season, while annuals are longer lived but not perennial. In the descriptions and keys, we also are not always consistent in using singular and plural nouns for part of plants (plural is usually implied), e.g., spikelet vs. spikelets.

The keys and following descriptions pertain to grasses occurring in the flora area and may not cover the variation found in other regions. The descriptions are meant to be informative, brief, and tailored for grasses in the flora area and are not necessarily of consistent detail for the different taxa. More detailed descriptions are available in many other sources such as the Manual of Grasses for North America (Barkworth et al. 2007a) and the Flora of North America (Barkworth et al. 2003, 2007b). Our keys do not include the fossils.

1. Plants bamboo- or reed-like, 1–3 m tall.

- 2. Plants mostly 1–1.5 m tall; leaf blades not more than 12 cm long, less than 0.5 cm wide; spikelets with 1 floret; Ajo Mountains..... **Muhlenbergia dumosa**
- 2. Plants mostly more than 2 m tall; leaf blades (7) 30–40 cm long, more than 1 cm wide; spikelets several florets; vicinity of Quitobaquito..... **Phragmites australis**

1. Plants not bamboo or reed-like.

3. Plants with stolons and/or rhizomes; perennials.

4. Plants creeping and/or forming dense colonies or mats, the rhizomes or stolons creeping and scaly; spikelets awnless; often in riparian or weedy habitats, or saline or alkaline soils.

- 5. Inflorescence a panicle of digitately arranged branches; spikelets, 2–2.5 mm long, with 1 floret..... **Cynodon dactylon**
- 5. Inflorescences of compact racemes or panicles, not digitately arranged; spikelets 1.4–15 mm long, with 1 to several florets.

- 6. Spikelets with several florets; glumes 2.7–4.5 mm long, the lemmas 3–5 mm long.
..... **Distichlis spicata**
- 6. Spikelets with 1 floret; glumes 1.4–2.1 mm long, the lemmas 0.8–1 mm long.
..... **Polypogon viridis**

4. Plants tufted, with short or long stolons or rhizomes, these not scaly, not creeping, and not mat forming; spikelets awned or awnless; often in open, desert habitats.

7. Inflorescence spike-like and elongated, less than 1.5 cm wide (and more than 4 cm long).

- 8. Stolon less than 20 cm long; spikelets awned, in clusters of 3's..... **Hilaria**
- 8. Stolons to 1+ m long; spikelets awnless, not in 3's..... **Hopia obtusa**

7. Inflorescences various, dense or open panicles, mostly more than 2 cm wide, not elongated and spike-like.

9. Stems often 1–2 m tall; inflorescences of open panicles often more than 10 cm wide; spikelets awnless..... **Panicum antidotale**

9. Stems less than 40 cm tall; inflorescences or their branches with spikelets crowded, less than 3 cm wide; spikelets awned.

10. Plants 8–40 cm tall; flowering stems more than twice as tall as the leaves; inflorescence a panicle of spicate, unilateral branches, 1 to several widely spaced on the flowering stem..... **Bouteloua trifida**

10. Plants less than 15 cm tall; flowering stems less than twice as tall as the leaves; inflorescence a dense panicle of spicate but not unilateral branches
..... **Dasyochloa pulchella**

3. Plants without conspicuous stolons or rhizomes; annuals (ephemerals) or perennials.

11. Spikelets subtended by 1 or more bristles or enclosed in burs or fascicles.

12. Spikelets enclosed in burs or fascicles with many spines or bristles, the bur or fascicle falling as a unit with the attached spines or bristles..... **Cenchrus**

12. Spikelets not enclosed in burs or fascicles, with 1–few slender bristles below the spikelets; spikelets breaking off above the bristles..... **Setaria**

11. Spikelets not subtended by bristles and not enclosed in burs or fascicles.

13. At least some spikelets with awns.

14. Spikelets or some or all florets with 3 terminal awns from a common point or central column.

15. Inflorescences panicles of spicate, unilateral branches; spikelets with 2–several florets including rudiments; awns 8 mm or less in length..... **Bouteloua**

15. Inflorescences panicles of racemose branches, not unilateral; awns 12 or more mm long.

16. Spikelets clearly with 1 floret with 1 or 3 awns..... **Aristida**

16. Spikelets with 2 florets, 1 fertile and 1 sterile, each with 3 awns.
..... **Leptochloa crinita**

14. Spikelets with 1 or more awns, but not 3-awned as above.

17. Perennials, almost always obviously so with well-developed root systems.

18. Lemmas with 7 or more scabrous or feathery awns.

19. Plants not forming cleistogenes; glumes with 1 prominent vein.

..... **Pappophorum vaginatum**

19. Plants forming cleistogenes at stem bases; glumes with 5–13 veins (not the cleistogene spikelets).

- 20. Panicles open and diffuse; glumes with 7–13 veins; lemma with 9 or more scabrous awns (not feathery)..... **Cottea pappophoroides**
- 20. Panicles contracted and dense; glumes with 5–7 veins; lemmas with 9 feathery awns..... **Enneapogon**

18. Lemmas with 1 to several awns.

- 21. Plants less than 15 cm tall; leaves fascicled..... **Dasyochloa pulchella**
- 21. Plants usually more than 20 cm tall; leaves not conspicuously fascicled.

22. Awns 2 or more cm long.

- 23. Awns several per spikelet, scabrous, straight or moderately curved but not bent..... **Elymus elymoides**
- 23. Awns one per spikelet, feathery or twisted at base, and bent.

- 24. Older leaves semi-persistent and reddish brown or rust colored; inflorescences unbranched (rames); awns 4.5–7 cm long. **Heteropogon contortus**
- 24. Older leaves drying straw color; inflorescences branched (panicles); awns 2–4.5 cm long.

- 25. Inflorescence a panicle of short cottony rames clustered near top of stem; awns 2 cm long, the basal portion twisted and not feathery..... **Bothriochloa barbinodis**

- 25. Inflorescence an elongated spike-like panicle and not cottony; awns 3.3–4.5 cm long, the basal portion feathery (plumose) and not twisted..... **Pappostipa speciosa**

22. Awns less than 1.5 (2) cm long.

- 26. Inflorescence spike-like, appearing unbranched, less than 1.5 cm wide, the main axis zigzag; spikelets in clusters of 3..... **Hilaria**
- 26. Inflorescence a panicles, the main axis not zigzag, usually more than 1.5 cm wide; spikelets solitary, or in 2's (terminal spikelets sometimes in 3's).

- 27. Plants bushy, not tufted, branching freely in upper part of plant; panicles about as wide as long..... **Muhlenbergia porteri**
- 27. Plants tufted, branching mostly from base (not including the inflorescences); panicles usually longer than wide.

- 28. Spikelets dissimilar, in 2's (3's terminally on branchlets); awns twisted and readily deciduous..... **Sorghum halepense**
- 28. Spikelets all similar, not as above; awns persistent, not twisted.

- 29. Spikelets with 1 floret; awns more than 10 mm long. **Aristida ternipes** var. **ternipes**

29. Spikelets with several florets; awns less than 0.5 mm long..... **Tridentopsis eragrostoides**

17. Ephemerals (roots often weakly developed)/annuals.

30. Spikelets clustered in 3's; glumes bristle-like..... **Hordeum murinum**

30. Spikelets not clustered in 3's; glumes not bristle-like.

31. Spikelets (excluding awns and pedicels) at least 10 mm long (rarely 8 or 9 mm long in *Festuca*), clearly with 2 or more florets; winter-spring ephemerals.

32. Glumes thin and longer than the florets (excluding awns), the glumes and lemmas of different textures; awns twisted and bent, 3.5–4.5 cm long..... **Avena fatua**

32. Glumes shorter than the spikelet and similar in texture to the lemmas; awns straight or twisted and bent, 2.2 cm or less in length.

33. Sheaths closed most of their length; spikelets 12–40 mm long (not including awns); lemmas 8–13 mm long; awns straight, curved, or twisted..... **Bromus**

33. Sheaths open; spikelets 8–13 mm long (not including awns); lemmas 4–8 mm long; awns straight..... **Festuca**

31. Spikelets (excluding awns and pedicels) 2–6 (7) mm long, with 1–several florets; winter-spring or summer ephemerals.

34. Inflorescences panicles of spicate, unilateral branches.

35. Inflorescence branches single at intervals along main inflorescence axis (occasional, stunted plants with a single branch).

36. Awns 6 mm or less in length; sterile florets above fertile florets, the sterile lemmas minute; desert habitats, widespread.... **Bouteloua**

36. Awns often more than 10 mm long; sterile floret below the fertile floret, the sterile lemma equal to upper glume and fertile lemma; wetland habitats or moist soil..... **Echinochloa crus-galli**

35. Inflorescence branches 2 or more digitately arranged at top of main axis (rarely a single spike on stunted *Dactyloctenium* plants).

37. Spicate branches (4) 5–10 (12 or more) and ascending (upright); rachis tip not extending beyond spikelets; spikelets (lemma of lower floret) with a tuft of long white hairs, the awns 5–20 mm long.
..... **Chloris virgata**

37. Spicate branches (rarely 1) 2–6, spreading (at nearly right angles to main axis); rachis tip extending beyond the spikelets; spikelets glabrous, the awns 0.5–3.2 mm long.... **Dactyloctenium aegyptium**

34. Inflorescences not panicles of spicate, unilateral branches.

38. Spikelets with a conspicuous basal cup-like or disk-like ring, with only one well-developed glume..... **Eriochloa**

38. Spikelets without a basal cup or disk, with 2 glumes.

39. Spikelets with several fertile florets; awns 1 mm long
..... **Dinebra viscida**

39. Spikelet with only 1 fertile floret; awns at least 5–10 mm long.

40. Panicles dense, more or less cylindrical and appearing “furry” like a rabbit’s foot..... **Polypogon monspeliensis**

40. Panicles open or interrupted with spike-like branches, not appearing “furry.”

41. Coarse grasses with dense spike-like branches at widely spaced intervals on a main axis; fertile lemmas hard and shiny; cleistogenes none; natural and disturbed wetland habitats.

..... **Echinochloa crus-galli**

41. Delicate grasses with open and filmy panicles; lemmas thin and dull; lower stem axils commonly with cleistogenes; widespread including desert habitat.

..... **Muhlenbergia microsperma**

13. Spikelets not awned (sometimes with minute bristles or mucros).

42. Non-seasonal ephemerals to perennials; spikelets with 1 floret, 1.4–2.1 mm long, with a pedicel-like stipe; glumes longer than the florets and minutely scabrous; lemmas 5-veined; Quitobaquito **Polypogon viridis**

42. Spikelets with 1 or more florets, if with a single floret the spikelets larger, and/or not scabrous, and/or the lemmas not 5-veined.

43. Perennials.

44. Spikelets pubescent.

45. Spikelets cottony with silky, white or purplish, usually curling hairs; lower glume less than 1 mm long..... **Digitaria californica**

45. Spikelets not cottony, sparsely to moderately pubescent, the hairs straight and not silky; lower glume 2+ mm long..... **Tridentopsis**

44. Spikelets glabrous.

46. Spikelets including the glumes papery and shiny, glumes 7–15 mm long.
..... **Melica frutescens**

46. Spikelets not papery and shiny; glumes not more than 5 mm long.

47. Inflorescences 0.5–1 cm wide, dense, spike-like panicles.

..... **Muhlenbergia rigens**

47. Inflorescences more than 3 cm wide, not dense, spike-like panicles.

- 48. Cleistogenes often present at stem bases; panicles not enclosed in leaf sheaths; spikelets with 5 or more florets; lemmas 3-veined, notched at tip..... **Disakisperma dubium**
- 48. Cleistogenes not present stem bases; young panicles often enclosed in a large leaf sheaths, with age usually becoming open and diffusely branched; spikelets with 1-floret; lemmas 1-veined, not notched.
..... **Sporobolus**

43. Ephemerals.

49. Hot weather (summer-fall) ephemerals.

- 50. Spikelets with only one well-developed glume and a cup-like disk at the base (the glume and sterile lemma are similar)..... **Eriochloa**
- 50. Both glumes well developed, spikelets without a cup-like disk at base.

51. Spikelets with 2 or more distinct, fertile florets; glumes similar or unequal in length.

52. Primary panicle branches two or more times branched, the secondary branches usually ascending to spreading; pedicels often as long as or longer than the spikelets..... **Eragrostis**

52. Primary panicle branches unbranched, spike-like, or with secondary branchlets closely appressed; pedicels much shorter than the spikelets or spikelets sessile..... **Dinebra panicea**

51. Spikelets with 1 floret, or superficially appearing to have a single floret (with 1 fertile floret and one reduced floret represented by a sterile lemma); glumes unequal in length, one or both conspicuously shorter than the lemma.

53. Leaves often with purple spots or bands; inflorescences of 3–7 racemosely-arranged, widely spaced, spicate branches 1–2 (3) cm long; spikelets densely crowded..... **Echinochloa colona**

53. Leaves not purple spotted or banded; inflorescences diffuse panicles or contracted and spike-like in immature inflorescences of *Sporobolus*; spikelets pedicellate, not densely crowded.

54. Spikelets 1–1.8 mm long, breaking apart above the glumes; spikelets with 1 floret, lacking a sterile floret; lemma, palea, and caryopsis distinct from each other.

55. Panicle branches alternate (single) or opposite; spikelets 1–1.2 mm long; lemmas 3-veined..... **Muhlenbergia fragilis**

55. Branches at lowest node of panicle whorled with (4) 5 or more branches (concealed by leaf sheath in younger inflorescences); spikelets 1.5–1.8 mm long; lemmas 1-veined.
..... **Sporobolus pyramidatus**

54. Spikelets 2.3–4 mm long, falling as a unit (breaking off below the glumes); spikelets with a fertile and a sterile floret, the sterile

floret represented by a prominent lemma; fertile lemma firmly enclosing the palea and caryopsis.

56. Plants variously hairy but panicle branches, branchlets, and spikelets glabrous; prominent veins of spikelets longitudinal only. **Panicum**

56. Plants hairy, including panicle branches, branchlets and spikelets; prominent veins of spikelets longitudinal and transverse on upper part of spikelet to form a net-like pattern..... **Urochloa**

49. Cool season (winter-spring) ephemerals.

57. Primary panicle branches spreading; prominent large shining yellow, pink, or purplish glandular areas or rings at or below nodes, especially prominent on lower nodes of inflorescences (rare in the flora area)..... **Eragrostis barrelieri**

57. Primary panicle branches appressed or closely ascending; plants without large shining glandular areas or rings.

58. Glumes conspicuously shorter than florets..... **Poa**

58. Glumes longer than the florets.

59. Spikelets with one fertile floret and 1 or 2 scale-like sterile florets below; glumes usually with a winged keel..... **Phalaris**

59. Spikelets with several similar fertile florets, and without sterile florets below the fertile ones; glumes not winged..... **Schismus**

SPECIES ACCOUNTS

This is a specimen-based flora and we have seen or verified all specimens cited. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2013). Vernacular (common) names follow the scientific names or synonyms and when known or deemed worthwhile are given in English, Spanish, and the Hia C-ed O’odham dialect, respectively. The Spanish-language names are italicized.

All photos and scans are by Sue Rutman and all line art is by Lucretia Brezeale Hamilton (1908–1986) unless otherwise stated. The scans were made with fresh specimens. Lucretia’s artwork also has appeared in numerous publications, especially ones published by the University of Arizona Press (e.g., Felger 2000, Felger & Moser 1985, Gould 1951, Parker 1972).

Aristida – Three-awn; *zacate tres barbas*

Annuals/ephemerals and perennials, often tufted, without stolons or rhizomes. Ligule a line of hairs. Spikelets with 1 floret, readily breaking off above the glumes (often lodging in socks and fabric shoes, so that people are often dispersal agents along with various animals). Glumes persistent, the upper and usually also the lower glume 1-veined. Lemmas hard at maturity, terete, slender, with a sharp-pointed callus at the base, the lemma apex elongated into a straight or twisted awn column or neck (narrowed part of awn column), the awn column bearing 3 awns, or the lateral awns sometimes reduced or absent, or the awns occasionally suppressed in drought-stressed plants. Figure 2.

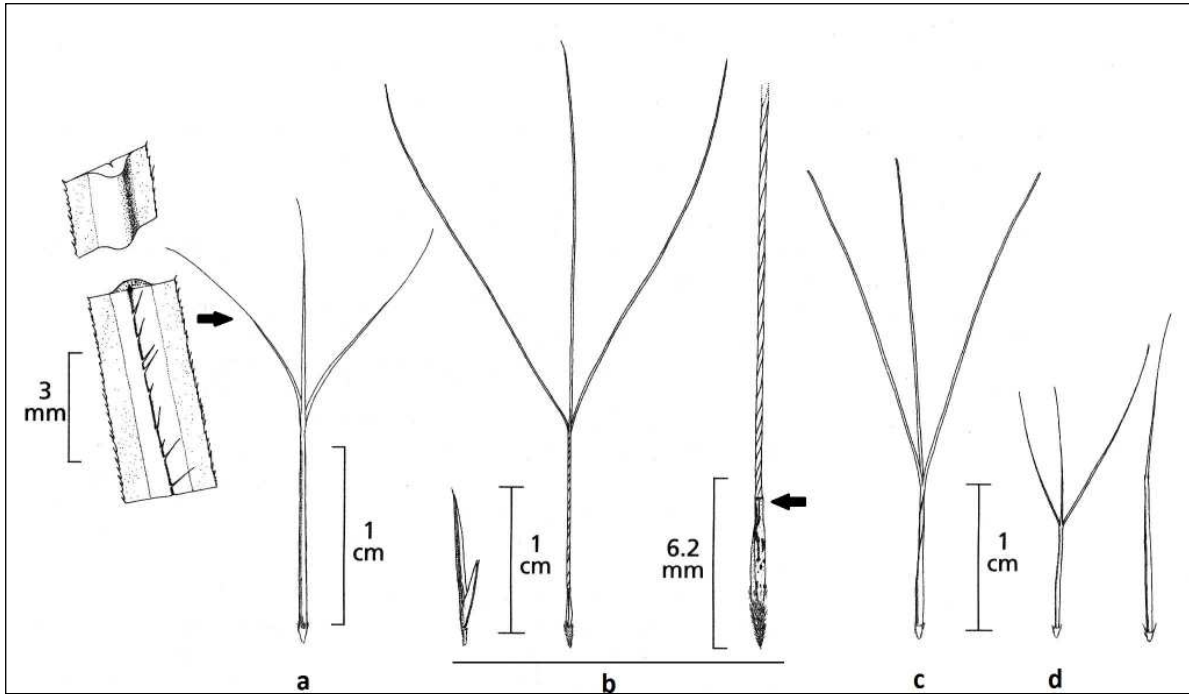


Figure 2. *Aristida* spikelets. (A) *A. adscensionis*, note enlarged portion of flattened awn and minute hairs on the upper surface; (B) *A. californica* var. *californica*, glumes on left, arrow points to the articulation near the base of the long awn column; (C) *A. purpurea* var. *nealleyi*; (D) *A. ternipes* var. *gentilis* (left) and var. *ternipes*. Illustration by Matthew B. Johnson (from Felger 2000).

The four species in the flora region can grow and become reproductive at various seasons depending on soil moisture, although the perennials tend to become inactive with cooler weather in winter and are sometimes reproductive in their first season.

1. Spikelets 1-awned, or lateral awns very short and stubby; perennials. ***Aristida ternipes* var. *ternipes***
1. Spikelets 3-awned, the 3 awns usually well developed (if lateral awns reduced, then the plants are stunted ephemerals); ephemerals or perennials.
 2. Ephemerals; awns flattened with minutely serrated margins (seen with at least 10× magnification), reaching 1.5 (1.7) cm long (awns occasionally very reduced, especially the lateral ones)..... ***Aristida adscensionis***
 2. Perennials (sometimes flowering in the first season); awns terete, (1.6) 2 or more cm long.
 3. Awn column of mature spikelets breaking apart at a line of separation (seen as a horizontal line across the column) just above the lemma body; awns 3–5 cm long.... ***Aristida californica***
 3. Awn column not jointed; awns (1.6) 2–3 cm long.
 4. Panicles open and conspicuously branched, the branches mostly long and spreading at about 90° from the main axis..... ***Aristida ternipes* var. *gentilis***
 4. Panicles contracted to moderately spreading, the branches short, mostly spreading at 45° or less..... ***Aristida purpurea***

***Aristida adscensionis* Linnaeus**

Six-weeks three-awn; *zacate tres barbas*. Figure 3.

Non-seasonal ephemerals; 7–30 (60) cm tall, often with a purple-brown cast during cooler, drier seasons and green to yellow-green during summer-fall rainy season; glabrous except very short hairs of the ligule and minutely scabrous pedicels. Roots usually weakly developed. Panicles narrow (contracted), with short erect-ascending branches, or larger well watered plants often with larger and somewhat spreading branches. Glumes unequal: lower glume shorter, the upper glume longer, ranging from shorter to slightly longer than lemma. Lemmas 6.5–10.5 mm (shorter on drought-stressed plants), tapered toward the tip, not twisted; awn column short or with no discernable neck. Awns usually 3, often 5–15 (17) mm long, about equal to unequal in length, flattened (a useful diagnostic character and one of striking beauty seen with at least 10× magnification), the midrib prominent, its upper (adaxial) surface bearing a row of slender hairs 0.5–0.8 mm long; awn margins narrowly winged, thin, translucent, and serrulate. Drought-stressed plants or local populations sometimes with reduced or aborted lateral awns, or all awns reduced or rarely awnless.



Figure 3. *Aristida adscensionis*. (A & C) Little Ajo Mts, Pima Co., 2 Apr 2013; (B) spikelet.

Widespread and seasonally common across the flora area, from lowest to highest elevations, sandy to rocky soils. It has been widespread in the region for at least 32,000 years.

One of the several most widespread and abundant ephemerals of the Sonoran Desert and the only annual (ephemeral) *Aristida* in the Sonoran Desert Region. Warmer regions of the world (Africa, Americas, Eurasia), deserts to relatively humid, tropical and temperate climates. In some non-desert regions plants of this species are short-lived perennials with stout roots.

Worldwide “a number of varieties have been proposed . . . but they intergrade one with another and their significance is doubtful” (Clayton 1972: 372). Beetle (1974) recognized 7 varieties for Mexico, but Felger (2000) and others did not find them worthy of recognition. Recognizing two subspecies worldwide, Tzvelev (1983) restricted subsp. *adscensionis* to the New World and parts of Africa. He reported subsp. *heymanii* in the Old World, distinguished by having the lemma longer than the upper glume and being scabrous only along the keel. However, these features occur on plants from the flora area and elsewhere in the New World. Furthermore, the relative lengths of the lemma and upper glume can vary with age and growing conditions (Allred 2003; Felger 2000).

OP: Bates Well, *Nichol 26 Apr 1939*. Alamo Canyon, 3 Dec 1977, *Bowers 978*. Sierra de Santa Rosa, 11 Feb 1978, *Bowers 1034*. †Alamo Canyon, florets, 8590 to 32,000 ybp (3 samples). †Montezuma’s Head, 13,500 to 21,800 ybp (4 samples). †Puerto Blanco Mts, 130 to 7560 ybp (6 samples, Van Devender et al. 1990: 339).

CP: 6 mi E of Papago Wells, 1100 ft, 28 Feb 1976, *McLaughlin, Fugate, & McManus 1037* (SNM). Charlie Bell Pass, 3 Apr 1992, *Whipple 3954*. Bates Well Rd at E boundary of the Refuge, 14 Sep 1992, *Felger 92-681*. San Cristobal Wash, 14 Sep 1992, *Felger 92-690*. Pinta Sands, 1 Feb 1992, *Felger* (observation).

TA: Frontera Canyon, 18 Mar 1998, *Felger* (observation). Tinajas Altas, 25 Oct 2004, *Felger 04-69*. †Butler Mts, 8160 & 10,615 ybp (Van Devender et al. 1990: 342). †Tinajas Altas Mts, 5080 to 10,070 ybp (3 samples, Van Devender et al. 1990: 341).

***Aristida californica* Thurber**

Non-seasonal perennials, readily recognized by the articulated awn column and long, slender awns. Lemmas jointed at the column base (the articulation, visible as a line across the column, is best seen on mature spikelets); awn column relatively long, loosely twisted, relatively slender, often lighter colored than the lemma body. Reproductive at various seasons depending on soil moisture.

Soon after (or sometimes even before) the florets fall away or blow away from the parent plant, the awn column breaks off at the joint just above the body of the lemma, leaving the seed-bearing lower part free from the long awns and thus slowing its movement. The jointed, or articulated, awn column is a distinctive feature of a small group of sand-inhabiting aristidas in widely disjunct regions around the world once regarded as section *Arthratherum* (Henrard 1929–1932), but Cerros-Tlatilpa et al. (2011) clearly show that Henrard’s *Arthratherum* is not monophyletic. There is no other *Aristida* in western North America with an articulated awn column. There are two allopatric varieties.

- 1. Stems pubescent..... ***Aristida californica* var. *californica***
- 1. Stems glabrous..... ***Aristida californica* var. *glabrata***

Aristida californica* var. *californica[*A. peninsularis* Hitchcock. *A. californica* var. *fugitiva* Vasey]California three-awn; *tres barbas de California*. Figure 4.

Figure 4. *Aristida californica* var. *californica*. Plant with young panicles showing the reddish awns, a common color during cooler and drier months, dunes south of Sierra Blanca, Pinacate Reserve, Sonora, 20 Feb 2002.

Perennials, sometimes flowering in the first season; small tufted clumps overtopped with densely-flowered panicles; often with a red-purple cast during the cooler, drier times of the year and green during summer rainy season. Roots relatively thick, fleshy, well developed, encased in a jacket of sand laced together by a felt-like mat of root hairs. At least the lower stem internodes with fine to coarse white-woolly hairs (note: look at the actual stem, not just the leaf sheath). Upper glume 10.5–17.5 mm long, the lower one shorter. Lemma body (portion below joint of column) (5) 5.5–6 (7) mm long, often gray and mottled; awn column (10) 12–18 (28) mm long, loosely twisted, slender, often lighter colored than the lemma body; awns 3–5 cm long.

Cabeza Prieta on the sand flats and dunes of the Pinta Sands and similar nearby habitats along the southern margin of the Refuge. Also in nearby regions such as the Mohawk Dunes and widespread in the adjacent Gran Desierto.

Southwestern Arizona, southeastern California, both Baja California states, and northwestern Sonora southward on coastal dunes to northwestern Sinaloa.

The roots of this and various other perennial grasses inhabiting desert sands are often encased in a jacket of sand laced together by mucilage and felt-like mats of persistent root hairs. These sheaths of sand grains, or rhizosheaths, create a nano-habitat supporting nitrogen-fixing bacteria (Danin 1996). The rhizosheaths of *Aristida californica* var. *californica* are especially conspicuous and seem best developed during times of high soil moisture (Felger 2000). The Seris fashioned hairbrushes from the wiry roots (Felger & Moser 1985).

CP: Pinta Sands, 590 ft $2n = 22$, 5 Mar 1977, *Reeder 6835*. Edge of Pinacate Lava and Pinta Sands (8 mi W of O'Neill's Grave), 590 ft, sandy wash, 6 Mar 1977, *Reeder 6838*. E Pinta Sands, 16 Jun 1992, *Felger 92-628*.

***Aristida californica* var. *glabrata* Vasey**

[*A. glabrata* (Vasey) Hitchcock]

Smooth California three-awn, Santa Rita three-awn

Plants glabrous, including stems. Sandy loam soils of washes and roadsides in the north-central part of Organ Pipe.

Eastward and northward across much of the southern half of Arizona, northern and west-central Sonora, Isla Tiburón, and both states of Baja California. This variety generally occurs on firmer ground than does var. *californica* and their local ranges do not overlap (Reeder & Felger 1989).

OP: 4 km S of the N entrance of Monument along Hwy 85, localized clumps at edge of road, 27 Oct 1987, *Reeder 8218*. 2.2 mi on Hwy 85 south of N entrance of monument, roadside, 12 Nov 1987, *Felger 87-334* (ARIZ, ASU).

***Aristida purpurea* Nuttall**

Purple three-awn. Figure 5.

Tufted perennials with well-developed fibrous roots. Ligules with a sparse tuft of loosely tangled hairs; leaf blades narrow, firm, inrolled or flat when well-watered during growing seasons, the upper surfaces with short, stiff, somewhat scabrous hairs. Panicles overtopping the leaves. Glumes usually unequal. Lemmas with or without a conspicuous neck (column), but shorter than 3 mm; awns about equal in length. Flowering response non-seasonal.

Aristida purpurea including its varieties extends from Mexico through western USA to Canada. Allred (1984, 2003) recognized 10 varieties in North America, and other members of the complex occur in South America.

- 1. Panicles contracted to often moderately open; glumes often with a short awn or mucro; body of lemma gradually tapering, without an evident awn column (lacking a discernable neck).
..... ***Aristida purpurea* var. *parishii***
- 1. Panicles mostly contracted; glumes not awn-tipped; upper part of awn column often twisted, the neck (narrowed part of awn column) usually evident, often 1–2 mm long.
- 2. All or most panicle branches straight (lower branches sometimes lax); pedicels straight, appressed to ascending; awns 15–30 mm long..... ***Aristida purpurea* var. *nealleyi***
- 2. All or most of the panicle branches and pedicels drooping to sinuous distally; awns (29) 35–42 mm long..... ***Aristida purpurea* var. *purpurea***

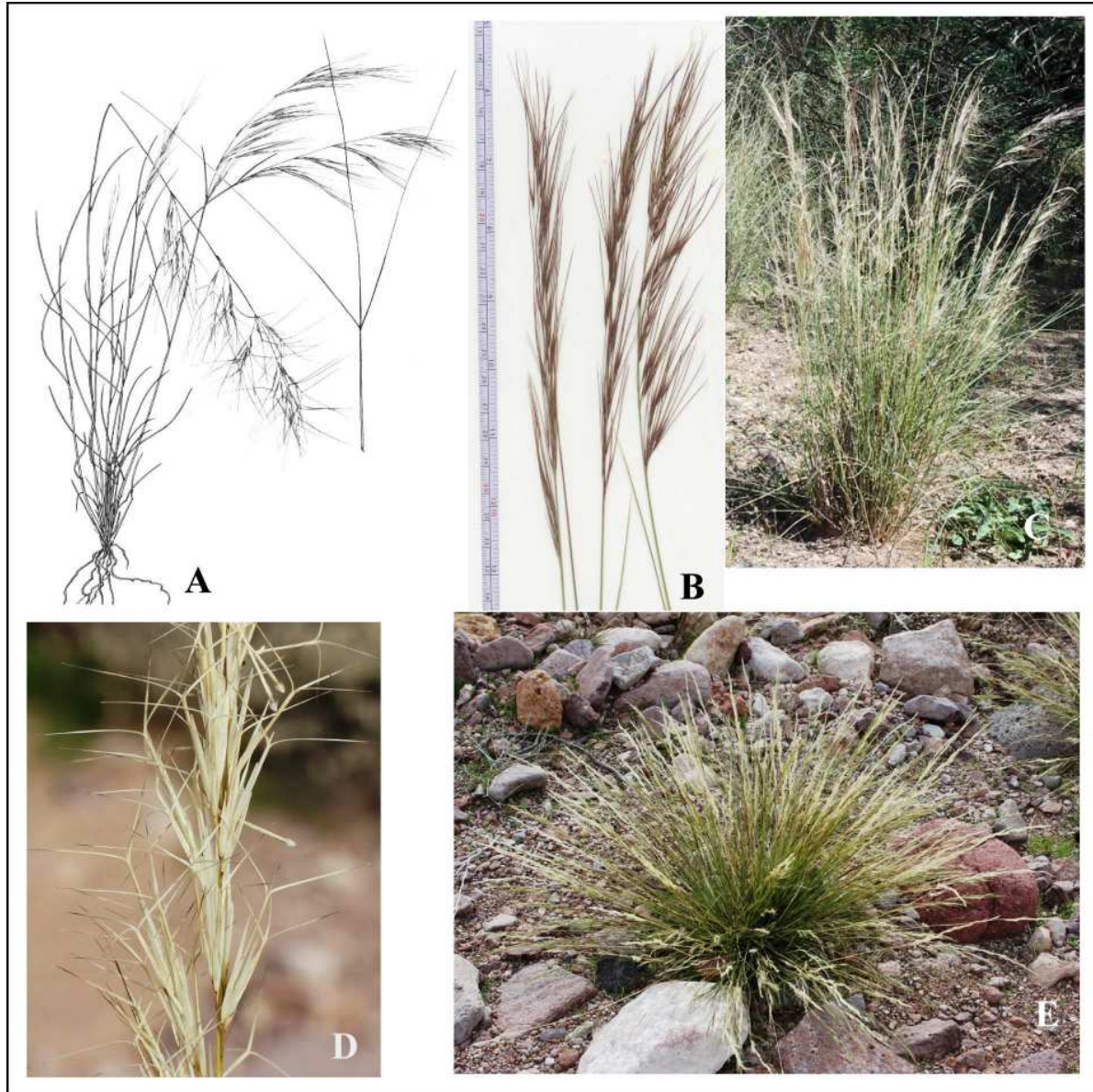


Figure 5. *Aristida purpurea*. Var. *purpurea*: (A) plant and spikelet; (B) Hwy 85 near north boundary of Organ Pipe, 30 Jan 2014; (C) Hwy 86 near Quijotoa, Pima Co., 21 Sep 2004. Var. *nealleyi*: (D & E) Valley of the Ajo, drainage near Hwy 85 near mile marker 66, 28 Dec 2013.

***Aristida purpurea* var. *nealleyi* (Vasey) Allred**

[*A. glauca* (Nees) Walpers]

Nealley three-awn; *tres barbas*. Figure 5D & E.

Perennials mostly 30–60 cm tall. Panicles mostly contracted (at first glance sometimes appearing unbranched; or exceptionally well-watered plants may reach 70 cm and the panicles not strongly contracted). Upper glume (8.5) 10–14.5 mm long, usually at least 1/3 longer than the lower glume. Lemmas 8–13.5 mm long. Awns nearly equal, 1.5–3 cm long; awn column often twisted (but not always conspicuously so), 1–2+ mm long, lighter in color than the lemma body and slightly narrowed to form the neck; drought-stressed plants tend to have a shorter columns.

One of the most common perennial grasses in the region; widespread including bajadas, hills and mountains often to their summits, valley plains often along small drainageways, and common along Highway 85; not on dunes. The history of the species or variety in the flora area extends to 11,250 years.

Var. *nealleyi* is the most wide-ranging taxon in the *A. purpurea* complex as well as in the flora area; this variety ranges from Puebla, Mexico, to southwestern USA. Some of the Organ Pipe plants might be identified as var. *purpurea*, but such specimens may be difficult to distinguish. “Although var. *nealleyi* is more distinct than the other varieties, having tufts of foliage exceeded by narrow, straw-colored panicles, it grades into var. *purpurea* (Allred 2003: 333).

OP: Bates Well, *Nichol 26 Apr 1939*. 0.7 mi N of Visitor Center on Hwy 85, 8 Sep 1984, *Van Devender 84-446*. Between Quitobaquito and Aguajita, 23 Feb 1990, *Felger 90-49*. 1 mi W of Hwy 85 near Armenta Rd, *Rutman 16 Aug 2001* (ORPI). Trail above Bull Pasture, 4090 ft, 10 Apr 2005, *Felger 05-290*.

CP: 6 mi E of Papago Wells, in wash, 11 ft, 28 Feb 1976, *McLaughlin 1044*, *Fugate*, & *McManus* (SNM). 10.5 km W of Tule Well along Camino del Diablo, 15 Mar 1983, *Reeder 7591*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger 92-606*. Packrat Hill, 12 Jun 1992, *Felger 92-540*. Childs Mt, 2845 ft, 18 Aug 1992, *Felger* (observation). Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: Tinajas Altas: *Vorhies 16 Apr 1924*; 17 Apr 1948, *Kurtz 1165*. Butler Mts, *Van Devender 27 Mar 1983*. †Butler Mts, 6490 ybp (Van Devender et al. 1990: 342). †*A. cf. purpurea*, Butler Mts, 6490 to 11,250 ybp (3 samples, Van Devender et al. 1990: 342). †Tinajas Altas Mts, 4010 & 9700 ybp (Van Devender et al. 1990: 341).

***Aristida purpurea* var. *parishii* (Hitchcock) Allred**

[*A. parishii* Hitchcock]

Parish three-awn

Perennials often 40–70 cm tall. Young inflorescences and spikelets dark purple-brown during winter and spring. Panicles contracted to moderately open. Glumes mostly (or at least some on each panicle) equal or subequal, the upper glume 11–13.5 mm long. Lemmas 9–13 mm long, tapering to the awn base, sometimes narrowed into a neck and slightly twisted; awns equal or nearly so, 16–27 mm long.

Localized, often as small populations and apparently not widespread in the flora area. Generally in sandy to gravelly or rocky soils along the margins of washes. Vicinity of Quitobaquito and the western margin of Organ Pipe and the eastern portion of Cabeza Prieta. Often growing near but not intermixed with *A. purpurea*. Although growing within 100 m of the Mexico border, var. *parishii* is not known for Sonora.

Variety *parishii* can be distinguished from var. *nealleyi* by its more robust habit and often moderately spreading panicle branches, subequal glumes often with a short mucro or awn, somewhat larger spikelets, and shorter awn column—without an evident and twisted neck. Allred (2003) reports that var. *parishii* flowers March–May in response to cool-season rains.

Southern California, Baja California, southern Nevada, and Arizona.

OP: Puerto Blanco Drive, 22 Oct 1964, *Ranzoni 368* (ORPI). Aguajita Wash, 3 Mar 1992, *Felger 92-102*.

CP: Agua Dulce Mts, wash, 305 m, 2n = 66, 5 Mar 1977, *Reeder 6830*. Papago Well, 31 Jan 1992, *Felger 92-10*. 3.4 mi N of Tule Tank, 2 Feb 1992, *Felger 92-70*. Daniels Arroyo at Charlie Bell Rd, 25 Feb 1993, *Felger 93-73*.

Aristida purpurea var. **purpurea**

Purple three-awn. Figure 5A-C.

Plants to 50 cm tall. All or most of the panicle branches and pedicels drooping and often sinuous distally; awns (29) 35–42 mm long (the longer ones in a spikelet). Perhaps the few records for this variety in the flora area are robust specimens of var. *nealleyi*.

Var. *purpurea* is geographically wide-ranging but generally a non-desert taxon. There are relatively few specimens identified as this variety from the Sonoran Desert and these mostly at the margins of the desert. Some well-watered plants within the usual range of var. *nealleyi* have been identified as var. *purpurea*. Are they genetically different? Allred (2003: 333) points out that “var. *purpurea* is admittedly, a broadly defined taxon.” This variety ranges from Canada to Mexico and Cuba.

OP: Valley of the Ajo, Kuakatch Wash, 450 m, fine sandy loam, uncommon, *Rutman 5 Oct 1995* (ORPI, det. J.R. Reeder 1996). Drainage N of Bates Mts and E of Bates Well Road, 32.18751° N, 112.90445° W, perennial grass on sandy loam flat, in an area where water settles and a relatively high density of perennials and annuals occur, including *Hilaria rigida*, *Prosopis velutina* and *Ambrosia deltoidea*; surrounding area relatively flat and dominated by *Larrea*, 7 Oct 2006, *Rutman 20061007-2*.

Aristida ternipes Cavanilles

Coarse, tufted perennials 0.5–1 m tall, also flowering in the first season. Roots tough and wiry. Ligules glabrous or with a sparse tuft of loose hairs. Leaf blades inrolled in drought to flat when well watered, the upper surface glabrous or with short, somewhat rough hairs. Panicles openly branched, the branches spreading to approximately 90°. Glumes subequal (spikelets at first often showing only one glume, the lower glume develops with a little more age). Awns 1 or 3 in number, 11–20 mm long (when 3 awns present, one usually longer than the others). Awn column not twisted (or only slightly so), short (1 mm or less), with no discernable neck.

There are two varieties and they have not been found growing intermixed in the flora area or across much of the Sonoran Desert. There places, however, where they do occur intermixed, such as in Catalina State Park on the west side of the Catalina Mountains above Tucson.

- 1. Spikelets 3-awned..... **Aristida ternipes** var. **gentilis**
- 1. Spikelets 1-awned..... **Aristida ternipes** var. **ternipes**

Aristida ternipes var. **gentilis** (Henrard) Allred

[*A. gentilis* Henrard. *A. hamulosa* Henrard. *A. ternipes* var. *hamulosa* (Henrard) Trent]

Poverty three-awn; *zacate araña de tres barbas*. Figure 6A.

Upper glume 12–14.5 mm long; lemmas 10–12 mm long. Awns 3, well developed but often unequal in length, the longer awn 12–20 mm long.

Common in the Ajo Mountains and scattered elsewhere in Organ Pipe. Apparently rare in Cabeza Prieta and occasional along roadsides in nearby regions.

Western Texas to southern California and southward to Guatemala.

OP: Bull Pasture, *Wirt 12 Nov 1989* (ORPI). 0.2 mi E on Bates Well Rd from intersection with Pozo Nuevo Rd, *Rutman 23 Aug 2001* (ORPI). N extension of Puerto Blanco Mts, N of Puerto Blanco Drive, 14 Mar 2003, *Rutman 2003-306* (ORPI).

CP: Just N of Jose Juan Tank, gravelly soil, several dozen plants, 14 Sep 1992, *Felger 92-710*.

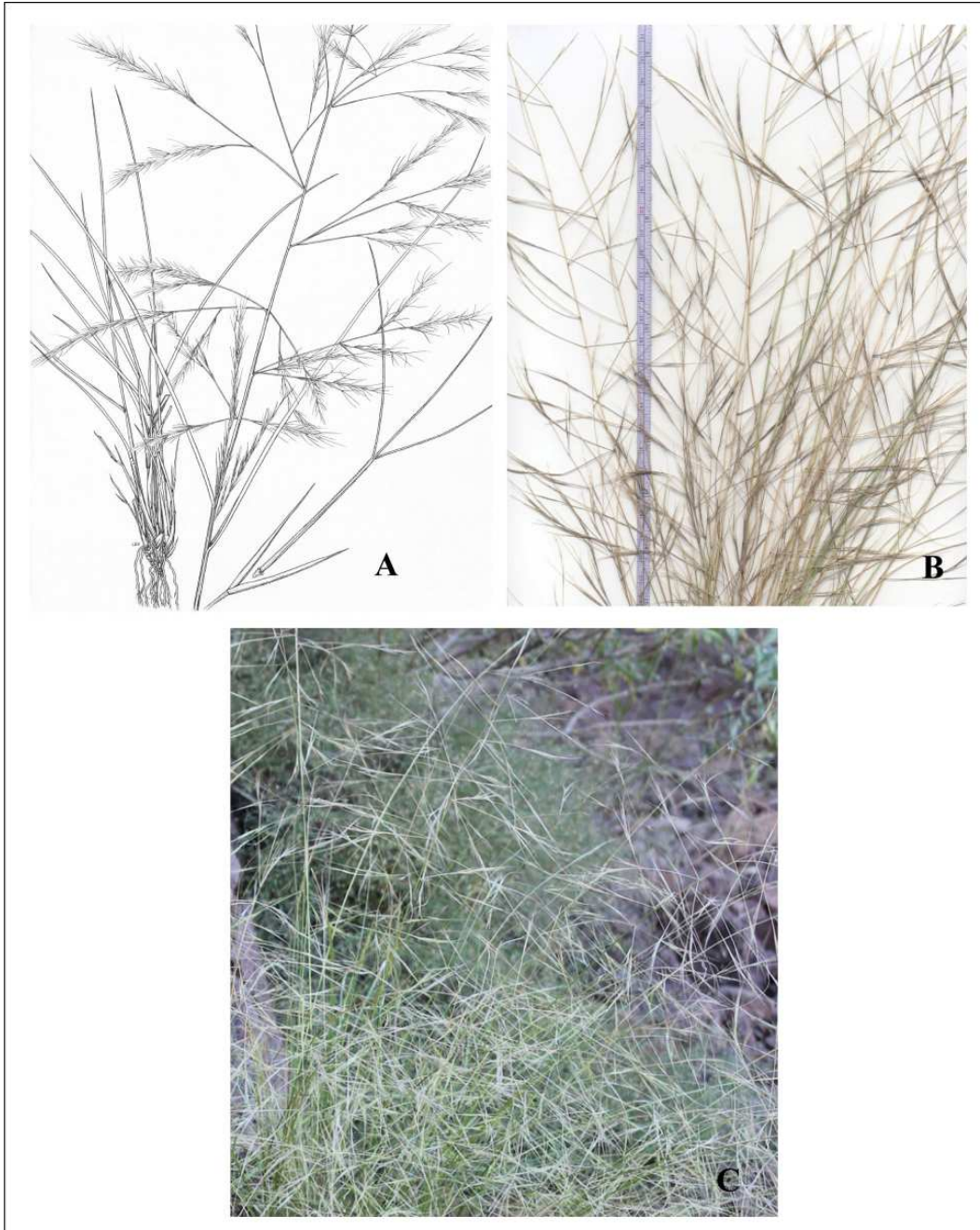


Figure 6. *Aristida ternipes*. (A) Var. *gentilis*: plant, panicle, and spikelet with floret separated from the glumes; Var. *ternipes*: (B) Chuckwalla Hills, Organ Pipe, 5 Oct 2013; (C) Bull Pasture, Ajo Mts, 25 Sep 2013.

Aristida ternipes* var. *ternipes

Spider grass; *zacate araña*. Figure 6B-C.

Upper glume 10–15 mm long; lemmas 13–19 mm long, with one well-developed awn, straight or moderately curved, 11–14 mm long. The lateral awns fail to develop or are present but greatly reduced.

Canyons and slopes; fairly common at scattered mountain localities across Cabeza Prieta and much of Organ Pipe including the Ajo Mountains.

Arizona to Texas and South America, and the West Indies.

OP: Alamo Canyon, *Nichol* 4 May 1939. Ajo Mt Drive, 2000 ft, 5 Nov 1977, *Bowers* 917. Diablo Mts, grassy slopes, 12 Sep 2013, *Rutman* 20130912-2.

CP: Agua Dulce Spring, 13 Jun 1992, *Felger* 92-579b. Eagle Tank, 13 Jun 1992, *Felger* (observation).

****Avena fatua*** Linnaeus. Figure 7.

Wild oats; *avena silvestre*, *avena cimarróna*, *avena loca*; 'agspĩ mudat-kam, ko:ksam

Winter-spring ephemerals, often 0.5+ m tall (occasionally to about 1 m). Panicles open and sparse, the branches drooping. Spikelets relatively large, on long, slender, and often curled pedicels, mostly with 2 or 3 florets, breaking apart above the glumes and between the florets. Glumes 2–3 cm long, thin and longer than the florets. Lemma often 1.5–2 cm long with red-brown hairs and a stout awn 3.5–4.5 cm long, strongly twisted below and bent at the middle.

Widely scattered in Organ Pipe where it has become locally more common since about 2000.

Native of Eurasia; widely naturalized and weedy including western North America. Common along roadsides north and east from Ajo, AZ. Cultivated oats are *A. sativa*.

OP: Bull Pasture, 2 May 1978, *Bowers* 1275. Eagle Pass, base of hills, Hwy 85, N end Diablo Mts, *Rutman* 14 Apr 1998. Estes Canyon, 18 Mar 2005, and 25 Apr 2013, *Rutman*, photos.



Figure 7. *Avena fatua*. (A) Plant, leaf, panicle, and spikelet; (B) Javelina Mts, Maricopa Co., 5 Mar 2005.

Bothriochloa barbinodis (Lagasca) Herter
 [*Andropogon barbinodis* Lagasca]
 Cane bluestem; *zacate popotillo*. Figure 8.



Figure 8. *Bothriochloa barbinodis*. (A) Bull Pasture, 25 Sep 2013; (B) panicles, east of Why, Pima Co., 15 Sep 2013.

Robust tufted perennials often 0.75–1 m tall; growing and reproductive during warm weather. Usually villous with dense tufts of long, white hairs at nodes, ligules, and on inflorescences. Leaves drying reddish brown, at least the bases semi-persistent; leaf blades flat. Fresh, crushed pieces of the plant, especially the inflorescences, often have a mild blueberry-like fragrance. Inflorescences of terminal panicles, the branches simple rames or sparingly rebranched. Panicles 5–11 cm long, white and cottony, with numerous branches clustered at the top of tall, nearly naked culms. Spikelets andropogonoid, the rames (individual stalks of the spikelet pairs or triplets, the rachis joints, and pedicels) with a central groove or membranaceous area appearing as a thin, translucent or “naked” area; rachis joints and pedicels with hairs reaching 6–8 mm long. Glumes of both spikelets large and firm (indurate). Glumes of the sessile (fertile) spikelets about equal in size, 5–5.5 mm long, but

differently shaped: lower glume broad, green, and flat to concave on the back; upper glume markedly humpbacked or V-shaped with a blunt keel (ridge). Fertile lemma bearing a stout, twisted, bent awn 14–22 mm long. Sterile (pedicelled) spikelet reduced to a deciduous linear rudiment 3.5–4 (5) mm long.

Abundant at the high elevations in the Ajo Mountains and much less common at lower elevations. West of the Puerto Blanco Mountains in Organ Pipe, it is found in places of higher than usual soil moisture such as near waterholes and seeps along canyon bottoms. In Cabeza Prieta locally in the vicinity of Cabeza Prieta and Tule Tanks and in the Tinajas Altas Region it has been observed in the mountains above the tanks. This grass occurred in the Puerto Blanco Mountains about 5200 years ago, and this or a similar grass grew in the Ajo Mountains about 8000 to 9500 years ago.

Scattered populations occur in the Sonoran Desert, but the species is much more common and widespread at elevations above the desert in Arizona, the eastern part of Sonora, and mountains in Baja California Sur.

Southwestern USA to South America.

OP: Alamo Canyon, *Nichol 4 May 1939*. Ajo Mt Drive 6.7 mi NE of Visitor Center, 5 Nov 1977, *Bowers 911*. Entrance to Arch Canyon, 2 Dec 1990, *Felger 90-522*. Diablo Mts, wash, along Ajo Mt Drive, 12 Sep 2013, *Rutman 20130912-10*. †Puerto Blanco Mts, 5240 ybp (Van Devender et al. 1990: 339). †*B. cf. barbinodis*, Alamo Canyon, florets, 8130 & 9570 ybp (Van Devender et al. 1990: 339).

