

A Beginner's Guide to Agaves



by

Terrie M. Gent
Cochise County Master Gardener

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Agaves are among the most stunning native plants in the southwest. While still a newcomer to Cochise County, Arizona, I first got a good look at an agave while hiking to the summit of Miller Peak in the Huachuca Mountains about 11 years ago. My husband and I stopped to photograph the spectacular views of the high desert arrayed below us. And there, beside the trail, at nearly 7,000 feet was a perfect *Agave parryi huachuensis*. In the summer heat, its cool blue-green skin reminded me of the glacial ice of the Athabasca Ice Fields in Canada. It was refreshing just to look at the symmetrical rosette of broad and strong leaves with their delicate sculpture of lace-like bud impressions. I knew that this plant had to be as strong as it was beautiful to withstand the winter snow and summer heat at the upper reaches of the Huachucas. And the more I learned about agaves, the more mesmerized I became. When our esteemed instructor, Robert E. Call, the Cochise County Agriculture Extension Agent, asked us to write a paper for our Master Gardener class, I knew right away what my topic would be. To aid readers in conducting their own research, I have included endnotes for the material taken from other authors. My husband, Bob, has been my ever-patient photographer.



Sometimes it's difficult to distinguish young plants in the wild. Young yuccas may look like agaves, but agaves generally have broader, stiffer leaves, and stems that are well disguised by symmetrically arranged leaves. Plants in the genus *Agavaceae* are evergreen with succulent leaves forming basal rosettes. Some form colonies from underground rhizomes sprouts, but all reproduce from seeds.¹ The leaves of all agave are firm and tipped with a hard and sharp spine.² In some varieties, they also have prickles.³ Agaves generally produce flower stalks only once after about 8 to 20 years.⁴



Agave stalks are relatively tall and large at maturity and bear several flowers in spikes. The flowers are greenish to yellow or pinkish with six perianth segments forming a floral tube. The fruit of an agave is a brown capsule that contains black seeds in two rows in each cell.

Most agaves die the year that they flower. But the *A. harvardiana* takes from 25 to 55 years before it finally sends up a 10 to 20-foot stalk.

The photograph at the left shows *A. parryi huachuensis* with stalks. These plants occur above 8,700', near Carr Peak, in the Huachuca Mountains in Arizona. Miller Peak is in the background. Arizona state law protects these plants.

The staff at Big Bend National Park in Texas studies agaves. In 1968, they found that one *A. harvardiana* stalk grew 16 inches in a single day!⁵ It is the spectacular blooms of the agave that prompted noted horticulturalist Mary F. Irish to write,

The blooming of an agave is an event. It is cause for grabbing a chair, setting up an observation post, and enjoying the show. The stalk develops quickly, sometimes as much as 12 to 14 inches a day. And it is big. Even in small agaves the stalk is enormous compared to the plant . . . in larger plants stalks can rise 40 feet in the air.⁶

Agaves are perfectly suited to the xerophytic climates of the southwest. Their rosette leaf formation is arranged in a spiral that channels water down the leaves and close to the stem, so that it reaches the root area.⁷ During drought conditions, the agave stem may shrink, allowing a fissure between the plant and its surrounding soil. This allows even more water to penetrate to the root zone.⁸ The leaves of agave are hard and somewhat rigid and fibrous inside.⁹ In another adaptation to arid climates, they have a fine to heavy waxy coating to reduce moisture loss.¹⁰ Leaf colors range from glossy green to a dull grayish blue. Some leaf margins bare sharp teeth, while others are smooth.¹¹

Agave leaves may live a remarkably long time, often 12 to 15 years, or the entire life of the plant.¹² Because all the water and energy storage capacity of the plant is in the leaves, it must retain them to survive. On a single plant there will be mature leaves, juvenile leaves, and leaves still held in bud. The leaves held in the bud mark the surface of the adjacent leaves. These imprints are called bud impressions.¹³



You can see the delicate bud impressions on this *A. parryi huachucensis*.

As I mentioned before, agave reproduce from seeds and in some varieties, rhizomes as well.¹⁴ Small buds occur along the rhizome, break through to the surface of the soil and form one or more new rosettes.¹⁵ These may also form extensive colonies of clones from the parent plant.¹⁶ The new plants are commonly called offsets or pups by those in the nursery trade. Depending upon the species, pups form only when the plant is young, only after flowering, or during the entire life of the plant.¹⁷

The genus Agavaceae, a member of the Amaryllidaceae family, has about 200 - 250 species and is native to tropical and subtropical regions of the Americas, the West Indies, as well as some areas of the deserts and mountains in the southwest.¹⁸ Howard Scott Gentry is recognized as the preminent expert on this genus. He recognized 136 species and 197 taxa when all varieties and subspecies are included.¹⁹ However, more have been found and are under consideration.²⁰



Even the largest agaves also show well-defined bud impressions. This photo shows the bud impressions on an *A. americana* growing at the Ft. Davis National Historic Site in the Davis Mountains in Texas.

Some agave varieties are quite content in elevations well above 8000 feet.²¹ I've found agaves at nearly 9,000 feet, just below the summit of Carr Peak. The largest proportion of the species lives at lower elevations in Mexico.²² There are 136 species on the mainland of North America, not counting Baja California.²³ Mary and Gary Irish report that there are 15 species in the United States, with 12 native to Arizona.²⁴

In addition to their ornamental qualities, agaves have been valued for both food, fiber, medicine, and soap for millennia.²⁵ Both historically and today, every part of the agave is put to use by peoples of the Americas.²⁶ Agaves are cultivated in Mexico on a very large scale to produce beverages. Some say that the national drink of Mexico is a fermented agave juice called pulque or mescal.²⁷ To collect the juice from agaves, the terminal bud is removed and a deep hole is carved into the center of the plant. The sap that collects there is removed and fermented to brew pulque. The heart of the plant is also roasted and mashed to produce a distilled product known worldwide -- tequila.²⁸



Master Gardener Jacqueline Jones, is standing next to a pulque agave growing at the Boyce Thompson Arboretum in Superior, Arizona. You can see pups emerging from beneath the plant.

People of the Americas have eaten agaves for hundreds, perhaps thousands of years.²⁹ The crowns of agave, stripped of leaves, were roasted in pits lined with hot stones. The heat converted the starch in the plant to sugar and made this vegetable a tasty, nutritious dish called mescal. The Mescalero Apache are called so because they extensively used mescal as food. And in what was later to become Cochise County, Arizona, those now called the Chiricahua Apache also ate mescal. Modern pulque brewers have merely copied, albeit on an industrial scale, the process perfected by ancient Americans who allowed the juice of roasted agave to ferment and produce a strong beverage.³⁰

In Arizona, *A. murphyi* has been found only with archaeological sites that include roasting pits and rock walls.³¹ This leads ethnobotanists to conclude that the plant has been kept alive over the centuries as a food source. According to Mary Irish, “Its habit of making thousands of bulbils on a single stalk has undoubtedly extended its usefulness.”³² The Arizona Sonoran Desert Museum, near Tucson, Arizona, contains an extensive collection of agaves and perhaps the only demonstration in the United States showing how ancient Americans grew agaves. The demonstration garden shows that plants were