CP: Tule Tanks, 4 Dec 1935, *Goodding 127*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger 92-605*.

TA: Tinajas Altas, canyon bottom just above uppermost tinaja, 19 Mar 1998, *Felger* (observation).

Bouteloua – Grama grass; *navajita*

Diverse ephemerals and perennials. Culms and inflorescence axes slender. Leaves mostly basal; ligules membranous, ciliolate, or a fringe of hairs. Inflorescences panicles with 2–many spicate, unilateral branches arranged in a racemose pattern or sometimes 1 per inflorescence. Inflorescence branches persistent or falling entire; spikelets relatively small, in 2 rows arranged at the margins along one side of a flattened rachis. These spicate, unilateral branches are an easily recognized feature (even *B. aristidoides* with its small branches has a flat-topped rachis). Spikelets variously awned, with 1 bisexual or unisexual floret below, and 1–3 staminate or sterile and usually smaller and different-looking florets (rudiments) above. Glumes unequal. Lemma of fertile floret with 3 veins, awnless or the veins often extending into short awns, and the palea with 2 veins and also awnless or the veins often extending into short awns.

Two summer ephemerals, *B. aristidoides* and *B. barbata* var. *barbata*, are widespread and often abundant across the Sonoran Desert. Other *boutelouas* are much less widespread in the desert; the perennial species are much more common and widespread in regions above or beyond the desert. Grama grasses are esteemed for forage.

1. Ephemerals, usually growing with summer rains; roots often weakly developed; lower leaves few, internodes between them readily visible.

2. Panicle branches (spicate branches) needle-arrow shaped, with 1–4 slender spikelets closely appressed to the branch axis (not spreading) **Bouteloua aristidoides**

2. Panicle branches pectinate (comb-like), often with 20–50 spikelets, these crowded in a double row and spreading perpendicular to the spike axis..... **Bouteloua barbata** var. **barbata**

1. Perennials with hard, knotty bases; roots well developed; basal (lower) leaves densely clustered, internodes between lower leaves usually very short and often not readily visible.

- 3. Panicle branches pectinate, more or less persistent.
 - 4. Spikelet awns (on lemmas) to 3 mm long; lemmas pubescent below with white hairs..... **Bouteloua barbata** var. **rothrockii**
 - 4. Spikelets awns 5 mm long or more; lemmas glabrous or nearly so..... **Bouteloua trifida**
- 3. Panicle branches not pectinate, readily deciduous as a whole.
 - 5. Panicle usually with more than (18) 20 branches..... **Bouteloua curtipendula**
 - 5. Panicle with fewer than 15 branches..... **Bouteloua repens**

Bouteloua aristidoides (Kunth) Grisebach

[*B. aristidoides* var. *arizonica* M.E. Jones]

Six-weeks needle grama; *aceitilla*, *navajita aguja*. Figure 9.

Summer-fall ephemerals usually with rather weakly developed roots. (Sometimes a few plants overwinter, resume growth, and flower in spring, or rarely germinate and grow in the spring but these plants are stunted.) Highly variable in size. Culms and panicle axes delicate, slender, erect to spreading-ascending, 10–30 (70) cm long. Ligule a fringe of hairs. Panicle branches 8–22 mm long, 11–16 (24) per stem, slender and needle-arrow-like, and readily falling at maturity together with their several spikelets, or spikelets falling separately. (These can be bothersome, sticking in socks and shoes. People are probably supplanting animals as dispersal agents.) Spikelets (1 or 2) 3 (4–10) per branch, appressed to the rachis; rachis flattened, ciliate, curving out from the attachment of the terminal spikelet, which it about equals or exceeds in length. Lowermost spikelet sub-sessile, with 1 floret, awnless, and without a rudiment. Upper spikelets short-pedicelled, bearing a sessile, awnless, fertile floret and a sterile floret with a short stipe and 3 conspicuous *Aristida*-like awns 2.5–6 mm long. Grain golden brown, oblong, flattened, with a prominent dorsal groove.

Seasonally common and widespread in many habitats across the region, reaching peak abundance on sandy loams in valley bottoms or lower bajadas. The common name describes the ability of plants to reach reproductive size in a short period of time. Generally more numerous than *Bouteloua barbata* var. *barbata*, the only other ephemeral grama grass in the region. *Bouteloua aristidoides* has been widespread across the region for at least 21,900 years.

This is one of the most abundant hot-weather ephemerals in the Sonoran Desert. The great success of this grass in the desert seems to be partly due to plasticity in size and number of structures and to rapid growth and reproduction. As soon as the grain ripens and the plants dry, *Pogonomyrmex* harvester ants stream out along their paths and carry home the whole, disarticulated spikelets. At their nest they remove the grain and pile the chaff in crater-like mounds around the entrance to their subterranean colonies.

Southwestern USA to Argentina. *Bouteloua aristidoides* growing during highly favorable conditions may become relatively large and vigorous; such plants have been called var. *arizonica* M.E. Jones.

OP: Alamo Canyon, 10 Apr 1952, *Fouts 447*. Armenta Well, Warren 16 Nov 1974. Aguajita, 13 Sep 1986, *Felger 86-280*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-16*. N end Bates Mts, 11 Sep 2013, *Rutman 20130911-4*. †Alamo Canyon, florets, 14,500 ybp.



Figure 9. *Bouteloua aristidoides*. (A & D) Alamo Canyon, Ajo Mts, 15 Sep 2013. Valley of the Ajo, W of Hwy 85 at mile marker 60; (B) 16 Aug 2006; (C) Ants collecting spikelets, 7 Oct 2008.

†Montezuma’s Head, spikelets, florets, and fragments, 13,500 to 21,840 ybp (3 samples). †Puerto Blanco Mts, 980 to 10,540 ybp (8 samples, Van Devender et al. 1990: 339). E of Armenta Ranch, *Rutman 30 Sep 2006*.

CP: Bates Well Rd at Organ Pipe boundary, 14 Sep 1992, *Felger 92-682* (CAB, UC). Childs Mountain, 2845 ft, 18 Aug 1992, *Felger 92-643*. Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-667*. Growler Valley, 25 Sep 2013, *Rutman 20130926-2*.

TA: Tinajas Altas, above the tinajas, 19 Mar 1998, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-31*. †Butler Mts, 610 to 11,250 ybp (6 samples, Van Devender et al. 1990: 342). †Tinajas Altas Mts, 4010 & 8700 ybp (Van Devender et al. 1990: 341).

Bouteloua barbata Lagasca

Panicle branches pectinate (comb-like), nearly straight to arched. Ligules membranous-ciliolate. The two varieties occupy different ecological and geographic ranges.

- 1. Ephemerals, the root system often weakly developed. **Bouteloua barbata** var. **barbata**
- 1. Perennials with a hard, knotty base, the root system well developed.
..... **Bouteloua barbata** var. **rothrockii**

Bouteloua barbata var. **barbata**

Six-weeks grama; *navajita, zacate liebrero*; s-cuk mudadt-kam. Figure 10 A–C.

Summer-fall ephemerals (rarely growing with spring rains and then stunted). Roots weakly developed. Usually branched from near the base, the culms and panicles 5–50 (80+) cm long, geniculate-spreading (abruptly bent upward from near the base of the plant) to erect and straight, or sometimes prostrate. Panicles with (1) 4–12 branches, (6) 10–25 (30) mm long, pectinate, nearly straight to arched. Spikelets often 20–54 per branch, 2.2–3.5 (4.5) mm long (including awns), crowded, more or less in 2 rows and at right angles to axis of spike. First (basal) floret in the rudiment with 3 short awns on a column. Upper florets of the rudiment greatly reduced and consisting of tiny petal-like structures on top of awn bases of the first (lower) sterile floret. Anthers cream colored, pale yellow, orange, or red.

Widespread including sand flats, valley floors, and bajadas to hills and mountains. On sandy loams of the valley floor and lower bajadas in Organ Pipe, *Bouteloua barbata* along with *B. aristidoides* can form carpets of ephemeral grasses. Together with *B. aristidoides* it is seasonally abundant in many habitats across the region as well as through most of the Sonoran Desert.

Southwestern USA to southern Mexico (Oaxaca) and disjunct in Argentina.

OP: Ajo Mts, *Begeman 1968* (ORPI). Aguajita, 13 Sep 1986, *Felger 86-279*. Armenta Ranch, *Wirt 8 Sep 1990* (ORPI). 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-7*. Growler Valley, *Rutman 23 Aug 2001* (ORPI).

CP: Bates Well Rd at Organ Pipe boundary, 14 Sep 1992, *Felger 92-683*. Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-668*. Jose Juan Represo, 12 Jun 1992, *Felger 92-561*. Las Playas, 28 Nov 2001, *Felger 01-578*. San Cristobol Wash, 26 Sep 2013, *Rutman 20130926-12*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-32*. Tinajas Altas, 25 Oct 2004, *Felger 04-70*.

Bouteloua barbata var. **rothrockii** (Vasey) Gould

[*B. rothrockii* Vasey]

Rothrock grama; *zacate liebrero*. Figure 10 D & E.

Tufted perennials with a hard, knotty base at or below the soil surface and well-developed roots. Stems most often straight and erect. Panicles with 4–8 (10) branches. Stigmas blue; anthers red or yellow. Growing and reproductive during the warmer months, especially following summer-fall rains.

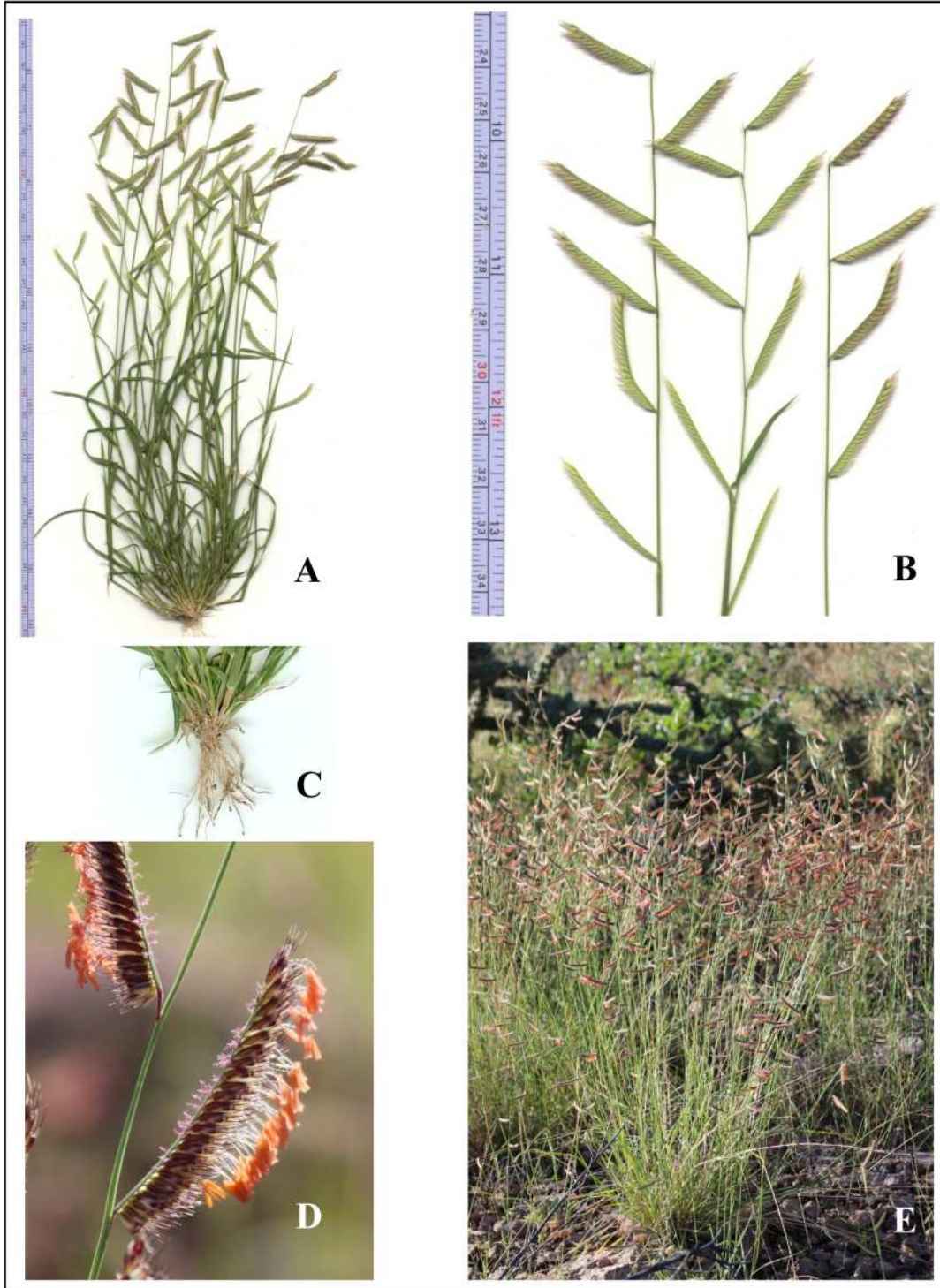


Figure 10. *Bouteloua barbata*. Var. *barbata*: (A & B) Hwy 85 near N boundary of Organ Pipe, 15 Sep 2013. (C) Valley of the Ajo, W of Hwy 85 at mile marker 60, 10 Sep 2006. Var. *rothrockii*: (D & E) Diablo Mts, 14 Sep 2013.

Common at mid- and upper elevations in the Ajo Mountains, and locally common in the Bates and Diablo Mountains and probably elsewhere in larger mountains in Organ Pipe.

Western and southern Arizona, generally above the desert. Southern California, Arizona, southwestern and central New Mexico, and northwestern and north-central Mexico.

OP: Ajo Mt Drive, 6.7 mi by road NE of Visitor Center, 2000 ft, 5 Nov 1977, *Bowers 913*. Bull Pasture Trail, rocky slopes, 2500 ft, 9 May 1979, *Bowers 1708*. Rocky slope NW of Kino Peak, 1782 ft, 20 Mar 2005, *Rutman 2005-0320-46* (ORPI).

†***Bouteloua barbata*** var. ***barbata*** and/or var. ***rothrockii***

One or more likely both of these grama grasses are well represented in the fossil record across the flora region for at least 21,900 years. The two taxa are distinguished by growth form (ephemeral versus perennial) and cannot be distinguished by the fossils, which are fragments of reproductive parts.

OP: †Alamo Canyon, 1150 ybp. Montezuma's Head, 20,490 ybp. Puerto Blanco Mts, 130 to 9720 ybp (9 samples, Van Devender et al. 1990: 339).

TA: †Tinajas Altas Mts, 5080 & 8700 ybp (Van Devender et al. 1990: 341).

Bouteloua curtipendula (Michaux) Torrey

Sideoats grama; *banderilla*; da:pk vasai. Figure 11.

Tufted perennials often 40–70 cm tall; culms slender, often with 4 or 5 nodes above the base of the plant. Panicles bearing (18) 25–80 branches, these often 1–2.5 cm long, slender, evenly spaced, drooping, and deciduous at maturity; branches each with 2–7 spikelets; upper glumes often 6–8 mm long. Anthers red-orange. Growing and reproductive during the warmer months, especially following summer-fall rains.

Ajo and Puerto Blanco Mountains, most common at higher elevations. These plants align with the widespread var. *caespitosa* Gould & Kapadia, but the varieties seem poorly defined (Siqueiros-Delgado et al. 2013). *Bouteloua curtipendula* has been in the Ajo Mountains for at least 20,500 years.

Widespread in Arizona, generally at the upper elevation limits and above the desert. Canada to South America.

OP: Alamo Canyon, *Nichol 4 May 1939*. Arch Canyon, *Rutman 8 Nov 1995* (ORPI). Ridge NNE of Pinkley Peak, 31 Oct 2003, *Rutman 2003-1031-22* (ORPI). Diablo Mts, wash, along Ajo Mt Drive, 12 Sep 2013, *Rutman 20130912-7*. †Alamo Canyon, florets, 1150 to 9570 ybp (4 samples). †Montezuma's Head, florets, 13,500 & 20,490 ybp.

Bouteloua repens (Kunth) Scribner & Merrill

[*B. filiformis* (E. Fournier) Griffiths]

Slender grama; *navajita delgada*. Figure 12.

Perennials mostly 15–50 cm tall, forming dense, knotty bases, not rhizomatous. Roots wiry and well developed. Leaves mostly basal. Apparently capable of flowering at any time of year but especially with warm weather, and also flowering in the first year but then the spikelets often not maturing. Panicles mostly with (2) 4–12 branches, these 10–20 mm long, relatively broad, deciduous at maturity, and bearing spikelets 9–13 mm long. Pedicels, rachises, and glume veins with short, coarse hairs. Anthers yellow or orange.

Widespread in the Ajo and Puerto Blanco Mountains and locally elsewhere in Arizona Upland portions of Organ Pipe; often on shallow rocky soils or in crevices on bedrock. Its history in

the Ajo Mountains extends to more than a millennium and it was in the western edge of the flora region at least 8200 years ago.

Western and southern half of Arizona to Texas and through Mexico to Central America, the Caribbean and northern South America.

OP: Alamo Canyon, 2500 ft, 3 Dec 1977, *Bowers 980*. Diablo Canyon, *Van Devender 20 Jan 1984* (ORPI). Ajo Mt Drive 2.3 mi E of Visitor Center, 1750 ft, large wash, 9 May 1985, *Van Devender 85-113*. Diablo Mts, 2480 ft, grassy slopes, 12 Sep 2013, *Rutman 20130912-4*. †Alamo Canyon, florets, 1150 ybp.

TA: †Butler Mts, 8160 ybp (*Van Devender et al. 1990: 342*).

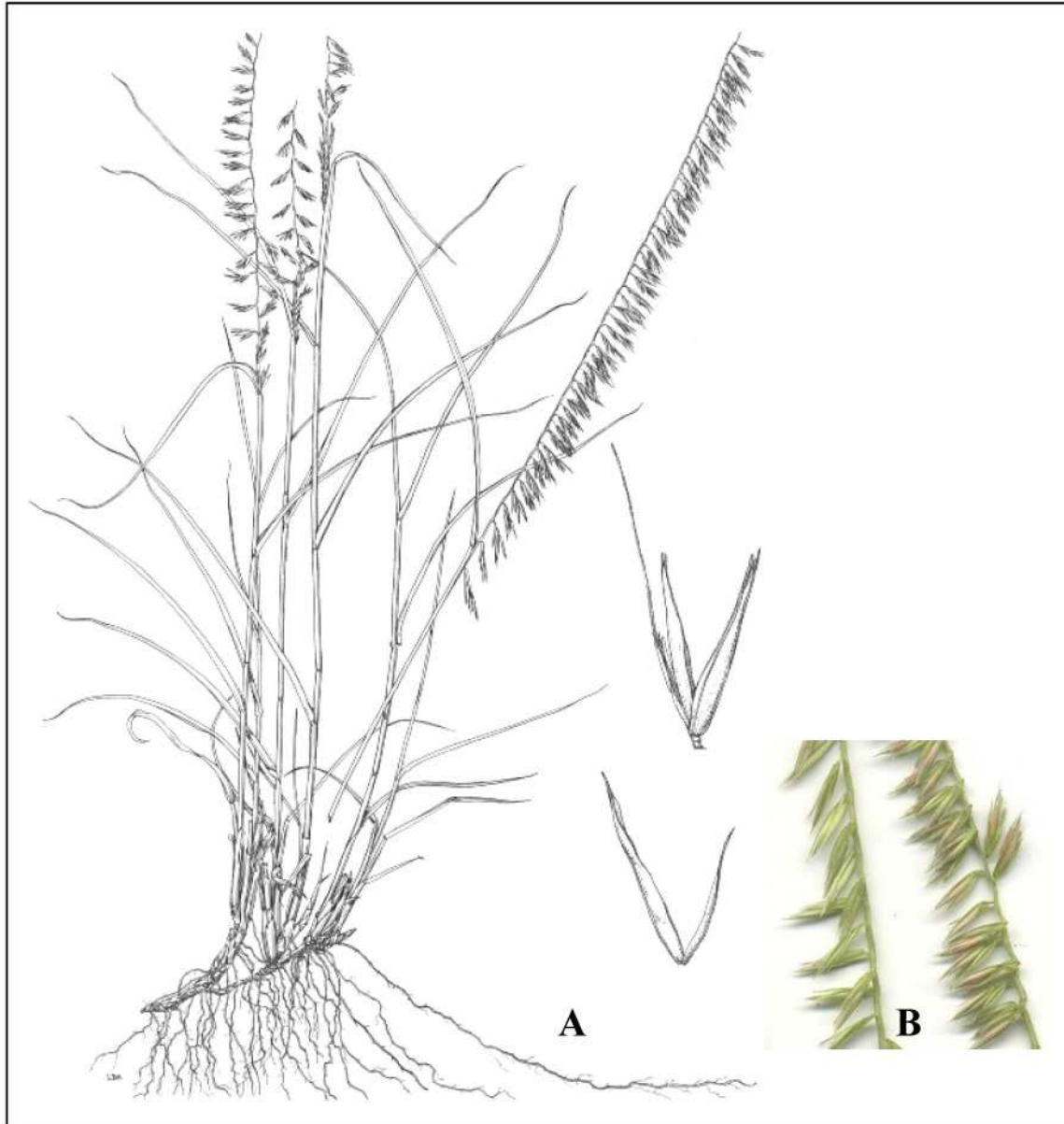


Figure 11. *Bouteloua curtispindula*. (A) Plant and spikelet; (B) portion of panicle with spikelets, Alamo Canyon, Ajo Mts, 15 Sept 2013.



Figure 12. *Bouteloua repens*. Diablo Mts: (A) 22 Sep 2013, (B) 14 Sept 2013.

***Bouteloua trifida* Thurber**

Red grama; *navajita china*. Figure 13.

Small tufted perennials, (5) 12–30 (40) cm tall, with hard knotty bases and sometimes with short rhizomes; occasionally forming “fairy ring” colonies. Leaves mostly basal. Panicles with 2–6 branches, pectinate, bristly, purplish, and persistent; often reddish when young.

This small grama grass is found at widely scattered localities across the northern part of the Sonoran Desert. It is much more prevalent above the desert. A single fossil record establishes it in Organ Pipe Cactus National Monument about 1000 years ago.

Canyons, arroyos, rocky slopes, and mesas; widely scattered and often local populations in some of the mountains in Cabeza Prieta and Organ Pipe. Often growing from crevices in bedrock. It is probably more common than collections indicate.

This species is unusual among grama grasses in that it has adapted to a winter rainfall regime, at least in the western part of the Sonoran Desert Region, where it seems to grow and flower at almost any time of year.

Southern Utah to southern California and Texas, and drier regions of northern and central Mexico including Baja California, Chihuahua, Coahuila, Nuevo León, San Luis Potosí, northern Sonora, and Tamaulipas.

OP: Gunsight Hills, on granite, *Rutman 4 Apr 1998* (ORPI). Granite foothills, NW side Puerto Blanco Mts, *Rutman 7 Apr 1998* (ORPI). NW of Kino Peak, Bates Mts, 20 Mar 2005, *Rutman 2005-0320-46*. Puerto Blanco Mts, Red Tanks Wash, 21 Sep 2013, *Rutman 20130921-1*. †Puerto Blanco Mts, 980 ybp (Van Devender et al. 1990: 339).

CP: 0.5 mi above Gray Tank, T2S, R19W, S35, dry wash, 8 Dec 1985, *Russo 251*. Eagle Tank, 13 Jun 1992, *Felger 92-587*. Little Tule Well, 18 Aug 1992, *Felger 92-648*. Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-304* (CAB).

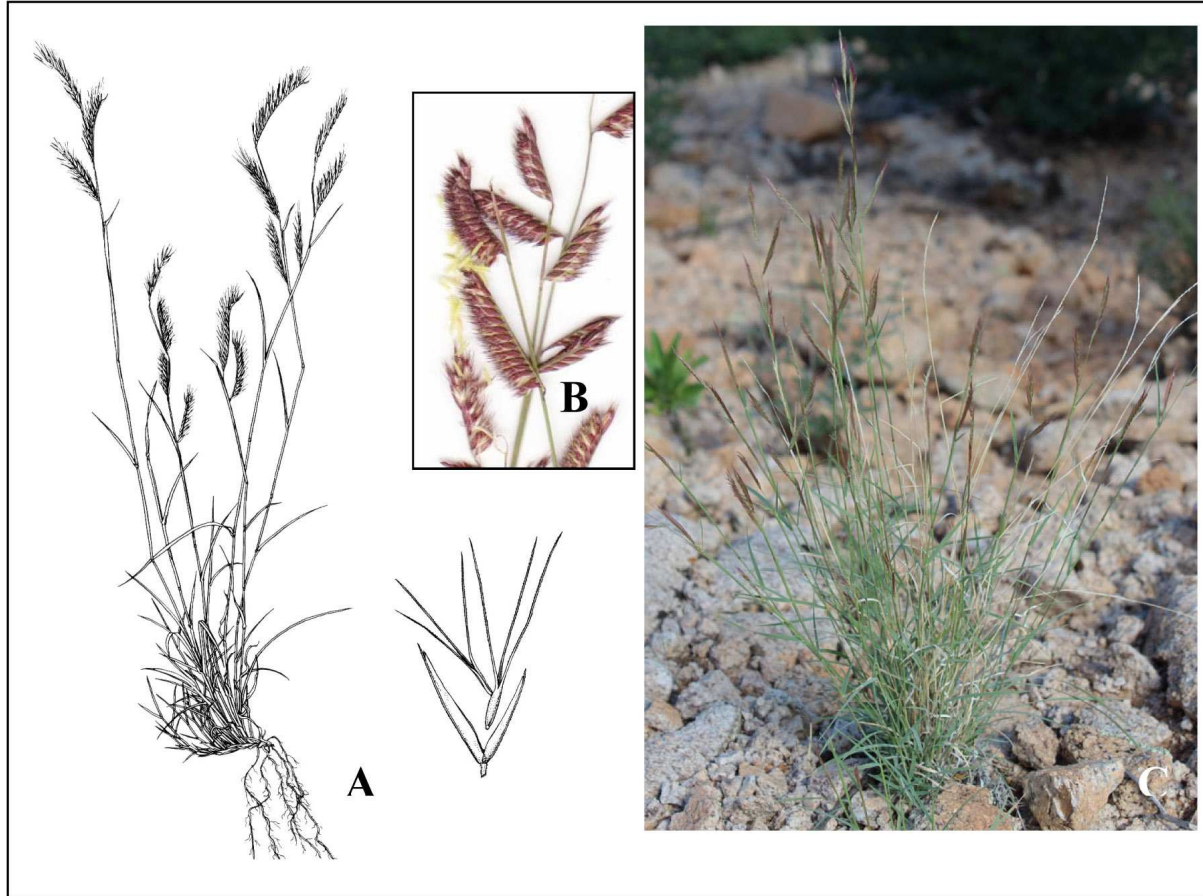


Figure 13. *Bouteloua trifida*. (A) Plant and spikelet with glumes and florets separated; (B) spicate branches on portions of two panicles, Gunsight Hills near Kuakatch Village, 10 Sept 2013; (C) Estes Canyon, Ajo Mts, 2 Apr 2010.

Bromus – Chess, brome

The Sonoran Desert populations are winter-spring ephemerals; no *Bromus* survives the Sonoran Desert summer. In wetter regions many brome grasses are perennials. Leaf-sheath margins closed to near the top of the sheath. Ligules membranaceous; auricles none (those in the flora area). Panicles open or compact; spikelets relatively large, with several florets, laterally compressed or turgid and only slightly compressed, breaking apart above glumes and between florets; the florets often cleistogamous. Glumes persistent, usually unequal, lanceolate, shorter than the florets (excluding awns). Florets (lemmas) often progressively smaller above but similar in shape to the lower ones. Lemmas 1-awned from a notch between the bilobed tip or awnless. Ovary capped by a hairy bilobed appendage bearing sub-terminal stigmas.

1. Spikelets conspicuously flattened (laterally compressed); upper glumes 5- or 7-veined; lemmas strongly keeled, V-shaped in cross section..... **Bromus arizonicus**

1. Spikelets rounded in cross section; upper glumes 3- or 5-veined; lemmas not strongly keeled, U-shaped in cross section.

2. Panicles compact and dense, the branches very short and spikelets mostly erect **Bromus rubens**

2. Panicle open, the branches and pedicels rather long and conspicuously curving-drooping, spikelets mostly not erect..... **Bromus tectorum**

Bromus arizonicus (Shear) Stebbins

[*B. carinatus* Hooker & Walker var. *arizonicus* Shear]

Arizona brome. Figure 14.

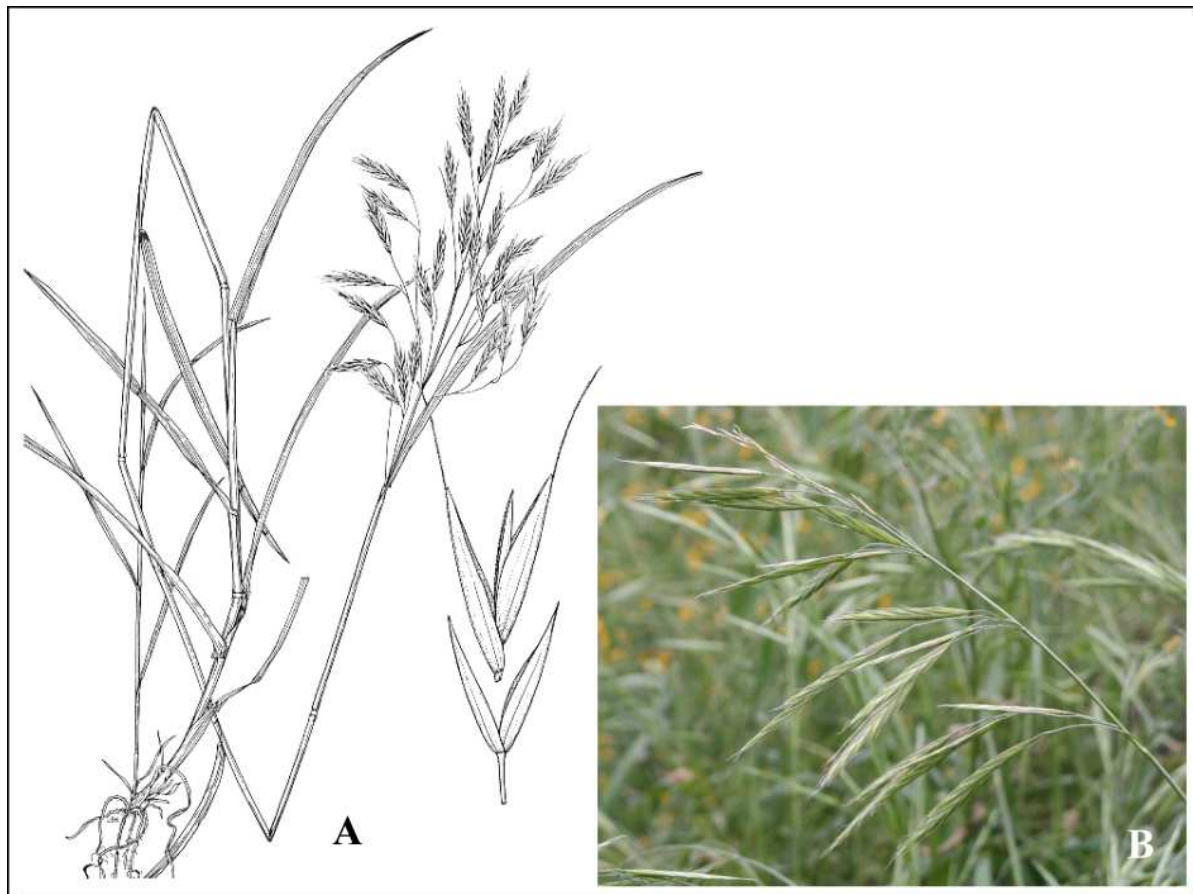


Figure 14. *Bromus arizonicus*. (A) Plant and spikelet; (B) panicle, Alamo Well, Alamo Canyon, Ajo Mts, 18 Mar 2005.

Slender grasses (20) 50–120 cm tall. Spikelets conspicuously laterally compressed when young, but less so as the grain matures. Lower glumes 7–12 mm long, with 3–5 veins; upper glumes 8–18 mm long, with 5–7 veins. Lemmas 11–15 mm long, strongly keeled, V-shaped in cross section, with 7–11 veins, and a stout awn often 4–11 mm long.

Abundant along drainageways during favorable years, especially El Niño years. Organ Pipe and the eastern part of Cabeza Prieta. This brome can form near pure stands in localized areas of large washes, e.g., Alamo, Cherioni, Kuakatch, and San Cristobal Washes.

California to New Mexico, Nevada, Baja California Norte, and northernmost Sonora.

Bromus arizonicus is part of the *B. carinatus* complex (e.g., Pavlick et al. 2007; Saarela & Peterson 2012; Saarela et al. 2014). *Bromus carinatus* is a short-lived perennial, native from Alaska to Central America and apparently is not native within the Sonoran Desert. Sonoran Desert *B. arizonicus* specimens do not seem separable from *B. carinatus* when a suite of specimens are examined. Plant sizes, relative glume lengths, spikelet sizes, and sometimes even numbers of veins in spikelet parts can vary to a maddening degree, undoubtedly influenced by environmental conditions, especially soil moisture. Should the *arizonicus* taxon be recognized?

OP: 9 mi S of N entrance to the Monument, Sonoita road, 8 Apr 1941, *McDougall 46*. Alamo Canyon, *Tinkham Apr 1942*. Bull Pasture Trail, 5 Apr 1978, *Bowers 1209*. Growler Canyon, 30 Mar 1979, *Bowers 1602*. Puerto Blanco Mts, 2 mi NW of Visitor Center, 8 Mar 1987, *Van Devender 87-7*.

CP: San Cristobal Wash, 31 Jan 1992, *Felger 92-2*. Daniels Arroyo on Charlie Bell Rd, 12 Jun 1992, *Felger 92-541*. Little Tule Well, 9 Apr 1993, *Felger 93-334*. Papago Well, 26 Mar 2010, *Felger 10-112*.

****Bromus rubens* Linnaeus**

[*B. madritensis* Linnaeus subsp. *rubens* (Linnaeus) Husnot]

Red brome; *bromo rojo*. Figure 15.

Plants often 10–25+ cm tall, hairy especially on leaf sheaths and stems, the hairs often soft and retrorse (backward pointing) on leaf sheaths. Panicles densely contracted, brush-like, the branches and spikelets mostly upright, more or less sessile, and not compressed (flattened). Lower glumes 5–8 mm long, with 1 (3) veins; upper glumes 10–15 mm long, with 3–5 veins. Lemmas 10–15 mm long and hairy, with slender bifid terminal teeth (lobes) 1–3 mm long, and an awn 12–26 mm long, stiff, stout, straight or slightly curved but not bent or twisted. Sometimes germinating as early as September.

Across most of Organ Pipe, often abundant in the Ajo Mountains to the crest, but less common and localized elsewhere. Well established in Cabeza Prieta, especially in the eastern portion; washes, plains, and many mountains to peak elevations. Also in the Tinajas Altas Region but not common.

Red Brome has become abundant in southern Arizona and across the northern part of Sonora, especially since the 1970s (Bowers 1980; Felger 1990, 2000). It has been present in the Ajo Mountains at least since 1942 and in the town of Ajo since 1916. It is invasive nearly throughout the region and with favorable rains can become dense enough to carry a fire when dry.

This weedy Mediterranean grass, adventive and common through much of the western USA, was established in California by 1848 (Frenkel 1970). Red brome seeds in the Sonoran Desert soils have a relatively short life span, which has important conservation implications (Salo 2004).

OP: Alamo Canyon, 2000 ft, *Tinkham 18 Apr 1942*. Arch Canyon, 5 Apr 1978, *Bowers 1180* (ORPI). Residence area, 30 Mar 1988, *Felger 88-139*. Hocker Well, 10 Apr 1996, *Rutman* (observation). Cherioni Wash near Hwy 85, *Rutman 12 May 2003*. Trail from Bull Pasture to crestline, 10 Apr 2005, *Felger 05-247*.

CP: San Cristobal Wash at Bates Well Rd, 14 Sep 1992, *Felger 92-694*. Chico Suni temporal, NW of Bassarisc Tank, Antelope Tank, 12 & 13 Jun 1992, *Felger* (observations). Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-324*. Jose Juan Tank, 26 Feb 1993, *Felger 93-102* (CAB).

TA: Camino del Diablo at Coyote Wash, 10 Jan 2002, *Felger 02-8*. Tinajas Altas, 30 Dec 2005, *Felger 05-483*.

****Bromus tectorum** Linnaeus

Downy chess, cheat grass

Panicles branched, the branchlets and pedicels slender, curved, and drooping under the weight of the relatively large spikelets. Spikelets 10–20 mm long, often reddish brown, laterally and moderately compressed. Lower glumes 4–9 mm long, with 1 vein; upper glumes 7–13 mm long, with 3 or 5 veins. Lemmas 10–12 mm long, hairy, with an awn 12–14 mm long and straight.

Known from two records and not known to be reproducing in Organ Pipe. Generally not well established in the Sonoran Desert. Fairly common in Arizona above the desert and non-desert regions of northern Baja California and especially California. Native to Europe and extensively naturalized in temperate North America and elsewhere.

OP: International fence at El Papalote, adjacent to Aguajita Spring, 9 Apr 1986, *Felger 86-133*. Visitor Center parking lot, one plant, 15 Mar 1998, *Rutman* (observation, plant removed).

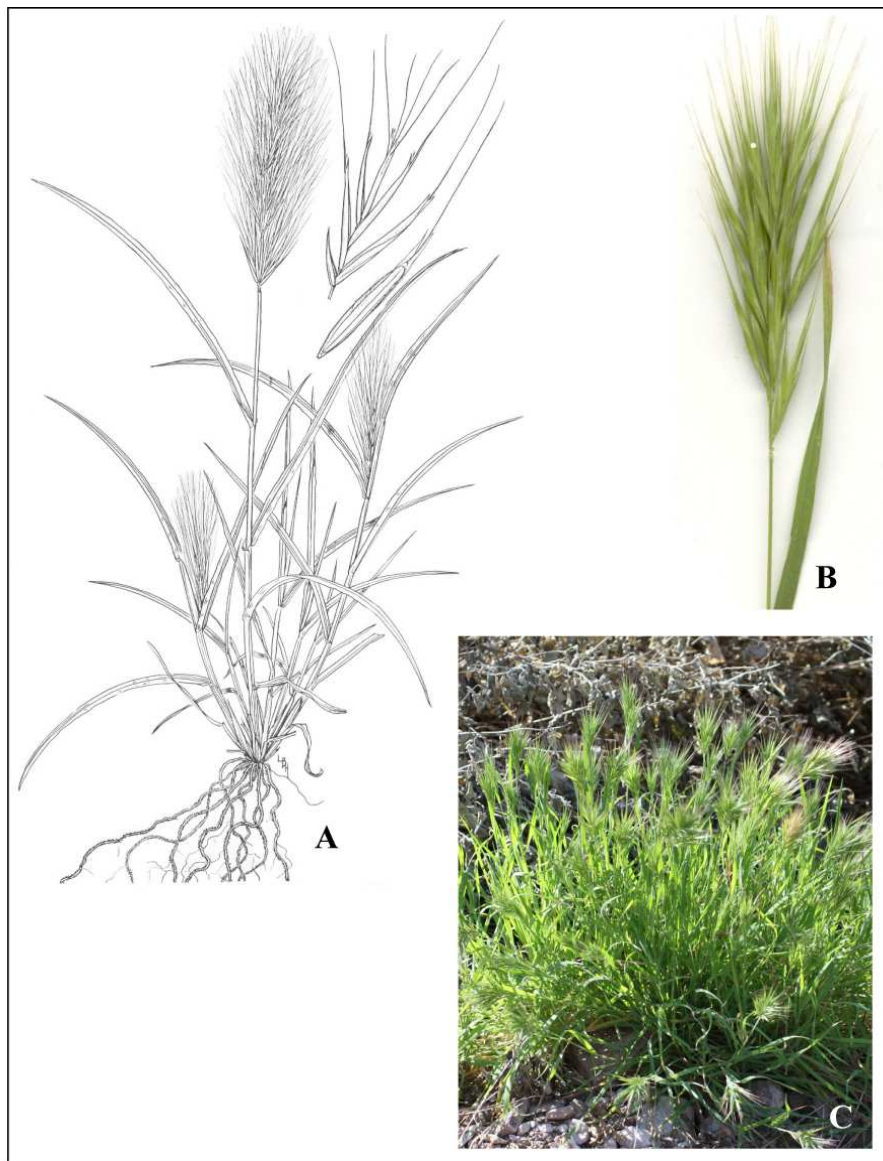


Figure 15. *Bromus rubens*. (A) Plant, spikelet, and single lemma. Alamo Canyon, Ajo Mts: (B) 12 Mar 2005; (C) 7 Feb 2013.

Cenchrus – Sandbur, buffelgrass, and fountain grass
 [*Pennisetum*]

Highly diverse ephemerals and perennials. Panicles spike-like, bearing spikelets enclosed in burs with fused, flattened, barbed spines (*Cenchrus sensu stricto*) or panicles more or less contracted with spikelets enclosed in fascicles of bristles (*Pennisetum*), the burs or fascicles fall with the spikelets as a unit; the spines and bristles are derived from modified branchlets. Spikelets panicoid, with 2 florets, the lower floret staminate or sterile, the upper one bisexual. See Chemisquy et al. (2010) and Columbus and Smith (2010) for uniting *Pennisetum* and *Cenchrus*.

- 1. Spikelets enclosed in burs, the spines united, at least below (*Cenchrus sensu stricto*).
 - 2. Inflorescences with 1–3 burs; larger spines of bur (6) 9–15 mm long **Cenchrus palmeri**
 - 2. Inflorescences usually spike-like with 10 or more burs; larger spines of bur 3.5–6 mm long.
 - 3. Basal bristles slender, many in a ring, the larger flattened spines of different sizes and more or less in a single whorl..... **Cenchrus echinatus**
 - 3. Basal bristles none to several, not forming a ring, the larger flattened spines mostly of the same size and at different positions on the bur..... **Cenchrus spinifex**
- 1. Spikelets in fascicles with distinct or nearly distinct bristles (*Pennisetum*).
 - 4. Panicles (1.5) 4.5–10 cm long; longer spikelet bristles 7–12 (15) mm long; basal bristles often slightly united..... **Cenchrus ciliaris**
 - 4. Panicles 13–26 cm long; longer spikelet bristles 18–35 mm long (ignore occasional shorter-bristled spikelets at the tip of the panicle); basal bristles not united..... **Cenchrus setaceus**

***Cenchrus ciliaris** Linnaeus
 [*Pennisetum ciliare* (Linnaeus) Link]
 Buffelgrass; *zacate buffel*. Figure 16.

Robust perennials often 0.5–1 m tall, often with a knotty base, and often flowering in the first season; growing and flowering during the warmer months. Leaves often reddish during cool weather; leaf sheaths laterally compressed and keeled, glabrate to sparsely pilose with long slender hairs; hairs near collar usually sparse, white, and straight, reaching 5 mm with enlarged bases, the ligule membranous, ciliate; leaf blades glabrate, scabrous, or sparsely pilose, especially on lower surface, larger blades 23–34 cm × 7–10 mm, the midrib prominent. Panicles 4.5–12.5 cm long, densely flowered and contracted. Fascicles essentially sessile; bristles mostly united at the very base, flexible and somewhat sinuous, often purplish brown, unequal in length, plumose basally with spreading silky white hairs, the larger bristles 8–13.5 mm long and conspicuously flattened, the outer bristles in a loose ring around the fascicle base, much smaller, many, slender, terete, and scabrous. Spikelets 4.5–5.5 mm long, sessile or subsessile, 2 or 3 per fascicle.

Buffelgrass has been well established along Mexico Highway 2 just south of the flora area since at least the 1970s (Felger 1990, 2000) and spread into Organ Pipe where the first documented record was in 1984. It rapidly increased in abundance in Organ Pipe in the 1980s and was found in relatively small but growing populations throughout the Monument. Relatively small (less than 1 acre) but rapidly expanding colonies of buffelgrass are common throughout Organ Pipe (2010–2013) and in the eastern mountains of Cabeza Prieta on all soil types. It shows the least preference for dunes and Pleistocene-aged surfaces. Low summer rainfall probably limits its growth and expansion in the western part of the flora area and is only weakly established at the margins of the Tinajas Altas

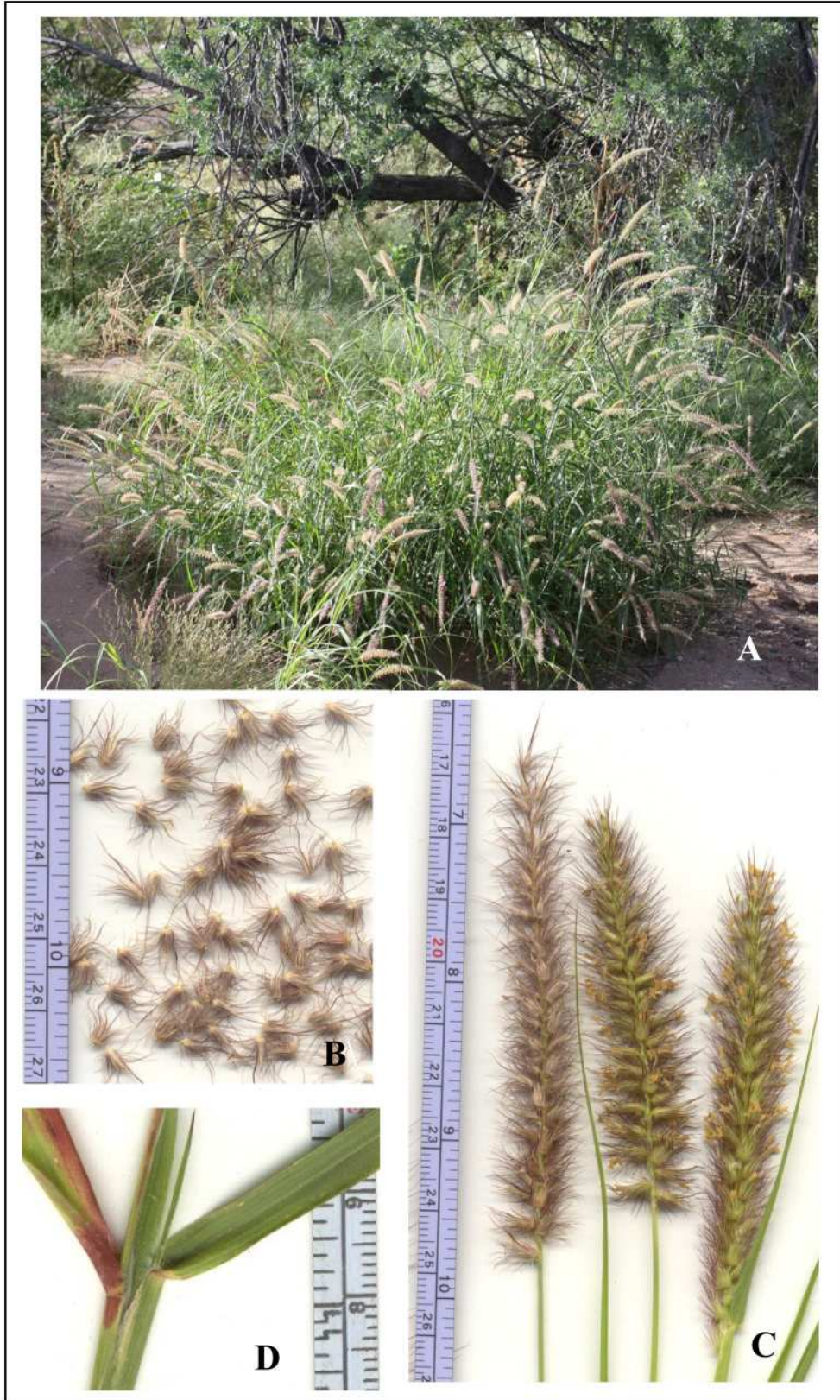


Figure 16. *Cenchrus ciliaris*. (A) Valley of the Ajo, Organ Pipe, 6 Oct 2012. Ajo, Pima Co.; (B & C) detached spikelets and panicles, 15 Apr 2013; (D) summit of leaf sheath at collar area, 25 Mar 2013.

region at the Sonora border. It is abundant all along Mexico Hwy 2 just south of the flora area, as far west as the granitic mountains south of the Tinajas Altas Region (e.g., Felger 2000).

Native to the warmer parts of Africa, Madagascar, and India, and introduced in many hot, semi-arid regions of the world for forage and fodder. Widely planted as a forage grass in Sonora, it has become a serious invasive weed in southern Arizona and Sonora.

Since 1994 the National Park Service has conducted an aggressive, labor-intensive program of manual removal of this tenacious invasive weed in some areas of Organ Pipe with successful results, but as long as sources of infestation remain the program needs constant attention (Rutman 2010). The U.S. Fish and Wildlife Service has also conducted an eradication program on Cabeza Prieta, mostly centered on Childs Mountain.

In the 1940s the U.S. Department of Agriculture Plant Materials Center in Tucson introduced buffelgrass into the southwestern USA for soil erosion control and livestock forage. Starting in the 1950s Mexico followed with government and bank-supported programs for wholesale removal of native vegetation replaced by monoculture buffelgrass stretching across vast swaths of the state of Sonora and elsewhere. This is one of the several most serious invasive species in the Sonoran Desert Region and poses a major threat in Organ Pipe and Cabeza Prieta (e.g., Rutman & Dickson 2002). Buffelgrass can carry fire, introducing a major threat to Sonoran Desert ecosystems that are not fire-adapted (e.g., Búrquez et al. 2002; Franklin et al. 2006). There are a number of strains selected for various traits, including increased forage value and frost tolerance, and some of these are patented.

OP: Near Growler Valley rain gauge, *Anderson 29 Oct 1984* (ORPI). 4 mi W of Bates Well, *Anderson 8 Mar 1986* (ORPI). Quitobaquito, 14 Sep 1988, *Felger 88-448*. W side of Sierra Santa Rosa, along border, 12 Mar 2003, *Felger 03-354*. Wash NE of Pinkley Peak, 31 Oct 2003, *Rutman 2003-1031-8* (ORPI). Growler Valley, “the few living plants are legacy of a very large population removed in the early 2000s,” 8 Oct 2006, *Rutman 20061008-3*.

CP: 1 mi W of O’Neill’s Grave, 11 Apr 1992, *Harlan 199* (CAB). Bassarisc Tank, 13 Jun 1992, *Felger* (observation). 2.5 mi S of Jose Juan Tank, 14 Sep 1992, *Felger 92-727*. Pinacate Lava, 1 mi E of Namer’s Grave, sandy-silty loess over lava, 15 Sep 1992, *Felger 92-769*. Small wash near N end Agua Dulce Mts, 26 Sep 2013, *Rutman 20130926-19*.

TA: Tinajas Altas Mts, dirt road, 1986 (Van Devender et al. 1990: 339). Frontera Canyon, international border, not common, 18 Mar 1998, *Felger* (observation).

****Cenchrus echinatus** Linnaeus

Southern sandbur; *guachapori*. Figure 17.

Warm-weather ephemerals. Panicles spike-like to 7.5 cm long, with 18–40 burs. Burs often 4–5 mm diameter (not including spines), with a basal ring of often 30–50 small, slender bristles; larger spines flattened, 3.5–6 mm long.

Agricultural weed in the Sonoyta region and extending into the southern margin of Organ Pipe east of Lukeville. Not native to the region. It has not been relocated in Organ Pipe since the one collection, despite Rutman searching for it.

Unwelcome and often weedy from southern USA to South America and adventive in the Old World. *Cenchrus echinatus* and *C. spinifex* are separated on the basis of rather technical features.

OP: 0.5 mi E of Lukeville, 15–20 m N of border fence, locally common, 11 Nov 1987, *Felger 87-319*.



Figure 17. *Cenchrus echinatus*. (A) Culm, leaves, and panicle; (B) detached bur.

Cenchrus palmeri Vasey

Giant sandbur; *guachapori*, *huizapori*. Figure 18.

A unique grass with large, sharp-spined burs. Non-seasonal ephemerals, perishing with winter freezing; highly variable in size. Burs 1–3 per inflorescence, 20–31 mm in diameter, plus sharp stiff spines (6) 9–15 mm long, dark purple-brown most of the year, yellowish green during hot, humid weather. The obnoxious burs, the largest of any species of *Cenchrus*, persist long after the plant dies, often half hidden in the sand.

Widespread in northwestern Mexico especially on sandy soils including dunes in the Gran Desierto near the U.S. border. “This readily recognizable sandbur is one of the most distinct of the genus and is one of the very few grasses endemic to the Sonoran Desert” (Gould & Moran 1981: 123; also see Felger 2000). However, its range extends somewhat south of the Sonoran Desert along the coast to northwestern Sinaloa.

This species was not known to occur in the USA until 2013 when it was found in sandy soil about 15 km west of the flora area (Malusa et al. 2013). The sandy soils along the southern border in Cabeza Prieta and the Tinajas Altas Region are likely places for it to be found within the flora area. It apparently is advancing with the help of foot traffic including illegal border crossers (burs sticking to cloths and shoes) and vehicles (burs sticking to tires), and it is likely to spread into the flora area and on into the Yuma region.

Yuma County: Barry M. Goldwater Air Force Range, approx. 3 mi NW of Yodaville (Quad: West of Vopoki Ridge); UTM Zone 11, 7 46 608 E, 35 94 308 N, WGS 1984, 130 m, roadside at observation tower, and in nearby runnels, sandy flats, *Larrea*, *Palafoxia arida*, *Dalea mollis*, *Brassica tournefortii*, population estimate at 500–1000 plants, Malusa & Sundt 19 Jan 2013 (2 sheets, ARIZ 413972 & 413973).



Figure 18. *Cenchrus palmeri*. Dunes south of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 20 Feb 2010.

****Cenchrus setaceus*** (Forsskål) Morrone
 [*Pennisetum setaceum* (Forsskål) Chiovenda]
 Fountain grass. Figure 19.

Robust, tufted perennials to about 1 m tall. Culms erect to geniculate spreading. Leaves dull green and often reddish during cool weather. Leaf sheaths laterally compressed and keeled, glabrate to sparsely pilose with long slender hairs; hairs near collar usually sparse, white, and straight, reaching 5 mm with enlarged bases, the ligule membranous-ciliate. Leaf blades glabrate, scabrous, or sparsely pilose, especially on lower surface, larger blades 23–34 cm × 3–3.5 cm, the midrib prominent. Panicles feathery, 13–30 cm long, purplish especially during drier or cooler seasons and when young, and often whitish especially with age and during hot, humid times. Fascicles on slender, bristly stalks 1–2.5 mm long; fascicle bristles separate, flexible and somewhat sinuous, terete, unequal, the longer ones 22–34 mm and plumose basally. Spikelets 5.5–6.5 mm long, mostly on slender pedicels to 1 mm long, 1–4 per fascicle. Reproductive most of the year, especially during warmer months.

This Old World grass is often been planted as an ornamental garden subject in Ajo and Sonoyta and elsewhere in the Sonoran Desert Region, and has become a widespread invasive weed in desert areas of southern Arizona. It is naturalized in and around Ajo and is established on Childs Mountain and the Little Ajo Mountains. It was successfully eradicated along Hwy 85 through Organ Pipe in the 1990s but since then has been found at several very remote locations in the Ajo Mountains and foothills. It is abundant in Sonoyta, providing an invasion route into the Organ Pipe wilderness areas. It is a potentially serious invasive weed at waterholes, especially the disturbed habitats at

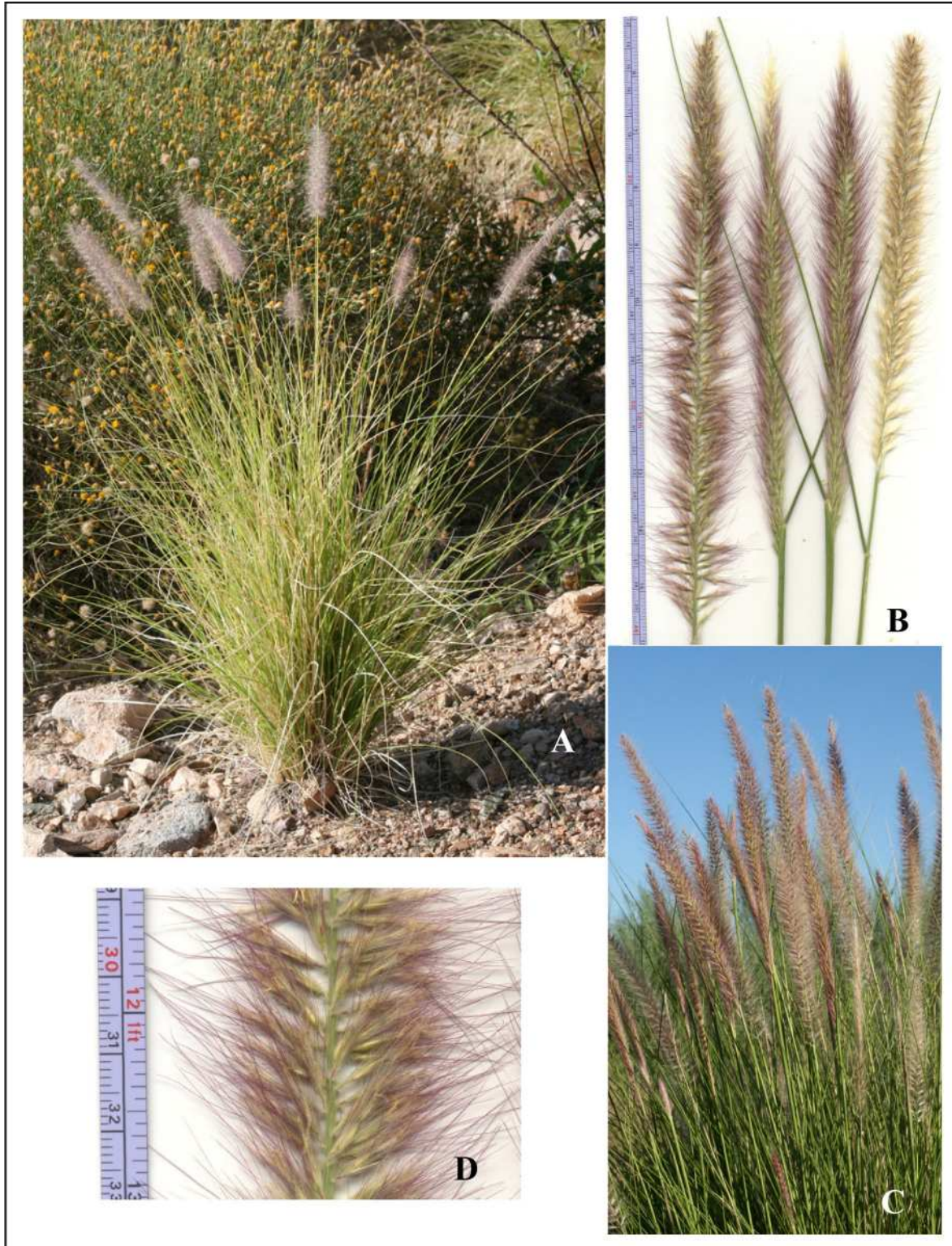


Figure 19. *Cenchrus setaceus*. Ajo, Pima Co.: (A) 14 May 2006; (B) 15 Sep 2013; (C) 12 Sep 2006; (D) 15 Sep 2013.

artificially enhanced waterholes, and could become a serious threat at higher elevations in the Ajo Mountains (Felger 1990).

Concerning fountain grass on Childs Mountain, Curtis McCasland (pers. comm. to R. Felger, October 2004) reported that he had a large and extensive population nearly eradicated. He observed it starting to spread down from the mountain top into drainages 1400–1700 ft and into an area to the west of Childs Mountain into Cabeza Prieta. It also extended into the Goldwater Range, but he had not seen there since 2002; it was about 1.5 mile east and a little bit north of the old officer's barracks on Childs Mountain (observed 15 Jul 2001, 0.1 acre of it seen with binoculars). Organ Pipe personnel have been eradicating fountain grass since the 1980s, when it was removed from several places along Highway 85. The largest known population was discovered in the southern Ajo Mountains in 2007 along a half km stretch of a rocky wash bed; in 2008 several hundred plants were eradicated from this site.

OP: 2 mi N of Visitor Center, *Anderson 18 Nov 1985* (ORPI). Hwy 85, vicinity of park headquarters, roadside, 11 Nov 1987, *Felger 87-333*. Alamo Canyon, ¼ to ½ mi downstream from junction of N and S forks, *Rutman 5 Mar 1995* (ORPI). Southern Ajo Mts, several hundred plants along a ¼ mile stretch of rocky wash bed, 10 Feb 2007, *Rutman* (observation).

CP: Childs Mt, 2300 ft, 18 Aug 1992, *Felger 92-646*.

****Cenchrus spinifex*** Cavanilles

[*C. incertus* M.A. Curtis. *C. pauciflorus* Bentham]

Common sandbur; *huizapori*, *guachapori*. Figure 20.

Warm-weather ephemerals or perhaps short-lived perennials with relatively deep and well-developed roots. Panicles compact and spike-like, 3.5–7 cm long, with 12–27 burs. Burs variable, 2.5–4 mm diameter (not including spines), shorter to longer than wide; spines mostly 8–40, very sharp, highly variable, long and slender to short and broad, the larger spines 4–5.7 mm long, the lower, smaller spines several and not in a basal ring.

Cabeza Prieta on the Pinta Sands near the Mexican border and nearby in similar habitat in Sonora several kilometers south of the international border (Felger 2000). Although highly localized, this population is apparently well established. This species was likely introduced into the flora area as a result of cattle grazing. The nearest records are from Yuma.

Southern USA to South America and the West Indies.

CP: 8 mi W of O'Neill's Grave, common in sand soil of a wash, 6 Mar 1977, *Reeder 6836*. E Pinta Sands, 6.5 mi W of O'Neill's Grave on Camino del Diablo, 15 Sep 1992, *Felger 92-758*.

Chloris virgata Swartz

Feather fingergrass; *zacate lagunero*. Figure 21.

Warm-weather ephemerals, 10–80 cm tall. Culms 1–many, often geniculate-spreading. Panicles with 4–17 spicate, unilateral branches at the top of the flowering stem, the branches ascending in a digitate pattern, the spikelets dense from the base, upright, whitish to tawny with silky hairs. Spikelets in two rows on the rachis, 2.8–3.5 mm long (excluding awns), with 2 differently shaped florets, each with a prominent awn. The lower floret fertile, the upper one sterile. Fertile lemma humpbacked on keel, bearing a conspicuous tuft of hair at the apex and a single stout awn 5–7.5 mm long. Sterile floret broad and truncate at apex, also bearing a single stout awn.



Figure 20. *Cenchrus spinifex*. (A) Lower Oak Creek, Sedona, Yavapai Co., photo by Max Licher, Jun 2001, from SEINet. Grant Co., NM, photos by Russell Kleinman, from Gilaflorea.com: (B) Burro Mts, Mangas Canyon Road, 23 Jul 2007; (C) bur opened revealing a spikelet, Mangas Springs, 27 Aug 2009.

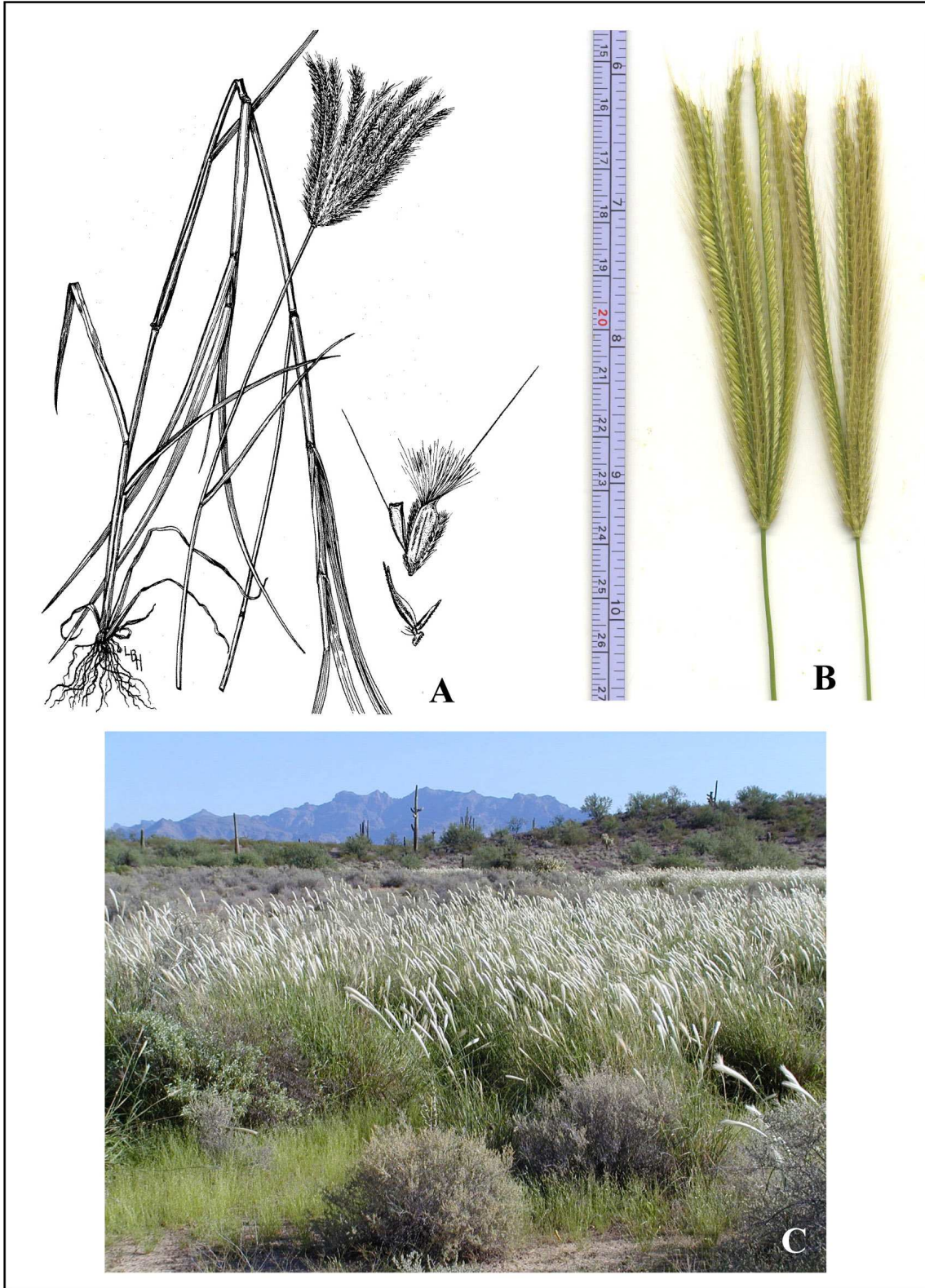


Figure 21. *Chloris virgata*. (A) Culms, roots, panicle, and spikelet with detached glumes and fertile and sterile florets. Near Dos Lomitas: (B) panicles, 11 Sep 2008; (C) dense, localized stands of exceptionally large plants, 29 Aug 2001.

Usually in sandy-silty soils in low-lying places, in natural habitats and often spreading from nearby disturbed habitats; locally common in the flora area at several widely scattered localities. For example, it is locally abundant in swales and eroded areas 1–2 miles east of Lukeville and north of the international border, co-occurring with Bermuda grass (*Cynodon dactylon*), buffelgrass (*Cenchrus ciliaris*), and blue panic grass (*Panicum antidotale*). Also found in Bull Pasture, Ajo Mountains.

Western USA to South America, and adventive in the Old World; often weedy.

OP: 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-315*. Quitobaquito, 24 Oct 1990, *Felger 90-487*. Puerto Blanco Drive at 0.9 mi W of Hwy 85, 3 Dec 1990, *Felger 90-573*. Bull Pasture, 25 Sep 2013, *Rutman 20130925-3*.

CP: Monreal Well, *Simmons 21 Oct 1962* (CAB). Redtail Tank, 12 Jun 1992, *Felger 92-550*.

***Cottea pappophoroides* Kunth**

Cotta grass; *zacate papo*. Figure 22.

Tufted grasses, facultatively perennial or annual, often 30–75 cm tall, with well-developed, tough, wiry roots. Culms slender, often rather delicate and softly pilose, the basal nodes producing cleistogamous spikelets. Panicles terminal, open but rather narrow, the panicle branchlets, pedicels, and spikelets densely hairy. Spikelets with 6–10 florets; glumes multi-veined; lemmas 8–12-veined, the veins extending into 9 or more uneven, bristly awns. Growing with summer rains, reproductive in late summer and fall.

Occasional to sometimes common in the northern part of Organ Pipe and with other grasses on lower bajada and floodplain deposits of sandy loams along flat reaches of drainages, particularly in the Valley of the Ajo and one record from a similar habitat in Cabeza Prieta. Also localized and apparently rare on rocky slopes in the Ajo and Diablo Mountains.

Southwestern USA, northern and central Mexico to Oaxaca, and disjunct in South America.

The plants are facultatively winter and dry-season dormant, often (or usually?) dying back to the cleistogene-bearing bases. Although such plants, with their well-developed roots and knotty bases, appear perennial, they are often (or usually?) actually annuals regenerating from seeds in the basal cleistogenes. For example, the Cabeza Prieta specimen, collected in January 2002 long after the summer rainy season, appeared dead except for the cleistogenes. Similar facultative growth forms occur elsewhere, including the Sonoran Desert such as in the foothills of the Catalina Mountains (Jim Verrier, pers. comm. to R. Felger, February 2014) and in Argentina (Prof. Fernando Biurrun of Chamental, Argentina, pers. comm. to John R. Reeder, with subsequent pers. comm. to R. Felger 2002).

OP: N border of Monument, 11 Sep 1943, *Clark 10977* (ORPI). Armenta Ranch road, 1.4 mi W of Hwy 85 [Valley of the Ajo], 1 Feb 2002, *Felger 02-73*. Bull Pasture, *Rutman 30 Oct 1997* (ORPI). Foothills of Diablo Mts, W of Ajo Mt Drive, coarse colluvium, 778 m, rare, 22 Sep 2013, *Rutman 20130922-7*

CP: Papago Well, sandy bank of major wash, localized, fewer than one dozen plants seen, 11 Jan 2002, *Felger 02-38*.

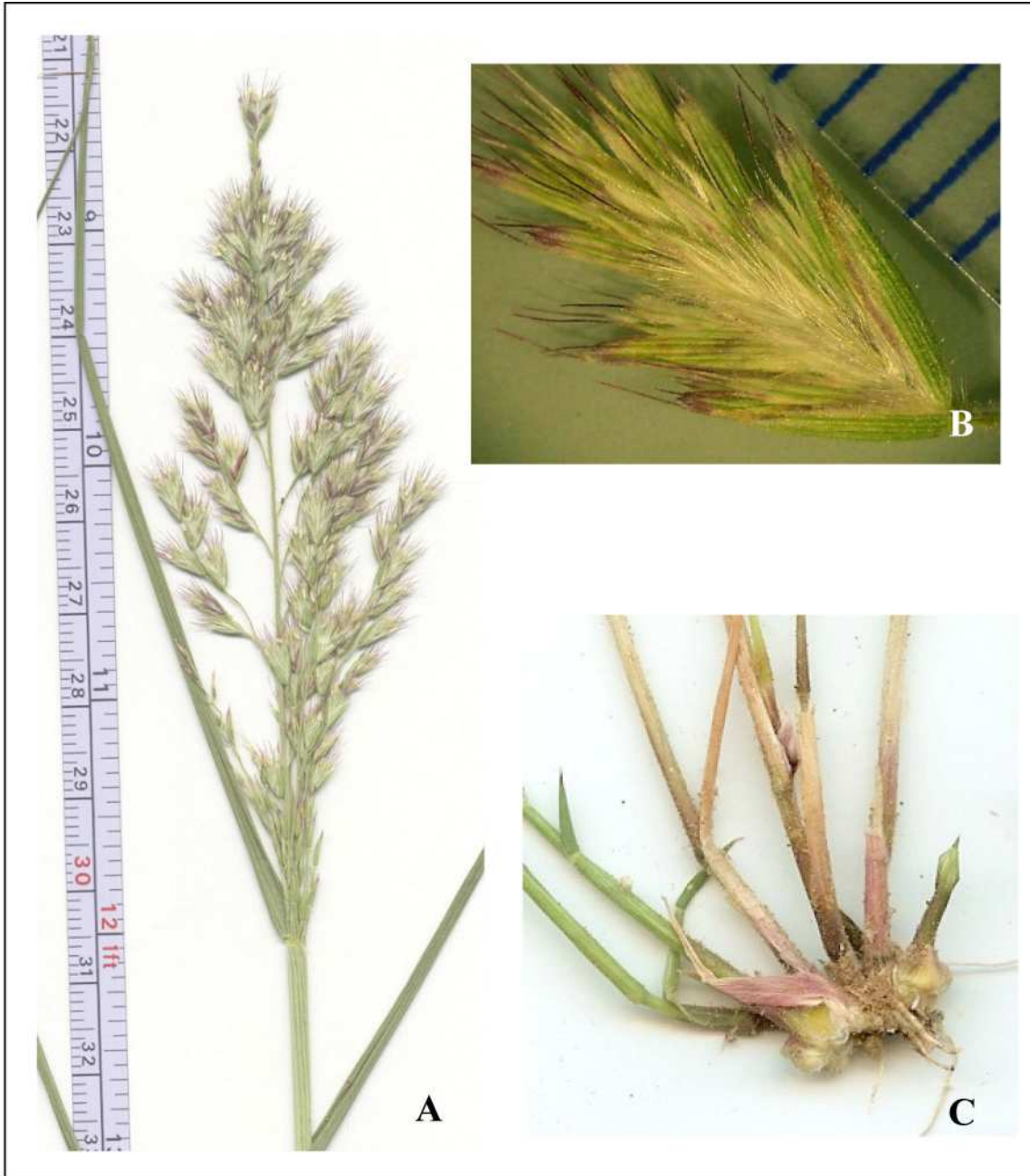


Figure 22. *Cottea pappophoroides*. (A) Panicle, Diablo Mts, 22 Sep 2013; (B) spikelet, photo by Elizabeth Makings, from SEINet; (C) base of plant showing the swollen cleistogenes, Valley of the Ajo, W of Hwy 85 at mile marker 60, 3 Sep 2006.

****Cynodon dactylon* (Linnaeus) Persoon var. *dactylon***

Bermuda grass; *zacate bermuda*, *zacate ingles*; ki: weco vasai, 'a'ai hihimdani vasai. Figure 23.

Deeply rooted perennials with creeping, scaly rhizomes and long stolons, forming extensive mats. Leaves short, mostly 2-ranked. Inflorescence a panicle of 4–7 slender, digitately-arranged spicate, unilateral branches (2) 2.5–6 (8) cm long, purplish to green. Spikelets with 1 floret, (1.7) 2–2.5 mm long, (1.7) 2–2.5 mm long, awnless, numerous and crowded in two rows on one side of the triangular

rachis. Actively growing and flowering during warmer months, and winter dormant unless protected from freezing weather.

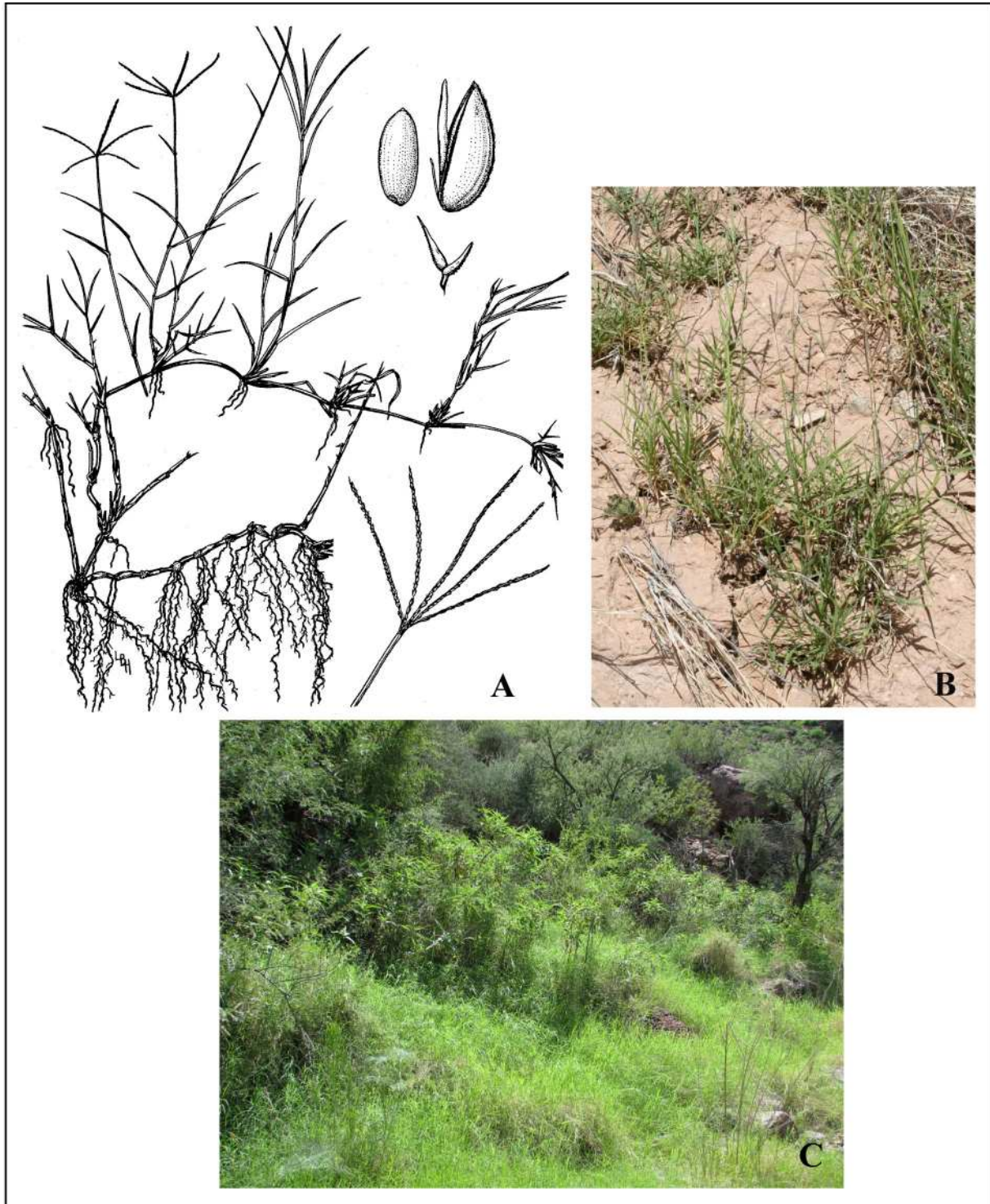


Figure 23. *Cynodon dactylon*. (A) Plant, panicle, and enlargement of glumes, lemma and palea, and caryopsis. Alamo Canyon: (B) 6 May 2006; (C) 9 Sep 2008.

Well established near springs, alkaline seeps, tinajas, and other waterholes where water may accumulate at least seasonally, in natural and disturbed habitats. Often at waterholes artificially “enhanced” or “improved” for wildlife. It can also occur in small or extensive patches in xeroriparian areas, along roadsides, and occasionally in uplands. It competes with *Distichlis spicata* and other native plants at Quitobaquito springs and has been at Quitobaquito at least since the early 1940s. *Cynodon* in 2013 covered several miles of xeroriparian area in Alamo Canyon. The upstream end is near the confluence of the middle and south forks of the canyon and extends several miles downstream. Perhaps it was planted or first established at or near the corral in Alamo Canyon.

Bermuda grass is the common summer lawn grass in the Sonoran Desert Region and also grown in irrigated fields for hay. There are a number of cultivated selections for turf grass and hay production. Native to the Old World and now a worldwide weed.

OP: Quitobaquito, 25 Mar 1941, *McDougall 36*. 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-320*. Alamo Canyon, near corral, *Rutman 5 Sep 1999*.

CP: Observations: Childs Mt, 2300 ft, abandoned military barracks, 18 Aug 1992, *Felger*. Eagle Tank, small colony at waterhole, 13 Jun 1992, *Felger*.

****Dactyloctenium aegyptium* (Linnaeus) Willdenow**

Crowfoot grass; *zacate de cuervo*

Summer ephemerals; glabrous, the culms spreading to ascending or decumbent, often rooting at the nodes and forming radiating mats. Leaf blades flat, short, and thick. Inflorescence a panicle of (1) 2–6 thick and stubby, digitately arranged, spicate, unilateral branches 1.5–4.5 cm long, spreading at nearly right angles from top of the culm. Spikelets 2.7–3.5 mm long overlapping, with 3–5 densely crowded tiny florets, the naked rachis extending beyond the spikelets. Glumes unequal in size and shape; upper glume with an oblique awn 0.5–3.2 mm long just below the tip. Lemmas strongly keeled; lemma of the first floret 2.2–3.2 mm long, pointed or with a recurved awn less than 1 mm long. The fruit is an achene, which is unusual among the grasses in that the seed can be seen through the thin pericarp, which is soon shed. The seed is glistening red-brown and elegantly sculptured with thin, transverse, wavy, and evenly-spaced ridges, these ridges often dark brown or black and the sulci (minute valleys) lighter colored (reminiscent of the seed of *Mollugo cerviana*).

Known in the flora area by a single record in 1987, when it was locally common in wet soil beneath cottonwood trees at Quitobaquito. Common weed in the nearby Sonoyta Valley, especially in agricultural fields.

Native to the Old World and now nearly worldwide, mostly as a weed.

OP: Quitobaquito, 10 Nov 1987, *Felger 87-289*.

***Dasyochloa pulchella* (Kunth) Willdenow ex Rydberg**

[*Triodia pulchella* Kunth. *Erioneuron pulchellum* (Kunth) Tateoka. *Tridens pulchellum* (Kunth) Hitchcock]

Fluff-grass; *zacate borreguero*. Figure 24.

Dwarf, tufted perennials 5–14 cm tall, sometimes flowering in the first season, with arching stolons of one internode, the longer ones 7–11 cm, bearing at their ends a tightly fascicled cluster of short leaves and inflorescences, often arching and bending to the ground and sometimes taking root and rarely producing a short, second stolon. Leaf blades 1.8–7 cm × less than 0.5 mm, minutely scabrous, the margins firm, in-rolled, and often white and thickened. Panicles densely white-pubescent, compact and densely flowered, on peduncles shorter than the longer leaves. Spikelets 6–

10 mm long, with (4) 6–8 florets, tardily breaking off above the glumes. Glumes and lemmas papery, sometimes purple-tinged, the glumes with a green midvein. Lemmas 3–5 mm long, densely pilose with long hairs on each of the 3 green veins, the lemma tip deeply 2-lobed with an awn 1–2 mm long from between the lobes. Flowering with warm weather and sufficient soil moisture; recruitment seems to generally occur with summer rains.

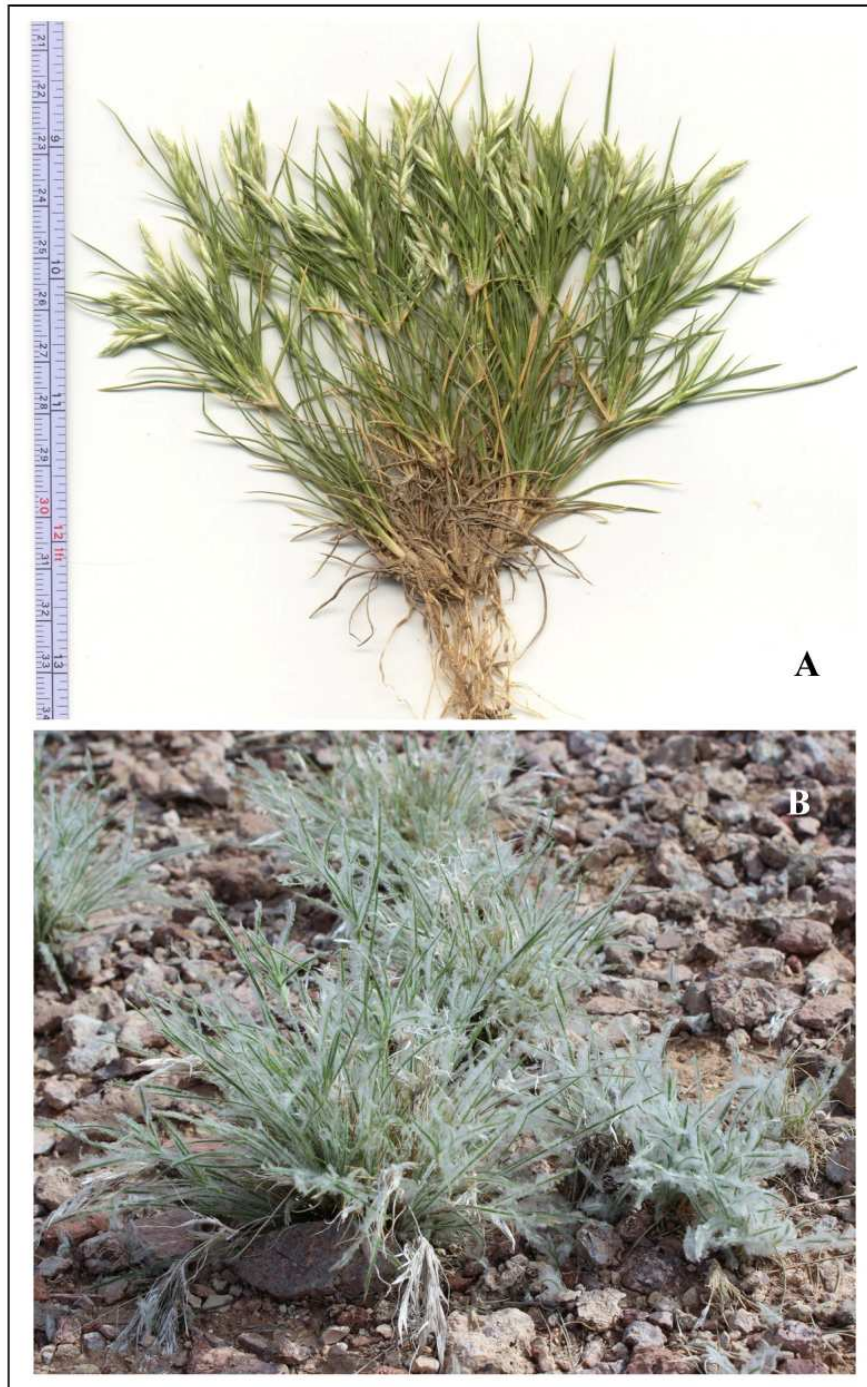


Figure 24. *Dasyochloa pulchella*. (A) Adult plant, Why, Pima Co., 15 Apr 2013; (B) Young leaves with bluish gray indumentum of hair-like crystals, between Boulder and Estes Canyons, Ajo Mts, 2 Aug 2013.

An impressively large pulse of recruitment occurred in Organ Pipe during summer 2012, a year with exceptionally high summer rainfall. Young plants and sometimes young leaves appear bluish gray or whitish: seedlings “are shaggy-white-villous. The indumentum is composed of myriads of hair-like, water-soluble crystals that wash off in water. They are the product of transpiration and evaporation” (Valdés-Reyna 2003: 47; Figure 24B). During the driest times the drought-killed aerial part of the plants persist, acting to shelter emerging shoots in subsequent favorable seasons, or the entire plant may die and apparently function as a nurse plant for seedlings at a later time. This grass is one of the most arid-inhabiting perennial grasses in the Sonoran Desert.

Widespread across the flora area in dry, open habitats including bajadas, hills, and mountains. It has been widespread across the region for more than 11,250 years.

Arid and semi-arid southwestern USA and northwestern Mexico and the Chihuahuan Desert Region.

OP: N border of Monument, 11 Sep 1943, *Clark 10982* (ORPI). Ajo Mt Drive 6.7 mi NE of Visitor Center, 5 Sep 1977, *Bowers 921*. Quitobaquito, 10 Nov 1987, *Felger 87-290*. Residence area, 30 Mar 1988, *Felger 88-142*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-11*. Between Boulder and Estes Canyons, along Ajo Mt Drive, 2 Aug 2013, *Rutman 20130802-2*. †Puerto Blanco Mts, 30 to 9070 ybp (13 samples, Van Devender et al. 1990: 339).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3937* (CAB). Childs Mountain, 18 Aug 1992, *Felger 92-641*. Scarface Mt, S-facing slope, 1750 ft, *Autenreith 20 Mar 1992* (ASC). Agua Dulce Pass, Heart Tank, Senita Tank, 13 & 14 Jun 1992, *Felger* (observations).

TA: Camino del Diablo SE of Raven Butte, 26 Nov 2004, *Felger 04-11*. Tinajas Altas, above upper tinajas, 26 Nov 2004, *Felger 04-92*. †Butler Mts, 220 to 11,250 ybp (9 samples, Van Devender et al. 1990: 342). †Tinajas Altas Mts, 4010 to 10,300 ybp (5 samples, Van Devender et al. 1990: 340).

Digitaria californica* (Bentham) Henrard var. *californica

[*Trichachne californica* (Bentham) Chase]

Arizona cottontop; *zacate punta blanca*. Figure 25.

Tufted perennials 50–90 cm tall, winter or dry-season dormant from a hard, knotty base. Culms firm, with felt-like hairs. Blades of larger leaves 12–17 cm × 4–6.5 mm. Panicles narrow, with 5–10 erect and densely-flowered branches. Spikelets panicoid; paired, one long-pedicelled, the other much shorter, or the second spikelet on portions of a branch sometimes not developing. Spikelets 2.5–5 mm long (excluding the hairs). Lower glume minute, the upper glume slightly narrower and shorter than the sterile lemma. Upper glumes and sterile lemmas each with 3 major veins in addition to the marginal and obscure veins, and densely pubescent with silky-cottony white to pale purplish marginal hairs overtopping and mostly covering the spikelet. Fertile lemmas with thin flat margins, the margins not inrolled (unlike many other panicoid grasses).

Arroyos, canyons, and rocky slopes, and along washes and on sandy loam. Widespread in Organ Pipe and especially common in the north-central part. It is favored by cattle and likely declined in much of the flora area during the cattle-grazing period. Also widespread in Cabeza Prieta and rare at Tinajas Altas. It has been in the Ajo and Puerto Blanco Mountains for at least 20,500 years. A spikelet from the oldest packrat midden is amazingly preserved, complete with dense, silky white hairs and a reduced lower glume.

Colorado to Texas and Arizona, rare in California, and southward to Puebla, the Caribbean, and South America. An additional variety, var. *villosissima* Henrard, occurs in South America and the Caribbean.

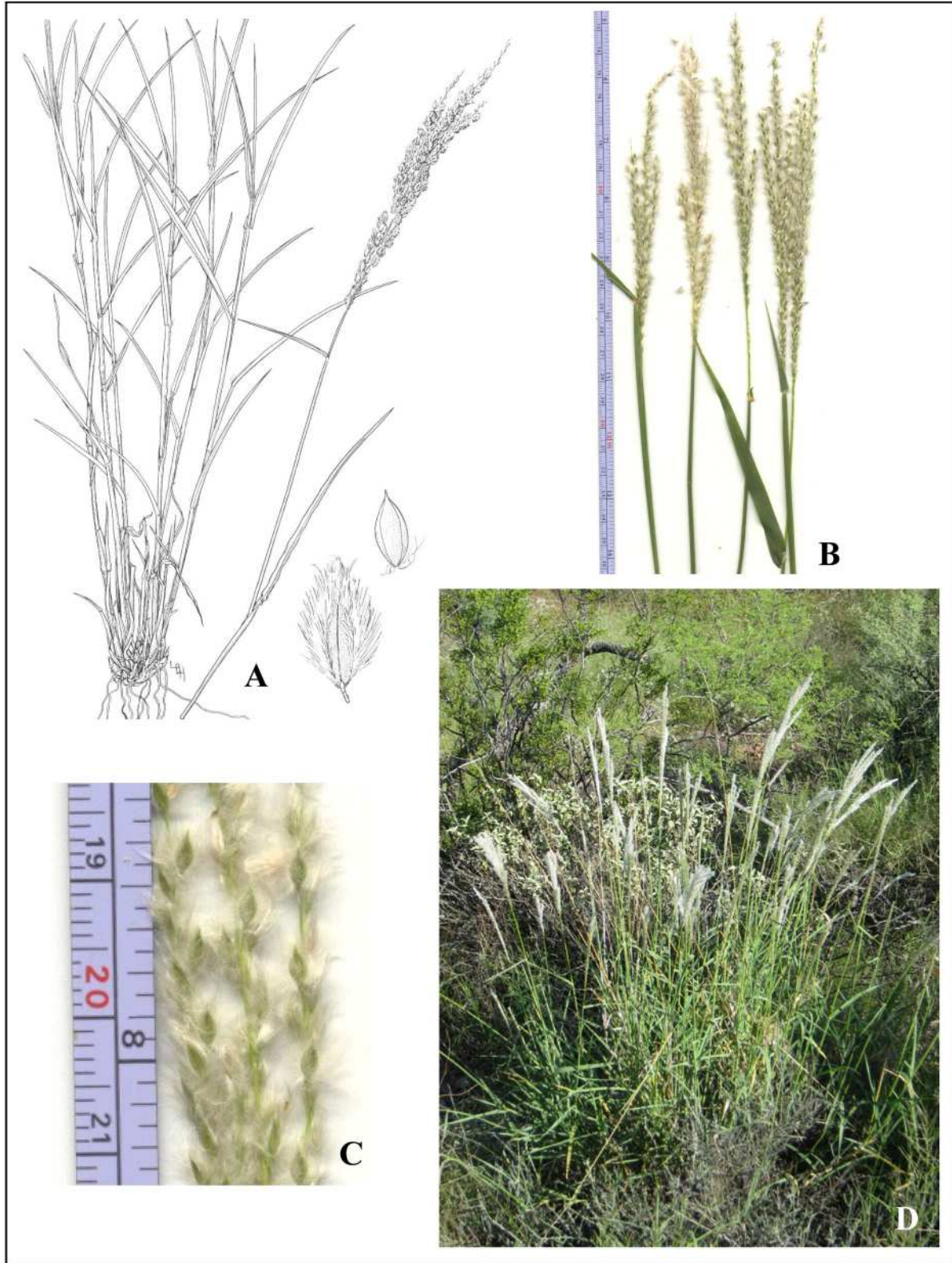


Figure 25. *Digitaria californica*. (A) Plant, culm with panicle, spikelet, and fertile floret; (B & C) panicles and spikelets, Why, Pima Co., 15 Sep 2013; (D) Diablo Mts, 14 Sep 2013.

OP: Alamo Canyon, *Nichol 4 May 1939*. Ajo Mt Drive 6.7 mi by road NE of Visitor Center, 5 Nov 1977, *Bowers 923*. Quitobaquito, 24 Oct 1990, *Felger 90-484*. About 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-2*. †Alamo Canyon, florets, 8590 & 9570 ybp. †Montezuma’s Head, spikelet, 13,500 & 20,490 ybp. †Puerto Blanco Mts, 7560 to 7970 ybp (3 samples, Van Devender et al. 1990: 339).

CP: 6 mi E of Papago Well, 15 Nov 1936, *Goodding 924G*. Pinacate Lava, E of Namer’s Grave, 15 Sep 1992, *Felger 92-771*. Agua Dulce Tank, Buckhorn Tank, 13 & 14 Jun 1992, *Felger* (observations). Childs Mt, 9 Apr 1993, *Felger 93-278*.

TA: Tinajas Altas, among rocks at base of tinaja slopes, 28 Mar 2010, *Felger 10-185*.

Dinebra

Annuals/ephemerals (sometimes stout and appearing perennial), the stems erect or geniculate-ascending. Ligule membranous. Inflorescences panicles of many racemose, unilateral branches bearing few to many spikelets. Spikelets packed broadside to the rachis, appressed, with 1–4 fertile florets and reduced florets above, laterally compressed, and breaking apart at maturity. Glumes persistent and exceeding the florets. Fertile lemma 3-veined, unawned or with a mucro (short bristle).

Dinebra includes 23 species widely distributed in the New and Old Worlds (Peterson et al. 2012; Snow & Peterson 2012).

- 1. Lemmas awnless **Dinebra panicea**
- 1. Lemmas short-awned **Dinebra viscida**

Dinebra panicea (Retzius) P.M. Peterson & N. Snow subsp. **brachiata** (Steudel) P.M. Peterson & N. Snow

[*Leptochloa brachiata* Steudel. *L. filiformis* (Persoon) P. Beauvois. *L. panicea* (Retzius) Ohwi subsp. *brachiata* (Steudel) N.W. Snow]

Red sprangletop; *deparramo rojo*. Figure 26.

Summer ephemerals, usually delicate and filmy; sometimes reaching 50+ cm tall but usually much smaller; green or sometimes reddish maroon. Roots often weakly developed. Glabrous or the leaf sheaths sparsely hispid with bulbous-based hairs. Spikelets 2.2–3.2 mm long, with (1) 2 or 3 florets, the mature (grain-bearing) spikelets sometimes appearing to have 1 floret. Glumes generally shorter than the rest of the spikelet; lemmas awnless, the veins, especially the midrib, often sparsely pubescent with small soft hairs, or sometimes glabrous or essentially so.

Often common along watercourses or floodplains, washes and canyon bottoms, margins of dirt tanks, playas, and depressions in silty-sandy soils; widespread in lowland areas.

Subspecies *brachiata* occurs in southern half of the USA to South America. It is often weedy and is introduced and spreading elsewhere in the world.

This grass was long known as *Leptochloa filiformis*, then *L. mucronata* (Michaux) Kunth, and then as *L. panicea* subsp. *mucronata* (Michaux) Nowack, and most recently as *Dinebra panicea* subsp. *brachiata*. Subspecies *mucronata* is restricted to southeastern and central USA, and subsp. *panicea* is native to the Old World (Peterson et al. 2012).

OP: Alamo Canyon, *Van Devender 31 Aug 1978*. Ajo Mt Drive, 12 Sep 1978, *Bowers 1518*. Aguajita Wash, 14 Sep 1988, *Felger 88-402*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-8*.

CP: Monreal Well, *Simmons 21 Oct 1962* (CAB). Jose Juan Represo, 12 Jun 1992, *Felger 92-564*. E of Namer’s Grave, 15 Sep 1992, *Felger 92-773*. San Cristobal Wash, 14 Sep 1992, *Felger 92-691*. Las Playas, 28 Nov 2001, *Felger 01-562*.



Figure 26. *Dinebra panicea*. Alamo Canyon: (A) 9 Sep 2013; (B) 15 Sep 2013. (C) Growler Canyon, Bates Mts, 8 Sep 2006.

Dinebra viscida (Scribner) P.M. Peterson & N. Snow
 [*Leptochloa viscida* (Scribner) Beal]
 Sticky sprangletop. Figure 27.

Scruffy little summer-fall ephemerals often 10–30 cm tall, but stunted plants can reproduce as small as 1.5 cm tall. The viscid-sticky feature is often used as a key character, but the plants are often only scarcely viscid. You can usually find a few sparkling droplets on the flowering axes and branches, and this exudate is sometimes thick on the lemmas. Roots often poorly developed. Culms often forming short, geniculate (“bent-knee”) and spreading branches, these sometimes forming roots at the nodes. Panicles at first often partially enclosed in the leaf sheath, later expanding and

spreading. Spikelets with several florets. Glumes and lemmas thin; glumes with a prominent green midvein. Lemmas 2–2.8 mm long, with a rounded, notched apex, and 3 prominent green veins with the midrib extending into a slender awn to 1 mm.

Seasonally abundant in the large playas in Cabeza Prieta and similar habitats in nearby northwestern Sonora.

Southern California to western Texas, both Baja California states, Chihuahua, Sonora, and Sinaloa.

CP: Las Playas: 10 Oct 1958, *Monson* 7; 28 Nov 2001, *Felger* 01-561.



Figure 27. *Dinebra viscida*. (A) Plant, culm with panicles, and spikelet and caryopsis; (B) spikelet, photo by Elizabeth Makings, from SEINet.

Diplachne fusca (Linnaeus) P. Beauvois ex Roemer & Schultz subsp. ***uninervia*** (J. Presl) P.M. Peterson & N. Snow

[*Diplachne uninervia* (J. Presl) Parodi. *Leptochloa uninervia* (J. Presl) Hitchcock & Chase. *L. fusca* (Linnaeus) Kunth subsp. *uninervia* (J. Presl) N. Snow]

Mexican sprangletop. Figure 28.



Figure 28. *Diplachne fusca* subsp. *uninervia*. (A) Plant, panicle, and spikelet; (B) panicles, Gila River Canal at Buckeye, Maricopa Co., 31 Mar 2013.

Robust annuals, often appearing perennial, often forming large clumps 0.5+ m tall, non-seasonal but responding best to hot weather. Herbage and inflorescences glabrous or minutely scabrous. Inflorescences panicles with many narrow, racemose branches. Spikelets generally dark grayish green (“lead-colored,” or sometimes pale rose-colored when immature), 4.2–6.4 mm long with 4–8 florets. Lemmas obtuse to truncate, awnless or with a minute awn in the terminal notch.

Infrequent in alkaline/saline, wet soils in the vicinity of Quitovaquito and the sandy-loam grassy flats along the Armenta Road.

Often in wetland habitats in the Sonoran Desert Region. Subspecies *uninervia* ranges from southern USA to Argentina, Chile, Peru, and the Caribbean. The *Diplachne fusca* complex includes 3 subspecies in addition to subsp. *uninervia*: *D. fusca* subsp. *fascicularis* (Lamarck) P.M. Peterson & N. Snow is widespread in the Americas, and the other two are native to the Old World.

OP: Sonoyta River near Quitovaquito, 30 Jan 1894, *Mearns 2741* (US). Rincon Spring, 13 Apr 1941, *McDougall 89*. Williams Spring, *Van Devender 30 Aug 1978* (ORPI). Armenta Rd, *Rutman 16 Aug 2001* (ORPI). Below Cement Tank, Santa Rosa Mts, 2 Apr 2003, *Rutman 2003-442*.

Disakisperma dubium (Kunth) P.M. Peterson & N. Snow
 [*Diplachne dubia* (Kunth) Scribner. *Leptochloa dubia* (Kunth) Nees]
 Green sprangletop. Figure 29.

Tufted perennials, 40–100 cm tall, often purple-tinged and with a tough, knotty base; sometimes reproductive in the first season or year. Ligule a membrane fringed with white hairs. Larger leaf blades 25–36 cm long, often somewhat bluish green. Enlarged, cleistogamous spikelets often at culm bases. Panicles 18–24 cm long, with several or more unbranched, racemose primary branches, the branches triangular in cross section. Florets of young spikelets crowded but at maturity become well separated and the rachis becomes readily visible. Spikelets with 5–12 florets. Spikelets breaking apart above the glumes and between the florets, each floret falling with its segment of rachis. Lemmas 2.1–5 mm long, 3-veined, broadly truncate (blunt-ended), with 2 broad lobes and the midrib extending into a slender bristle within the notch.

In the flora area known from the Ajo Mountain, at middle to higher elevations, and in 2013 seen along Kuakatch Wash about 1 mile west of Highway 85.

Arizona to Oklahoma and Texas, Florida, Mexico including Baja California to Central America, and South America.

OP: Main canyon N of Alamo Canyon, 3600 ft, 31 Mar 1948, *Gould & Darrow 4690*. Bull Pasture Trail, 2800 ft, *Henry 26 Sep 1976* (ORPI). Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-538* (ORPI). Kuakatch Wash near E boundary of the Monument, 10 Sep 2013, *Rutman* (observation).

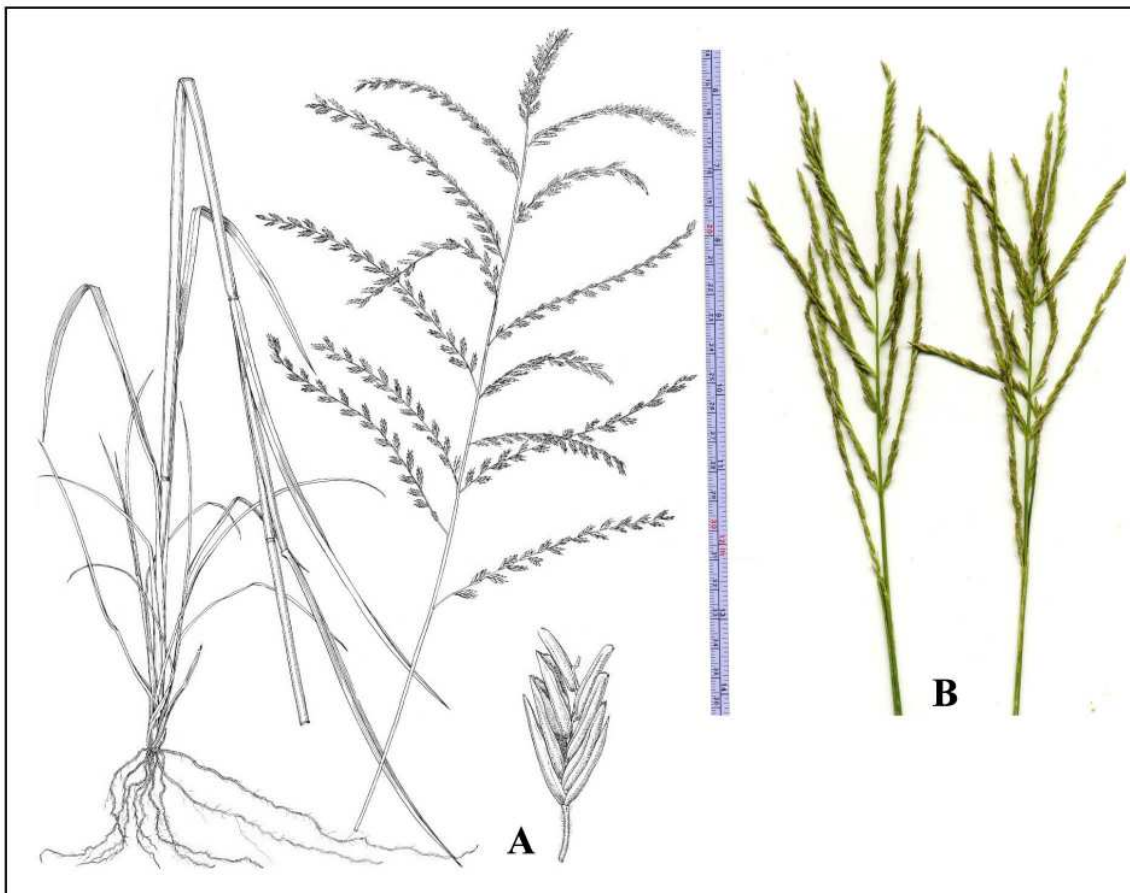


Figure 29. *Disakisperma dubium*. (A) Plant, panicle, and spikelet; (B) panicles, Alamo Canyon, 15 Sep 2013.

Distichlis spicata (Linnaeus) Greene

[*D. stricta* (Torrey) Rydberg]

Saltgrass; *zacate salado*; 'onk, vasai. Figure 30.

Perennials with creeping rhizomes, forming extensive colonies. Leaves 2-ranked, with salt-excreting bicellular hairs sunken in leaf tissue; ligules minute and membranous; leaf blades mostly 4–8 cm long, mostly firm and sharp-pointed (softer and not sharp-pointed when growing in shade with ample water). Inflorescence a slender, few-branched panicle or raceme; staminate and pistillate flowers on separate plants; staminate inflorescences usually overtopping the leaves, pistillate inflorescences about as tall as the leaves. Spikelets mostly 5–15 mm long, soon becoming straw-colored, laterally compressed, awnless, with few to many florets. Winter dormant; growing and reproductive during the warmer months.

In the flora area only known from the Quitobaquito region where it is locally abundant on moist to wet, hypersaline soils where perennial water is at or near the surface. When cattle were being grazed at Aguajita the wash near the spring was open and there was a perennial flow. After the cattle were removed in the late 1970s the local flora changed rapidly in response to the changing habitat: *Distichlis* increased and crowded out other plants, and subsequently the *Distichlis* declined as it was crowded out by arrow-weed (*Tessaria sericea*) and mesquite trees. A significant flood in the summer of 2012 once again opened the Aguajita wash bed allowing increase in the *Distichlis*. Extensive local populations occur at Quitobaquito Spring and Williams Spring, and a small population is at Burro Spring.

Coasts and interior basins; Canada to Mexico, the West Indies, and southern South America.

OP: Quitobaquito, *Nichol 28 Apr 1939*. Williams Spring, 13 Sep 1986, *Felger 86-274*. Aguajita Wash, 14 Sep 1988, *Felger 88-442*. Quitobaquito Spring, saline, crusty, sandy soil, *Glenn 26 May 1990*. On berm that creates Quitobaquito Pond and common on hypersaline soils seasonally wetted by springs, soil pH exceeding 10, with *Schoenoplectus americanus*, 15 Jun 2013, *Rutman 20130615-1*.

Echinochloa – Barnyard grass

Annuals (in the flora area). Ligules absent (those in the flora area, this being the only grass genus in the flora area without ligules). Leaf blades with a prominent midrib. Panicles terminal, with few to many spike-like branches. Spikelets panicoid, densely crowded in 2 or 4 crowded rows on one side of a flattened rachis, breaking off below the glumes, with 2 florets, the lower one sterile and reduced or staminate, the upper one bisexual. Lower glume short, the upper glume similar to the sterile lemma. Fertile lemma smooth, shiny, and flat, with margins covering a flat palea of similar texture.

- 1. Leaf blades with transverse purple bars or blotches; hairs or bristles (spines) on spikelets, panicle axes, and branches not bulbous-based; spikelets 2.2–2.6 (3) mm long, awnless; panicle branches 1–2 (3) cm long, simple **Echinochloa colona**
- 1. Leaves uniformly green, without purple markings; hairs and bristles on spikelets and panicle axis and branches often bulbous-based; spikelets 2.8–4 mm long (excluding awns and projections), often but not always long-awned; panicle branches usually 2.5–6 cm long, usually with at least some short secondary branches **Echinochloa crus-galli**

***Echinochloa colona** (Linnaeus) Link

Jungle rice, leopard grass; *zacate pinto*, *zacate tigre*, *zacate rayado*. Figure 31.

Summer ephemerals and sometimes occurring with warm weather at other seasons. Leaf blades with transverse purple bars or blotches—no other grass in Arizona and the Sonoran Desert has

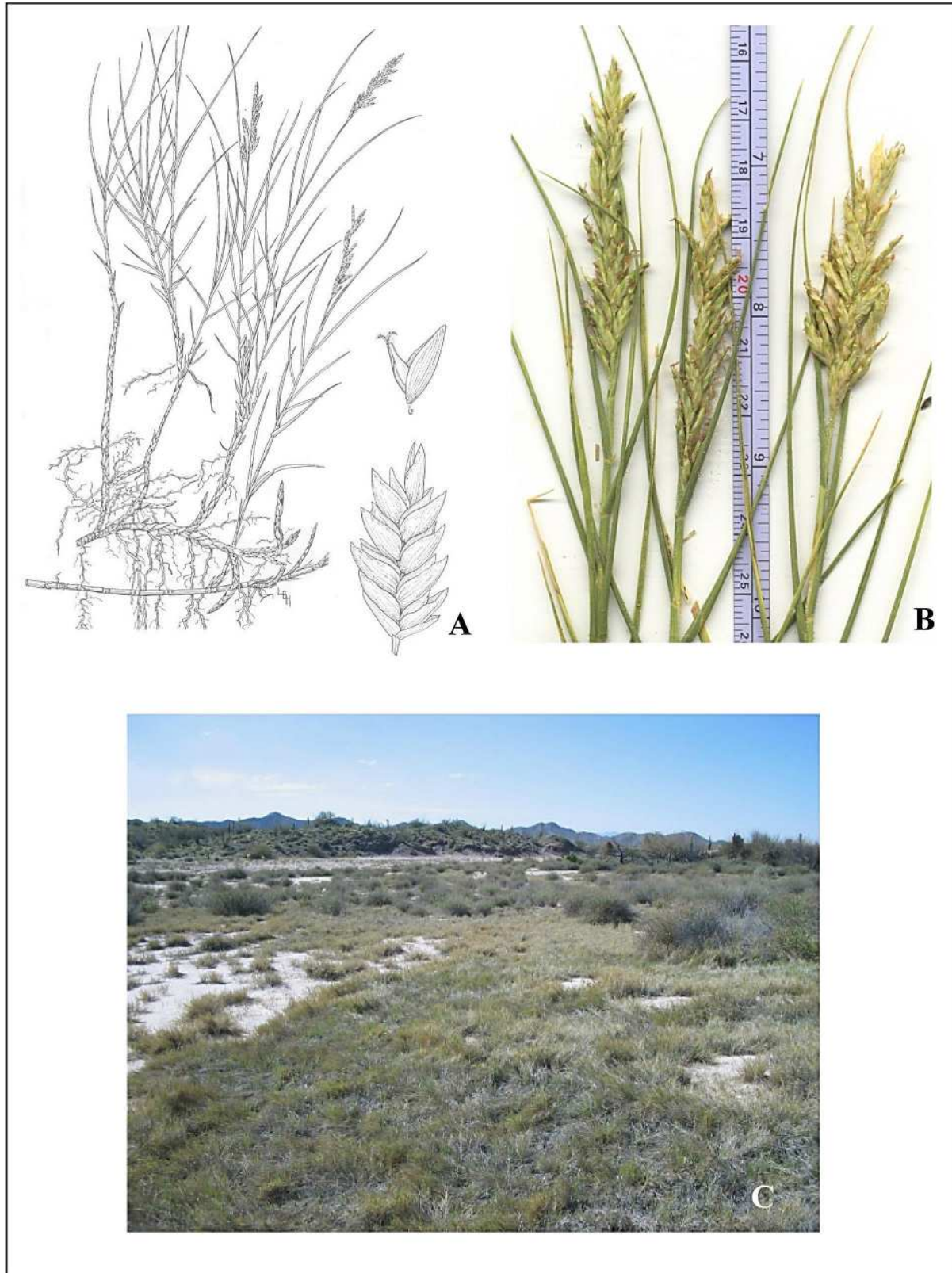


Figure 30. *Distichlis spicata*. (A) Plant with panicles, spikelet, and pistillate floret; (B) pistillate panicles, Quitobaquito Pond, 16 Jun 2005; (C) Williams Spring, 4 Feb 2005.

these markings. Panicle branches simple, 1–2 (3) cm long; panicle branches and spikelet hairs not bulbous-based. Spikelets in 4 rows, awnless, 2.2–2.6 (3) mm long. Lower florets sterile, or perhaps sometimes staminate.

Mostly in wet soil at waterholes including margins of dirt tanks and temporary wetland habitats such as arroyo bottoms; sometimes in wet soil at disturbed habitats. Also observed in 2012 below a chronically dripping faucet at the maintenance facility in Organ Pipe.

Native to the Old World, now widespread and mostly weedy in tropical and subtropical regions worldwide.

OP: Williams Springs, *Van Devender 31 Aug 1978* (ORPI). Ajo Loop Rd 2 mi NE of Visitor Center, 9 Sep 1984, *Van Devender 84-451*. 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-323*. Maintenance area, NPS headquarters, *Casper 24 Mar 2003*.

CP: Redtail Tank, 12 Jun 1992, *Felger 92-549*. Jose Juan Tank, 14 Sep 1992, *Felger 717*. San Cristobal Wash, deep shade under *Prosopis*, 26 Sep 2013, *Rutman 20130926-8*.

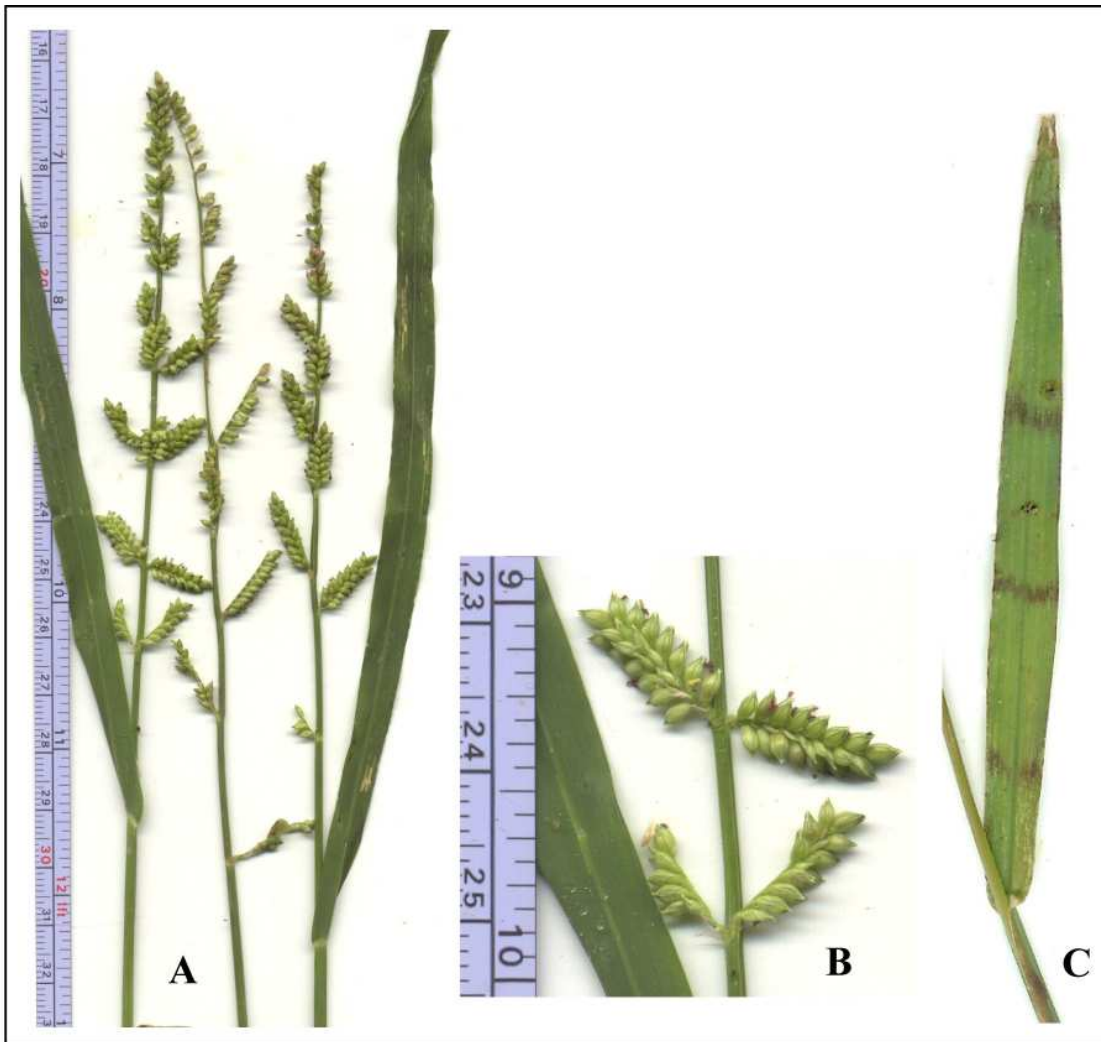


Figure 31. *Echinochloa colona*. (A & B) San Cristobal Wash at Camino del Diablo, 26 Sep 2013; (C) Alamo Canyon near Alamo Well, 21 Oct 2007.

****Echinochloa crus-galli*** (Linnaeus) P. Beauvois
 Barnyard grass; *zacate de agua*, *zacate de corral*. Figure 32.

Coarse, warm-weather annuals, the plants often more robust than those of *E. colona*. Leaf blades uniformly green, the larger ones mostly 1–1.5 cm wide. Panicle branches mostly 1–4 cm long (to 9 cm elsewhere in better watered places), the larger branches sometimes with short secondary branches; branches and main axis of panicles with stout, often bulbous-based bristle-like hairs. Spikelets 2.8–4 mm long, awned or awnless, even on the same plant and within the same panicle, the awns highly variable in length, often purplish, the longer awns 2.6–5.8 cm. Lower florets sterile, with a well-developed palea. (Description based on the one local specimen and ones from adjacent desert areas.)

Known from the flora area by a single record. Locally common in nearby Sonora in the vicinity of Sonoyta in seasonally wet mud along the riverbed, irrigation ditches, and at water impoundments.

Native to the Old World, now weedy and adventive nearly worldwide.

CP: Jose Juan Represo, 12 Jun 1992, *Felger 92-558*.



Figure 32. *Echinochloa crus-galli*. (A) Plant with panicles; open spikelet showing the small lower glume (bottom), upper glume (right), sterile lemma with smaller sterile palea (left), and fertile lemma and palea enclosing the caryopsis (center); fertile lemma and palea enclosing the caryopsis (center); two views of awned spikelet (above); (B) spikelets, photo by Elizabeth Makings, from SEINet.

Elymus elymoides (Rafinesque) Swezey var. ***brevifolius*** (J.G. Smith) Dorn

[*Sitanion hystrix* (Nuttall) J.G. Smith var. *brevifolium* (J.G. Smith) C.L. Hitchcock. *Elymus longifolius* (J.G. Smith) Gould]

Bottlebrush squirrel-tail; *triguillo desértico*. Figure 33.

Tufted perennials, without rhizomes. Leaf sheaths bear a pair of slender, fang-like auricles (like many *Hordeum* species); ligules minute. Inflorescence a spike 8–15 cm long (not including awns), densely flowered, and bristly with stout, scabrous awns mostly 2.5–12 cm long on glumes and lemmas. Spikelets usually paired at nodes, usually with 2–4 florets per spikelet, the lower floret fertile; glumes bristle-like. At maturity the inflorescences break apart in segments that roll away like miniature tumbleweeds. Grain linear-oblong, furrowed in back, adhering to the palea.

Ajo Mountains, mostly on rocky slopes at higher elevations—it extends no farther west into the desert. This or a similar grass has been in the Ajo Mountains for more than 29,000 years.

Widespread in Arizona, generally at elevations above the desert. This species, with 4 subspecies, occurs in western North America from Canada to Mexico. In the flora is var. *brevifolius*, which ranges farther south than the other subspecies and occurs from northwestern Mexico to Canada (Barkworth et al. 2007c). Taxonomy of the squirrel-tail grasses is complicated (see Allred & Ivey 2012).

OP: Alamo Canyon, *Nichol* 4 May 1939. Arch Canyon, 3 May 1978, *Bowers* 1302. Trail from The Cones to Mount Ajo, 3940 ft, 10 Apr 2005, *Felger* 05-262. †*E. cf. elymoides*: Alamo Canyon, florets, 9570 to 29,110 ybp (3 samples); Montezuma's Head, 13,500 to 21,840 ybp (4 samples).



Figure 33. *Elymus elymoides* var. *brevifolius*. Fay Canyon, west of Sedona, Yavapai Co., 8 May 2004, photo by Max Licher.

Enneapogon – Pappus grass

Tufted annuals or perennials, generally with soft, glandular hairs. Panicles slender and spike-like, overtopping the leaves, feathery, and with soft hairs. Spikelets with 2 or 3 florets, usually only the lower one bisexual. Lemmas rounded on the back, prominently 9-veined, the veins extending into 9 feathery awns, usually dark-colored—making this grass unmistakable (*Enneapogon* is derived from the Greek words for nine beards).

- 1. Robust annuals (may appear perennial); culms 2 mm wide, not forming cleistogenes; panicles 1–3 cm wide **Enneapogon cenchroides**
- 1. Small perennials; culms to 1 mm wide, with well-formed cleistogenes at their bases; panicles usually to 1 cm wide **Enneapogon desvauxii**

***Enneapogon cenchroides** (Lichtenstein ex Roemer & Schultes) C.E. Hubbard
Soft-feather pappus grass. Figure 34.



Figure 34. *Enneapogon cenchroides*. (A) King Canyon, Tucson Mts, Saguaro National Park, 9 Oct 2011, photo by Anthony Mendoza, from SEINet; (B) panicle, east Broadway Blvd., Tucson, 17 Oct 2007.

Robust annuals (often appearing perennial; probably non-seasonal annuals), (20) 35–70+ cm tall; roots strong and with conspicuous root hairs and rhizosheaths. The lower culms finely pilose. Panicles (5) 9–24+ cm long, 1–2 (3) cm wide, densely flowered and often dark-colored. Reproductive September to December or January.

Found at Alamo Canyon in the 1990s and later at an isolated hill west of the Diablo Mountains. It will probably spread and could become seriously invasive at higher elevation in the Ajo Mountains.

Introduced in the Tucson region and well established in the Catalina Mountains in Pima County at least since 1976 and documented since the 1980s in other scattered Arizona localities. Since the 1990s populations in the Tucson Basin have rapidly expanded and Rutman observed it in 2012 along Highway 86 on the eastern part of the Tohono O'odham Reservation. Locally established in desert, grassland, and oak woodland, sometimes with extensive populations in Cochise, Graham, and Pima Counties. Native to the Old World, in Africa and Madagascar to India.

This Old World grass might be confused for the native *Pappophorum*. *Enneapogon* has feathery (plumose) awns, while *Pappophorum* has scabrous (rough) but not plumose awns and narrower leaves. *Enneapogon cenchroides* panicles tend to be narrower and darker colored than those of *Pappophorum*.

OP: On a small, inconspicuous hill about 4–4.5 mi by road from the Visitor Center on the Ajo Mountain Drive, hill is SE of road: 24 Sep 2006, *Rutman 20060924-1*; 22 Oct 2006, *Rutman 2006-1022-1*.

Enneapogon desvauxii P. Beauvois

Spike pappus grass, nine-awn pappus grass; *zacate lobero*. Figure 35.

Small, tufted perennials or sometimes functionally annuals, often 15–20 (30) cm tall, with hard, knotty bases containing cleistogamous, awnless spikelets. Leaf sheaths and lower parts of the culms finely pilose. Ligules a row of hairs, these about 1 mm long. Leaf blades wiry, less than 10 cm × 0.5 (1) mm, the margins in-rolled during drier times, and flat and reaching 1.5 mm wide during moist times (e.g., with summer–fall rains). Panicles spike-like, terminal, slender, and densely flowered. Spikelets 4.5–7 mm long including awns, lead-gray or gray-green, mostly 3-flowered, only the lower one bisexual. Glumes subequal, sparsely and finely pubescent, with well-marked green veins plus 1 or 2 faint ones, the lower glume 5–7-veined, the upper glume 3–4-veined. Lemmas with dark-colored feathery awns, the longer awns 3–4.5 mm. Grain 0.8–1.2 mm long with an abruptly narrowed tip 0.1 mm long, golden- to tan-colored, plump and ovoid or oval. Cleistogamous spikelets buried in the lower part of the leaf sheaths at the stem bases, the stems breaking off “at the lower nodes, carrying the cleistogenes with them” (Hitchcock 1951: 227). Cleistogamous florets lack glumes and awns, the grain resembling the chasmogamous (“normal”) grain but larger (1.8–1.9 mm long) and at maturity splitting the sheath in which it develops.

The plants sometimes produce short culms with reduced panicles bearing spikelets with short-awned florets that are intermediate between the cleistogamous and chasmogamous florets. Sometimes the plants perish in drought but remain intact, and in subsequent rainy seasons new plants germinate from cleistogenes at the base of the dry, dead mother plant, which functions as a nurse plant—the plants thus being functionally annual. Also see *Cottea pappophoroides*.

Arid rocky and rocky-gravelly soils in hills and mountains. Widely scattered in Organ Pipe and on the eastern side of Cabeza Prieta.

Southwestern USA to Oaxaca, South America, and the Old World.

OP: Near Pozo Nuevo, 12 Feb 1978, *Bowers 1053*. Near mouth of Arch Canyon, 2 Dec 1990, *Felger 90-524* (ORPI). Eagle Pass, *Wirt 16 Sep 1990* (ORPI). Saddle between Arch and Boulder Canyons, *Rutman 24 Sep 1998* (ORPI). Gunsight Hills, 3557286N, 342604E, biotite granite bedrock or thin soil, 27 Sep 2006, *Rutman 2006-0927-1*.

CP: Charlie Bell Well, *Monson 24 May 1957* (CAB). Childs Mt, 18 Aug 1992, *Felger 92-643B*.

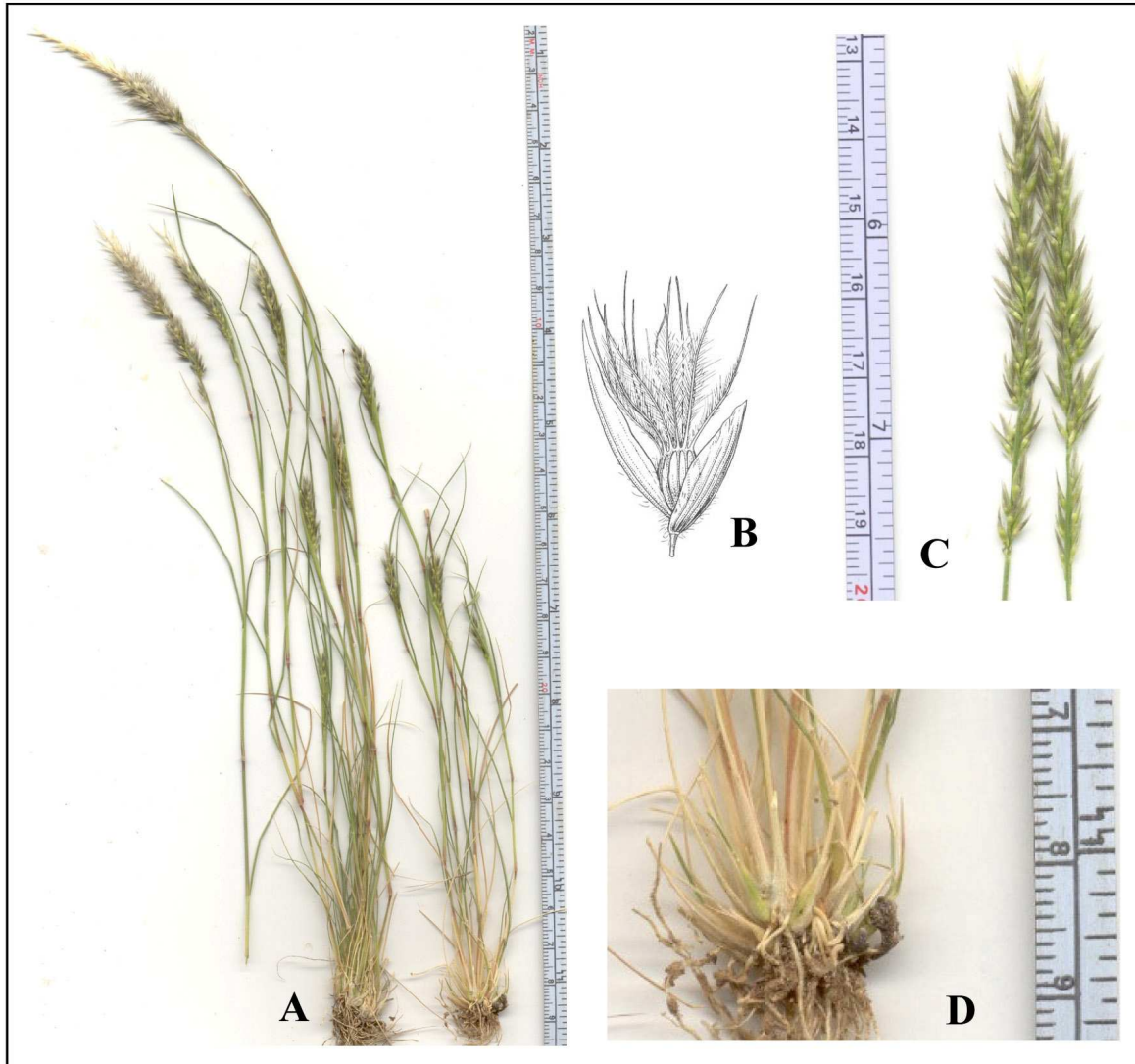


Figure 35. *Eneapogon desvauxii*. (A) Little Ajo Mts, Pima Co., 21 Sep 2008; (B) spikelet; (C) panicles, Alamo Canyon, 9 Sep 2013; (D) base of plant with cleistogenes, Little Ajo Mts, Pima Co., 21 Sep 2008.

Eragrostis – Lovegrass

Annuals/ephemerals or perennials, actively growing and reproductive during the warmer months, although some such as the Mediterranean *E. barrelieri* can be non-seasonal. Ligules ciliate with a line or band of hairs. Panicles with rebranching branches and usually overtopping the leaves, the branches and pedicels usually slender. Spikelets laterally compressed, with few–many florets, and awnless. Glumes thin; glumes and lemmas deciduous; lemmas 3-veined, the paleas often persistent. Anthers 3 (those in the flora area, elsewhere anthers 2 or 3).

- 1. Ephemerals, with prominent shining yellow, pink, or purplish glandular areas or rings at or below nodes, especially prominent on lower nodes of the panicles **Eragrostis barrelieri**
- 1. Ephemerals or perennials, without large shining glandular areas or rings.

- 2. Hot weather ephemerals; anthers small, 0.3–0.4 mm long.

- 3. Panicles usually dense, the spikelets close together; pedicels usually shorter than mature spikelets; tiny, warty, glandular pits on culms, leaf margins, keels of glumes, lemmas, and lower leaf surfaces; spikelets 2–4 mm wide; grain 0.5–0.6 mm long..... **Eragrostis cilianensis**
- 3. Panicles usually open, spikelets usually widely spaced; pedicels longer or shorter than spikelets; without glandular pits; spikelets less than 2 mm wide; grain 0.6–0.8 mm long..... **Eragrostis pectinacea**

2. Perennials; anthers relatively large, 0.6–1.1 mm long.

- 4. Pedicels longer than the spikelets; spikelets 1.6–1.8 mm wide; anthers 0.6–0.8 mm long; grain conspicuously grooved on one side..... **Eragrostis intermedia**
- 4. Pedicels mostly shorter than the spikelets; spikelets 0.8–1.1 mm wide; anthers 1 mm long; grain without a groove..... **Eragrostis lehmanniana**

****Eragrostis barrelieri** Daveau
Mediterranean love grass

Small summer-fall ephemerals, often persisting through the winter or perhaps non-seasonal. The plants resemble those of *E. pectinacea* but are readily distinguished by shining yellow, pink, or purplish glandular areas or rings at or below the nodes and often especially prominent on lower nodes of inflorescences. These colored, glandular rings or patches are unique among Arizona grasses.

Known from the flora region from a single specimen at Lukeville and also observed in Sonoyta.

A weedy species native to southern Europe. The earliest Arizona record is from Tucson in 1918 and it was common in Tucson by the 1930.

Pima County: Lukeville, weed at U.S. Customs Station, 23 Oct 1987, *Felger 87-276*.

***Eragrostis cilianensis** (Allioni) Vignolo Lutati ex Janchen
Stink grass, stinking lovegrass; *zacateapestoso*. Figure 36.

Summer-fall ephemerals, highly variable in size, to 45 cm long but mostly much smaller. Plants with small crater-like glands, these turgid, viscous, and glistening when fresh. These glands are often used as a key character although they are sometimes scarce, especially on small plants, but if you look hard enough you will eventually find at least a few, which are small scale-like warts on margins and/or keels (midribs) of glumes, lemmas, and leaf blades and sheaths. Mouth of leaf sheaths bearded, the ligules ciliate. Spikelets 3.5–21 (26) mm × 2–3 (3.6) mm. Lemmas 2–2.5 mm long. Anthers 3 per floret, mostly 0.3–0.4 mm long. Grain 0.5–0.6 mm long, red-brown, broadly ovoid to subglobose and somewhat compressed laterally. The plants are usually recognizable in the field by the pale green (when fresh) or straw color (at maturity) of the relatively broad spikelets.

Common and widespread across the flora area in lowland habitats, mostly where water temporarily accumulates, wetland soils of dirt tanks, floodplains, swales, sandy washes, and adjacent desert flats during years of favorable summer rains.

Native to the Old World, now worldwide, often weedy; well established in the Sonoran Desert in disturbed as well as natural habitats. The common name refers to the strong odor of fresh plants growing in non-desert regions, such as moist temperate or subtropical regions where this grass is often relatively large and abundant. The plants lose the odor on drying. In the flora area and elsewhere in the Sonoran Desert it does not seem to live up to its common name, at least sometimes and according to some botanists.

OP: Sandy arroyos, N border of Monument, 11 Sep 1943, *Clark 10976* (ORPI [E of Armenta Ranch]). Ajo Loop Rd 2 mi NE of Visitor Center, 9 Sep 1984, *Van Devender 84-447*. 0.5 km E of Lukeville, 11 Nov 1987, *Felger 87-324*. Aguajita Wash, 14 Sep 1988, *Felger 88-436*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-6*.

CP: Dan Drift's Mine near Tule Well, *Simmons 3 Oct 1963* (CAB). Jose Juan Represo, 12 Jun 1992, *Felger 92-567*. 3.6 mi N of Christmas Pass, 27 Nov 2001, *Felger 01-535*. Tule Well, 27 Nov 2001, *Felger* (observation).

TA: Coyote Water, 25 Oct 2004, *Felger 04-21*.

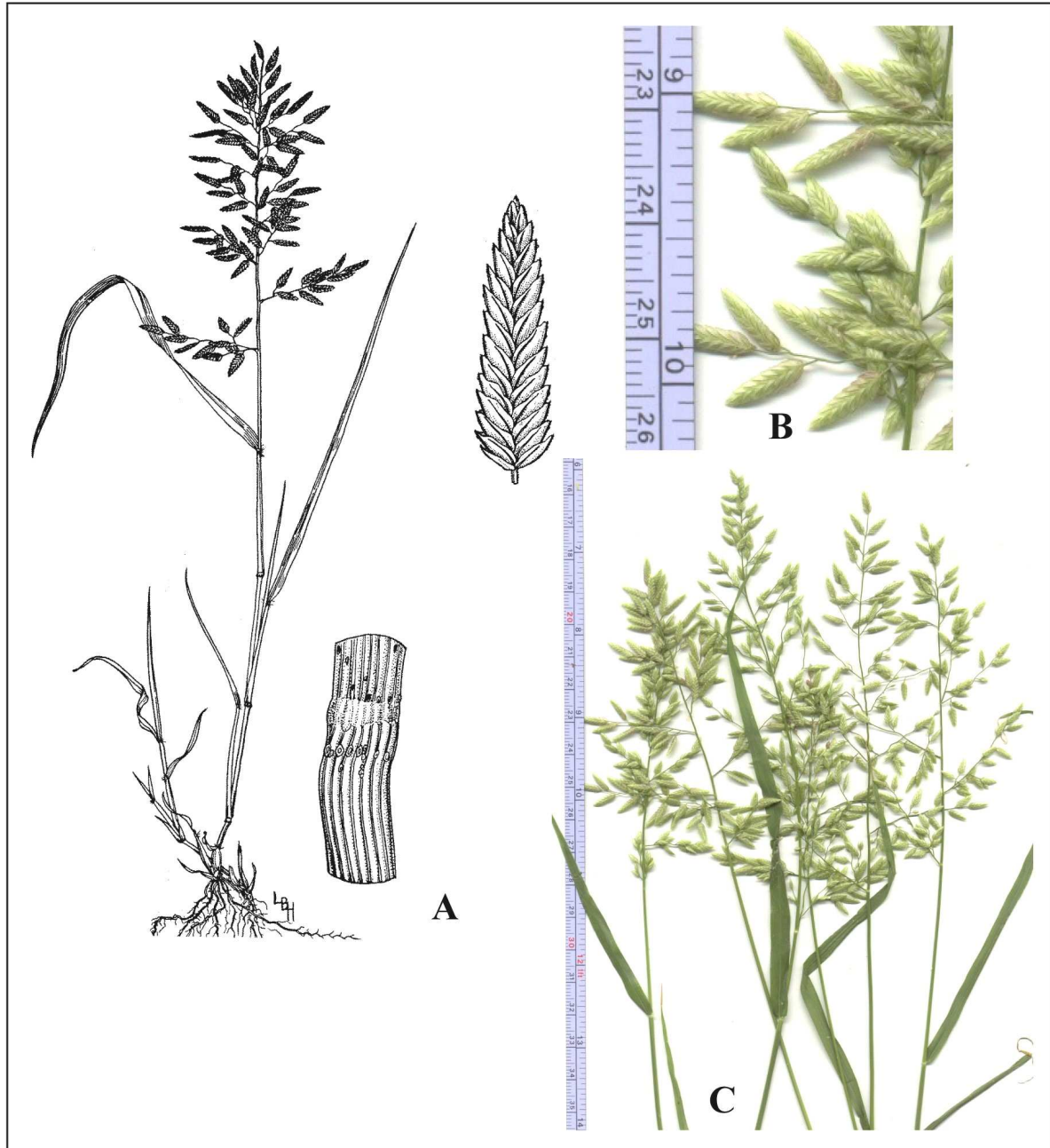


Figure 36. *Eragrostis cilianensis*. (A) Plant, portion of leaf sheath with glands, and spikelet; (B & C) panicles and spikelets, Why, Pima Co., 15 Sep 2013.

Eragrostis intermedia Hitchcock

Plains love grass. Figure 37.

Tufted perennials. Leaf blades mostly glabrous except densely hairy behind the ligule. Panicles 17–45 cm long, 10–30 cm wide, diffuse, and arching, with numerous slender, spreading branches. Pedicels very slender, slightly longer than the spikelets; spikelets 3–7 mm long, 1.6–1.8 mm wide, with 5–11 florets. Lemmas 1.8–2.2 mm long. Anthers three, 0.5–0.8 mm long. Grain 0.8–0.9 mm long, with a prominent groove.

Ajo Mountains, especially luxuriant at higher elevations and sometimes rooted in bedrock crevices, and locally in the Diablo Mountains.

Southern USA to South America.

Distinctions between *Eragrostis intermedia* and *E. lugens* Nees seem subjective and often become especially blurred in parts of Mexico. These involve overlapping sizes for spikelet width, lemma length, and supposed differences in the prominence of the caryopsis groove—*E. intermedia* is supposed to have a deeper groove (Gould & Moran 1981: 57; McVaugh 1983: 166–167; also see Peterson 2003: 97). John Reeder (pers. comm. to R. Felger, 2004) and Felger were not able to apply these features to separate these grasses. *Eragrostis lugens* was described in 1829 and has priority over *E. intermedia*, described in 1933.

OP: Ajo Mts, 31 Oct 1938, *Goodding 3720*. Alamo Canyon, *Nichol 4 May 1939*. Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-561*. Bench Canyon, Ajo Mts, 3700 ft, *Henry 6 Nov 1978*. Bull Pasture Trail, 2800 ft, 20 Oct 1978, *Bowers 1544*. Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20030922-11*.

***Eragrostis lehmanniana** Nees

Lehmann love grass; *zacate africano*. Figure 38.

Tufted perennials (also flowering in the first year or season), sometimes with short stolons. Culms and panicles 50–60+ cm long, the culms usually bent at the lower nodes. Leaf blades 4–15 cm long. Panicles often 15–21 cm long, openly branched, the branches and pedicels ascending to spreading; pedicels usually less than $\frac{1}{3}$ as long as the spikelets (or longer than spikelets on some terminal spikelets). Spikelets slightly compressed, often dark gray-green or straw colored, often $4\text{--}5.8 \times 0.8\text{--}1.1$ mm, with several–12 florets. Lemmas 1.7–1.8 mm long. Anthers 3 per floret, 1 mm long, conspicuously exserted and readily deciduous. Grain 0.6–0.8 mm long, ellipsoid with one side flattened.

This invasive grass is widespread and well established along roadsides and even natural areas to the north and east of the flora area and at the former military site and its access road on Childs Mountain. Highway 85 is the documented invasion route in Organ Pipe. In the late 1980s it was common at Why, north of Organ Pipe, but had not spread westward or southward into the drier and more natural desert areas. However, by the mid- to late-1990s it had spread southward along Highway 85 and became established on Bureau of Land Management lands near the northern boundary of the Monument. Since the mid-1990s occasional roadside plants have been found farther south along Hwy 85 within Organ Pipe and, since 2001, elsewhere in the Monument. In 2001 a population 10 meters long appeared along Hwy 85 at two miles north of the Visitor Center and scattered plants were found to the north. During this time Rutman actively removed these plants from the Monument. Suitable habitat exists in the Ajo Mountains where it could become a serious threat to the native ecosystem.



Figure 37. *Eragrostis intermedia*. (A) Plant, panicle, and spikelet; (B) spikelets, Alamo Canyon, Ajo Mts, 12 Sep 2008; (C) young panicles, Arch Canyon, Ajo Mts, 14 Sep 2013.

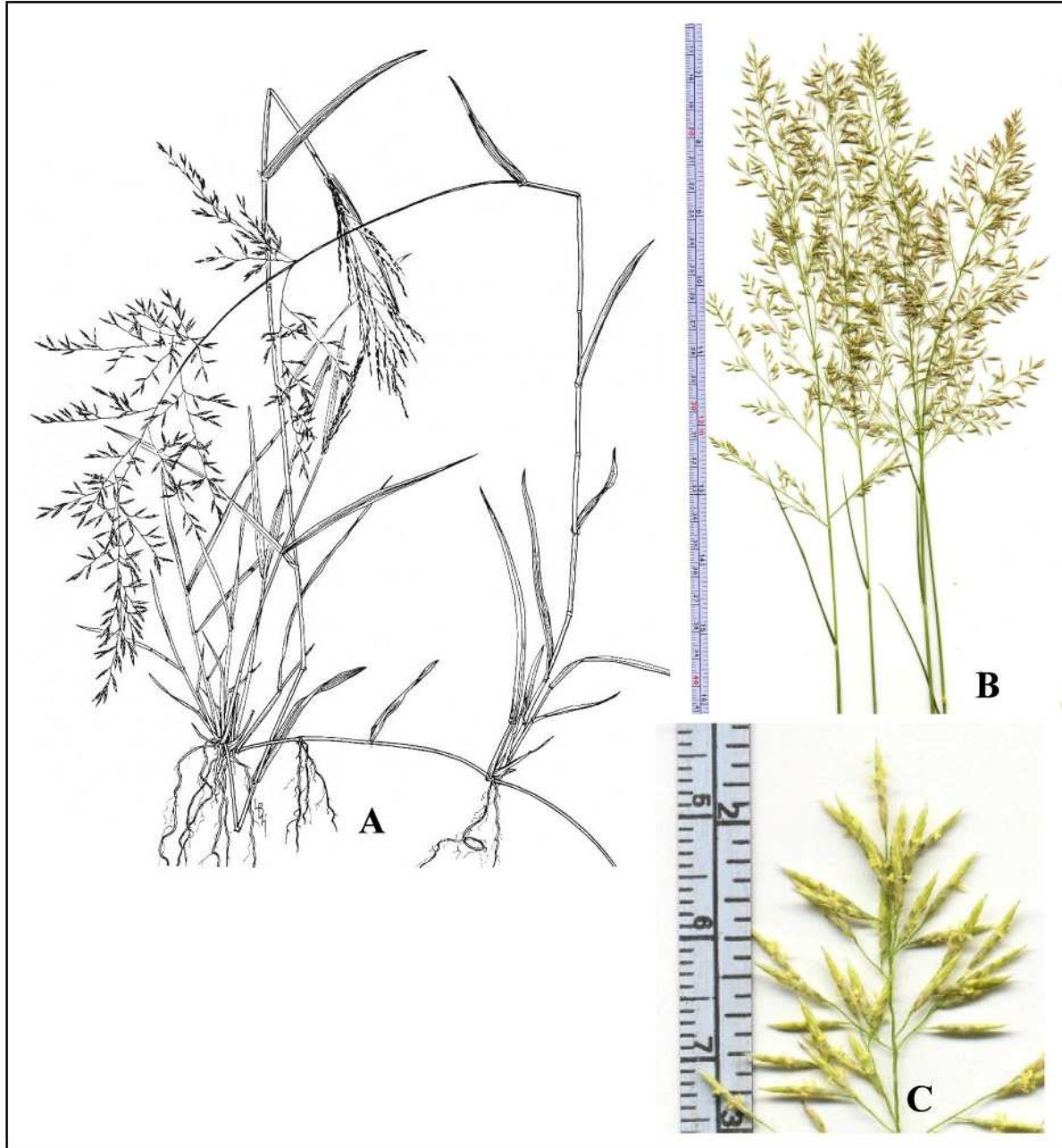


Figure 38. *Eragrostis lehmanniana*. (A) Plant with panicles. Why, Pima Co.: (B) 15 Sep 2013; (C) 11 Sep 2008.

Native to South Africa, introduced into Arizona by the U.S. Soil Conservation Service in the 1930s, and now well established in southern Arizona and much of northern Sonora as well as elsewhere in southwestern USA and northern Mexico.

OP: Gravel roadside, Hwy 85, 1 mi S of Visitor Center, single plant (removed), first ORPI record, *Rutman 9 May 1996* (ORPI). Planter at Visitor Center, *Rutman 14 Aug 2001* (ORPI). 7.9 mi W of Hwy 85 on S Puerto Blanco Drive, one plant (removed), *Rutman 27 Nov 2001* (ORPI).

CP: Childs Mt, 2300 ft, 18 Aug 1992, *Felger 92-647*.

Eragrostis pectinacea* (Michaux) Nees var. *pectinacea

[*E. arida* Hitchcock. *E. diffusa* Buckley. *E. pectinacea* var. *miserrima* (E. Fournier) Reeder. *E. tephrosanthes* Schultes]

Carolina lovegrass. Figure 39.



Figure 39. *Eragrostis pectinacea*. (A) Las Playas, Cabeza Prieta, 28 Nov 2001, *Felger 01-560* (ASU, from SEINet); (B) spikelet, photo by Elizabeth Makings, from SEINet.

Delicate, filmy summer-fall ephemerals, and rarely growing with winter-spring rains or germinating in fall and persisting through the winter, (5) 12–60 cm tall. Panicles 7–20+ cm long, the branches and pedicels slender. Spikelets 2.6–5.5 × 1.2–1.4 mm; lemmas 1.4–1.8 mm long;

disarticulation begins with the glumes and then the lowermost florets (except the paleas) in sequence. Paleas translucent and tardily deciduous to persistent after lemmas and glumes have fallen. Anthers 3 per floret, 0.35 mm long, not exerted or barely so. Grain not grooved (immature grain sometimes folding inward upon drying).

Seasonally abundant in the large playas of Cabeza Prieta. There are no other modern records for this grass from the flora area although it is common in adjacent regions both north and south of the flora area (Felger 2000, 2007a). The fossil record shows this or a similar grass in two pinyon-juniper samples from the Ajo Mountains during the Pleistocene.

Eragrostis pectinacea var. *pectinacea* is one of the most widespread, hot-weather ephemeral grasses in southern Arizona and Sonora. It ranges from Canada to South America and the West Indies.

Three varieties are listed for the Americas. Variety *traceyi* occurs only in Florida. The other two, var. *miserrima* and var. *pectinacea*, are widespread including the Sonoran Desert Region and western North America (e.g., Felger 2000; Reeder 1986, 2012; also see SEINet). The distinctions are pedicels mostly appressed (var. *pectinacea*) or mostly spreading (var. *miserrima*)—the distinctions do not seem to be biologically significant. Plants identifiable to both varieties often grow intermixed in western North America, especially in the Southwest, and a single handful can give you plants identifiable to both varieties, or a single specimen may show features of both varieties (Figure 39A).

OP: †*E.* cf. *pectinacea*, Montezuma’s Head, inflorescences fragments with attached paleas, 20,490 & 21,840 ybp.

CP: Las Playas, 28 Nov 2001, *Felger 01-560* (ARIZ, ASU, TEX, UC).

Eriochloa – Cup grass; *zacate taza*

The Sonoran Desert species are annuals growing during hot, wet, summer weather as weeds in well-watered places and in natural areas, especially in temporarily wet soils. They are among the first summer-fall grasses to shed their spikelets after maturity. The plants wither quickly with drying conditions at the end of summer and only a few weeks after the grain matures and falls there may be no sign of the plants. Culms relatively soft and sometimes semi-succulent. Ligules a line of soft hairs; leaf blades flat. Inflorescences panicles with spike-like branches. Spikelets panicoid, usually in pairs in two rows on one side of a slender rachis; spikelets teardrop shaped, quickly falling away when mature. The lower glume reduced and fused to a rounded callus derived from a segment of the rachilla to form a unique bulbous disk at the spikelet base. Fertile lemma firm and shiny, with conspicuous inrolled margins tightly gripping the palea and grain.

- 1. Spikelets 4–5 mm long from base of cup to awn tip **Eriochloa acuminata**
- 1. Spikelets 6.5–8 mm long from base of cup to awn tip **Eriochloa aristata**

***Eriochloa acuminata** (J. Presl) Kunth var. **acuminata**

[*E. lemmonii* Vasey & Scribner var. *gracilis* (E. Fournier) Gould]

Southwestern cupgrass; *zacate taza*. Figure 40.

Summer annuals often 30–50+ cm tall, the culms often weak. Leaf blades thin, flat, bright green, glabrous or sparsely hairy. Spikelets usually densely hairy, 4–5 mm long (including the cup and mucro). The glume awnless or extending into a short mucronate tip. Fertile lemmas awnless or with a mucronate tip to 0.1 (0.3) mm long.

Organ Pipe in temporarily moist soil in natural and disturbed habitats including areas adjacent to urban and agricultural areas in Sonoyta. The modern records indicate it has often spread in Organ

Pipe as a weed. It was, however, common in the Ajo and Puerto Blanco Mountains from about 1000 to 20,500 years ago. The florets are especially common in the Montezuma's Head middens, many of them complete with the basal cup and measuring to 5 mm long (including the awn).

Widespread in southwestern USA, both Baja California states, mainland Mexico and southwestern USA, from deserts to pine-oak woodland, and widely adventive elsewhere.

OP: 0.5 km W of Lukeville, 10 Nov 1987, *Felger 87-281*. 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-314*. Residential area, common weed in lawn of *Cynodon dactylon*, 13 Sep 1986, *Felger 86-266*. Near N boundary 0.2–0.2 mi E of Hwy 85, artificial catchment created in 1940s, abundant, 21 Sep 2013, *Rutman 20130921-21*. †Montezuma's Head, florets, 13,500 & 20,490 ybp. †Puerto Blanco Mts, 980 ybp (Van Devender et al. 1990: 339).

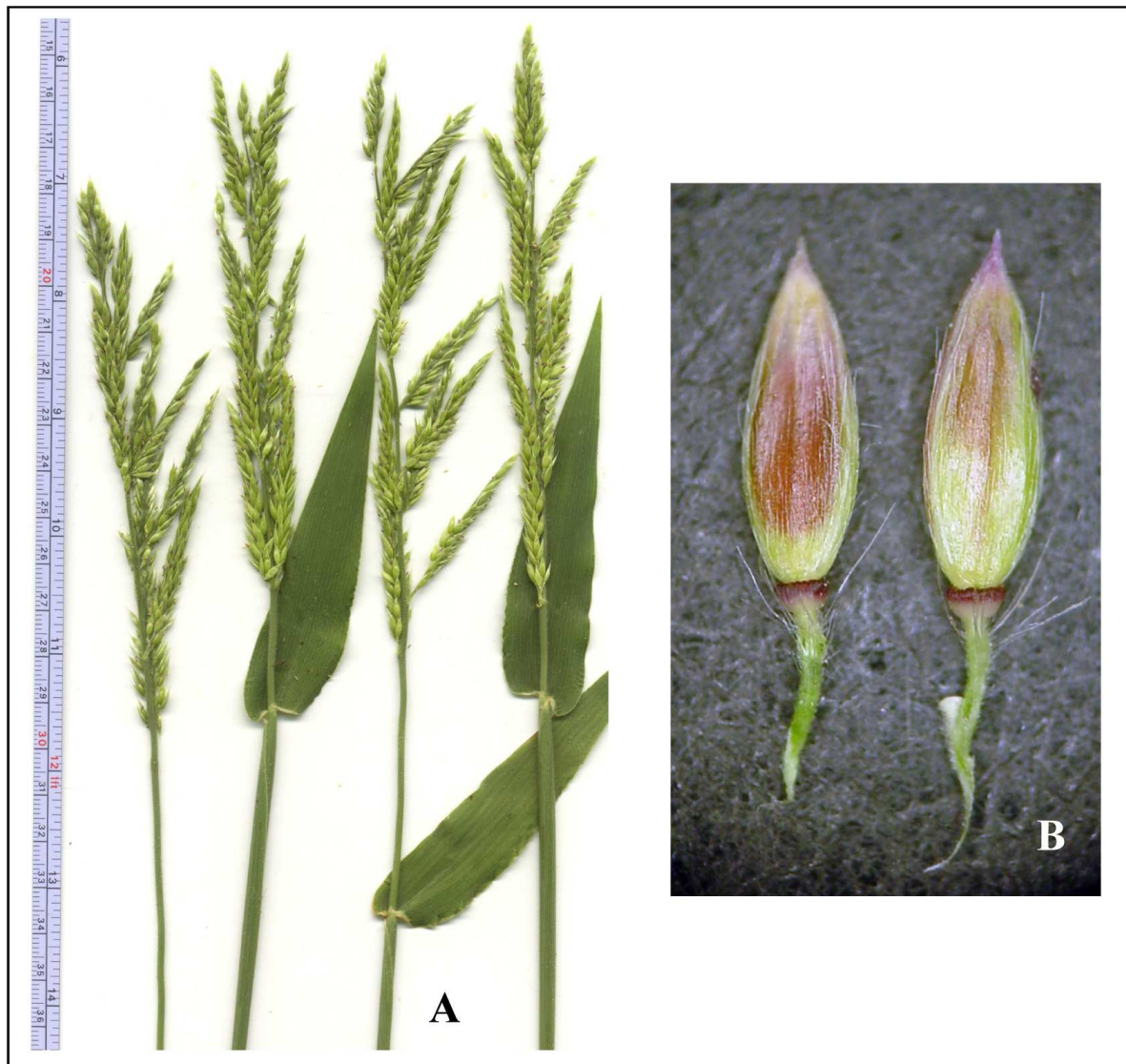


Figure 40. *Eriochloa acuminata*. (A) Tributary of Cuerda de Lena, N boundary of Organ Pipe, 17 Sep 2013; (B) spikelets, Silver City, NM, 21 Oct 2007, Russell Kleinman, from Gilaflores.com.

Eriochloa aristata Vasey var. **aristata**

Bearded cupgrass; *zacate taza*

Similar to *E. acuminata* but generally more robust and with larger spikelets. Leaf blades glabrous or sparsely hairy. Spikelets 5.5–8 mm long from base of cup to the awn tip. The glume tapering to an awn 1.5–3 mm long. Fertile lemma with a stubby mucronate tip or awn point 0.15–0.4 mm long. Several early collections from Tucson have exceptionally long, slender spikelets (11–12 mm long).

Temporarily wet, muddy or sandy soils of dirt tanks, washes, and swales in the eastern part of Cabeza Prieta and at least the northern and west-central part of Organ Pipe. Perhaps more widespread with favorable summer-fall rains.

Eastward from Organ Pipe in southern Arizona. Southwestern USA to Central America and Columbia.

OP: Growler Canyon, 1.5 mi E of Bates Well Ranch, *Wirt 13 Oct 1988*. W of Hwy 85 on road to Armenta Ranch, 1 Feb 2002, *Felger 02-73a*. Grower Valley, 8 Oct 2006, *Rutman 20061008-4*.

CP: Monreal Well, *Simmons, probably 20–21 Oct 1962 (CAB)*. Jose Juan Represo, 14 Sep 1992, *Felger 92-719*. Las Playas, 23 Sep 1993, *Harlan 411 (CAB)*.

Festuca – Fescue, ryegrasses

[*Vulpia*]

Small, winter-spring ephemerals (those in the flora area; elsewhere often perennials). Leaf sheaths usually open; ligules membranous; auricles none. Inflorescences usually of panicles, sometimes reduced, unbranched and racemose in drought-stressed plants. Spikelets laterally compressed, with multiple florets, the uppermost ones reduced. Glumes shorter than the lower lemmas, the lower glume shorter than the upper glume. Lemmas awned (those in the flora area).

About two dozen annual species worldwide have been segregated from *Festuca* as *Vulpia*. They tend to be small grasses with mostly cleistogamous flowers, usually with 1(2) stamen(s) and small stigmas. *Vulpia*, however, is not monophyletic and is nested within *Festuca* (e.g., Catalán et al. 2004). *Festuca* and *Poa*, each with about 500 species, are the largest genera of grasses and are worldwide in distribution. Except for the four ephemeral species in the flora area, these genera are essentially absent from the Sonoran Desert and there are relatively few species in deserts elsewhere.

1. Spikelets with 6 or more florets; awns mostly 5 (8) mm or less in length **Festuca octoflora**

1. Spikelets with 5 or fewer florets; awns mostly 8–12 mm long **Festuca microstachys**

Festuca microstachys Nuttall

[*F. grayi* (Abrams) Piper. *F. microstachys* var. *ciliata* A. Gray ex Beal. *F. microstachys* subsp. *grayi* Abrams. *F. microstachys* var. *pauciflora* Scribner ex Beal. *Vulpia microstachys* (Nuttall) Munro]

Small fescue

Small, slender ephemerals. Inflorescences of panicles 4–10 cm long, especially the lower branches spreading and often 1–3.5 cm long (excluding awns), or inflorescences unbranched and racemose. Axils of panicle branches and pedicels with a callus (seen with magnification and not visible on young plants where the branches and pedicels have not spread apart). Spikelets often 6–7 mm long (excluding awns), with 5 (rarely more) or fewer florets. Lower glumes much narrower and more than half as long as the upper glumes. Awns 9–12 mm long.

Ajo Mountains at least in Alamo Canyon and perhaps more common at higher elevations. It grew in the Tinajas Altas Mountains about 11,000 years ago.

Southern and central Arizona, mostly at elevations at or above the limits of the desert. Western North America from British Columbia to Baja California Sur. Not known for Sonora but expected in mountains in the northern part of the state.

Four varieties are sometimes recognized; var. *ciliata* occurs in the flora area. The varieties, however, are not geographically well marked—for example plants of var. *ciliata* with pubescent spikelets and var. *pauciflora* with glabrous or scabrous spikelets grow side by side in the Tucson Mountains.

OP: Slopes of Ajo Mts, *Albee Apr 1937*. Alamo Canyon, uncommon, among dense growth of spring annuals on N-facing bank of canyon bottom, intermixed with *F. octoflora*, *Poa bigelovii*, etc., 29 Mar 2003, *Felger 03-426*.

TA: †Tinajas Altas Mts, 10,950 ybp (Van Devender et al. 1990: 340).

***Festuca octoflora* Walter**

[*Festuca octoflora* var. *glauca* (Nuttall) Fernald. *F. octoflora* var. *hirtella* (Piper) Henrard. *F. octoflora* var. *tenella* (Willdenow) Fernald. *Vulpia octoflora* (Walter) Rydberg. *Vulpia octoflora* var. *glauca* (Nuttall) Fernald. *V. octoflora* var. *hirtella* Piper. *V. octoflora* var. *tenella* (Willdenow) Fernald]

Six-weeks fescue, eight-flowered fescue. Figure 41.

Plants highly variable in size, 4–15 (29) cm tall, or as small as 2.5 cm with a single spikelet when severely drought-stressed. Culms mostly single or few, and with few small leaves above. Inflorescences of spike-like panicles, mostly 2–10 cm long, with mostly short and tightly appressed branches, or unbranched and racemose. Pedicels and small branches flattened below. Spikelets 8–13 mm long. Florets crowded, 6–13 (15) per spikelet. Lower glumes more than half as long as the upper glumes. Lemmas 4–8 mm long, tapering to a slender awn 1–8 mm long, the length generally uniform within a local population.

Widespread and seasonally common across the flora area; flats, washes, disturbed habitats, and rocky slopes including highest elevations in the Ajo Mountains. Substantially larger plants and higher densities occur in shaded as compared to unshaded sites. It has been in the region for at least 22,000 years.

One of the most common winter-spring ephemerals grasses in the Sonoran Desert. Across North America from Canada to northern Mexico, and introduced in Eurasia and South America.

Three varieties are often recognized, but like *Festuca microstachys*, they seem to be of doubtful biological significance (e.g., Arnow 1987; Lonard & Gould 1974; Holmgren & Holmgren 1977). Variety *hirtella* occurs in the flora area, characterized in part by scabrous or pubescent spikelets (lemmas). Plants in the flora area with glabrous or merely scabrous lemmas are probably immature plants of var. *hirtella* rather than var. *octoflora*.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. 5 mi SW of Bates Wells Ranch, 12 Mar 1983, *Reeder 7583*. Quitobaquito, 29 Mar 1988, *Felger 88-116*. †Montezuma's Head, many florets with awns, 21,840 ybp.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3929* (CAB). San Cristobal Wash, 20 Mar 1992, *Harlan 31* (CAB). Agua Dulce Spring, 26 Feb 1993, *Felger 93-89*. Bassarisc Tank, 26 Feb 1993, *Felger 93-125*. Papago Well, 26 Feb 1993, *Felger 93-134*.

TA: Tinajas Altas, 1450 ft, *Van Devender 10 Mar 1980*. Coyote Water, 18 Mar 1998, *Felger* (observation). †Butler Mts, 11,250 ybp (Van Devender et al. 1990: 342). *V. cf. octoflora*: †Tinajas Altas Mts, 8970 to 10,950 ybp (4 samples, Van Devender et al. 1990: 340).

†*Festuca (Vulpia)* sp.

The small festucas (*Vulpia*) were important Ice Age grasses in the Ajo Mountains, especially about 20,000 years ago at Montezuma's Head. These fossils may be one or both species that occur in the region today.

OP: †Alamo Canyon, florets, 1150 to 32,000 ybp (3 samples). †Montezuma's Head, florets, 13,500 & 20,490 ybp.



Figure 41. *Festuca octoflora*. (A) Red Cone Campground, Pinacate Reserve, Sonora, 19 Mar 2010; (B) spikelets, photo by Elizabeth Makings, from SEINet.

Heteropogon contortus (Linnaeus) P. Beauvois ex Roemer & Schultes

[*Andropogon contortus* Linnaeus]

Tanglehead; *zacate colorado*. Figure 42.

Robust tufted perennials often 60–70 cm tall; culms erect, crowded. Dry leaves copper or rust-colored and persistent. Reproductive primarily during warmer months. Inflorescences of

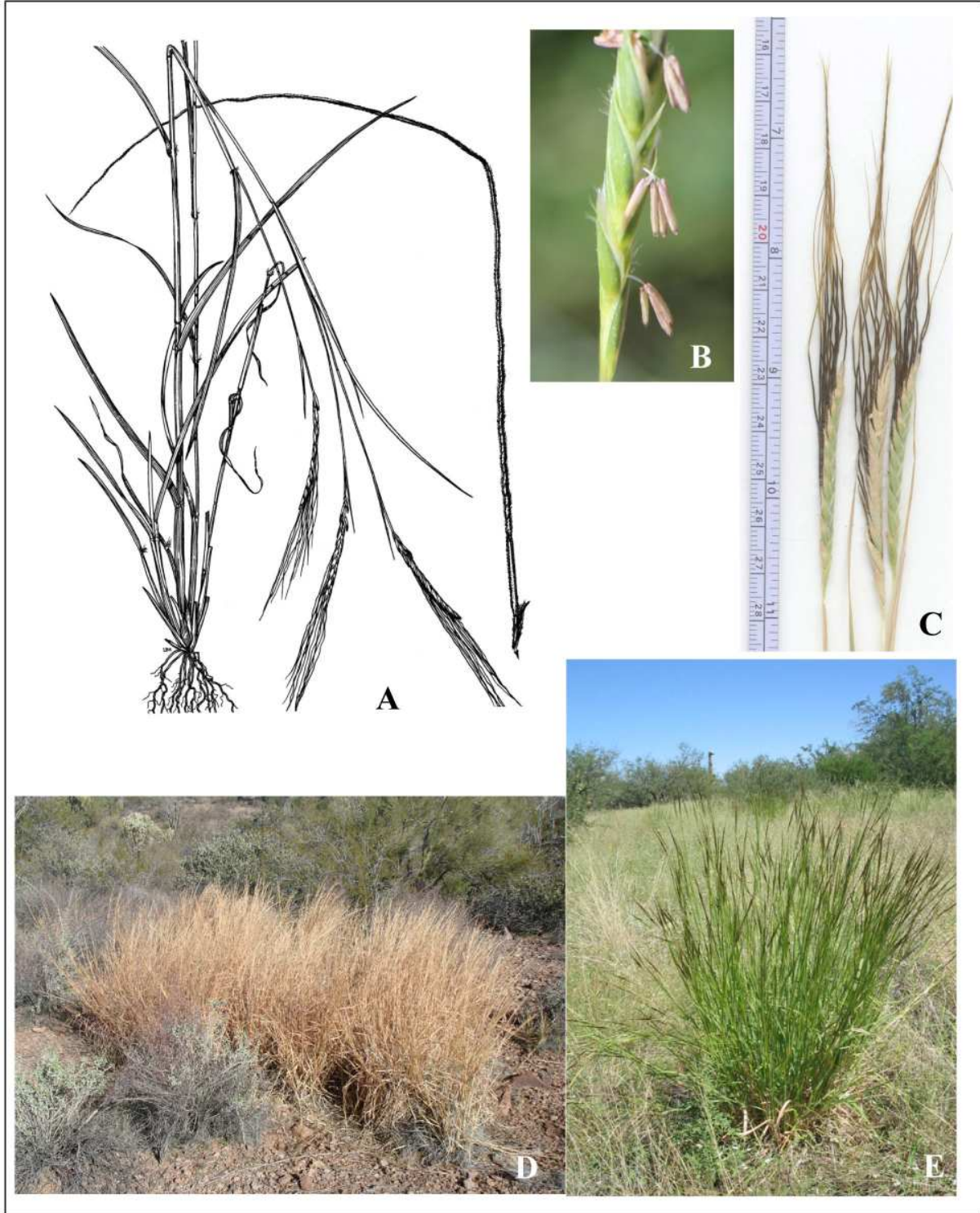


Figure 42. *Heteropogon contortus*. (A) Plant and fertile floret with its large awn; (B) portion of young rami with exserted anthers, Diablo Mts, 12 Sep 2013; (C) three rami, Chuckwalla Hills, Organ Pipe, 6 Oct 2013; (D) copper-colored dormant plants, Arch Canyon, Ajo Mts, 27 Dec 2007; (E) roadside, Hwy 85 south of Why, Pima Co., 25 Sep 2004.

unilateral rami (note that the awns are all on one side), one per culm or branch, breaking apart at maturity. Spikelets andropogonoid, in pairs very different from each other (a few spikelet pairs at

lower nodes of inflorescences may be staminate and sessile). (1) Pedicelled spikelets awnless and sterile, the lower glume 7–10 mm long (not including the short pedicel), green when fresh (the larger of the two glumes, and generally the only one you can see without dissecting the spikelet), glabrous or with a few bulbous-based large hairs; pedicelled spikelets larger than the body of the sessile spikelets. (2) Sessile spikelets bisexual, bearing a stout awn 4.5–7+ cm long, twisted and twice bent when mature, tawny brown with a needle-sharp base that “readily penetrates clothing and is a ferociously efficient dispersal mechanism” (Clayton & Renvoize 1986: 359).

Arroyos, larger washes, canyon bottoms, near waterholes, and hills and mountain slopes sometimes to their peaks; widely scattered and usually localized across the flora area. It has been at Tinajas Altas for at least 8000 years. East of Organ Pipe, on the Tohono O’odham Reservation, this native grass has been observed out-competing and gradually displacing the invasive *Eragrostis lehmanniana*.

Southwestern USA to South America and warm regions of the Old World. Although some authors have claimed it is “adventive in America since the time of Columbus” (Correll & Johnston 1970: 201; also Barkworth 2003), it has been in southwestern North America at least since the last Ice Age (e.g., Felger 2000; Felger et al. 2012; Van Devender et al. 1990).

OP: Quitobaquito, 30 Jan 1894, *Mearns 2752*. Alamo Canyon, *Nichol 4 May 1939*. Bull Pasture trail, 20 Oct 1978, *Bowers 1545*. Mouth of Estes Canyon, 17 Sep 1992, *Reeder 8911*. Diablo Mts, wash, along Ajo Mt Drive, 12 Sep 2013, *Rutman 20130912-6*.

CP: Tule Mts, 11 Feb 1894, *Mearns 2803* (US). S end of Cabeza Prieta Mountains, 1200 ft, 29 Feb 1976, *Fugate 694*. Little Tule Well, 18 Aug 1992, *Felger 92-651*. 3.4 mi N of Tule Tank, 2 Feb 1992, *Felger 92-71*. Sierra Pinta, summit, *Cain 15 Nov 2003*. Observations: Cabeza Prieta Tanks, Heart Tank, North Pinta Tank, 14 & 15 Jun 1992, *Felger*; Daniels Arroyo at Charlie Bell Rd, 25 Feb 1993, *Felger*.

TA: Tinajas Altas Mts, 1200 ft, *Van Devender 25 Mar 1983*. †Tinajas Altas Mts, 5860 to 7860 ybp (Van Devender et al. 1990: 341).

Hilaria – Galleta

Perennials, growth and flowering response primarily during the warmer months. Leaves usually relatively short. Inflorescences slender and spike-like panicles with very reduced branches, the main axis zigzag and remaining after the spikelets fall. Spikelets in clusters of 3 at each node of the zigzag rachis, the clusters falling as a unit; central spikelet with 1 floret and bisexual or female, differing in form from the two lateral spikelets, the lateral spikelets each with 2 male or sterile flowers. All glumes together forming a false involucre. Lemmas 3-veined, awned or awnless.

Among the ten species of *Hilaria*, three sister species are sometimes segregated as *Pleuraphis* or else treated as subgenus *Pleuraphis*.

- 1. Plants mostly less than 30 cm tall, with slender stolons; culms glabrous **Hilaria belangeri**
- 1. Plants mostly more than 40 cm tall, with strong, short rhizomes and lacking stolons; culms with felt-like or fine woolly hairs, at least near the base of the plant (older stems and leaf sheaths may become glabrous with age) **Hilaria rigida**

Hilaria belangeri (Steudel) Nash
 [*H. belangeri* var. *longifolia* (Vasey) Hitchcock]
 Curly mesquite; *zacate chino*

Small, tufted perennials, mostly less than 15 cm tall, some to 28 cm; with long, slender, stolons (above-ground stems); culms slender, glabrous or with hairs at nodes. Leaf blades relatively

short, often curling, and with bulbous-based hairs. Growing and reproductive during warmer months. Inflorescences slender, 2–5.5 cm long with 4–10 (14) spikelet clusters, the spikelet clusters 4.5–7 mm long with sparse pubescence basally of hairs 0.1–0.4 mm long. Glumes conspicuously fused basally and with slender awns 2.5–5 mm long.

Ajo and Diablo Mountains; forming scattered, small to large patches, often on slopes, and covering an extensive area in Bull Pasture in the Ajo Mountains.

Widespread in Arizona, mostly above and at the upper margins of the deserts. Also Texas, Baja California Sur, and Sonora to Tamaulipas and south-central Mexico.

OP: Ajo Mt Drive 6.7 mi by road N [NE] of Visitor Center [Diablo Mts], 5 Nov 1977, *Bowers 924* (ORPI). Bull Pasture: 9 Apr 2005, *Felger 05-179*; Shallow sediments in bedrock pockets, 18 Mar 2005, *Rutman 20050318-10* (ORPI).

Hilaria rigida (Thurber) Bentham ex Scribner

[*Pleuraphis rigida* Thurber]

Big galleta; *tobosa*. Figure 43.

Large tufted or bushy perennials forming dense clumps, often 0.5–1.2 m tall, the bases tough and knotty with short, almost woody rhizomes; roots tough and wiry. Culms rigid and stout, with felt-like white hairs, these readily rubbing off. Leaf sheaths glabrous; blades spreading, (4) 7–23 cm long, the length apparently depending upon soil moisture, the shorter blades commonly firm and sharp-tipped. Growth and flowering response especially during the warmer months, but some flowering may occur at least from February to November; plants becoming dormant or with considerable dieback during extended drought. Inflorescences densely flowered, (4.5) 5–13 cm long, the zigzag main axis remaining long after the spikelet clusters fall; sometimes forming a large, swollen gall structure 5–6 × 2–3 cm in place of an inflorescence. Spikelet clusters overlapping, each with a dense basal tuft of white hair. Spikelets (excluding awns) 6–10 mm long, fringed on their blunt tips. Glumes not obviously fused below, slender, lanceolate to narrowly oblong. Glumes, lemmas, and paleas more or less equal in length. Number and size of awns varying with position of spikelets and from one cluster to the next; glumes and lemmas each with (3 or 4) 5–7 veins, all, some, or none extending into awns 0.7–7 mm long. Lemma margins densely ciliate with silky hairs. Stigmas lavender to bluish purple. Spikelets often tinged pink to purple-brown during cool, dry seasons; usually drying straw-colored with prominent veins.

Common and widespread in Organ Pipe and increasingly abundant westward in Cabeza Prieta and the Tinajas Altas Region. Mostly on valley plains, sand flats, and dunes, although sometimes locally common on rocky slopes. Big galleta, bush muhly (*Muhlenbergia porteri*), and bamboo muhly (*M. porteri*) are the only shrubby grasses in the region. Big galleta, along with creosotebush (*Larrea*), is one of the most persistent and drought resistant perennials in the region. However, Rutman observed that the severe drought of the 2000s caused extensive dieback of *H. rigida* in the flora area, and a significant percentage of plants died. Rhizomes can survive and resprout after a low-temperature fire. This grass has been in the western margin of the flora area for more than 10,000 years.

Western Arizona, southwestern Utah, southern Nevada, southeastern California, northwestern Sonora, and northeastern Baja California.

OP: Bates Well, *Nichol 26 Apr 1939*. 2 mi NW of Visitor Center, 8 Mar 1987, *Van Devender 87-8*. E of Armenta, *Wirt 8 Aug 1988* (ORPI). Quitobaquito, 14 Sep 1988, *Felger 88-466*.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3931* (CAB). San Cristobal Wash, 20 Mar 1992, *Harlan 24* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-405*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-46*. Tinajas Altas, above the tinajas, 19 Mar 1998, *Felger* (observation). Surveyors Canyon, 29 Mar 2010, *Felger 10-201*. †Butler Mts, 3820 to 10,400 ybp (3 samples, Van Devender et al. 1990: 342).

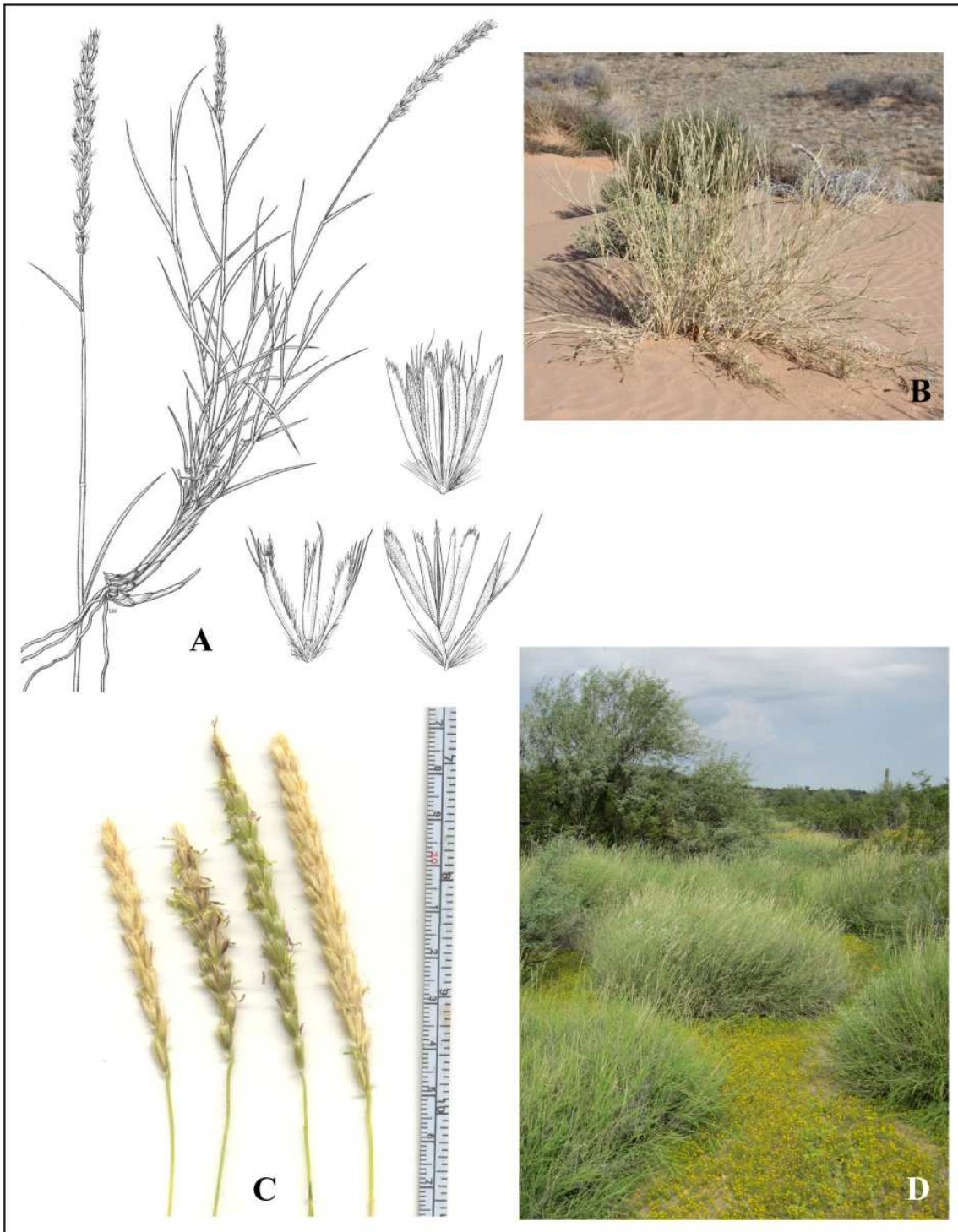


Figure 43. *Hilaria rigida*. (A) Plant and inflorescence, and spikelets: bisexual spikelet lower left, staminate spikelets lower right, and spikelet cluster upper right; (B) dunes SW of Las Playas, Gran Desierto Biosphere Reserve, Sonora, 28 Mar 2013; (C) panicles, Why, Pima Co., 31 Mar 2013; (D) N of Pozo Nuevo, Organ Pipe, 16 Aug 2012.

Hopia obtusa (Kunth) Zuloaga & Morrone
 [*Panicum obtusum* Kunth]
 Vine mesquite; zacate de guía. Figure 44.

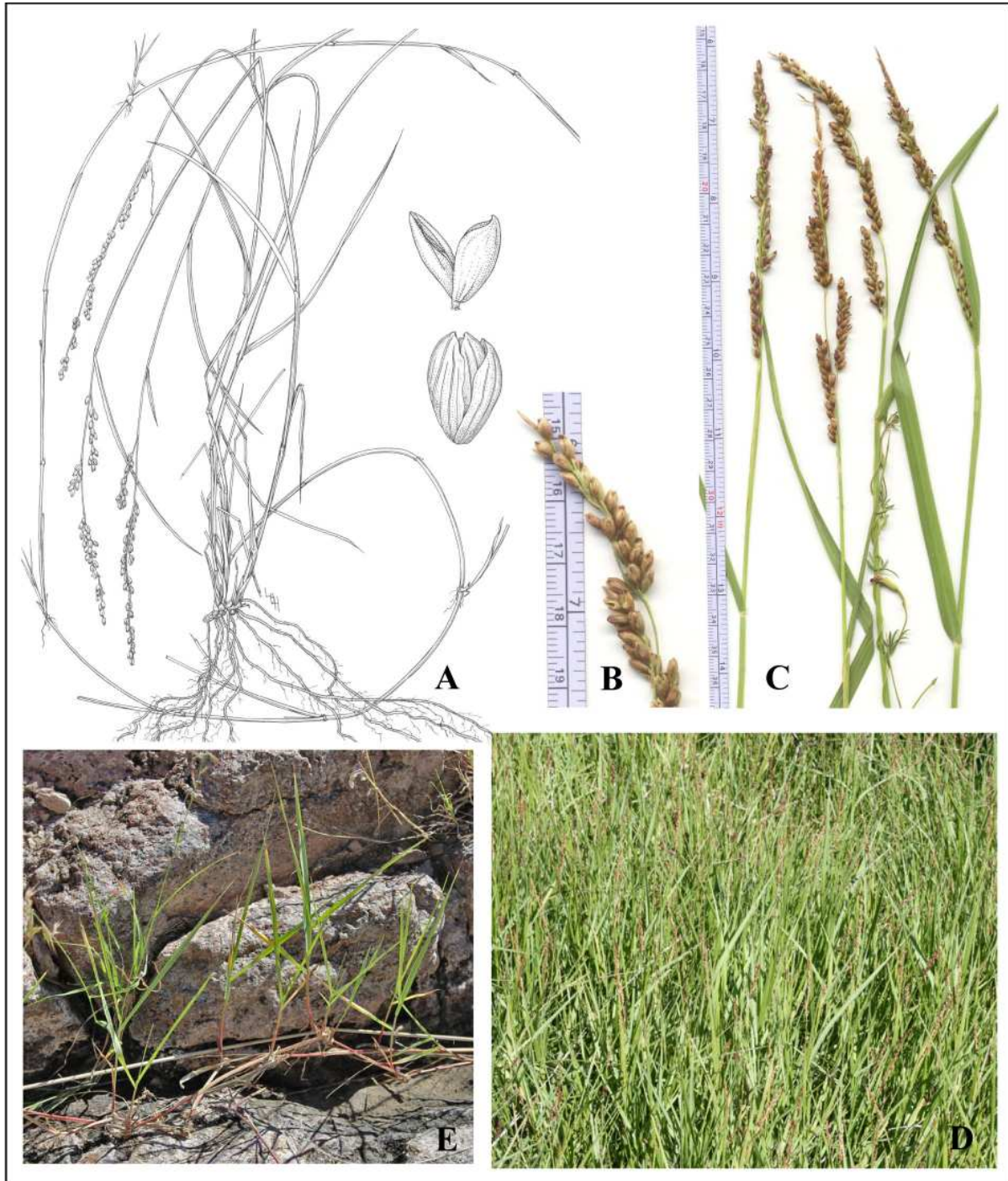


Figure 44. *Hopia obtusa*. (A) Plant and spikelet, with fertile lemma and palea spread open. Bull Pasture: (B & C) 25 Sep 2013; (D) 24 Sep 2006; (E) stolons and young shoots, 25 Sep 2013.

Perennials to about 50 cm tall, with hard, knotty bases and long, slender stolons sometimes to 1 m or more in length with swollen and conspicuously hairy (villous) nodes. Culms tough, slender, mostly erect and with swollen nodes. Inflorescences of slender panicles with appressed unilateral branches. Spikelets panicoid, usually crowded, paired, 2.8–4 mm long, firm, blunt-tipped, bead-like, and brown when mature; with a staminate lower floret and a bisexual upper floret. Glumes about ¾ as long as the spikelet. Lower floret staminate with a lemma similar to the upper glume and a well-developed palea. Fertile lemma firm, smooth and shiny with inrolled margins tightly clasping the palea and enclosed grain. Stigmas maroon; anthers bluish purple. Reproductive during warmer months.

Ajo Mountains at least at Bull Pasture and one record at the north end of the Monument.

Generally above the desert in Arizona and Sonora. Southeastern and midwestern USA to central Mexico.

OP: Bull Pasture, moist soil near streambed, 9 Aug 1979, *Bowers 1796*. Armenta Ranch, ditch along road, *Rutman 4 Oct 1995* (ORPI). Ajo Mountains, 3100 ft, common, growing with *Pappophorum vaginatum* at junction of Bull Pasture Trail and seasonally wet stream in Bull Pasture, 24 Sep 2006, *Rutman 20060924-3*.

Hordeum – Barley, *cebadilla*

Winter-spring ephemerals (those in the flora area). Inflorescences terminal, unbranched, breaking apart at maturity and often called a “spicate raceme.” Spikelets in triplets per node, relatively large, bearing long, scabrous awns, with one central, sessile spikelet and two, lateral pedicelled spikelets; spikelets, with 1 floret, glumes narrowed into firm bristles or awns. Central spikelet fertile (bisexual), the rachilla extended into a bristle behind the palea, the glumes side by side, bristle-like or somewhat flat in the basal part and in front of and often partially obscuring the fertile spikelet, the lemmas ovate, sharp-pointed, and essentially awnless or awned with a long, stout bristle. Lateral spikelets usually short-stalked, staminate or sterile (or fertile in most cultivated barleys), usually smaller than the central spikelet, often represented only by 3 awns or bristles. The triplet clusters alternate in cavities of the rachis in 2 longitudinal rows in wild and weedy species (often in 4 or 6 rows in cultivated barleys). In wild and weedy barleys the triplet clusters fall as a unit with the stalk-like rachis joint; in cultivated barleys the rachis is continuous and non-shattering.

- 1. Auricles present (ear-like or tongue-like flaps on each side of summit of leaf sheath); spikes 10+ mm wide (excluding awns); glumes of central spikelet long-ciliate on both margins; larger awns more than 15 mm long **Hordeum murinum**
- 1. Auricles absent; spikes 4–8 mm wide (excluding awns); glumes not ciliate; awns 7–12 mm long **Hordeum pusillum**

***Hordeum murinum** Linnaeus subsp. **glaucum** (Steudel) Tzvelev
 [*H. leporinum* Link subsp. *glaucum* (Steudel) T.A. Booth & A.J. Richards. *H. stebbinsii* Covas]
 Wild barley; *cebadilla silvestre*. Figure 45.

Plants variable, to 60 cm tall. Leaf auricles to 8 mm long. Inflorescences linear-oblong, 5.5–9.5 cm long (including awns), sometimes maturing partially enclosed by the uppermost leaf sheaths. Lateral spikelets with one of the glumes bearing long, spreading cilia on the margins, the other glume scabrous. Both glumes of the central spikelet are ciliate-margined, slightly flattened at their bases, and extend into a bristle. Stamens included within the florets, persistent and not exerted (enclosed or hidden by the lemmas and paleas); anthers of the central spikelet 0.5 mm or less in length and purple-spotted, those of lateral spikelets often 1+ mm long.

Well established along major washes in the eastern part of the Cabeza Prieta and scattered populations in Organ Pipe along roadsides, washes, and canyons. Extending into southeastern Organ Pipe from adjacent Sonora, where it is a common weed in disturbed habitats. It can form extensive stands in favorable habitats. It was at Quitobaquito in 1939 but has not been found there since.

Native to the Mediterranean and Middle East, now widespread and weedy in temperate regions of the world including western North America.

The mature inflorescences “may cause mechanical injury, when ripe, to nose and mouth membranes of grazing animals. The sharp-pointed rachis and rachilla joints and stiff awns of the mature spikelets are capable of penetrating both skin and flesh” (Gould 1951: 105–106). Dogs are also susceptible to this form of injury.

OP: Quitobaquito, *Nichol* 28 Apr 1939. Growler Canyon, 30 Mar 1979, *Bowers* 1606. Gachado Line Camp, 11 Nov 1987, *Felger* 87-327. Alamo Canyon, corrals at abandoned ranch, 29 Mar 2003, *Felger* 03-398.

CP: San Cristobal Wash, 20 Mar 1992, *Harlan* 33 (CAB). Daniels Arroyo at Charlie Bell Road, 25 Feb 1993, *Felger* 93-72.

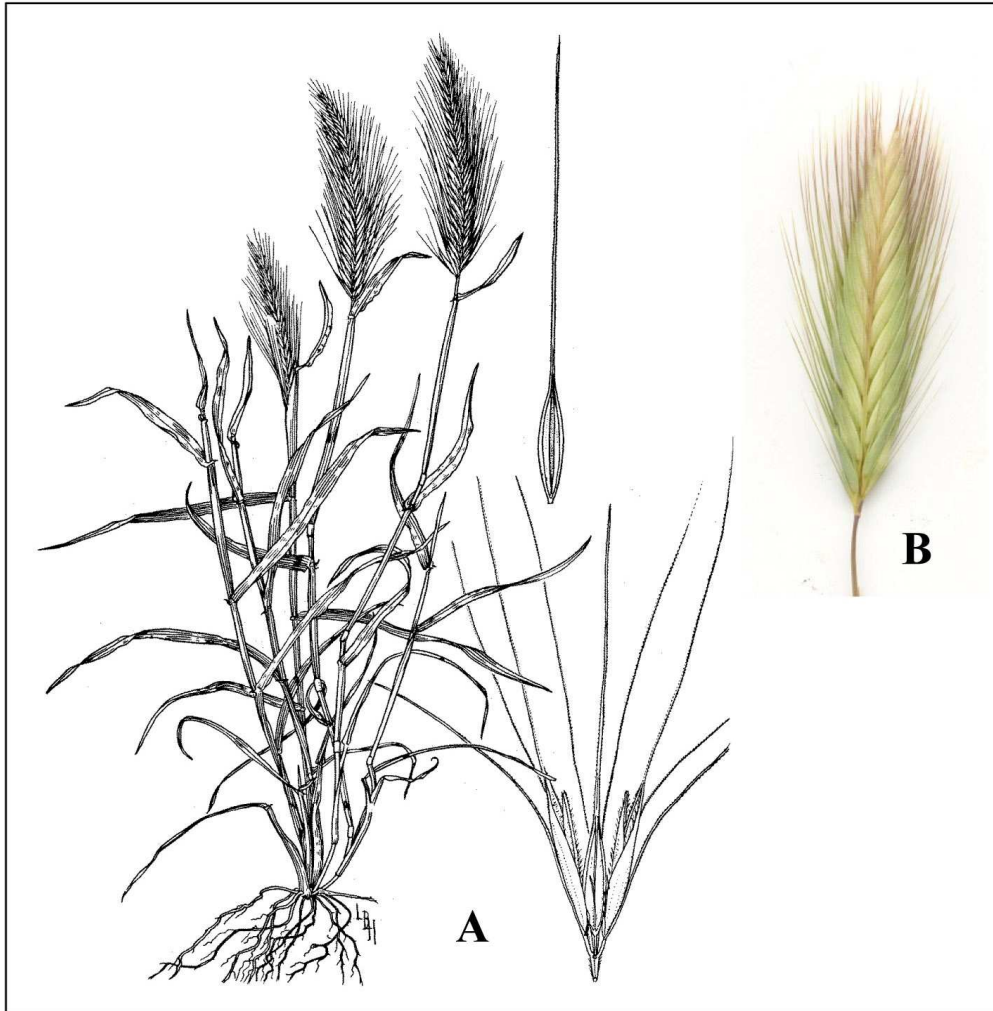


Figure 45. *Hordeum murinum*. (A) Plant, spikelet triplet, and floret with long bristle; (B) spikelet, Tucson, 2 Apr 2008.

††**Hordeum pusillum** Nuttall

Little barley

The plants including the inflorescences are generally smaller than those of *H. murinum*, without leaf auricles, and the inflorescences more slender and compact.

It was in the Ajo and Puerto Blanco Mountains at least from 8000 to 20,500 years ago. The nearest known, present-day population occurs at higher elevations in the Sand Tank Mountains. It should be sought at higher elevation in the Ajo Mountains.

Widespread in Arizona, but not in the lowland desert of the southwestern part of the state, and one record in north-central Sonora. Canada to northern Mexico.

OP: †Montezuma's Head, florets, 20,490 ybp. †Puerto Blanco Mts, 7970 ybp (Van Devender et al. 1990: 339).

Leptochloa – Sprangletop

As previously constituted, this familiar genus has been shown to be polyphyletic (Peterson et al. 2012), and those in the flora area distributed among three genera, with *Trichloris crinita* transferred to *Leptochloa*.

Leptochloa dubia, see **Disakisperma dubia**

Leptochloa fusca subsp. *uninervia*, see **Diplachne fusca** subsp. **uninervia**

Leptochloa panicea subsp. *brachiata*, see **Dinebra panicea** subsp. **brachiata**

Leptochloa viscida, see **Dinebra viscida**

Leptochloa crinita (Lagasca) P.M. Peterson & N. Snow

[*Chloris crinita* Lagasca. *Trichloris crinita* (Lagasca) Parodi. *T. mendocina* (Philippe) Kurtz]

Feather fingergrass; *zacate escoba*. Figure 46.

Robust tufted perennials; tallest ones along the southern border of Organ Pipe often reach 1–1.2+ m tall, some growing through desert shrubs, elsewhere in Organ Pipe generally less than 0.5 m tall; sometimes flowering in first season or year. Growing and reproductive primarily during the warmer months. Plants sometimes producing rhizomes. Culms upright and firm. Inflorescences panicles of mostly 6–20 erect, bristly white spicate branches 9–15 cm long clustered at the top of the culm. Spikelets crowded, with 1 fertile and 1 sterile floret (occasionally 2 in other regions), each with 3-veined lemmas, the veins extending into 3 slender awns often 1.5–2 cm long; sterile floret cylindrical, similar to the fertile floret but much smaller.

Localized on alkaline soils among low hills in the southern margin of Organ Pipe west and east of Lukeville and locally in the Ajo and Puerto Blanco Mountains.

Arizona to western Texas, south to Durango, Coahuila, Sonora, and Baja California Sur and in South America.

OP: W side of Alamo Canyon, 13 Sep 1941, *Gooding 307-41*. Boulder Canyon, 3 May 1978, *Bowers 1290* (ORPI). 0.5 km W of Lukeville [Dowling Ranch area], 10 Nov 1987, *Felger 87-280* [ca. 90 cm tall]. 4.5 km E of Lukeville, 15–20 m N of border fence, well established colony, but much more common on the Sonoran side of the fence, 11 Nov 1987, *Felger 87-330*. Puerto Blanco Drive, 9.3 mi W of Hwy 85, 14 Sep 1988, *Felger 88-400*. Puerto Blanco Mts, small tributary to Cherioni Wash near Red Tanks trailhead, 21 Sep 2013, *Rutman 20130921-8*.



Figure 46. *Leptochloa crinita*. (A) Plant, panicle, and spikelet with glumes separated (from Hitchcock 1951); (B) panicle, near Red Tanks parking area, North Puerto Blanco Drive, Puerto Blanco Mts, 20 Sep 2013.

Melica frutescens Scribner

Bushy melic, woody melic

Coarse, tufted perennials to 90 cm tall (to more than 1 m tall elsewhere), with brittle stems and purple dye at culm bases and sometimes in leaf sheaths and ligules. Leaf sheaths closed nearly to the top; ligules thin and membranous; leaf blades 10–17.5 cm long. Inflorescences panicles 6–12 cm long, robust and slender, with slender, appressed branches, and erect, appressed spikelets. Spikelets silvery-papery, 9–18 mm long, awnless, breaking apart below the glumes and readily falling entire, with 3–5 bisexual florets and terminal vestigial florets (rudiments) 2–6 mm long resembling the bisexual florets in shape; glumes 7–15 mm long, lower lemmas ca. 10 mm long. Grain shiny, free from the lemma and palea, and longitudinally furrowed. Reproductive at least March to early May.

Ajo Mountains, mostly at higher elevations, and sometimes descending into larger canyons. This isolated population is poorly known.

In Arizona otherwise known from the Tonto National Forest and the Estrella and Superstition Mountains in Maricopa County. Widespread, especially in non-desert areas, of California, Baja California, and northern Baja California Sur.

OP: Alamo Canyon, 13 Sep 1941, *Goodding 302-41*. Arch Canyon, 2600–3200 ft, 3 May 1978, *Bowers 1300*.

Muhlenbergia – Muhly grass

Annuals/ephemerals and perennials of diverse growth forms and sizes. Ligules membranous and not ciliate. Inflorescences of highly diverse panicles. Spikelets small, with 1 floret, breaking off above the glumes. Lemmas firm, slender, 3-veined, 1-awned or awnless. Grain usually slender, fusiform, not readily falling from the floret; pericarp closely covering the seed. Key characters include membranous ligules, spikelets with 1 floret, and 3-veined lemmas.

This is the most taxonomically diverse genus of grass in the flora region and includes nine species. *Muhlenbergia microsperma* is the only member of the genus ranging across the entire flora area, including the more arid regions. *Muhlenbergia porteri* occurs in some lowland desert areas, while the remaining muhly grasses are essentially non-desert species and in the flora area are known only from the Ajo and Diablo Mountains.

Muhlenbergia is one of the most taxonomically diverse genera in southwestern North America. This genus includes more than 160 species, mostly in the Western Hemisphere.

- 1. Delicate ephemerals; root systems often weakly developed (except *M. tenuifolia*).
- 2. Spikelets awnless **Muhlenbergia fragilis**
- 2. Spikelets awned.
- 3. Plants not forming cleistogenes; glumes acute to acuminate **Muhlenbergia tenuifolia**
- 3. Lower leaf axils bearing cleistogenes, these narrowly conical, awnless and without glumes, 4–10 (12) mm long; glumes of awned florets obtuse to somewhat acute.
- 4. Panicles conspicuously contracted (branches close together); glumes 1–2 mm long, the body of the lemma 4–6.2+ mm long **Muhlenbergia appressa**
- 4. Panicles loose, open and feathery; glumes 0.5–1.3 mm long, the body of the lemma 1.8–2.5 (3) mm long **Muhlenbergia microsperma**

1. Perennials; root systems well developed from a hard, knotty base.

5. Plants resembling a miniature bamboo, often more than 1 m tall, the culms woody below, branched above **Muhlenbergia dumosa**

5. Plants not bamboo-like, generally not more than 1 m tall, culms not woody and not branched above (except *M. porteri*).

6. Plants bushy, not tufted, the stems slender, and profusely branching above; panicles often as wide as long, and open with spreading branchlets **Muhlenbergia porteri**

6. Plants tufted, not bushy, not profusely branched above; panicles longer than wide, contracted or at least the branches ascending, appressed, or not evident.

7. Spikelets in pairs, one usually staminate or sterile and the other bisexual; lower glume with (1) 2 or 3 awns 0.5–4+ mm long **Muhlenbergia phleoides**

7. Spikelets alike and not in pairs; glumes unawned or occasionally with 1 awn to 0.5 mm.

8. Plants delicate, 25–55 cm tall (or long), the culms slender; panicles 8–12 (20?) cm long..... **Muhlenbergia tenuifolia**

8. Plants robust, mostly 50–100 cm tall, the culm not especially slender; panicles (9) 20–40 cm long.

9. Panicles more than 3 cm wide (often contracted when young); spikelets awned, the lemmas awns to 15+ mm long **Muhlenbergia emersleyi**

9. Panicles less than 1 cm wide; spikelets awnless or sometimes with a thick awn to 1.2 mm long **Muhlenbergia rigens**

Muhlenbergia appressa C.O. Goodding

Devil’s Canyon muhly. Figure 47.

Small, delicate ephemerals, apparently non-seasonal although mostly documented during the cooler seasons, sometimes reaching 40 cm tall but usually much smaller. Cleistogenes form in the lower leaf nodes. Panicles markedly contracted. Spikelets 4–7 mm long (not including the awn); glumes 1–2 mm long, the lemma slender, terete, with an awn 10–30 mm long. Reproductive with spring and summer-fall rains.

Ajo Mountains, recorded along Alamo Canyon and common in shady microsites, especially in upper elevations.

Central and southern Arizona, generally above the desert. Also southern California and both states of Baja California; not known but predicted for northern Sonora.

The plants of *Muhlenbergia appressa* generally resemble those of *M. microsperma* in habit and their similar-looking cleistogenes. Although they are clearly distinct, they are apparently closely related and are the only members of the genus in the flora area normally to have cleistogenes (Clayton & Renvoize 1986; Peterson & Annable 1991).

OP: Alamo Canyon: *Nichol* 4 May 1939; Soil in bed of canyon, 17 Dec 1945, *Goodding* 472-45. Middle fork Alamo Canyon near crestline of Ajo Mts, 15 Mar 2003, *Rutman* 2003-339.

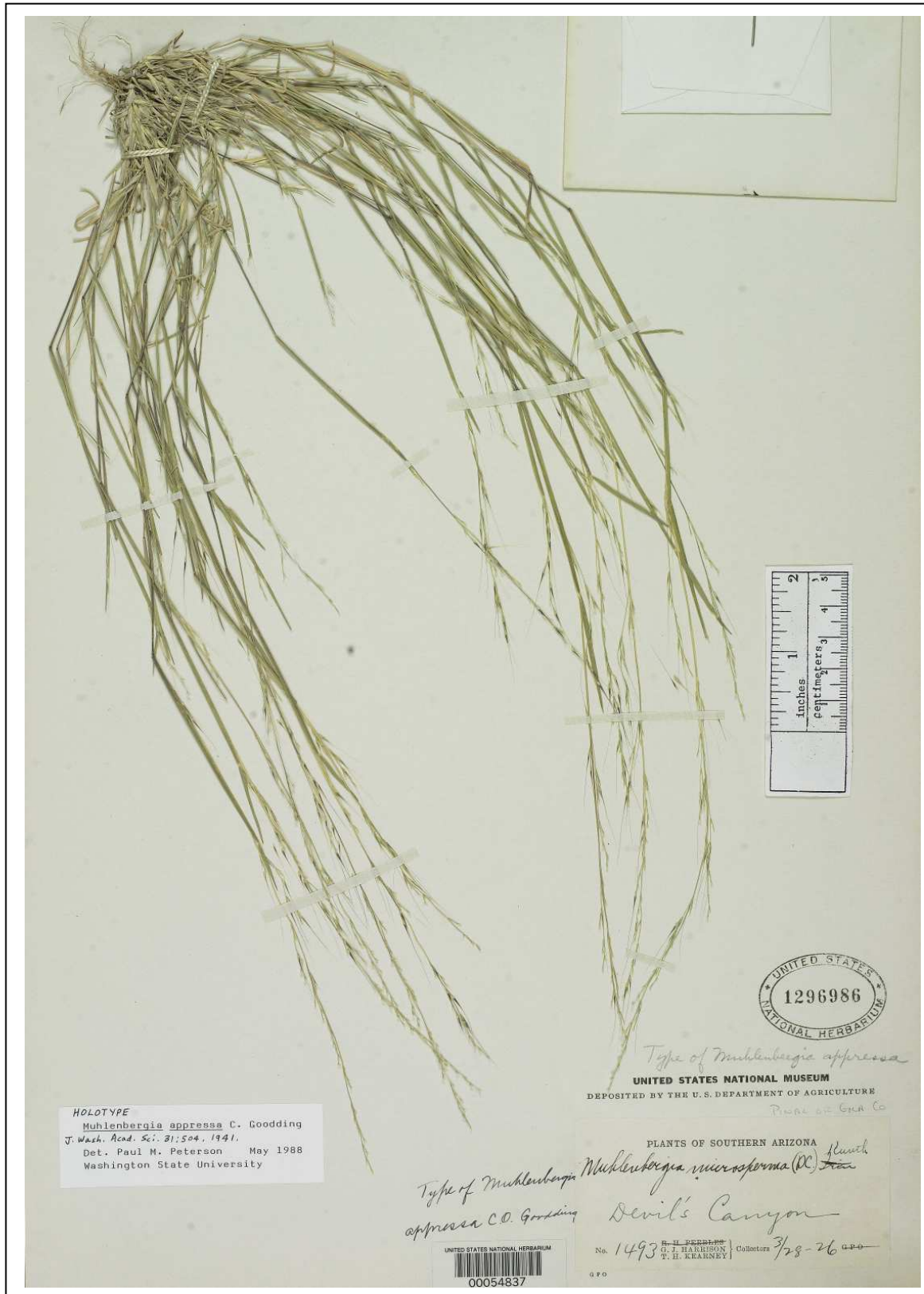


Figure 47. *Muhlenbergia appressa*. Devil's Canyon, Pinal Co., 28 Mar 1926, Harrison & Kearney 1493 (holotype, US).

Muhlenbergia dumosa Scribner ex Vasey
Bamboo muhly; *carricillo*, *otatillo*. Figure 48.

Perennials, the larger plants often 1–1.5 (2+) m tall with slender, bamboo-like culms, woody at the base, the much-branched above, and with short, thick rhizomes, often forming clonal colonies. Upper branches filmy with numerous slender leaves. Panicles slender and densely flowered, usually held above the leaves, about 3 cm or less in length, the spikelets 2.5–3 mm long with awns to 8 mm long but mostly much shorter, or some spikelets awnless. Reproductive late February to early April.

Ajo and Diablo Mountains, locally common in canyons, at cliff bases, and on north-facing slopes and ledges to the crestline, often in shaded places.

Widespread in southern Arizona, mostly at elevations near the upper limits of the desert. Also Baja California Sur, Sonora to Jalisco, and the Chihuahuan Desert Region.

The fruits are often infected with a smut fungus, *Ustilago muhlenbergiae* Henning (identified by Robert L. Gilbertson, 2001). The only other smut reported for this grass is *U. sonoriensis* Zundel, on plants from near Bavispe, Sonora (Fischer 1953). *Ustilago muhlenbergiae* is also known in southern Arizona from *Muhlenbergia pauciflora*, *M. porteri*, and *M. texana* (Rhodes & Gilbertson 1972).

OP: Alamo Canyon, 2500 ft, *Nichol 14 Mar 1939*. Arch Canyon: 17 Sep 1982, *Reeder 8909* (fruits with smut); 3300 ft, *Tinkham 19 Apr 1942* (fruits with smut). Bull Pasture Trail, *Bezy 25 Oct 1964* (fruits with smut). W slope of Montezuma's Head, above Pitahaya Canyon, 16 Jan 1976, *Van Devender 76-3* (fruits with smut). Diablo Mts, 807 m, shaded base of N-facing cliff, large clone/plant at shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-18*.

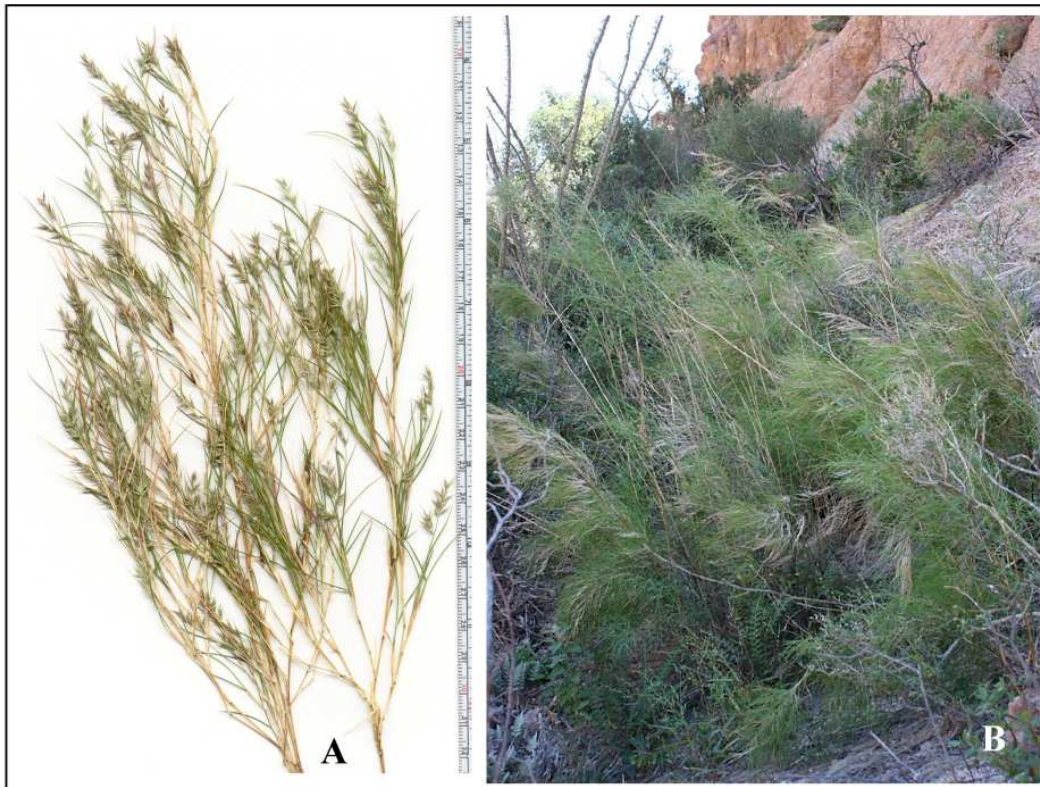


Figure 48. *Muhlenbergia dumosa*. (A) Arch Canyon, Ajo Mts, 31 Mar 2008; (B) trail to Bull Pasture, 24 Sep 2006.

Muhlenbergia emersleyi Vasey
[*M. gooddingii* Soderstrom]
Bullgrass, bull muhly; *zacate de toro*. Figure 49.

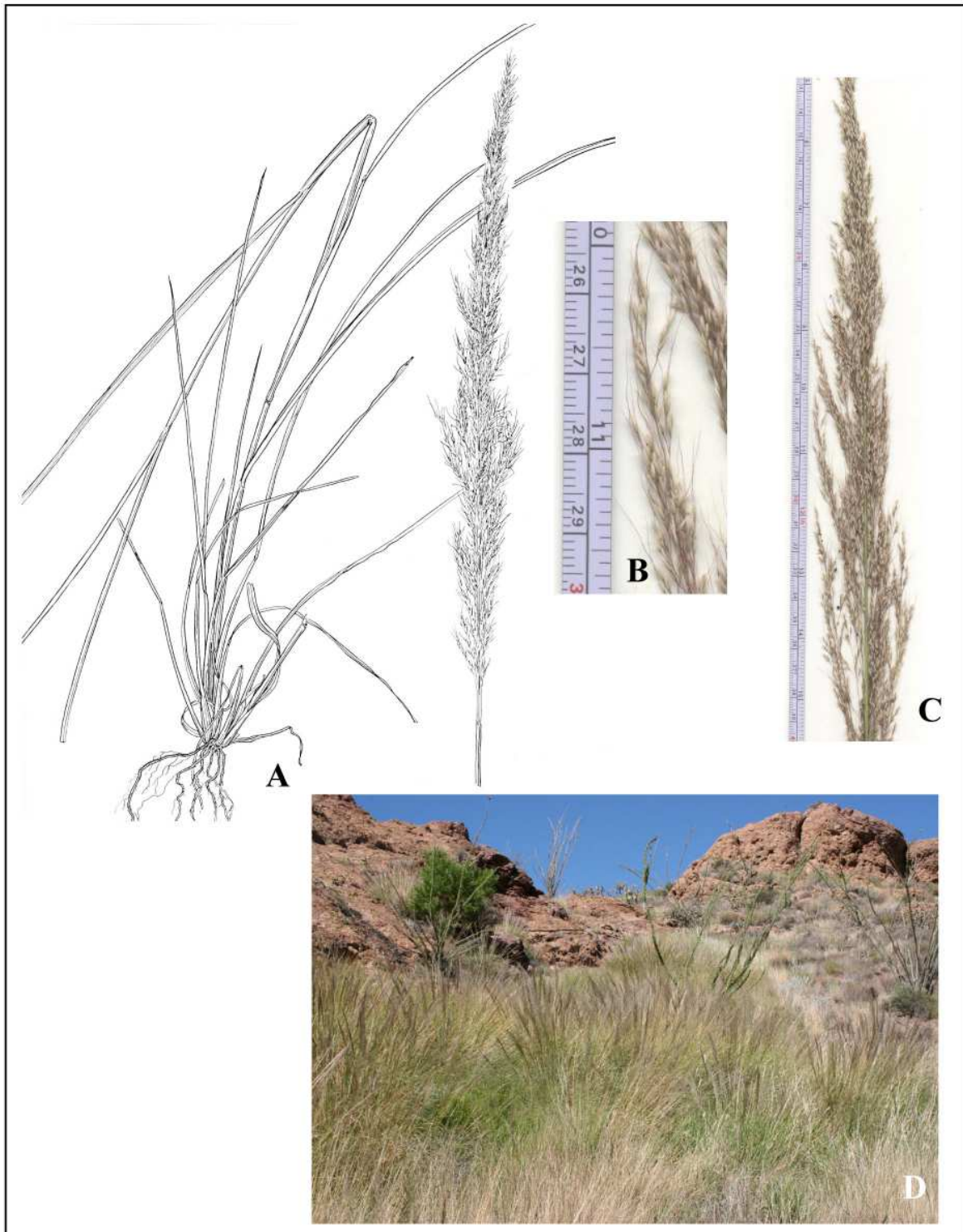


Figure 49. *Muhlenbergia emersleyi*. (A) Plant and a panicle; (B & C) portion of panicle, Dragoon Mts, East Cochise Stronghold, 13 Oct 2013; (D) saddle between Arch & Boulder canyons, Ajo Mts, 21 Sep 2008.

Robust tufted perennials, often 0.5–1 m tall. Leaf sheaths compressed and conspicuously keeled (in cross section) near the base. Panicles large and feathery, 20–40 cm long, the branches ascending and densely flowered. Spikelets 2–3 mm long not including the awn; glumes about as long as, or slightly exceeding, the florets; lemma midrib extending in an awn to 1.5+ cm long and mostly deciduous, or sometimes awnless.

Ajo Mountains, common at upper elevations. *Muhlenbergia emersleyi* has a 22,000-year history in the Ajo Mountains.

Widespread in Arizona above the desert. Also Nevada to Texas, and well represented in non-desert regions of northern Mexico and southward to Durango and Oaxaca.

OP: Ajo Mountains, 1 Nov 1938, *Goodding M-373*. Bench Canyon, 3600 ft, *Henry* 6 Nov 1977 (ORPI). Bull Pasture Trail, 3000 ft, with *Vauquelinia californica* and *Quercus ajoensis*, 20 Oct 1978, *Bowers 1547*. Side canyon immediately below the arch in Arch Canyon, canyon bottom, with lowermost *Vauquelinia*, *Rhamnus betulifolia*, and *Juniperus*, 2 Dec 1990, *Felger 90-535*. †Montezuma's Head, floret, 21,840 ybp (identified by Charlotte Reeder).

***Muhlenbergia fragilis* Swallen**

Delicate muhly. Figure 50.

Small, delicate summer-fall ephemerals, often 10–25 cm tall. Ligules hyaline, ragged with a relatively large tooth (“auricles” or lateral extensions) on each side. Leaf blades 2–6 cm long with white, cartilaginous margins and midrib. Panicles often 8–18 cm long, 3–10 cm wide, with numerous very slender, diffuse and spreading to partially reflexed branches, freely branching at lower nodes; panicles fragile, often breaking away at maturity. Pedicels 2.5–8 mm long, straight and very slender. Spikelets slender, 1–1.2 mm long, glabrous, and awnless.

Locally common at middle to higher elevations in the Ajo Mountains; on thin soils in open areas.

Arizona mostly in the central and southeastern part of the state above the desert. Southeastern California to western Texas and southward to Oaxaca and both states of Baja California.

OP: Ajo Mt crestline, *Rutman 8 Oct 1999* (ORPI). NE slope above trail to Bull Pasture, 975 m, 22 Oct 2006, *Rutman 20061022-2*.

***Muhlenbergia microsperma* (de Candolle) Kunth**

Little-seed muhly; *liendrilla*. Figure 51.

Non-seasonal ephemerals, mostly encountered during winter-spring seasons but also germinating and growing with summer-fall rains, (7) 10–40 cm tall, soft and delicate, often growing through other plants or decumbent-spreading in shaded places. Roots often weakly developed. Panicles terminal, longer than wide, filmy, open and loosely flowered. Upper (larger) glumes 0.5–1.3 mm long; lemmas, tapering to a slender awn 14–28 mm long. Lower leaf axils bearing single or clustered cleistogamous spikelets (cleistogenes), these narrowly conical, awnless and without glumes, 4–10 (12) mm long, resembling a miniature cornucopia. (See *M. appressa*).

Widespread across the flora area at all elevations and in many habitats but not on dunes. Most abundant in better watered, protected microhabitats, especially among rocks, under trees, along arroyos, canyons, north- and east-facing slopes, sand flats, and playas. It has been widespread across the flora area for at least 22,000 years.

Common across the Sonoran Desert. Southwestern USA to Guatemala, and South America.

OP: Quitobaquito, *Nichol 10 Mar 1939*. Cipriano Well, *Nichol 27 Apr 1939*. Bates Well, 5 Mar 1940, *Benson 9913*. Walls Well, *McDougall 26 Mar 1941*. Alamo Canyon, 10 Dec 1945, *Goodding 480-45*. Aguajita, 13 Sep 1986, *Felger 86-281*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-5*. †Alamo Canyon, cleistogenes and florets, 9570 & 14,500 ybp. †Montezuma's Head, florets, some with awns, 13,500 to 21,840 ybp (4 samples). †Puerto Blanco Mts, 2340 to 9720 ybp (3 samples, Van Devender et al. 1990: 339).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3928 (CAB)*. Jose Juan Represo, 2 Jun 1992, *Felger 92-569*.

TA: Tinajas Altas, 19 Mar 1998, *Felger (observation)*. Coyote Water, 25 Oct 2004, *Felger 04-51*. †Butler Mts, 750 ybp (Van Devender et al. 1990: 342). †Tinajas Altas Mts, 8700 to 15,680 ybp (3 samples, Van Devender et al. 1990: 341).



Figure 50. *Muhlenbergia fragilis*. Bull Pasture, 21 Sep 2008.



Figure 51. *Muhlenbergia microsperma*. Chuckwalla Hills, Organ Pipe, 6 Oct 2013.

***Muhlenbergia phleoides* (Kunth) Columbus**

[*Lycurus phleoides* Kunth. *L. setosus* (Nuttall) C. Reeder. *Lycurus alopecuroides* Grisebach.

Muhlenbergia alopecuroides (Grisebach) P.M. Peterson & Columbus]

Wolftail, Texas timothy. Figure 52.

Densely tufted, coarse perennials 20–60 cm tall; growing and reproductive mostly during warmer months. Leaves mostly basal, grayish green and slender; leaf tips ending in a bristle or fragile awn-like projection. Panicles spike-like and slender, mostly 3–10 cm long. Spikelets in pairs, one usually staminate or sterile and the other bisexual, the pairs falling together with the pedicels; spikelets bristly with glume and lemma awns 0.5–4 (5) mm long. Glumes 1–2 mm long, the lower glume with (1) 2 (3) awns, the upper glume with 1 awn. Lemmas 3–4 mm long, with a short, scabrous awn.

Ajo Mountains from middle to upper elevations; documented from Bull Pasture and scattered sites along the trail to Mt. Ajo.

Across most of Arizona except the lowland deserts of the far southwestern part of the state. Utah and Colorado to Oklahoma, Texas, Mexico, and Guatemala and disjunct in South America.

Muhlenbergia phleoides (*Lycurus phleoides* Kunth, described in 1815) and *M. alopecuroides* (*Lycurus alopecuroides* Grisebach, described in 1874) are distinguished on seemingly minor vegetative features, which appear to be influenced by environmental conditions. Their geographic and ecologic ranges broadly overlap and the two taxa appear to be conspecific.

OP: Bull Pasture, Ajo Mountains: *Wirt 29 Oct 1989* (ORPI). Bull Pasture area, 3185 ft, Dry, east-facing slope with shallow soils, associated species *Aristida ternipes*, *Bouteloua curtipendula*, *Cottea gracilis*, *Disakisperma dubium* *Heteropogon contortus*, *Hilaria belangeri*, and *Tridens muticus*, etc., 25 Sep 2013, *Rutman 20130925-8*.



Figure 52. *Muhlenbergia phleoides*. (A) Plant and spikelet with glumes and floret separated; (B) detail of panicle, Fillmore Canyon, Organ Mts, NM, 21 Sep 2008, photo by Patrick Alexander; (C) panicles, Bull Pasture, 25 Sep 2013.

††**Muhlenbergia polycaulis** Scribner
Cliff muhly

Tufted perennials with short rhizomes. It was in the Ajo Mountains more than 29,000 years ago. The nearest known present-day population is in the Baboquivari Mountains.

Southern Arizona in non-desert areas to Texas and central and western Mexico. This species is often mistaken for *Muhlenbergia tenuifolia* (*M. monticola*) or *M. pauciflora* (Gould 1951: 211).

OP: †Alamo Canyon, florets, 29,110 ybp (identification verified by Charlotte Reeder).

Muhlenbergia porteri Scribner ex Beal
Bush muhly; *zacate aparejo*; ku:kpadag. Figure 53.

Bushy perennials often 30–80 cm tall, from a hard, knotty, semi-woody base. Culms slender, brittle, profusely branched throughout, and often interweaving. Leaf blades 1.9–6 (8) cm long and readily drought deciduous. Panicles often 6–10 cm long and about as wide, open and rather sparsely flowered; the panicles become purplish with the advent of cool weather. Mature panicles often break off as a unit and scatter in the wind like miniature tumbleweeds. Pedicels slender, 2–9 (17) mm long. Body of lemma 3.2–3.9 mm long, with an awn (2.5) 4–9 mm long. Flowering various seasons including spring and summer.

Widespread on mountain slopes to bajadas and valley floors, wash banks, and floodplains across much of Organ Pipe and the east side of Cabeza Prieta.

Widespread in the Sonoran Desert except the most arid regions. Southeastern California to Colorado and Texas, Baja California, and Sonora to the Chihuahuan Desert Region in San Luis Potosí and Zacatecas.

Bush muhly, a preferred forage of livestock, was extirpated from large areas of Organ Pipe by cattle grazing. After the cattle were removed in the late 1970s the density and cover of this grass increased substantially along the southern border of the Monument (Warren & Anderson 1987). By the mid-1980s it was common on the Arizona side of the border (eastward from 10 km east of Aguajita Spring), sometimes within a few meters of the border fence, but rare on the Sonora side of the fence due to livestock grazing. Desert tortoises often park under bush muhly plants and graze on the overhead canopy.

OP: Alamo Canyon, *Mulroy 6 Oct 1969*. 5 mi W of Visitor Center along Puerto Blanco Drive, 16 Oct 1977, *Bowers 883* (ORPI). Puerto Blanco Drive 1 mi W of Ariz Hwy 85, 23 Jul 1986, *Felger 86-227* (ORPI). W of Hwy 85 at N boundary of Monument, 23 May 1991, *Felger* (observation).

CP: Childs Mountain, 25 Feb 1993, *Felger 93-45*. Scarface Mt, steep, coarse limestone slope, 1650 ft, *Autenreith 20 Mar 1992* (ASC). *Felger* (observations): Sheep Peak, N side, mid-elevations to peak, 31 Jan 1992; 1.5 mi N of Lower Well, washes in valley plain, 25 Feb 1993.

Muhlenbergia rigens (Bentham) Hitchcock
Deer grass; *zacate del venado*. Figure 54.

Large, robust, tufted perennials to about 1 m tall. Panicles overtopping the leaves, long, slender, and spike-like, (9) 25–40 cm by usually 0.5 to less than 1 cm wide, and densely flowered. Spikelets appressed, obscuring the short, tightly appressed branches; spikelets 2.5–4 mm long, awnless or sometimes with a thick awn to 1.2 mm long. Glumes almost as long as the florets.

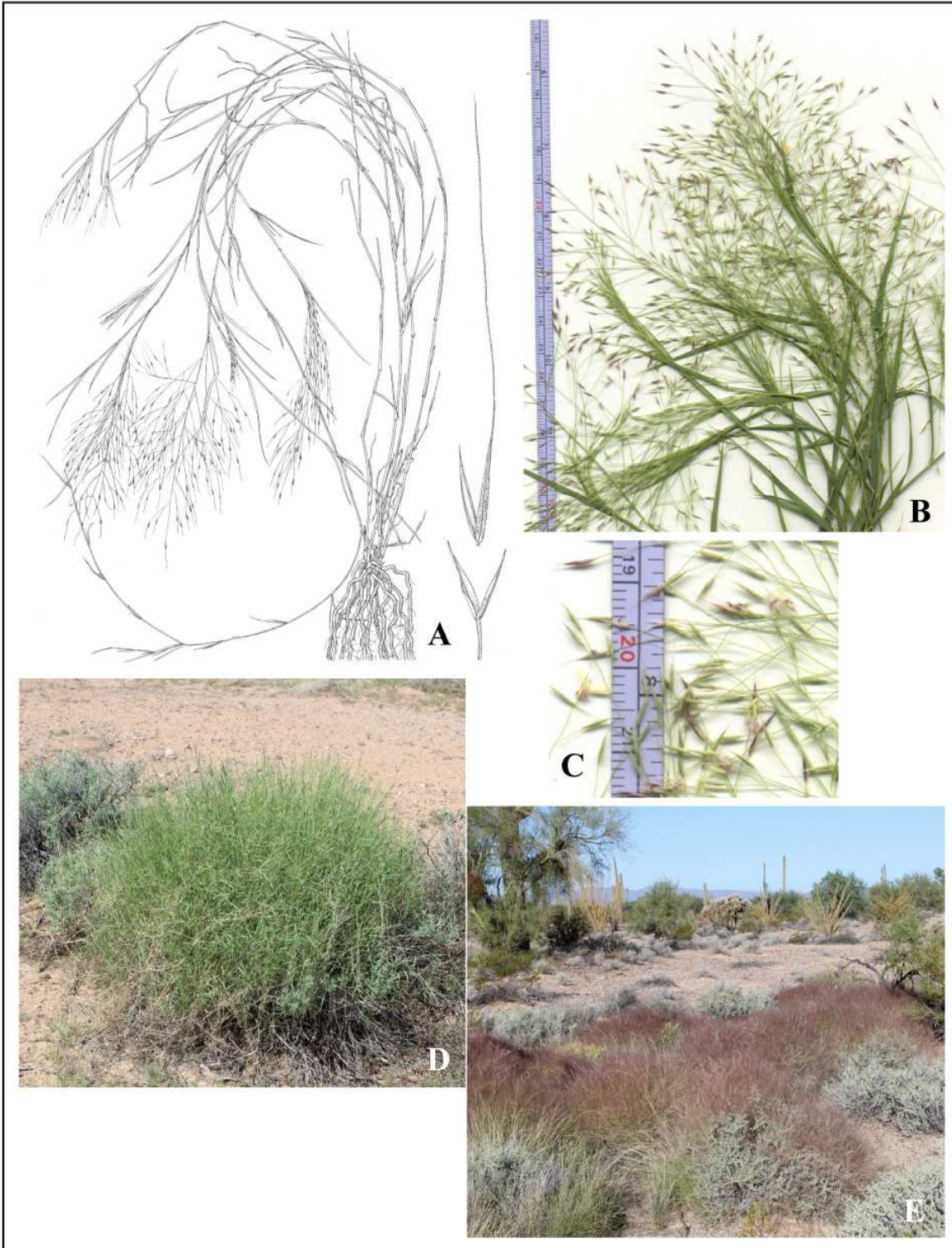


Figure 53. *Muhlenbergia porteri*. (A) Plant and spikelet with glumes and floret separated; (B & C) portions of panicles, Hwy 85 at N boundary of Organ Pipe, 15 Sep 2013; (D) summer monsoon appearance, Why, Pima Co., 8 Aug 2013; (E) winter coloration, Hwy 85 near N boundary of Organ Pipe, 6 Oct 2013.

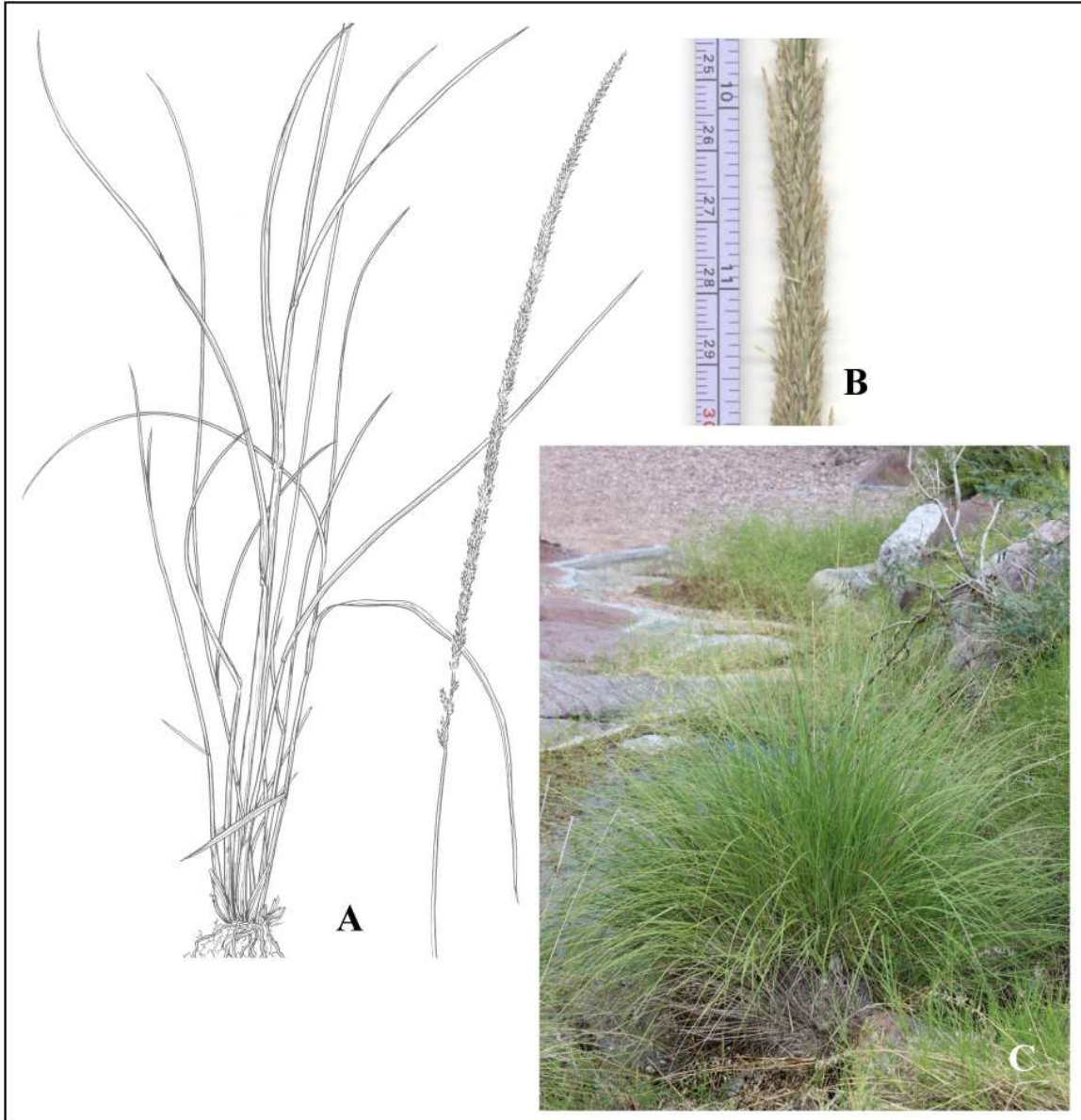


Figure 54. *Muhlenbergia rigens*. (A) Plant and panicle. Alamo Canyon: (B) portion of panicle, 17 Oct 2013; (C) plant, 9 Sep 2013.

Ajo Mountains, recorded from Alamo Canyon along the canyon bottom where it was locally common in the scour zone near Alamo Well. Tough roots anchor the plants in subsurface bedrock, allowing them to survive most scouring floods. Most of the plants were removed by the scouring 500-year flood of 10 September 2012, but some survived.

Widespread in Arizona, mostly above the desert. Southeastern California to Texas, both Baja California states, and Sonora to Coahuila, Durango, and Jalisco.

OP: Alamo Canyon: 2500 ft, *Nichol* 14 Mar 1939; Sandy canyon bottom, 18 Dec 1945, *Goodding* 479-45; Alamo Canyon where N & S forks meet, *Rutman* 5 Mar 1995 (ORPI); Canyon bottom near ruins of ranch house, 29 Mar 2003, *Felger* (observation); Canyon bottom near Alamo Well, 21 Sep 2012, *Rutman*, observation.

Muhlenbergia tenuifolia (Kunth) Kunth
[*M. monticola* Buckley]
Slender muhly, mesa muhly. Figure 55.



Figure 55. *Muhlenbergia tenuifolia*. Trail to Mt Ajo, above Bull Pasture, 16 Sep 2006.

Delicate tufted perennials, reported to be short-lived, or perhaps annuals, 25–55 cm tall. Leaf blades slender and mostly to about 10 cm long. Growing and reproductive with summer-fall rains. Panicles 8–12 (to 20?) cm long, mostly 0.5–1 (2) cm wide not including the awns, and densely flowered to somewhat open, and with short branches. Spikelets 2.5–4 mm long (excluding the awn), the lemmas conspicuously hairy towards the base with a sinuous awn to about 2.5 cm long.

Ajo Mountains, recorded from 2500 ft and common in grassy areas above 3600 ft.

Eastern and northern Arizona generally above the desert, northward to southwestern Colorado, eastward to Texas, and Mexico to northern South America.

OP: Arch Canyon, a few clumps in partial shade of overhanging cliff, 800 m, 17 Sep 1992, *Reeder 8910* (ARIZ, ASU). Saddle between Arch and Boulder canyons, 26 Oct 2003, *Rutman 20031026-23* (ORPI)

Panicum – Panic grass

Annuals/ephemerals or perennials of diverse habit. Ligules membranous-ciliate. Inflorescences panicles usually open with spikelets on long pedicels. Spikelets panicoid; awnless, with 2 florets, the lower one reduced to a sterile lemma or staminate, the upper one bisexual. Lower glume short, or at least shorter than the upper glume; upper glume and sterile lemma similar in texture. Lemma of fertile floret firm, smooth (papillose in *P. alatum*) and shiny, with inrolled margins tightly clasping the palea and enclosed grain. The spikelet may appear to have a single floret until you open it to see the characteristic sterile lemma in addition to the glumes and hard, shiny fertile lemma characteristic of panicoid grasses.

- 1. Summer ephemerals, usually less than 0.5 m tall, the roots often weakly developed.
 - 2. Upper (fertile) floret short-stipitate (stalked), the fertile lemma with two fleshy expansions (like little ears) at its base **Panicum alatum**
 - 2. Upper (fertile) floret not stipitate, the fertile lemma without fleshy expansions **Panicum hirticaule**
- 1. Perennials with well-developed roots.
 - 3. Plants usually 1–2+ m tall; panicles open with conspicuous, spreading branches drooping with weight of the grain; spikelets 2.5–3 mm long..... **Panicum antidotale**
 - 3. Plants less than 1 m tall; panicles contracted, the branches appressed or the inflorescence open and the branches spreading but not drooping; spikelets 2.8–4 mm long.
 - 4. Plants tufted, without stolons; inflorescences open, generally more than 3 cm wide, the branches spreading; glumes unequal **Panicum hallii**
 - 4. Plants with long stolons; inflorescences slender and contracted, less than 1.3 cm wide, the branches closely appressed; glumes subequal *See Hopia obtusa*

Panicum alatum Zuloaga & Morrone var. **alatum**

Winged panic grass

Hot-weather annuals, highly variable in size. Spikelets 2.4–3.2 mm long; upper (fertile) florets short-stalked (stipitate), strongly papillose on the entire surface and with 2 ear-like fleshy expansions at the base of the lemmas (elaiosomes); lower floret sterile.

Found in the large playas in Cabeza Prieta in clayish soils, where large populations grow during years of favorable hot-weather rains. Also in nearby Sonora and elsewhere in western Sonora in similar habitats with temporary standing water and clayish soils, especially inland playas where it is often locally abundant.

Variety *alatum* occurs in southwestern USA (southeastern California and southern Arizona) and northern Mexico to Michoacán. It has also been found along arroyos and canyon bottoms and is widespread across a wide variety of habitats in Baja California Sur. *Panicum alatum* ranges from southwestern USA to South America; Zuloaga and Morrone (1996) recognized three varieties of *P. alatum*.

Panicum alatum resembles *P. hirticaule* except for features of the spikelets: the upper (fertile) floret short-stipitate (stalked) and most noticeably the fertile lemma has a pair of elaiosomes at its base. Elaiosomes are oil-rich structures adapted for ant dispersal. The two species occupy distinct habitats and have not been found intermixed in the flora area or in western Sonora. Elsewhere they are sometimes sympatric and do not show obvious differences in geographic distribution. While the distinctions between *P. alatum* and *P. hirticaule* and their varieties are easy enough to discern with magnification, some authors treat *P. alatum* as a synonym of *P. hirticaule* subsp. *hirticaule* (e.g., Freckmann & Lelong 2003).

CP: Pinta Playa, *Edwards 9 Oct 1977*. Las Playas, 28 Nov 2001, *Felger 01-555*.

***Panicum antidotale** Retzius

Giant panic grass, blue panic grass; *panizo azul*. Figure 56.

Robust perennials mostly 1–2+ m tall, with hard knotty bases, short rhizomes, tough roots, and woody-based culms. Branching and leafy from near the base to the upper part of the plant. Leaves often bluish glaucous. The above-ground part of the plant may die back to the rhizomes during the winter. Panicles mostly terminal, open with conspicuous, spreading branches drooping with weight of the grain; spikelets 2.5–3 mm long, the lower floret staminate. Reproductive during warm weather.

Common in drainages along the international border east of Lukeville, spreading from adjacent agricultural areas in Sonora. It was rather rare in Organ Pipe in 1987, but by the late 1990s it had become common northward at least 1 km from the border in gully bottoms and swales of sandy loams. Giant panic grass also was established in roadside ditches at Why at least from the 1980s to 1992, but it was no longer present in 2012.

Native to India, grown as a forage grass and adventive in southwestern USA and tropics worldwide.

OP: 2 mi E of Lukeville, 15–20 m N of border fence, about one dozen plants with *Cynodon*, *Setaria macrostachya*, and *Salsola*, 11 Nov 1987, *Felger 87-329*. E of Lukeville, 1.6 mi E of Border Monument 166, *Rutman 29 Aug 2001* (ORPI). Near the U.S./Mexico boundary, NW of Gachado line camp, fine sandy loam, in a shallow depression where water settles, with *Cenchrus ciliaris*, *Rutman 8 Aug 2005*.



Figure 56. *Panicum antidotale*. Plant, panicle, fertile floret (below), and spikelet (above) spread open showing the smaller lower glume, upper glume (right), and sterile lemma.

Panicum bulbosum, see **Zuloagaea bulbosa**

Panicum hallii Vasey var. **hallii**

[*P. lepidulum* Hitchcock & Chase]

Hall's witchgrass

Tufted perennials, sparsely hairy, the basal leaves often curly like slender wood shavings. Plants glaucous bluish-green. Spikelets often 3–4.2 mm long; lower glumes $\frac{1}{2}$ – $\frac{3}{4}$ as long as the spikelets; lower floret sterile. Growing and reproductive during warm weather.

Documented in the flora area by a single specimen from the Ajo Mountains in 1938. This or a similar panic grass grew in the Puerto Blanco Mountains about 1000 years ago and in the Ajo Mountains 20,500 years ago. The nearest records are from Sierra El Humo, WSW of Sasabe, Sonora (*Van Devender 2005-841*) and Table Top Mountain in Pinal County (*Felger 02-58*).

Eastern and southern Arizona, mostly at elevations above the desert. Southwestern USA to central Mexico. Another variety occurs in Texas and northeastern Mexico and has been found in California, almost certainly as a weed (Riverside Co, 20 mi W of Blythe, 11 Sep 2012, *Rink 11695*, ASC).

OP: Ajo Mts, *Goodding 31 Oct 1938*. †*P. cf. hallii*: †Puerto Blanco Mts, 980 ybp (Van Devender et al. 1990: 339). †Montezuma's Head, florets, 20,490 ybp.

Panicum hirticaule* J. Presl subsp. *hirticaule
 [*P. capillare* Linnaeus var. *hirticaule* (J. Presl) Gould]
 Mexican panicgrass. Figure 57.



Figure 57. *Panicum hirticaule*. (A & B) Young flowering plants, Alamo Canyon, 15 Sep 2013; (C) spikelet spread apart showing glumes and sterile lemma (below) and fertile floret (above); (D) portion of plant showing pubescence, Alamo Canyon 12 Sep 2008.

Summer ephemerals, highly variable in size, (5) 20–60 cm tall (sometimes much taller elsewhere), often with a single main axis; roots often weakly developed. Plants usually with prominent, spreading, coarse and usually bulbous-based hairs, especially on stems, leaf sheaths, lower leaf-blade surfaces, or rarely glabrate or glabrous; flowering branches and spikelets glabrous. Panicles erect, the branches mostly straight, or drooping with weight of the grain on large, robust plants with especially large panicles. Spikelets 2–4 mm long. Lower glumes 1.5–2 mm long, $\frac{1}{2}$ – $\frac{3}{4}$ as long as the spikelets; glumes and lemmas with conspicuous longitudinal (parallel) green veins. Lower floret sterile. Fertile lemmas smooth and shiny, 1.6–2 × 0.7–1 mm, shiny cream-white, becoming dark brown with age.

Often common along major drainageways and also on rocky slopes, sandy plains, and many other habitats. Widespread and seasonally common nearly throughout Organ Pipe and at least the eastern part of Cabeza Prieta. Documented in the Ajo Mountains for 20,500 years, these fossils clearly are subsp. *hirticaule*.

Widespread in the Sonoran Desert; southwestern USA to South America and the West Indies.

OP: Washes N of Customs House, 27 Aug 1943, *Clark 10904* (ORPI). Alamo Canyon, 18 Dec 1945, *Gooding 475-45*. Estes Canyon, 20 Aug 1950, *Supernaugh 448*. Aguajita Wash, 14 Sep 1988, *Felger 88-428*. Growler Wash, *Wirt 2 Aug 1990* (ORPI). E of Armenta Ranch, *Rutman 30 Sep 2006*. †Alamo Canyon, florets, 1150 to 9570 ybp (3 samples). †Montezuma's Head, florets, 13,500 & 20,490 ybp.

CP: Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-657*. San Cristobal Wash, 14 Sep 1992, *Felger 92-690*.

Panicum obtusum, see **Hopia obtusa**.

Pappophorum vaginatum Buckley

[*P. apertum* Munro ex Scribner. *P. subbulbosum* Arechavaleta. Not *P. vaginatum* Philippi]
Pappus-grass; *puntiagudo barbón*. Figure 58.

Robust, tufted perennials, often about 50–70 cm tall, essentially glabrous. Inflorescences of panicles overtopping the leaves, often whitish, slender and densely flowered, often 15–18 × (0.8) 1–1.5 cm. Spikelets with 3 florets, the lower ones bisexual, the upper ones reduced. Glumes translucent, 1-veined, awnless or rarely with an awn to 1 mm long. Fertile lemmas plump, with multiple veins and lobes extending into 10 or more stiff, scabrous (not plumose) unequal awns often 5–6.5 (7) mm long, the awns mostly spreading at right angles at maturity and longer than the lemma body.

Locally in Bull Pasture and probably elsewhere in the Ajo Mountains.

The nearest records are from the vicinity of Why and eastward and the Vekol Valley in the Sonoran Desert National Monument, usually in low-lying, fine textured soils of valley bottoms. Eastward in southern Arizona to Texas and northern Mexico, disjunct in Argentina.

OP: Ajo Mts, *Albee Apr 1937*. Bull Pasture, 3100 ft, small patch with *Panicum obtusum*, 24 Sep 2006, *Rutman 20060924-2*.

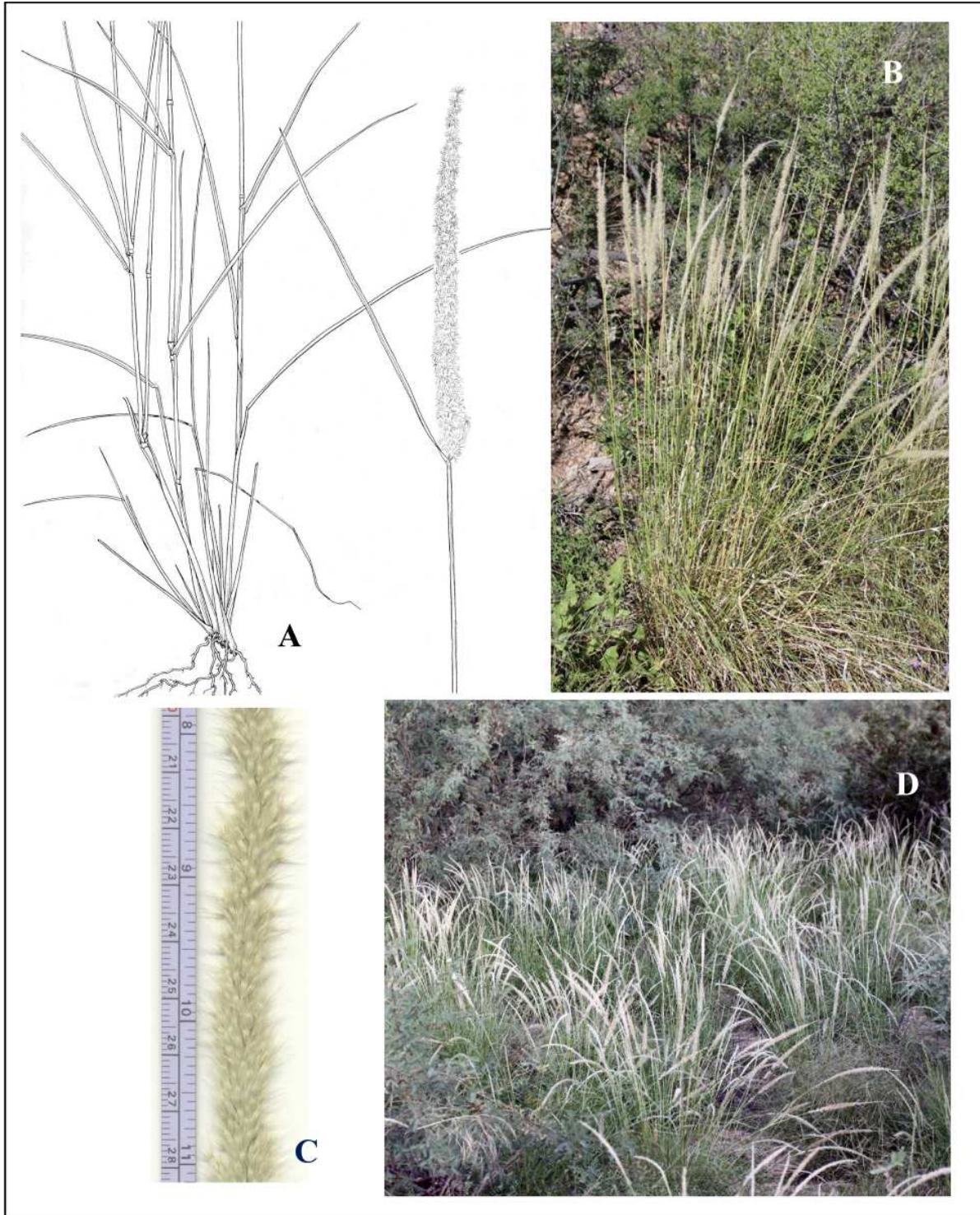


Figure 58. *Pappophorum vaginatum*. (A) Plant and panicle; (B & C) Bull Pasture, 25 Sep 2013; (D) Hwy 86 roadside east of Why, Pima Co., 21 Sep 2012.

Pappostipa speciosa (Trinius & Ruprecht) Romaschenko

[*Achnatherum speciosum* (Trinius & Ruprecht) Barkworth. *Jarava speciosa* (Trinius & Ruprecht) Peñailillo. *Stipa speciosa* Trinius & Ruprecht]
Desert needle-grass. Figure 60.

Tufted perennials often 65–75 cm tall with a dense basal clump of leaves. Leaf sheaths reddish brown; ligules densely ciliate with a tuft of hairs on each side of the collar (ligules in this species reported to be variable among different leaves, some perhaps less hairy or glabrous, e.g., Arriaga 2007); leaf blades tough and inrolled, the longer one often 45–60 cm, and less than 1 mm wide when dry. Dormant during the cooler months as well as the hotter months; growing and reproductive March–May and in fall. Inflorescences of panicles 10–26 cm long, contracted, densely flowered and spike-like; young, emerging panicles and lower part of mature panicles partially enclosed by a broad leaf sheath. Spikelets readily separating above the glumes, and with 1 floret. Glumes 13–20 mm long, longer than the lemma body, elongated and tapering, papery, and persistent. Lemmas firm at maturity with overlapping margins, tightly enclosing the palea, and bearing a stout, persistent terminal awn 3.3–4.5 cm long, with 1 bend (once geniculate), the awn column strongly twisted and bearded (plumose) below the bend with slender white hairs (3) 5–6 (8) mm long, awn and body of lemma of different textures and colors, the junction abrupt.



Figure 60. *Pappostipa speciosa*. Alamo Canyon: (A) 16 Sep 2006; (C) 17 Oct 2013. (B) Near village of Kuakatch, Organ Pipe, 24 Mar 2013.

Canyons and mostly north-facing slopes in the Tinajas Altas Mountains and common at middle to upper elevations in the Ajo Mountains, especially along the crestline, often growing out of rock crevices on north- and east-facing slopes.

Southern California to Colorado and Arizona, both Baja California states, and northwestern Sonora, and disjunct in Chile and Argentina. The type locality is in Chile. “Several varieties are recognized in South America. It is not clear to which of these varieties, if any, the North American plants belong” (Arriaga 2007: 181).

Desert needle-grass has grown in mountains across the flora area for at least 11,000 years. Its maximum distribution seems to have been in the early Holocene. This grass, like the Joshua tree, is now widespread in the Mohave Desert and seems to have expanded northward into Nevada in the early Holocene.

OP: Sierra de Alamos, *Nichol 16 May 1937*. Alamo Canyon, *Nichol 4 May 1939*. Arch Canyon, 3 May 1978, *Bowers 1301*. Bull Pasture, 3215 ft, 9 Apr 2005, *Felger 05-183*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, florets, 8130 to 9570 ybp (3 samples). †Puerto Blanco Mts, 7970 ybp (Van Devender et al. 1990: 339).

TA: Tinajas Altas, *Van Devender 26 Mar 1983*. Borrego Canyon, 16 Jun 1992, *Felger 92-616*. †Butler Mts, 3820 & 10,615 ybp (Van Devender et al. 1990: 341–342). †Tinajas Altas Mts, 5860 to 10,950 ybp (7 samples, Van Devender et al. 1990: 341).

††**Paspalum** sp.

A single, well-preserved floret 2.2 mm long, from an Ajo Mountain midden 22,000 years old, was identified by John Reeder. It is perhaps *P. setaceum* Michaux var. *stramineum* (Nash) D.J. Banks. No member of this genus is known to occur in the flora region today. This large and widespread genus generally occurs in wetland places in the Sonoran Desert Region. The nearest modern populations are along the lower Gila and Colorado Rivers.

OP: †Montezuma’s Head, 21,840 ybp.

***Phalaris** – Canary Grass

Winter-spring ephemerals in the Sonoran Desert Region. Panicles ovoid to cylindrical and densely flowered. Spikelets breaking off above the glumes, laterally compressed, and awnless, with 1 bisexual (fertile) floret and 1 or 2 (those in the flora area) small, scale-like sterile florets below, these falling with the fertile floret. Fertile lemma tightly enclosing the palea and grain.

- 1. Keel of glumes scarcely winged and neither notched nor toothed; sterile florets 2
..... **Phalaris caroliniana**
- 1. Keel of glumes conspicuously winged and often notched or toothed; sterile florets 1
..... **Phalaris minor**

***Phalaris caroliniana** Walter

Carolina canary grass; *alpistillo*. Figure 61A.

Known in the flora area from a single record at Las Playas and perhaps locally established. The nearest known record is from a heavily grazed playa in the Pinacate Region (Rancho los Vidrios) in nearby Sonora (Felger 2000).

Native in eastern USA and naturalized in many parts of the world.

CP: Las Playas, under mesquite, in channels, not common, 1 Mar 1998, *Harlan 494*.

***Phalaris minor** Retzius

Little-seed canary grass; *alpistillo silvestre*; ba:bkam. Figure 61.

Plants highly variable in size. Panicles spike-like, mostly several centimeters long, sometimes 8–10 cm long. Glumes 4.5–5.5 mm long, the keel expanded into a wing often notched or with small irregular teeth. Fertile lemmas 3–3.5 mm long, broadly ovate-lanceolate, and hairy.

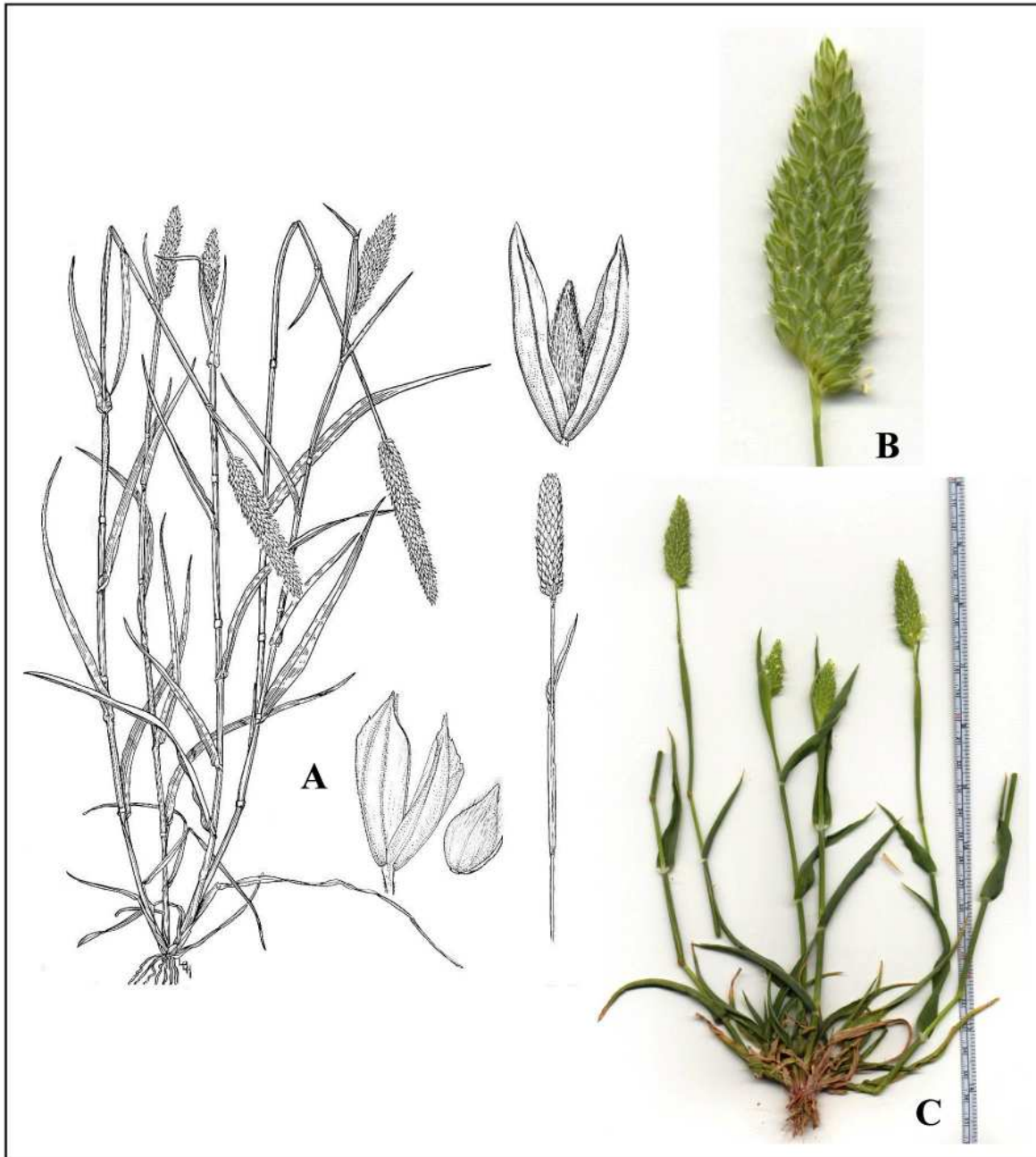


Figure 61. *Phalaris*. (A) *P. minor*, plant, panicle, glumes and fertile floret with reduced single sterile floret (below) and *P. caroliniana* spikelet (above); (B) *P. minor*, below Gillespie Dam, Maricopa Co., 31 Mar 2013; (C) *P. minor*, Hwy 85 near Organ Pipe visitor center, 7 Apr 2008.

Often in locally dense stands at waterholes and dirt tanks, and major washes on the east side of Cabeza Prieta, where large stands of this grass often grow in drying mud above stagnant water of dirt tanks (*charcos*). It is apparently not eaten by deer, javelina, or jackrabbits. In years of favorable rains it is abundant in Organ Pipe, mostly in xeroriparian areas.

Native to the Mediterranean region; widely naturalized in the Sonoran Desert region and elsewhere in the world.

OP: Growler Canyon, 30 Mar 1979, *Bowers 1603*. 2-way section Puerto Blanco Drive, 2 mi W of Hwy 85, roadside, 10 May 1979, *Bowers 1722*. Gachado Line Camp, 11 Nov 1987, *Felger 87-328*. Cuerda de Leña at N boundary, *Rutman 16 Mar 1995* (ORPI). Ruin of ranch building near mouth of Alamo Canyon, 29 Mar 2003, *Felger 03-397*. Cherioni Wash 100 ft W of Rte 85, *Casper 10 Apr 2003* (ORPI). Hwy 85, roadside, imported by ADOT in straw used as mulch, N of park headquarters, 9 Apr 2005, *Felger 05-160*.

CP: San Cristobal Wash, 20 Mar 1992, *Harlan 55* (CAB). Agua Dulce Mts, localized colony in sandy-gravel soil in canyon bottom near the tank, 13 Jun 1992, *Felger 92-579A*. *Felger*, observations: Redtail Tank, 12 Jun 1992; Antelope Tank, 13 Jun 1992; Charlie Bell Rd at Daniels Arroyo, 10 Apr 1993.

Phragmites australis (Cavanilles) Trinius ex Steudel subsp. ***berlandieri*** (E. Fournier) Saltonstall & Hauber

[*P. communis* Trinius]

Common reed, reedgrass; *carrizo*; va:pk. Figure 62.



Figure 62. *Phragmites australis*. Growing among *Tessaria sericea*, Williams Spring, 31 Jan 2013.

Bamboo-like perennials reeds reaching about 3 m in height, with strong rhizomes and tough roots. Major culms stout, reaching 10–15 mm diameter, and also often producing numerous smaller branched culms as slender as 1.7 mm diameter. Leaf blades (7) 30–40 cm long. Reproductive at least July to October. Inflorescences of terminal, plume-like, and densely flowered panicles. Spikelets with several florets, the glumes unequal, the upper florets reduced; spikelets usually break off below the long-bearded rachillas, which aid in wind dispersal. Rachillas with long silky white hairs, the lemmas glabrous; glumes unequal. Birds flying between wetlands and waterholes are likely dispersal agents.

Small but well-established colonies occur in wet soil at the Burro and nearby Williams Springs, northwest of Quitobaquito, growing with *Tessaria sericea* and *Prosopis glandulosa*. Several large, local populations occur nearby along the Río Sonoyta in Sonora (Felger 2000).

Phragmites australis occurs on every vegetated continent on earth and is one of the world's most widespread species of flowering plants. Three subspecies are recognized; subsp. *berlandieri*, known as the Gulf Coast lineage, ranges across southernmost USA and through Mexico to South America.

OP: Burro Spring: 4 May 1978, *Bowers 1316* (ORPI); 23 Jul 1986, *Felger 86-214*; 24 Oct 1987, *Warren 87-110*. Williams Spring, hypersaline, wet through most of the year, with *Pluchea sericea*, *Tibbitts 13 Feb 2013*.

Poa – Bluegrass; *zacate azul*

The two species found within the Sonoran Desert are cool-season ephemerals (elsewhere this large genus of about 500 species includes annuals and mostly perennials). Ligules membranous; leaf blades with a boat-shaped tip (sometimes described as “prow-shaped” or “navicular”). Inflorescences of terminal panicles. Spikelets 2–8 florets, awnless, laterally compressed, breaking apart above the glumes and between the florets. Uppermost florets reduced or rudimentary. Lemmas 5-veined, often with a cottony, cobwebby tuft of hair.

Poa and *Festuca*, each with about 500 species, are the largest genera of grasses and worldwide in distribution. Except for the four ephemeral species listed in this flora, these genera are essentially absent from the Sonoran Desert and there are relatively few species in deserts elsewhere.

- 1. Spikelets mostly 3.6–4.6 mm long; lemmas 2.1–2.7 mm long, glabrous to slightly hairy on veins but without a cottony web; well-watered disturbed habitats, probably extirpated from the flora area **Poa annua**
- 1. Spikelets mostly 4.5–6.5 mm long; lemmas 3.2–4 mm long with a cottony web at base; desert habitats and roadsides **Poa bigelovii**

****Poa annua** Linnaeus

Annual bluegrass, winter-grass; *pastito de invierno*

Winter-spring annuals; plants small, soft, glabrous, and bright green.

Collected at Quitobaquito in 1945 when the site was inhabited and not recorded there since. It grew in the marsh around the pond with *Myosurus* and *Veronica*. The local demise of this water-loving weedy little grass is probably due to the increase in vegetation cover since the domestic livestock were removed. It occurs as a winter lawn and garden weed in nearby Sonoyta.

Native to the Old World and weedy and naturalized worldwide.

OP: Quitobaquito, marsh around reservoir, 17 Mar 1945, *Darrow 2405*.

Poa bigelovii Vasey & Scribner

Bigelow bluegrass; *zacate azul precoz*. Figure 63.

Winter spring ephemerals, (8) 12–55 cm tall, with delicate slender and erect culms and panicles, the roots often weakly developed. Spikelets pale green, 4.5–8 mm long, with 3–8 florets, the young spikelets spear-shaped, the spikelet base with a dense cottony tuft or web. Florets at first overlapping and compressed (flattened) against each other, spreading apart at maturity with the floret margins becoming visible. Lemmas 3.2–4.4 mm long, the margins membranous and with white hairs.



Figure 63. *Poa bigelovii*. (A) Kuakatch Wash near Organ Pipe east boundary, 24 Mar 2013; (B) Alamo Well, 6 Feb 2005.

Washes, floodplains, and rocky slopes to higher elevations; fairly common and widespread during years of favorable winter-spring rains across Organ Pipe but scarce in the more arid southwestern corner, and also seasonally common in the eastern part of Cabeza Prieta. It has been in Organ Pipe for at least 20,500 years.

Widespread in Arizona. This is the only native *Poa* in the Sonoran Desert. Southwestern USA, Baja California and Sur, and Sonora to Chihuahua, Coahuila, and Nuevo León.

OP: Dripping Springs, 17 Mar 1945, *Darrow 2444*. Alamo Canyon, 12 Apr 1978, *Bowers 1250*. 0.6 mi E of Lukeville, 20 Feb 1988, *Felger 88-04*. Aguajita, 3 Mar 1992, *Felger 92-111*. Trail from The Cones to Mount Ajo, 4100 ft, 10 Apr 2005, *Felger* (observation). †Montezuma’s Head, 20,490 ybp.

CP: Agua Dulce Pass (plants dry and dead), 13 Jun 1992, *Felger 92-574*. Charlie Bell Rd just W of E boundary of Refuge, 25 Feb 1993. Childs Mt, 9 Apr 1993, *Felger 93-291*.

††***Poa fendleriana*** (Steudel) Vasey

Mutton bluegrass

Tufted perennials. Male and female flowers usually on separate plants.

Mutton bluegrass grew in the Ajo Mountains during the last Ice Age (Soreng & Van Devender 1989). Today this species in Arizona occurs in woodland and forested areas, mostly above 5000 ft but occasionally descending to 3500 ft. The nearest present-day population is in the Baboquivari Mountains. Gould (1951: 70) reported that it “produces relatively small amounts of viable seed.” Western North American from Canada to Mexico.

OP: Alamo Canyon, 14,500 ybp. Montezuma’s Head, 20,490 & 21,840 ybp.

***Polypogon**

Ephemeral/annuals and potentially perennials. Leaf blades flat, thin, and bright green. Inflorescences of panicles densely flowered and contracted or with short branches and densely to loosely flowered. Spikelets small, with 1 floret, breaking away below the glumes; spikelets with a pedicel-like stipe. Glumes longer than the florets. Lemmas membranous, 5-veined.

1. Ephemerals; spikelets awned **Polypogon monspeliensis**

1. Ephemeral/annuals (and potentially perennials); spikelets awnless **Polypogon viridis**

***Polypogon monspeliensis** (Linnaeus) Desfontaines

Rabbitfoot grass; *zacate cola de zorra*. Figure 64.

Non-seasonal ephemerals. Highly variable in size depending upon soil moisture. Leaf blades 3.5–22 × 0.5–1 cm. Panicles densely flowered, appearing furry like a rabbit’s foot, (1.5) 3–15 cm long, with white to tawny-brown awns. Glumes 1.5–2.2 mm long, each with a slender awn 4–7 mm long. Lemmas and paleas thin, translucent, slightly exceeding the grain, the lemmas with a delicate, deciduous awn 1 mm long. Reproductive at least April to October.

Common in moist to wet, often alkaline soil near springs and seeps in the Quitobaquito region and near water in Alamo Canyon, and one record from Cabeza Prieta. Normally a wetland plant, *P. monspeliensis* grew along Highway 85 in 2005, the seed being present in the “certified weed-free” straw originating from California and used as mulch in construction zones by the Arizona Department of Transportation; these plants did not persist.

Native to Europe, widely naturalized in the Sonoran Desert and elsewhere in western North America, mostly in wetland habitats.



Figure 64. *Polypogon monspeliensis*. (A) Below Gillespie Dam, Gila River, 31 Mar 2013; (B) Ajo Mountains Wayside, Hwy 85, 29 Apr 2009; (C) seasonally wet swale, Quitobaquito, 5 Apr 2008.

OP: Quitobaquito, *Nichol* 28 Apr 1939 (ORPI). Rincon Spring, 13 Apr 1941, *McDougall* 91. Alamo Canyon, *Tinkham* Apr 1942. Burro Spring (with *P. viridis*), 23 Jul 1986, *Felger* 86-215b. State Route 85, N of park headquarters, area of roadside construction as seed mixed with the “weed-free” straw used as mulch, 9 Apr 2005, *Felger* 05-162 (ASU).

CP: Near Agua Dulce seep, Agua Dulce Mts, *Henry* 05/08/1996 (CAB).

****Polypogon viridis*** (Gouan) Breistroffer

[*Agrostis semiverticillata* (Forsskål) C. Christensen. *Polypogon semiverticillata* (Forsskål) Hylander] Water bentgrass. Figure 65.

Ephemeral/annuals and sometimes perennials with creeping rhizomes or stolons, the culms often reaching 30–40 cm long, decumbent to erect, rooting at the lower nodes. Leaf blades flat, 5.5–14 cm × 3.5–13 mm. Panicles 5–8 (12) cm long, compact or sometimes interrupted and with a few

branches, or sometimes rather loosely and much branched. Spikelets awnless. Glumes 1.4–2.1 mm long, minutely scabrous and appearing speckled, membranous and translucent with a broad green midstripe or sometimes partially or all purplish. Lemmas 0.8–1 mm long. Growing and flowering March through the warmer months.

Localized, dense colonies in wet mud at periphery of the *Phragmites* colony at Burro Spring and at Quitobaquito in wet mud and shallow running water at springs and ditches leading into the pond. In the 1980s and 1990s it was well established at Quitobaquito, where it seemed to be competing successfully with the similar-looking *Cynodon dactylon* and *Distichlis spicata* in ditches with running water. The nearest known population is at Quitovac in northwestern Sonora.

Native to the Old World and widely naturalized in western North America.

OP: Burro Spring: Moist soil, with *Pluchea sericea* & *Prosopis glandulosa*, 4 May 1978, *Bowers 1311*; Common perennial, wet mud at periphery of *Phragmites* colony, 13 Jul 1986, *Felger 86-215*. Quitobaquito: Moist soil of marsh, 17 Mar 1945, *Darrow 2409*; Emergent from shallow water and very wet soil along water ditch, *Scirpus americanus*, *Distichlis spicata*, 6 Apr 1988, *Felger 88-318*; Common along shaded channel N of pond, with *Polypogon monspeliensis*, *Cynodon dactylon*, and *Eleocharis rostellata*, shaded by *Prosopis velutina* and *Ziziphus obtusifolia*, 5 Apr 2013, *Rutman 20130405-2*.

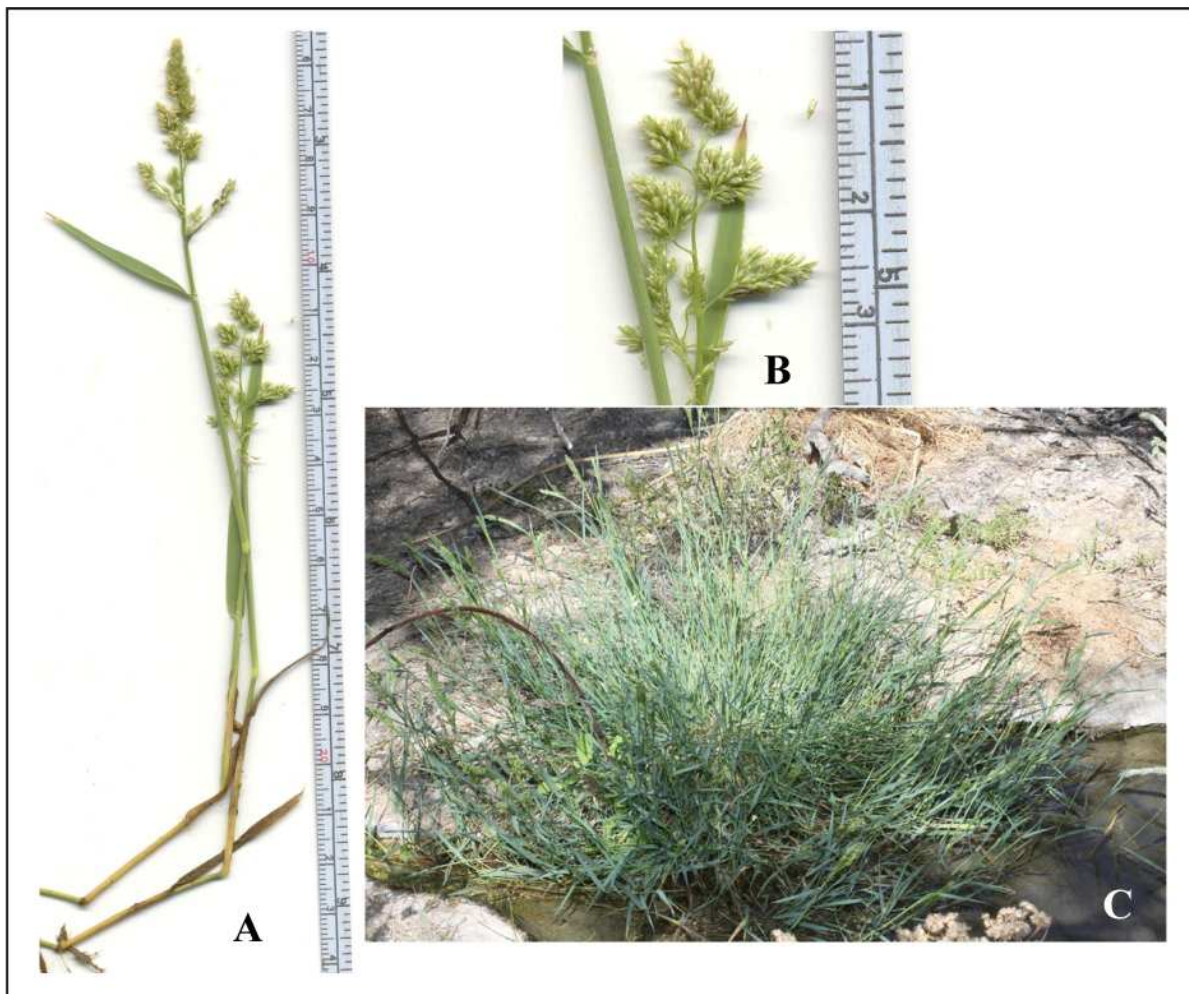


Figure 65. *Polypogon viridis*. Quitobaquito: (A & B) 11 Sep 2008; (C) 5 Apr 2013.

***Schismus** – Mediterranean and Arabian grasses

Small winter-spring ephemerals. Culms erect to often spreading or semi-prostrate. Leaves mostly basal, the blades bright green and narrow. Inflorescences of compact panicles. Spikelets with several florets, awnless, breaking apart above glumes and between florets. Glumes longer than the lemmas, with membranous white margins. Native to the Old World.

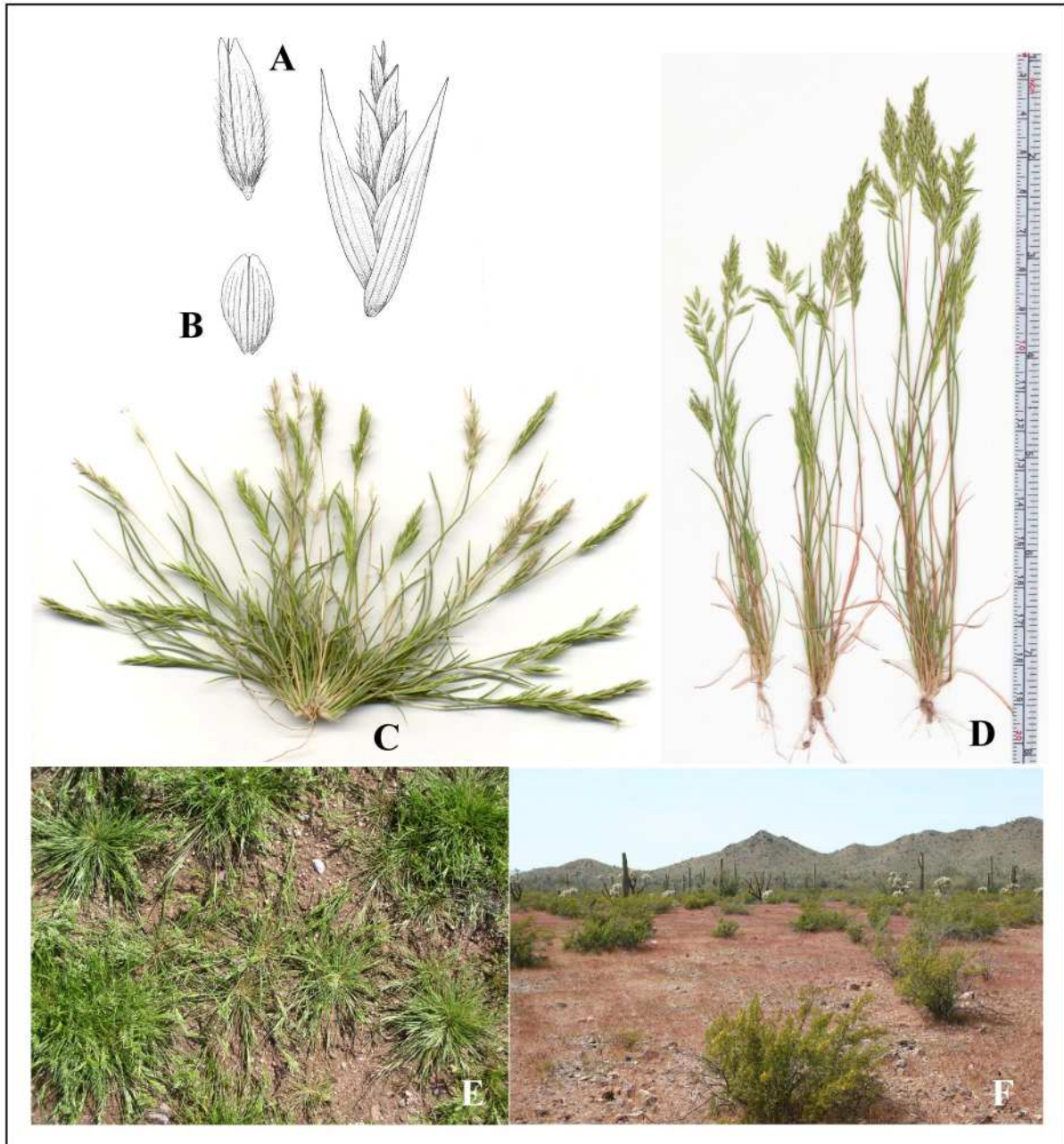


Figure 66. *Schismus*. (A) *S. arabicus*, spikelet and lemma, and (B) *S. barbatus*, lemma; (C) *S. barbatus*, Armenta Ranch area, 4 Apr 2002; (D) *S. barbatus*, upright form, Estes Canyon, 3 Apr 2010; (E) prostrate form, Armenta Ranch area, 13 Feb 2005; (F) plants turn reddish as they senesce, (creosotebush in foreground), NW of Bates Mts, 20 Mar 2005.

The two species, distinguished by subtle differences in the spikelets, are widely established in arid and semi-arid regions of the world. These little grasses are ubiquitous across the Sonoran Desert and can become abundant, sometimes to the near exclusion of native ephemerals (Felger 1990, 2000; Felger et al. 2003). *Schismus* germinates and grows rapidly with cool-weather rains. The culms and leaves often spread close to the ground, especially in open, arid sites and during cooler weather early in the season, effectively excluding or preventing other ephemerals from sprouting (Felger 2000). The spreading-prostrate habit may also function much like the rosette, first leaves of many dicotyledonous winter-spring ephemerals. Upright growth forms are also common, especially in shaded places and later in the season in warmer spring weather.

Both species of *Schismus* are seasonally common across much of the flora area, although they seem to replace each other with respect to the Lower Colorado Valley–Arizona Upland boundaries (Felger 2000). Similar eco-geographic segregation also occurs in their native habitat as well as the Middle East (Conert & Türpe 1974; Feinbrun-Dothan 1986).

Seasonally dense growth of *Schismus* grasses can fuel fires. The Tule Fire of 2005 in Cabeza Prieta National Wildlife Refuge was carried by heavy winds and ample fuel loads of *S. arabicus* and the native woolly plantain (*Plantago ovata*) (Felger et al. 2007b; Curtis McCasland, pers. comm. to R. Felger 2005). During years of favorable rain, high-density stands of taller than usual *Schismus* can interfere with the movement of lizards. Sue Rutman observed lizards near Gachado Ranch during the 1997 winter season “swimming” over the top of dense *Schismus* about 15 cm tall rather than attempting ground navigation.

- 1. Lemmas hairy on back and margin; palea shorter than the lemma, usually not reaching the lemma notch **Schismus arabicus**
- 1. Lemmas glabrous over back (occasionally with few hairs near the base) or with some hairs on margins; palea about as long as the lemma **Schismus barbatus**

***Schismus arabicus** Nees

[*S. barbatus* subsp. *arabicus* (Nees) Marie & Weiller]

Arabian grass. Figure 66.

Culms and panicles (4) 10–20 (22) cm long. Lemmas 1.5–2.4 mm long, pubescent, the tip notched, the lobes often pointed (acute).

Most abundant on sandy soils of sand flats, arroyos and washes, interdune troughs, and bases of larger dunes, but also common on rocky soils and hills. Lower Colorado Valley region, from the western part of Organ Pipe westward through Cabeza Prieta and Tinajas Altas.

Native from southwestern Africa to the western and northern Sahara and the western Mediterranean Region.

OP: N of Pozo Nuevo, 30 Mar 1978, *Bowers 1109*. Growler Canyon, 1.5 mi E of Bates Well, *Wirt 24 Apr 1989*.

CP: W of Namer’s grave site, 14 Mar 1983, *Reeder 7590*. Growler Mts above Charlie Bell Wash, 3 Apr 1992, *Whipple 3927*. Charlie Bell Rd at Daniels Arroyo, 9 Apr 1993, *Felger 93-358*. E Pinta Sands, 11 Apr 1993, *Felger 93-411*. Childs Mt, 5 Mar 1994, *Felger 94-15*.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-154*.

***Schismus barbatus** (Linnaeus) Thellung
Mediterranean grass. Figure 66.

Resembling *Schismus arabicus* but the glumes tending to be slightly shorter, the lemma usually glabrous on the back or with hairs on the margins or occasionally near the base, the apical notch of the lemma often shallow or minute and the lobes variously obtuse or not, and the palea about as long as the lemma.

Widespread across Organ Pipe in the Arizona Upland including mountains to higher elevations, and occasionally found in Cabeza Prieta.

Native from Greece to Kashmir and southern Russia.

OP: N of Headquarters, 26 Mar 1965, *Ranzoni 310* (ORPI). Alamo Canyon, near old corral, 16 Feb 1979, *Bowers 1558*. Aguajita, 6 Apr 1988, *Felger 88-301*. 3.5 mi S of N boundary of Monument, Hwy 85, 20 Feb 1988, *Felger 88-02*. Bates Well, 11 Mar 2003, *Felger 03-297*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-295*.

CP: Kino Peak Quad., UTM 3564500N 318050E 12,1650 ft, base of Scarface Mt, off dirt road, by S-running arroyo, in coarse sand, *Autenreith 20 Mar 1992* (ASC).

Setaria – Bristlegrass

Ephemerals or perennials. Inflorescences of contracted panicles. Spikelets subtended by one or more persistent, scabrous bristles (the bristles represent reduced panicle branches or branchlets). Spikelets panicoid, detaching below the glumes, awnless, with 2 florets, the lower one sterile and reduced to a lemma similar to the upper glume, the fertile lemma firm and tightly grasping the fertile palea and grain (the spikelet thus appearing to have a single floret).

Setarias reach their desert limits in the flora area—they do not extend into the western areas of Cabeza Prieta or into the adjacent Gran Desierto of northwestern Sonora. Their absence in these drier regions is probably due to the lack of dependable summer rains.

- 1. Perennials, roots stout and coarse **Setaria macrostachya**
- 1. Summer fall ephemerals, roots weakly developed.
 - 2. Spikelets more or less oval in outline, widest at middle; fertile lemmas very finely rugulose (evenly textured with a fine, bead-like textured surface, the beads in rows)..... **Setaria grisebachii**
 - 2. Spikelets diamond-shaped, widest below middle; fertile lemmas coarsely rugose with transverse wrinkles **Setaria liebmanni**

Setaria grisebachii E. Fournier

Grisebach's bristlegrass; *zacate cola de zorra*

Summer-fall ephemerals, highly variable in size, superficially resembling *S. liebmanni*. Leaf blades scabrous or sparsely pubescent on both surfaces. Panicles cylindrical, loosely flowered, usually held well above the few leaves on relatively long, slender culms. Bristles 1 below each spikelet, with forward-pointing barbs. Spikelets 1.7–1.9 mm long, more or less oval in outline, widest at the middle; sterile paleas often present, varying in size from much less than to more than half as long as the spikelets (best seen at 30× magnification), or sterile paleas absent (both conditions may be found on the same plant); fertile lemmas very finely rugulose, with a granular or bead-like pattern.

Canyons and slopes in the Ajo and Diablo Mountains. More than a half dozen beautifully preserved florets as old as 20,500 years were recovered from fossil packrat middens in the Ajo Mountains.

This grass occurs in an arc around the northern and eastern limits of the Sonoran Desert, mostly at slightly higher elevations than the desert. Southwestern USA to Central America.

The texture of the fertile lemma needs to be inspected before being confident of distinguishing *Setaria grisebachii* from *S. liebmannii*. This is easily done by putting a drop of water on the spikelet and lifting the second glume and looking at the texture of the fertile lemma, using a 10× lens. The overall geographic ranges of the two species are similar except in the north where they tend to diverge.

OP: Mid-Alamo Canyon, bed of wash, 18 Dec 1945, *Gooding 474-45*. Arch Canyon, W of the arch, 2 Dec 1990, *Felger 90-551*. Trail to Mount Ajo, 3800 ft, 22 Oct 2006, *Rutman 2006-1022-9*. Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-10*. †Montezuma's Head, florets, 13,500 & 20,490 ybp.

***Setaria liebmannii* E. Fournier**

Summer bristlegrass, Liebmann's bristlegrass; *zacate cola de zorra*. Figure 67.

Summer-fall ephemerals, highly variable in size, culms unbranched or with several or more slender branches. Leaf blades relatively broad, thin, yellowish green, and scabrous on both surfaces. Panicles cylindrical, loosely flowered, usually held well above the few leaves on relatively long, slender culms. Bristles 1 below each spikelet, with forward-pointing barbs. Spikelets 2.1–2.5 mm long, diamond-shaped, widest below the middle; sterile paleas absent; fertile lemmas coarsely rugose with transverse wrinkles.

Known in the flora area only from the Ajo Mountains.

This grass is mostly a tropical species and is the only annual bristlegrass in the lowland desert in Arizona and lowland desert and thornscrub in western Sonora and northwestern Sinaloa. Organ Pipe to central Arizona near the Mexican border, and Mexico to Central America.

Van Devender et al. (1990) reported this species from Montezuma's Head, 20,490 ybp, but the specimens apparently are *S. grisebachii* and not *S. liebmannii*.

OP: Alamo Canyon, on rocky slopes, *Gooding 25 Sep 1943*. Arch Canyon, shaded microsite below the arch, 2880 ft, 12 Sep 2013, *Rutman 20130912-19*.

***Setaria macrostachya* Kunth complex**

Plains bristlegrass; *zacate tempranero*. Figure 68.

Tufted, often robust, perennial clumping grasses, with well-developed, strong, fibrous roots. (Sometimes flowering in the first season farther east in southern Arizona.) Panicles strongly contracted and spike-like, cylindrical, and densely flowered. Bristles solitary, with forward-pointing barbs. Spikelets 1–3 mm long, globose, the fertile lemmas coarsely rugose with transverse wrinkles. Flowering with sufficient soil moisture at various seasons, especially with summer-fall rains.

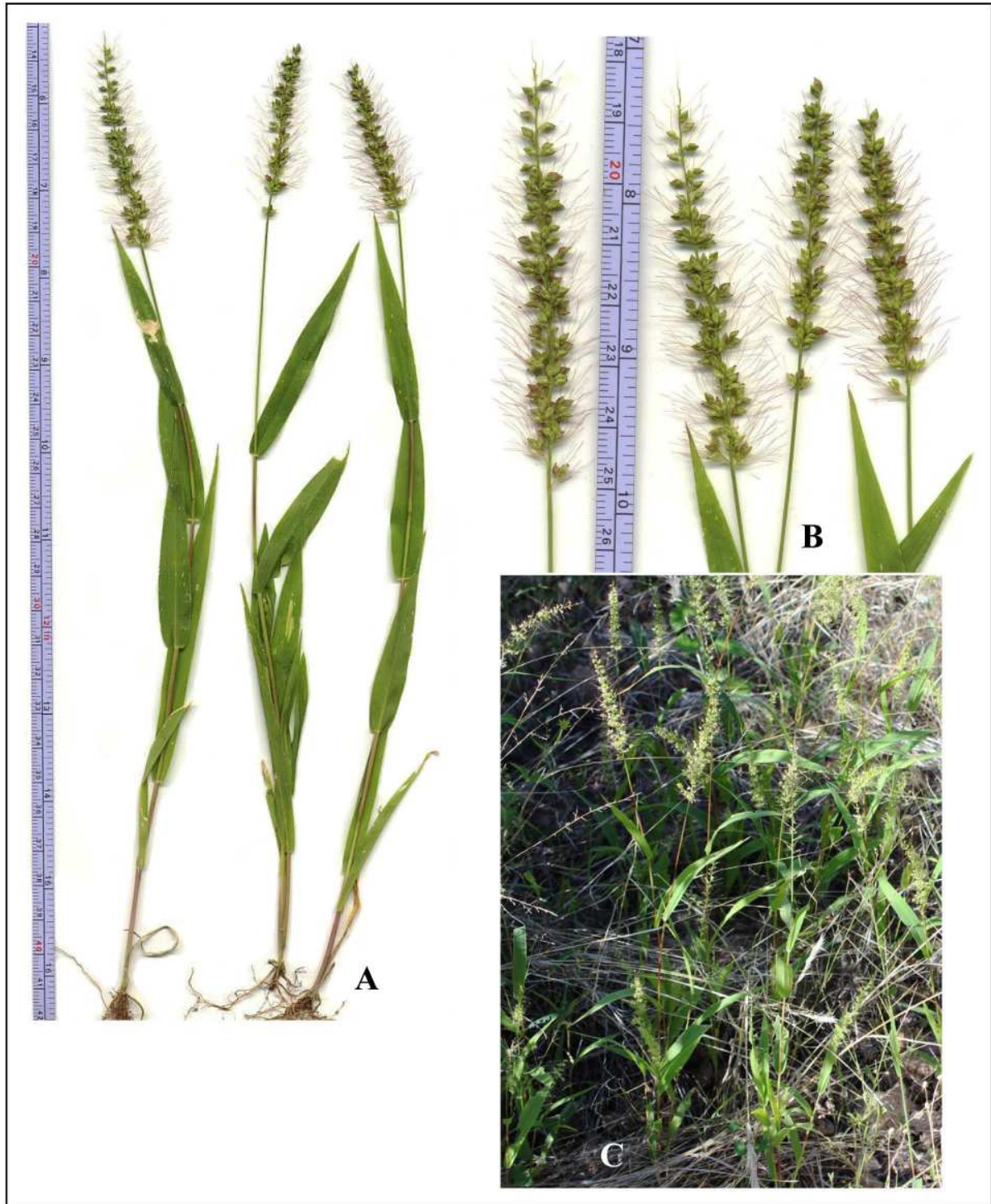


Figure 67. *Setaria liebmannii*. Arch Canyon: (A & B) 13 Sep 2013; (C) 22 Sep 2013.



Figure 68. *Setaria macrostachya*. (A) Plant, panicle and leaf blade, and spikelets (opened with glumes and sterile lemma, below; fertile lemma with palea spread open, middle; spikelet and bristle); (B & C) Alamo Canyon, 9 Sep 2013.

Locally common in scattered places in Organ Pipe except the more arid areas. Small arroyos and washes, canyons, and sandy loam to rocky slopes to higher elevations including the Ajo Mountains. Also canyons and mountain slopes in the eastern part of Cabeza Prieta westward to the Cabeza Prieta Mountains, especially at higher elevations. It has been in the Ajo Mountains for at least 32,000 years and was in Tinajas Altas more than 11,000 years ago. The specimens from Montezuma's Head, 13,500 ybp, are represented by several florets 2 mm long.

The *Setaria macrostachya* complex ranges from Colorado southward through much of Mexico. Part of this complex, including populations in southwestern Arizona and adjacent northwestern Mexico, has been segregated as *S. leucopila* (Scribner & Merrill) Schumann. McVaugh (1983: 361) noted that “after a little practice one can see the difference between the very plump fruit of the one and the less plump fruit of the other; the convexity or lack of it in the fertile palea, and the length of the sterile palea, can be diagnostic in the extremes, but not very useful in intermediate forms.” In *S. leucopila* the fertile lemma is gibbous and in *S. macrostachya* sensu stricto it is not. Rominger (1962, 2003) distinguished *S. leucopila* also on the bases of leaf width; *S. leucopila* is supposed to have a narrower leaf. This distinction, however, does not hold up; leaf width seems to be a function of duration of rainfall and temperature (Felger & Wilder 2012; Felger et al. 2011).

OP: Alamo Canyon, *Nichol 4 May 1939*. Boulder Canyon, 2600 ft, 3 May 1978, *Bowers 1294*. Walls Well Rd, *Van Devender 30 Aug 1978*. 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-313*. Mouth of Arch Canyon, 2 Dec 1990, *Felger 90-565*. About 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-4*. †Alamo Canyon, florets, 1150 to 32,000 ybp (7 samples). †Montezuma’s Head, florets, florets, 13,500 to 21,840 ybp (3 samples). †Puerto Blanco Mts, florets, 2340 to 14,120 ybp (11 samples, Van Devender et al. 1990: 339).

CP: Agua Dulce Spring, 1400 ft, *Simmons 24 Jan 1965*. Canyon slopes at Agua Dulce Tank, 13 Jun 1992, *Felger 92-570*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger* (observation).

TA: †Tinajas Altas Mts, florets, 10,950 ybp (Van Devender et al. 1990: 341).

****Sorghum halepense* (Linnaeus) Persoon**
Johnson grass; *zacate Johnson*. Figure 69.



Figure 69. *Sorghum halepense*. (A) Plant, panicle, terminal spikelet cluster with paired pedicellate spikelets and the larger sessile, fertile spikelet, and an awnless fertile floret with a pair of pedicels; (B) Sedona, Yavapai Co., 25 Sep 2013, photo by Max Licher, from SEINet.

Perennials, potentially robust and to 1+ m tall, but probably much smaller in the flora area, with strong rhizomes in better-watered habitats, or facultative annuals without rhizomes. Growing and flowering with warm weather. Leaf blades 0.8–2+ cm wide, flat with a prominent midvein. Inflorescences of panicles, usually open, and breaking apart at maturity; branches not floriferous to the base. Spikelets andropogonoid. Sessile maturity breaking, bisexual spikelets relatively slender, awnless or with once bent (geniculate), twisted, and readily deciduous awns often 7–13 mm long; awned and awnless spikelets sometimes on the same panicle. Pedicellate spikelets staminate smaller, elliptic, awnless, and deciduous at maturity.

Washes and drainageways in Organ Pipe near the international border east of Lukeville, spreading from the adjacent agricultural fields in Mexico, and one record from Childs Mountain. Occasionally found along roadsides.

Native to the Mediterranean, now in the warmer parts of the world. Grown as a forage and fodder crop but also considered a noxious weed.

OP: 1 mi E of Lukeville, 11 Nov 1987, *Felger 87-325*.

CP: Childs Mt, 2000 ft, *Simmons 30 Oct 1962* (CAB).

Sporobolus – Dropseed

Ephemerals or perennials of diverse sizes and growth habits. Ligules a line of hairs (ciliate), sometimes also with large hairs at the collar and leaf sheath “behind the collar.” Inflorescences of strongly contracted to open panicles. Spikelets small, with 1 floret, glabrous, awnless, and separating above the glumes. Glumes different in size, or sometimes subequal. Lemmas 1-veined. Grain readily falling from spikelets at maturity (hence the name “dropseed”); pericarp usually thin and closely enclosing the seed but free from it, readily soaking up water, becoming mucilaginous when wet and forcibly ejecting the seed, the “naked” seed often clinging to the tip of the palea and lemma especially after a rain. Among the Sonoran Desert species, growth and flowering occur during the warmer times of the year. Key characters include a ciliate ligule, spikelets with 1 floret, and 1-veined lemmas.

Among the dropseed grasses in the flora area, the young panicles often are strongly contracted and partially to even fully enclosed in an enlarged leaf sheath, at least at first in *Sporobolus cryptandrus*, *S. flexuosus*, and *S. pyramidatus*, and the lower portion of the panicles are also often contracted in *S. airoides*. As the panicles mature the branches usually spread: the contrast is striking and can be confusing for identification. “Those species of *Sporobolus* in which some or all of the inflorescences remain enclosed in the subtending leaf sheaths tend to reproduce cleistogamously, that is, pollen cannot be dispersed and obligately pollinates the stigma of the same floret. The percentage of seed set in these inbred plants is usually quite high” (Yatskievych 1999: 727).

Sporobolus cryptandrus is part of a complex including *S. contractus* Hitchcock, *S. flexuosus*, and *S. giganteus* Nash. These species have conspicuous tufts of hair at the summit of the leaf sheath. *Sporobolus cryptandrus*, which often produces the smallest-sized plants, is the most common and widespread member of this complex in the Sonoran Desert region. Some specimens from Arizona (Tinajas Altas and Tule Well) and northwestern Sonora appear intermediate with *S. flexuosus* in having swollen pulvini with hairs but with relatively small and mostly contracted panicles characteristic of *S. cryptandrus* (Felger 2000). Patrick Alexander (pers. comm. to R. Felger 2014) points out that *S. cryptandrus* and *S. flexuosus* in New Mexico produce mostly or completely cleistogamous inflorescences in dry years, and the panicles remain enclosed in the leaf sheath, probably a means of ensuring seed set when conditions are poor. In wetter seasons or years the

inflorescences generally extend half way or more out of the sheath. Similar scenarios seem to hold for the Sonoran Desert.

1. Ephemerals; branches at lowest node of panicle whorled with (4) 5 or more branches (often concealed by the leaf sheath in younger inflorescences); spikelets 1.5–1.8 mm long

..... **Sporobolus pyramidatus**

1. Perennials; branches at lower nodes mostly solitary, rarely with 3 branches (lower nodes of young inflorescences often concealed by the leaf sheath); spikelets 1.8–2.4 mm long.

2. Large, coarse grasses, often reaching 1–1.5+ m tall; hairs at the collar region of leaf, if present, usually straight; larger (lower) branches of panicles 6.5 cm or more long; grain (seeds) 0.95–1.2 mm long **Sporobolus airoides**

2. Medium-sized or slender and relatively delicate grasses, the culms slender, if culms and panicles more than 1 m long then usually tangled and growing through shrubs, otherwise usually less than 1 m; leaf collar with a dense and often tangled mat of hairs; grain (seeds) 0.7–0.9 mm long.

3. Plants erect-ascending and free-standing, usually not more than 0.75 m tall; pulvini not hardened into hooks, not as below; spikelets generally appressed to the branches

..... **Sporobolus cryptandrus**

3. Plants often reaching 1–1.6 m, the panicles long, lax, often curved and clambering into shrubs and sometimes becoming tangled; pulvini at base of panicle branches becoming hardened into persistent hooks, and with a few, rather stout hairs; spikelets generally spreading

..... **Sporobolus flexuosus**

Sporobolus airoides (Torrey) Torrey subsp. **airoides**

Alkali sacaton; *zacatón alcalino*. Figure 70.

Coarse perennials often 1–1.5 m tall, forming large clumps with tough, knotty bases and very well-developed roots. Sometimes forming clonal “fairy rings” to 2+ m wide. Leaves mostly basal, the blades coarse and tough, often (30) 50–85 cm long; leaf sheaths sparsely pilose “inside” the summit of the leaf sheath, the collar region glabrous; lower portion of leaf sheaths near base of plants persistent, rather firm, shiny and smooth. Panicles openly branched at maturity, (15) 25–53 cm long; larger panicle branches (6) 7–16 (20) cm long; branches mostly solitary at each node (rarely 3 or 4 branches per node). Spikelets 1.8–2.2 mm long. Anthers 1–1.5 mm long. Grain (seeds) 0.95–1.2 mm long. Mostly growing April–November, dormant during the cooler months.

Locally common on alkaline flats, often in moist, sandy soil at Quitobaquito, Burro, and Williams Springs. Also found in the canyon bottom and water seeps at Cabeza Prieta Tanks.

Western USA and northern Mexico, often on alkaline or semi-saline soils. Another subspecies occurs in Coahuila.

OP: Quitobaquito, 9 Aug 1979, Bowers 1803. Williams Spring, 13 Sep 1986, *Felger 86-273*.

CP: Cabeza Prieta Tanks, 15 Jun 1992, *Felger 92-604*.

Sporobolus cryptandrus (Torrey) A. Gray

Sand dropseed; *zacate areñero*. Figure 71.

Tufted perennials, 30–75 (100) cm tall. Leaf sheaths usually pilose with relatively dense, long white and often tangled hairs at the summit, these hairs usually extending onto part of the collar. Base, or sometimes the entire panicle, enclosed by an enlarged, inflated leaf sheath (often with a reduced blade), the upper part of the panicle often but not always becoming free and the branchlets

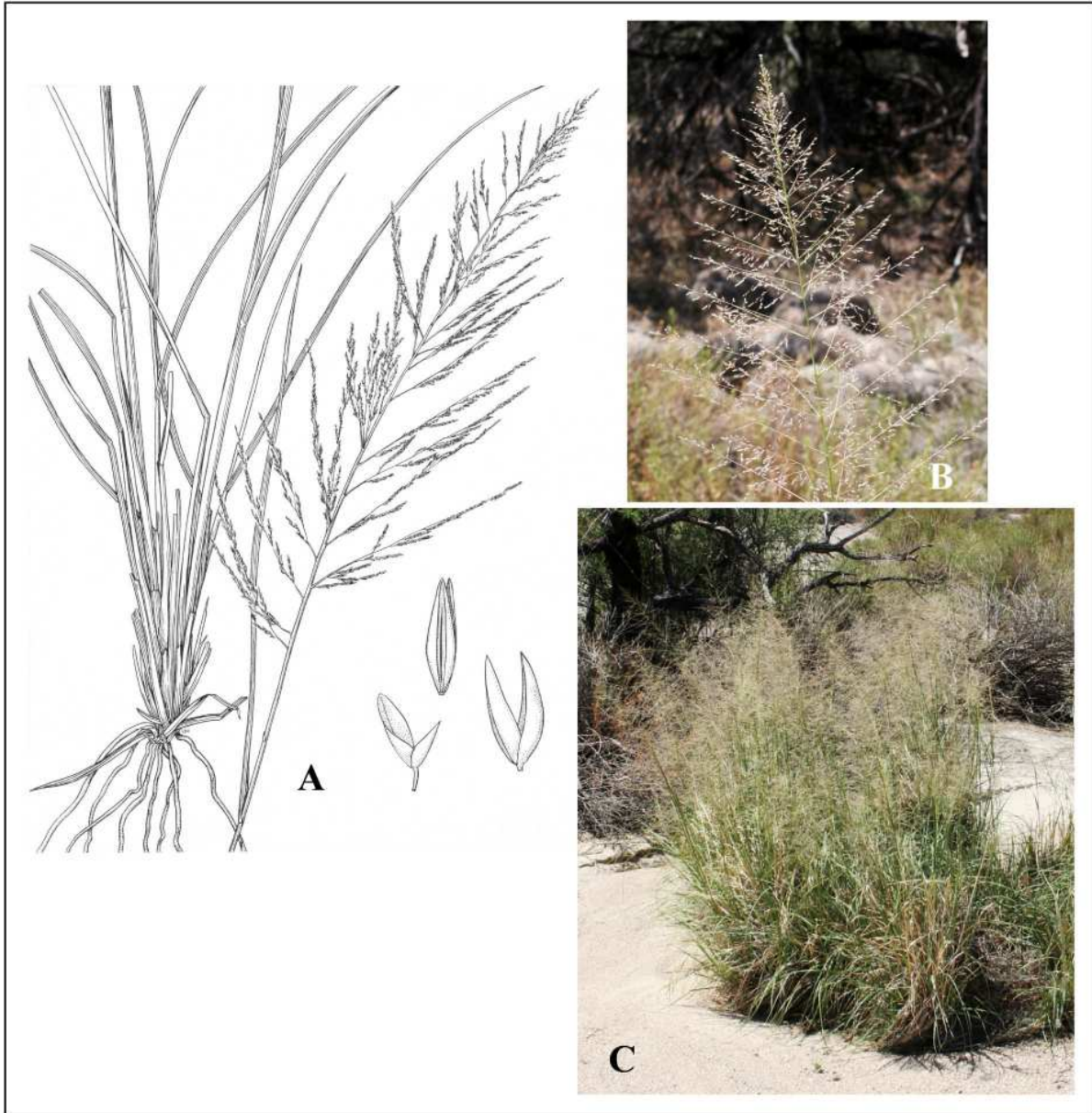


Figure 70. *Sporobolus airoides*. (A) Plant, panicle, glumes, and two views of lemma and palea; (B & C) Quitobaquito, 13 Sep 2006.

spreading at maturity. Panicles (including enclosed portion) often 20–30 cm long, erect or arched; panicle branches single at nodes of exposed upper branches, often 3–5 (6) cm long. Spikelets 1.9–2.4 mm long, tan to dark olive-gray. Anthers 0.15–0.6 mm long. Grain (seeds) 0.7–0.9 mm long. Growing and reproductive during the warmer months.

Widely scattered in Organ Pipe and apparently scarce in Cabeza Prieta. Mostly along margins of washes, swales, and floodplains on sandy loams of the lower bajadas and valley floors, and infrequent on rocky slopes. Known from Tinajas Altas by single record.

Southern Canada to central Mexico.

OP: Quitobaquito, 24 Oct 1990, *Felger 90-474*. Tributary to Cuerda de Leña, 11 Sep 2013, *Rutman 20130912-10*. Diablo Mts, wash, along Ajo Mt Drive, 12 Sep 2013, *Rutman 20130912-10*.
CP: Childs Mt, 2750 ft, 18 Aug 1992, *Felger 92-643d*. Tule Tanks, 30 Nov 1938, *Goodding A9590*.
TA: Tinajas Altas, 6 Dec 1935, *Goodding 599*.



Figure 71. *Sporobolus cryptandrus*. (A) Plant, panicle, and spikelet with glumes separated from the floret; (B) Hwy 86, east of Why, Pima Co, 17 Sep 2013; (C) Cuerda de Lena, N boundary of Organ Pipe, 17 Sep 2013; (D) Hwy 86, east of Why, 12 Sep 2008.

Sporobolus flexuosus (Thurber ex Vasey) Rydberg
 [*S. cryptandrus* var. *flexuosus* (Thurber ex Vasey) Thurber]
 Mesa dropseed. Figure 72.

Tufted perennials similar to *Sporobolus cryptandrus*, semi-scandent, often reaching 1–1.6 m, with long, lacey, lax, and often curving panicles, sometimes somewhat prehensile in spiny shrubs. Panicles to 60 cm long, often drooping and loosely clambering into shrubs. Exposed panicle branches (parts not enclosed in the subtending leaf sheath; see *S. cryptandrus*) reaching 12–15 cm long, often spreading and becoming tangled. Pulvini at base of panicle branches swollen and with several stout hairs, hardening at maturity, the branches or branchlets falling away leaving the pulvini and a short portion of the branch as persistent hooks becoming tangled and anchoring the panicles onto shrubs. The distinctive pulvini often are seen only on mature panicles.

In the northern part of Organ Pipe and small scattered populations elsewhere in the Monument; sandy and sandy-loam soils of drainage channels, swales, and floodplains.

Northern Mexico and southwestern USA.

OP: E of Armenta at 2.2 mi W of Hwy 85, *Wirt 8 Sep 1990*. Sonoyta Valley, 0.4 mi E of Boundary Monument 164, *Rutman 29 Aug 2001* (ORPI). 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-12*.

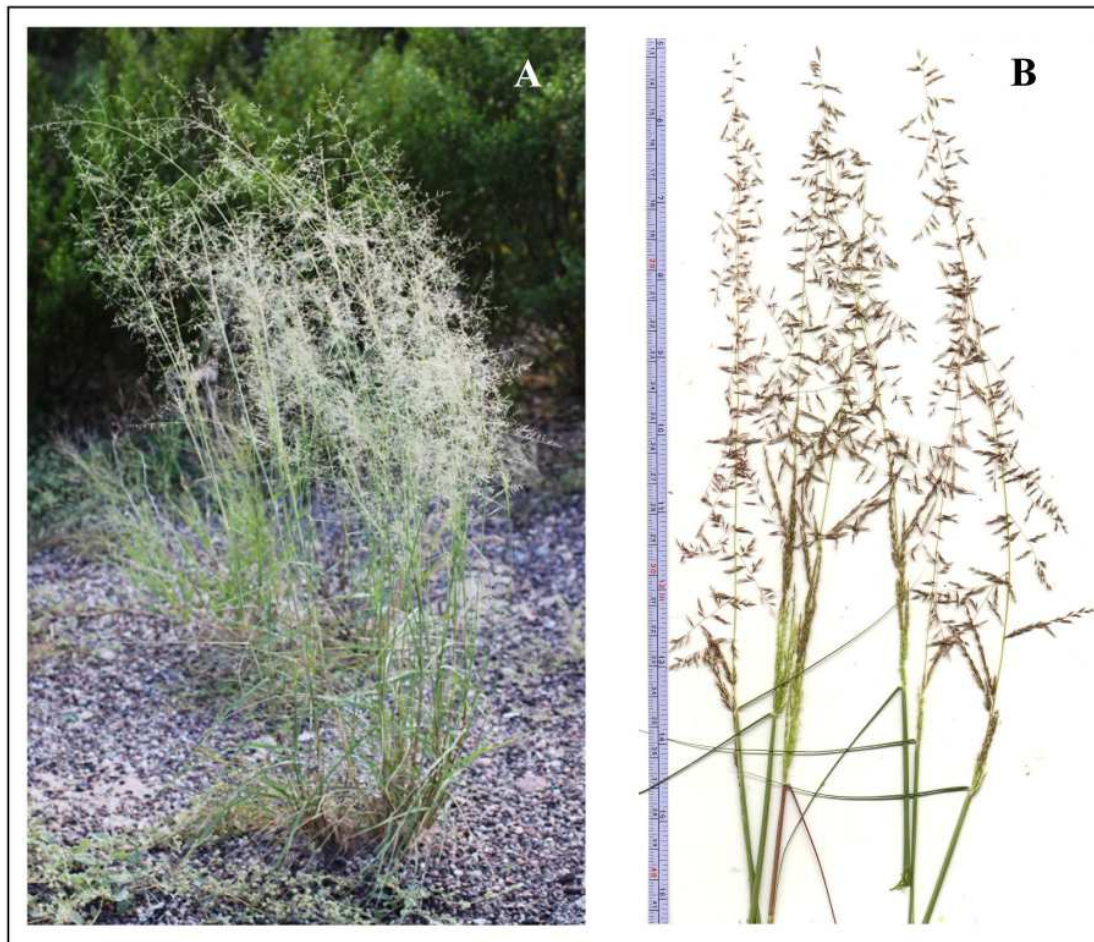


Figure 72. *Sporobolus flexuosus*. (A) Why, Pima Co., 21 Sep 2012; (B) sandy wash near N boundary of Organ Pipe, west of Hwy 85, 15 Sep 2013.

Sporobolus pyramidatus (Lamarck) Hitchcock

[*S. patens* Swallen. *S. pulvinatus* Swallen]

Whorled dropseed

Hot-weather ephemerals in the Sonoran Desert (elsewhere often perennials), highly variable in size, erect to spreading, often 10–25+ cm tall. Upper margin of leaf sheaths sparsely pubescent with long white hairs (not in dense tufts). Panicles at first contracted and narrow, often partly enclosed by the leaf sheath, the branchlets ultimately spreading and the panicles somewhat pyramidal. Lower panicle branchlets whorled, (4) 5–11 per node; upper panicle branchlets single at nodes; branchlets very slender with glandular areas appearing as lighter-colored, elliptic depressions or patches, and may be sticky. (These glands, seen with magnification, may be cryptic and their extent variable.) Spikelets 1.5–1.8 mm long. Lower glume much smaller than the upper one. Anthers 0.3–0.4 mm long. Grain (seed) 0.8–0.9 mm long.

Seasonally abundant in the springs of the Quitobaquito Hills, especially in floodplains of washes and margins of small watercourses, spring slopes, along irrigation ditches in the old fields and moist soil of alkaline flats.

Southern and Midwestern USA to Argentina.

OP: Williams Spring, *Van Devender* 30 Aug 1978. Aguajita, 14 Sep 1988, *Felger* 88-420.

Tridentopsis

[*Tridens*, in part]

Tufted perennials with hard, knotty bases. Culms nodes pubescent. Panicles slender and raceme-like or openly branched. Spikelets laterally compressed, breaking apart above the glumes and between the florets, and with multiple florets (5–12 in the flora area), the uppermost florets reduced and sterile. Glumes 1–7 veined. Lemmas prominently 3-veined, the tips rounded or minutely notched. Anthers reddish purple. *Tridentopsis* includes at least two species in western North America (Peterson et al. 2014).

1. Ligules glabrous; panicles open and spreading, usually more than 10 cm wide; spikelets 3–5 (7) mm long **Tridentopsis eragrostoides**

1. Ligules hairy; panicles strongly contracted (narrow), often spike-like, to 1 (1.5) cm wide; spikelets 9–13 mm long **Tridentopsis mutica**

Tridentopsis eragrostoides (Vasey & Scribner) P.M. Peterson

[*Tridens eragrostoides* (Vasey & Scribner) Nash]

Lovegrass tridens

Tufted perennials to nearly 1 m tall with slender culms and panicle branches. Culm nodes sparsely pubescent. Ligules glabrous. Panicles often more than 20 cm long and nearly as wide, open and lacey with slender branches. Spikelets often about 5 mm long with 5–10+ florets. Lemmas and sometimes the glumes with a delicate awn or bristle (mucro) less than 0.5 mm long, or awnless.

Poorly known in the flora area; in the Ajo Mountains, generally at higher elevations, especially north-facing slopes.

Organ Pipe and eastward in southern Arizona. Southern USA to Venezuela, and the Caribbean.

OP: W side Alamo Canyon, 13 Sep 1941, *Gooding* 295-41. Arch Canyon, N-facing slopes, 900 m, desertscrub with lowermost *Vauquelinia*, *Rhamnus betulifolia*, *Juniperus*, 2 Dec 1990, *Felger* 90-539.

Tridentopsis mutica (Torrey) P.M. Peterson var. ***mutica***
[*Tridens muticus* (Torrey) Nash var. *muticus*]
Slim tridens. Figure 73.

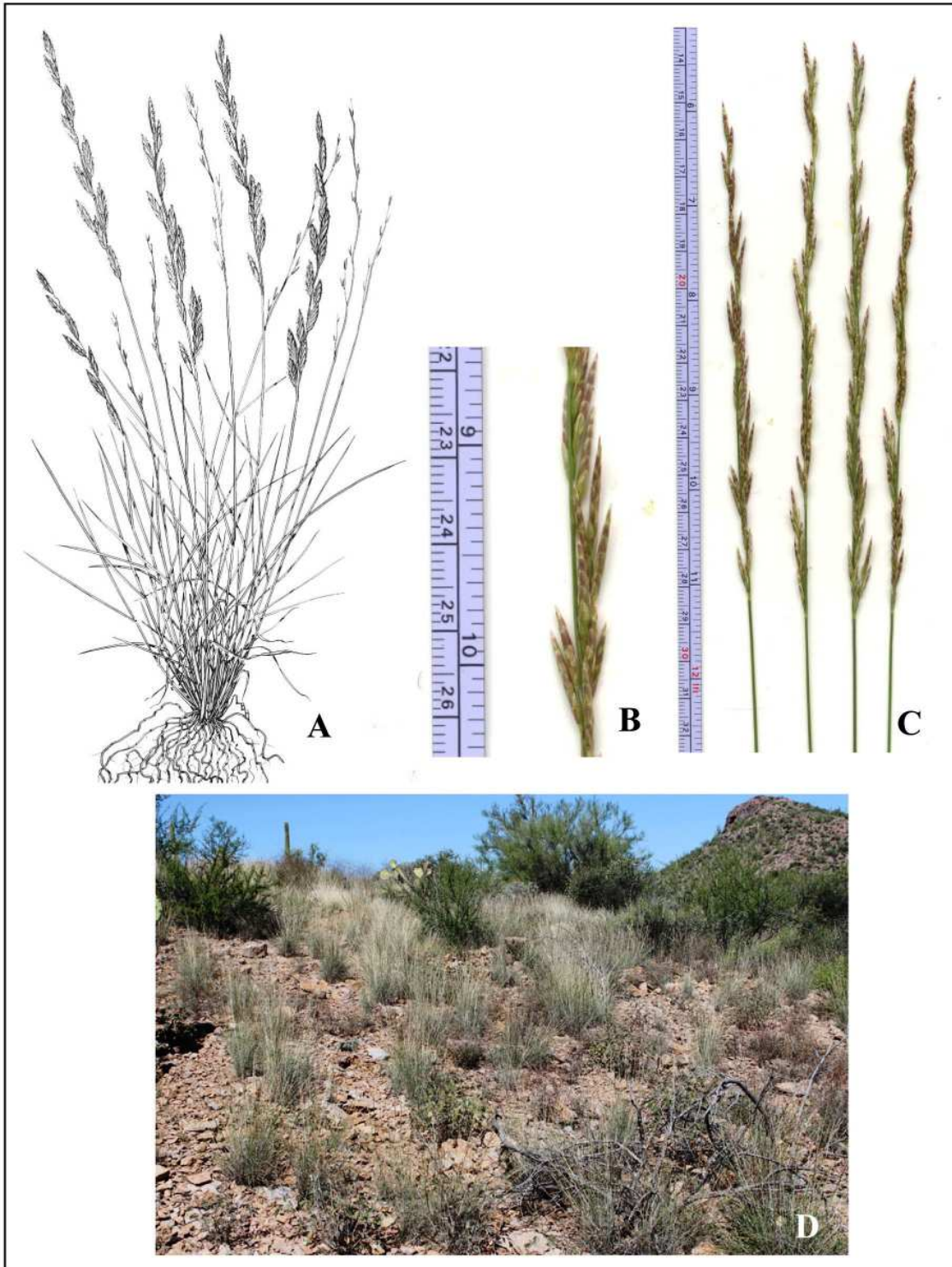


Figure 73. *Tridentopsis mutica*. (A) Plant. Diablo Mts, west of Boulder Canyon, 22 Sep 2013; (B & C) panicles; (D) a dense stand.

Tufted perennials (22) 28–40 (50) cm tall, with firm, slender culms. Leaves often bluish glaucous. Collar and ligule with a dense tuft of long white hairs, the sheaths sparsely to moderately pubescent with similar hairs; leaf blades slender and usually tightly inrolled. Growth and flowering response apparently non-seasonal. Panicles slender and spike-like, with closely appressed short branches, each branch with 1–several spikelets. Spikelets (5.5) 6.5–13.5 mm long, awnless (or lemmas sometimes with a minute awn or mucro). Glumes persistent, shorter than the spikelets. Florets strongly overlapping. Lemmas (3) 3.5–5.2 mm long, the lower parts (about the lower half) with densely hairy (pilose) veins. Spikelets green during hot and often humid weather of summer and early fall, and purplish at other seasons.

Common across the region, mostly on rocky slopes, canyons, and arroyos with shallow soils; hills and mountains often to the peaks. One of the most widespread and drought-tolerant perennial grasses in the region and often in surprisingly harsh, xeric habitats such as the hyperarid Sierra del Rosario in the Gran Desierto of Sonora, south of the Tinajas Altas region (Felger 2000). The single fossil record in the region, from the Ajo Mountains, is about 1200 years old.

Two varieties are often recognized. Variety *mutica* occurs in southwestern USA and northern Mexico and typically grows on rocky, or firm substrates. Variety *elongata* does not occur in the Sonoran Desert and ranges into higher elevations, extending farther eastward and northward in the USA than does var. *mutica*. Some authors, however, treat var. *elongata* as a synonym of var. *mutica* or recognize it as a distinct species.

OP: Bates Well, *Nichol 26 Apr 1939*. Alamo Canyon, 2500 ft, 16 Feb 1979, *Bowers 1559*. Twin Peaks, above Park Service residence area, 9 Sep 1984, *Van Devender 84-448*. Quitobaquito, 29 Mar 1988, *Felger 88-117*. †Alamo Canyon, 1150 ybp.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3955*. *Felger*, observations: Childs Mt, 18 Aug 1992; Sheep Mt, N side, mid-elevations to peak, 31 Jan 1992, Eagle Tank, Granite Pass Tank, 12 & 13 Jun 1992. Tule Mts, near crestline, *Rutman 17 Feb 2002*. Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: Borrego Canyon, 16 Jun 1992, *Felger* (observation). Tinajas Altas Mts, 26 Oct 2004, *Felger 04-75*.

****Triticum aestivum** Linnaeus

Wheat, common wheat; *trigo*; pilkañ. Figure 74.

Cool season ephemerals with large spikes bearing stout, bristly awns 7–15+ cm long. Wheat plants are occasionally seen along highways in nearby Sonora growing from grain spilled from passing trucks, and occasional plants are seen in Organ Pipe, especially along roads. Sterile wheat was used in a roadside seeding in Organ Pipe in 2005.

Native to the Old World. Widely cultivated in Sonora and Arizona.

OP: International boundary just W of Senita Basin, *Rutman 29 May 1998* (ORPI). Sand along road to Pozo Nuevo 1 mi N of international boundary, single plant, *Rutman 12 Mar 2001* (ORPI). Hwy 85, roadside seeding, N of park headquarters, area of roadside construction [see note for *Polypogon monspeliensis*], 9 Apr 2005, *Felger 05-159*.



Figure 74. *Triticum aestivum*. Hwy 85 roadside, Organ Pipe: (A) 9 Apr 2003; (B) 18 Jan 2006.

Urochloa arizonica (Scribner & Merrill) Morrone & Zuloaga

[*Panicum arizonicum* Scribner & Merrill. *Brachiaria arizonica* (Scribner & Merrill) S.T. Blake]
Arizona signal-grass; *piojillo de Arizona*. Figure 75.

Hot-weather ephemerals, slender and single-stemmed to sometimes many branched, light green and variously soft-pubescent, the hairs often bulbous-based, or the culms and leaves sometimes glabrous or essentially so. Roots weakly to well developed. Leaf size and width varying with soil moisture and warmth. Inflorescences of panicles 9–16 cm long with spike-like branches, the branches triangular in cross-section. Panicle branches and pedicels conspicuously hairy, the hairs often bulbous-based. Pedicels shorter than the spikelets. Spikelets panicoid, breaking off below the glumes. Spikelets generally elliptic, 2.8–3.8 mm long, mostly hairy but sometimes glabrous, pale green or reddish, the upper glumes and sterile lemmas with longitudinal veins and a net-like pattern of green cross-veins toward the tip, or cross veins sometimes absent. Lower glume often to about half as long as the spikelet. Lower floret sterile or staminate, with a lemma and palea, the lemma similar to upper glume. Fertile lemma hard, the margins inrolled, enclosing the palea and grain.

Washes, arroyos, sand flats, and canyons; widespread and seasonally common across much of Organ Pipe except the most arid areas, and Cabeza Prieta from the Pinta Sands eastward.

Texas to southern California and southward to Oaxaca.

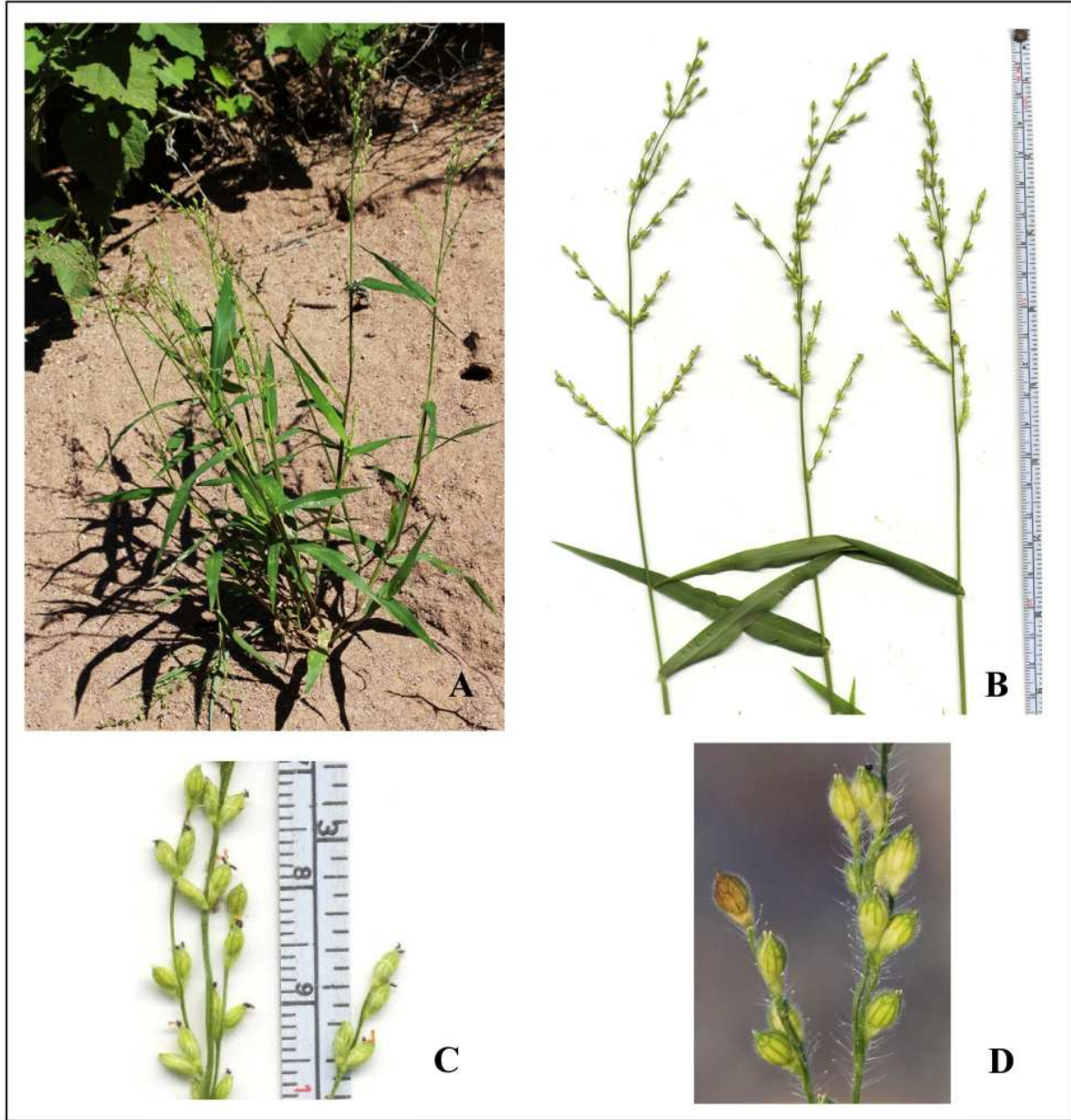


Figure 75. *Urochloa arizonica*. (A) Alamo Canyon, 15 Sep 2013; (B) between Armenta Ranch and Hwy 85, 6 Oct 2012; (C & D) Hwy 85, near N boundary of Organ Pipe, 11 Sep 2008.

OP: Sonoyta Hills, sandy flats along arroyo, 27 Aug 1943, *Clark 10891* (ORPI). 8 mi by road W of Visitor Center along Puerto Blanco Drive, 16 Oct 1977, *Bowers 894*. Armenta Well Ranch, 13 Sep 1978, *Bowers 1532*. Estes Canyon, 12 Sep 1978, *Bowers 1519*. 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-13*.

CP: East Pinta Sands, 15 Sep 1992, *Felger 92-759*. Arroyos along Charlie Bell Rd, 18 Aug 1992, *Felger* (observation). Road from Bates Well to Papago Well, 1.7 mi SW of W boundary of Organ Pipe, 14 Sep 1992, *Felger 92-698*.

Vulpia, see **Festuca**

††**Zuloagaea bulbosa** (Kunth) Bess[*Panicum bulbosum* Kunth. *P. plenum* Hitchcock & Chase]

Bulb panic grass

Perennials often 50+ cm tall, with short, knotty rhizomes, the culm bases swollen and bulbous, forming an ovoid corm—a unique feature among the grasses of the region. Spikelets panicoid, 3.5–4 mm long. A monotypic genus segregated from *Panicum*.

Zuloagaea bulbosa was in the Ajo Mountains during the last Ice Age. The nearest known present-day population is in the Baboquivari Mountains.

Widespread in Arizona above the desert, and not in the arid southwestern part of the state since the last Ice Age. Arizona to Texas and South America.

OP: †Alamo Canyon, florets, 14,500 to 32,000 ybp (3 samples).

ACKNOWLEDGEMENTS

Supplementing the gratitudes expressed in the introduction to our flora (Felger et al. 2013a), we thank Kelly W. Allred, Michael M. Bauer, Janice Emily Bowers, Travis Columbus, Laura Lynn Crumbacher, Ellen Dorn, George Ferguson, Pedro P. Garcillan, Russell Kleinman, Elizabeth Makings, Guy Nesom, William (Bill) R. Norris, Jon Rebman, Jeffery M. Saarela, Andrew Salywon, J. Gabriel Sánchez-Ken, Andrew Sanders, Robert Soreng, James Henrickson, Paul M. Peterson, Thomas R. Van Devender, James (Jim) Thomas Verrier, and George Yatskievych for significant information, assistance, and/or reviews. Patrick J. Alexander provided an essential and detailed review. From Richard: I am especially indebted to the late John Reeder and Charlotte O. Reeder for sharing so much information on grasses and leading me into the wonderful world of grasses.

LITERATURE CITED

- Allred, K.W. 1984. Morphological variation of the North America *Aristida purpurea* complex (Gramineae). *Brittonia* 36: 382–395.
- Allred, K.W. 2003. *Aristida* L. Pp. 315–342, in Barkworth et al. (eds.). *Flora of North America*, Vol. 25, Poaceae, part 2. Oxford Univ. Press, New York.
- Allred, K.W. and E.D. Ivey. 2012. *Flora Neomexicana* III. Lulu.com.
- Arriaga, M.O. 2007. *Jarava* Ruiz & Pav. Pp. 178–181, in Barkworth et al. (eds.). *Flora of North America*, Vol. 24, Poaceae, part 1. Oxford Univ. Press, New York.
- Arnou, L.A. 1987. Gramineae A.L. Juss., Grass family. Pp. 684–788, in S.L. Welsh, N.D. Atwood, S. Goodrich, and L.C. Higgins (eds.). *A Utah Flora*. Gt. Basin Nat. Mem. 9. Brigham Young Univ., Provo
- Barkworth, M.E. 2003. *Heteropogon* Pers. Pp. 680–681, in Barkworth et al. (eds.). *Flora of North America*, Vol. 25, Poaceae, part 2. Oxford Univ. Press, New York.
- Barkworth, M.E., L.K. Anderton, K.M. Capels, S. Long, and M.B. Piep (eds.). 2007a. *Manual of Grasses for North America*. Utah State University Press, Ogden.
<<http://herbarium.usu.edu/webmanual>>
- Barkworth, M.E., J.J.N. Campbell, and B. Solomon. 2007c. *Elymus* L. Pp. 288–338, in M.E. Barkworth et al. (eds.). *Flora of North America*, Vol. 24, Poaceae, part 2. Oxford Univ. Press, New York.
- Barkworth, M.E., K.M. Capels, S. Long, L.K. Anderton, and M.B. Piep (eds.). 2007b. *Flora of North America*, Vol. 24, Poaceae, part 2. Oxford Univ. Press, New York.
- Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep (eds.). 2003. *Flora of North America*, Vol. 25, Poaceae, part 1. Oxford Univ. Press, New York.
- Beetle, A.A. 1974. Noteworthy grasses from Mexico, II. *Phytologia* 28: 313–318.

- Bolton, H.E. 1919. Kino's Historical Memoir of Pimería Alta: A Contemporary Account of the Beginnings of California, Sonora, and Arizona. 2 vols. Arthur H. Clark, Cleveland.
- Bowers, J.E. 1980. Flora of Organ Pipe Cactus National Monument. *J. Ariz.-Nev. Acad. Sci.* 15: 1–11, 33–47.
- Búrquez-Montijo, A., M. Miller, and A. Martínez-Yrizar. 2002. Mexican grasslands, thornscrub, and the transformation of the Sonoran Desert by invasive exotic buffelgrass (*Pennisetum ciliare*). Pp. 126–146, in B. Tellman (ed.). *Invasive Exotic Species in the Sonoran Region*. Univ. of Arizona Press, Tucson.
- Burrus, E.J. 1971. Kino and Manje: Explorers of Sonora and Arizona. Jesuit Historical Institute, Rome.
- Castetter, E.F. 1935. Uncultivated native plants used as sources of food. *Ethnobiological Studies in the American Southwest, I*. Univ. of New Mexico Bull., Biol. Series 4 (1): 1–62.
- Castetter, E.F. and W.H. Bell. 1942. Pima and Papago Indian Agriculture. Univ. of New Mexico Press, Albuquerque.
- Castetter, E.F. and W.H. Bell. 1951. Yuman Indian Agriculture. Univ. of New Mexico Press, Albuquerque.
- Castetter, E.F. and R. Underhill. 1935. The ethnobiology of the Papago Indians. *Ethnobiological Studies in the American Southwest, II*. Univ. of New Mexico Bull., Biol. Series 4 (3): 1–84.
- Catalán, P., P. Torrecilla, J.Á. López Rodríguez, and R.G. Olmstead. 2004. Phylogeny of the festucoid grasses of subtribe Loliinae and allies (Poeae, Pooideae) inferred from ITS and trnL–F sequences. *Mol. Phylogenet. Evol.* 31: 517–541. <doi:10.1016/j.ympev.2003.08.025>
- Cerros-Tlatilpa, R., J.T. Columbus, and N.P. Barker. 2011. Phylogenetic relationships of *Aristida* and relatives (Poaceae, Aristidoideae) based on noncoding chloroplast (trnL-F, rpl16) and nuclear (ITS) DNA sequences. *Amer. J. Bot.* 98: 1869–1886.
- Chemisquy, M.A., L.M. Giussani, M.A. Scataglini, E.A. Kellogg, and O. Morrone. 2010. Phylogenetic studies favour the unification of *Pennisetum*, *Cenchrus*, and *Odontelytrum* (Poaceae): a combined nuclear, plastid and morphological analysis, and nomenclatural combinations in *Cenchrus*. *Ann. Bot.-London* 106: 107–130.
- Childs, T. with H.F. Dobyns. 1954. Sketch of the “Sand Indians.” *Kiva* 19: 27–39.
- Clayton, W.D. 1972. Gramineae, pp. 349–512, in J. Hutchinson and J.M. Dalziel (eds.). *Flora of West Tropical Africa*, vol. 3, part 2 of 2nd edition. Crown Agents for Overseas Governments and Administrations, London.
- Clayton, W.D. and S.A. Renvoize. 1986. *Genera Graminum, Grasses of the World*. Kew Bulletin Additional Series XIII. Her Majesty's Stationery Office, London.
- Columbus, J.T. and J.P. Smith, Jr. 2010. Nomenclatural changes for some grasses in California and the *Muhlenbergia* clade (Poaceae). *Aliso* 28: 65–67
- Conert, H.J. and A.M. Türpe. 1974. Revision der Gattung *Schismus* (Poaceae: Arundinoideae, Danthonieae). *Abh. Senckenb. Naturforsch. Ges. (Frankfurt)* 532: 1–81.
- Correll, D.S. and M.C. Johnston. 1970. *Manual of the Vascular Plants of Texas*. Texas Research Foundation, Renner.
- Danin, A. 1996. *Plants of Desert Dunes*. Springer-Verlag, Berlin.
- Feinbrun-Dothan, N. 1986. *Flora Palestina, Part 4, Alismataceae to Orchidaceae*, 2 vols. Israel Academy of Sciences and Humanities, Jerusalem.
- Felger, R.S. 1990. Non-native plants of Organ Pipe Cactus National Monument. Cooperative National Park Resource Studies Unit, Univ. of Arizona, Technical Report No. 31, Tucson.
- Felger, R.S. 2000. *Flora of the Gran Desierto and Río Colorado of northwestern Mexico*. Univ. of Arizona Press, Tucson.
- Felger, R.S. 2007. Living resources at the center of the Sonoran Desert: Native American plant and animal utilization. Pp. 147–192, in Felger and B. Broyles (eds.). *Dry Borders: Great Natural Reserves of the Sonoran Desert*. Univ. of Utah Press, Salt Lake City.
- Felger, R.S., B. Broyles, M. Wilson, G.P. Nabhan, and D. Turner. 2007b. *Six Grand Reserves, One*

- Sonoran Desert. Pp. 3–26 in Felger and Broyles (eds.). *Dry Borders: Great Natural Reserves of the Sonoran Desert*. Univ. of Utah Press, Salt Lake City.
- Felger, R.S. and M.B. Moser. 1985. *People of the Desert and Sea: Ethnobotany of the Seri Indians*. Univ. of Arizona Press, Tucson.
- Felger, R.S., S. Rutman, J. Malusa, and T.R. Van Devender. 2013a. Ajo Peak to Tinajas Altas: Flora of southwestern Arizona, an introduction. *Phytoneuron* 2013-5: 1–40.
- Felger, R.S., S. Rutman, J. Malusa, and T.R. Van Devender. 2013b. Ajo Peak to Tinajas Altas: A flora of southwestern Arizona, part 2. The Checklist. *Phytoneuron* 2013-27: 1–30.
- Felger, R.S., S. Rutman, M.F. Wilson, and K. Mauz. 2007a. Botanical diversity of southwestern Arizona and northwestern Sonora. Pp. 202–271, in Felger and B. Broyles (eds.). *Dry Borders: Great Natural Reserves of the Sonoran Desert*. Univ. of Utah Press, Salt Lake City.
- Felger, R.S., D.S. Turner, and M.F. Wilson. 2003. Flora and vegetation of the Mohawk Dunes, Arizona. *Sida, Contrib. Bot.* 20: 1153–1185.
- Felger, R.S., T.R. Van Devender, B. Broyles, and J. Malusa. 2012. Flora of Tinajas Altas, Arizona—A century of botanical forays and forty thousand years of *Neotoma* chronicles. *J. Bot. Research Inst. Texas* 6: 157–257.
- Felger, R.S., P.L. Warren, L.S. Anderson, and G.P. Nabhan. 1992. Vascular plants of a desert oasis: flora and ethnobotany of Quitobaquito, Organ Pipe Cactus National Monument, Arizona. *Proc. San Diego Soc. Nat. Hist.* 8: 1–39.
- Felger, R.S. and B.T. Wilder in collaboration with H. Romero-Morales. 2012. *Plant Life of a Desert Archipelago: Flora of the Sonoran Islands in the Gulf of California*. Univ. of Arizona Press, Tucson.
- Felger, R.S., B.T. Wilder, and J.P. Gallo-Reynoso. 2011. Floristic diversity and long-term vegetation dynamics of Isla San Pedro Nolasco, Gulf of California, Mexico. *Proc. San Diego Soc. Nat. Hist.* 43: 1–42.
- Fischer, G.W. 1953. *Manual of the North American Smut Fungi*. Ronald Press, New York.
- Franklin, K.A., K. Lyons, P.L. Nagler, D. Lampkin, E.P. Glenn, F. Molina-Freaner, T. Markow, and A.R. Huete. 2006. Buffelgrass (*Pennisetum ciliare*) land conversion and productivity in the plains of Sonora, Mexico. *Biol. Conserv.* 127: 62–71.
- Freckmann, R.W. and M.G. Lelong. 2003. *Panicum* L. Pp. 455–488, in *Flora of North America*, Vol. 25, Poaceae, Part 2. Oxford Univ. Press, New York.
- Frenkel, R.E. 1970. *Ruderal Vegetation Along Some California Roadsides*. Univ. of California Publications in Geography 20. Univ. of California Press, Berkeley.
- Gasser, R. 1982. Hohokam use of desert foods. *Desert Plants* 34: 216–234.
- Gould, F.W. 1951. *Grasses of the Southwestern United States*. Univ. of Arizona Press, Tucson.
- Gould, F.W. and R. Moran. 1981. *The Grasses of Baja California, Mexico*. Mem. San Diego Soc. Nat. Hist. 12: 1–140.
- Grass Phylogeny Working Group. 2001 (and 2012 update). Phylogeny and subfamilial classification of the grasses (Poaceae). *Ann. Missouri Bot. Gard.* 88: 373–457.
<www.umsl.edu/services/kellogg/gpwg/default.htm>
- Henrard J.T. 1929–1932. A monograph of the genus *Aristida*. *Meded. Rijks-Herb.* 58: 1–325.
- Hitchcock, A.S. 1951 [1950 on title page]. *Manual of the Grasses of the United States*. 2nd edition revised by A. Chase. U.S.D.A. Misc. Publ. 200. U.S. Gov. Printing Office, Washington, D.C.
- Hodgson, W.C. 2001. *Food Plants of the Sonoran Desert*. Univ. of Arizona Press, Tucson.
- Holmgren, A. and N. Holmgren. 1977. Poaceae. Pp. 175–584, in A. Cronquist et al. (editors), *Intermountain Flora*, Vol. 6. Columbia Univ. Press, New York.
- Lord, E.M. 1981. Cleistogamy: A tool for the study of floral morphogenesis, function, and evolution. *Bot. Rev.* 47: 421–449.
- Lumholtz, C.S. 1912. *New Trails in Mexico: Travels among the Papago, Pima and Cocopa Indians*. Charles Scribner Sons, New York. Reprinted 1971, Rio Grande Press, Glorieta, New Mexico, and 1990, University of Arizona Press, Tucson

- Malusa, J., K. Reichhardt, and R.S. Felger. 2013. Giant Sandbur (*Cenchrus palmeri*, Poaceae) New for Arizona and the United States. *Phytoneuron* 2013-92: 1–5.
- McVaugh, R. 1983. *Flora Novo-Galiciana*, vol. 14, Gramineae. Univ. of Michigan Press, Ann Arbor.
- Pavlick, L.E. and L.K. Anderton. 2007. *Bromus* L. Pp. 193–237, in M.E. Barkworth et al. (eds.). *Flora of North America*, Vol. 24, Poaceae, part 1. Oxford Univ. Press, New York
- Pearlstein, S.L., R.S. Felger, E.P. Glenn, J. Harrington, K.A. Al-Ghanem, and S.G. Nelson. 2012. Nipa (*Distichlis palmeri*): A perennial grain crop for saltwater irrigation. *J. Arid Environ.* 82: 60–70.
- Peterson, P.M. 2003. *Eragrostis* Wolf. Pp. 65–105, in M.E. Barkworth et al. (eds.). *Flora of North America*, Vol. 25, part 2. Oxford Univ. Press, New York.
- Peterson, P.M. and C.R. Annable. 1991. Systematics of the annual species of *Muhlenbergia* (Poaceae-Eragrostidae). *Syst. Bot. Monogr.* 31: 1–109.
- Peterson, P.M., K. Romaschenko, and Y. Herrera Arrieta. 2014. A molecular phylogeny and classification Cteniinae, Farragininae, Gouiniinae, Gymnopogoninae, Perotidinae, and Trichoneurinae (Poaceae: Chloridoideae: Chlorideae). *Taxon* 63 (in press).
- Peterson, P.M., K. Romaschenko, N. Snow, and G.P. Johnson. 2012. A molecular phylogeny and classification of *Leptochloa* (Poaceae: Chloridoideae: Chlorideae) sensu lato and related genera. *Ann. Bot.-London* 109: 1317–1330.
- Rea, A. 1997. *At the Desert's Green Edge: An Ethnobotany of the Gila River Pima*. Univ. of Arizona Press, Tucson.
- Reeder, J.R. 1986. Another look at *Eragrostis tephrosanthes* (Gramineae). *Phytologia* 60: 152–154.
- Reeder, J.R. 2012. *Eragrostis*, love grass. Pp. 1448–1464, in B.G. Baldwin et al. (eds.). *The Jepson Manual* (ed. 2). Univ. of California Press, Berkeley.
- Reeder, J.R. and R.S. Felger. 1989. The *Aristida californica-glabrata* complex (Gramineae). *Madroño* 36: 187–197.
- Rhodes, D.C. and R.L. Gilbertson. 1972. Check list and host index for Arizona smut fungi. Agricultural Experiment Station, Technical Bulletin 193. Univ. of Arizona, Tucson.
- Rominger, J.M. 1962. Taxonomy of *Setaria* (Gramineae) in North America. *Illinois Biol. Monogr.* 29: 1–132.
- Rominger, J.M. 2003. *Setaria* P. Beauv. Pp. 539–558, in Barkworth et al. (eds.). *Flora of North American*, vol. 25, Poaceae, part 2. Oxford Univ. Press, New York.
- Rutman, S. 2010. Invasive Plant Management Program: Field Season Report, Fall 2009–Spring 2010, Organ Pipe Cactus National Monument. Unpublished report, Organ Pipe Cactus NM, Ajo, Arizona.
- Rutman, S. and L. Dickson. 2002. Management of buffelgrass on Organ Pipe Cactus National Monument, Arizona. Pp. 311–318, in B. Tellman (ed.). *Invasive Exotic Species in the Sonoran Region*. Univ. of Arizona Press, Tucson.
- Saarela, J.M. and P.M. Peterson. 2012. *Bromus*, brome, chess. Pp. 1426–1431, 1435, in B.G. Baldwin et al. (eds.). *The Jepson Manual* (ed. 2). Univ. of California Press, Berkeley.
- Saarela, J.M., P.M. Peterson, and Jesus Valdés-Reyna. 2014. A taxonomic revision of *Bromus* (Poaceae: Pooideae: Bromeae) in México and Central America. Unpublished manuscript.
- Salo, L.F. 2004. Population dynamics of red brome (*Bromus madritensis* subsp. *rubens*): times for concern, opportunities for management. *J. Arid Environ.* 57: 291–296.
- Siqueiros-Delgado, M.E., A. Malika, J.T. Columbus, and A. Ainouche. 2013. Phylogeny of the *Bouteloua curtipendula* complex (Poaceae: Chloridoideae) based on nuclear ribosomal and plastid DNA sequences from diploid taxa. *Syst. Bot.* 38: 379–389.
- Snow, N. and P.M. Peterson. 2012. Nomenclatural notes on *Dinebra*, *Diplachne*, *Disakisperma*, and *Leptochloa* (Poaceae: Chloridoideae). *Phytoneuron* 2012-71: 1–2.
- Soreng, R.J., G. Davidse, P.M. Peterson, F.O. Zuloaga, E.J. Judziewicz, T.S. Filgueiras, O. Morrone, and K. Romaschenko. 2013. A World-wide Phylogenetic Classification of Poaceae

- (Gramineae): cǎo (草), capim, çayır, çimen, darbha, ghaas, ghas, gish, gramas, graminius, gräser, grasses, gyokh, he-ben-ke, hullu, kasa, kusa, nyasi, pastos, pillu, pullu, zlaki, etc. <<http://www.tropicos.org/projectwebportal.aspx?pagename=ClassificationNWG&projectid=10>>
- Soreng, R.J. and T.R. Van Devender. 1989. Late Quaternary fossils of *Poa fendleriana* (Muttongrass): Holocene expansions of apomicts. *Southwest. Nat.* 34: 35–45.
- Thiers, B. 2013 [continuously updated]. *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium <<http://sweetgum.nybg.org/ih/>>
- Tzvelev, N.N. 1983. *Grasses of the Soviet Union*. Academy of Sciences of the U.S.S.R. English edition, 2 vols., translated by B.R. Sharma. Amerind Publishing Co., New Delhi.
- Valdés-Reyna, J. 2003. *Dasyochloa* Willd. ex Rydb. Pp. 45, 47–48, in Barkworth et al. (eds). *Flora of North America*, vol. 25, Poaceae, part 2. Oxford Univ. Press, New York.
- Van Devender, T.R., L.J. Toolin, and T.L. Burgess. 1990. The ecology and paleoecology of grasses in selected Sonoran Desert plant communities. Pp. 326–349, in J.L. Betancourt, Van Devender, and P.S. Martin (eds.). *Packrat Middens: The Last 40,000 Years of Biotic Change*. Univ. of Arizona Press, Tucson.
- Warren, P.L. and L.S. Anderson. 1987. *Vegetation recovery following livestock removal near Quitobaquito Spring, Organ Pipe Cactus National Monument, Arizona*. Technical Report No. 20, Cooperative National Park Resource Studies Unit. Univ. of Arizona, Tucson.
- Zuloago, F.O. and O. Morrone. 1996. Revision de las especies Americanas de *Panicum* subgenero *Panicum* sección *Panicum* (Poaceae: Panicoideae: Paniceae). *Ann. Missouri Bot. Gard.* 83: 200–280.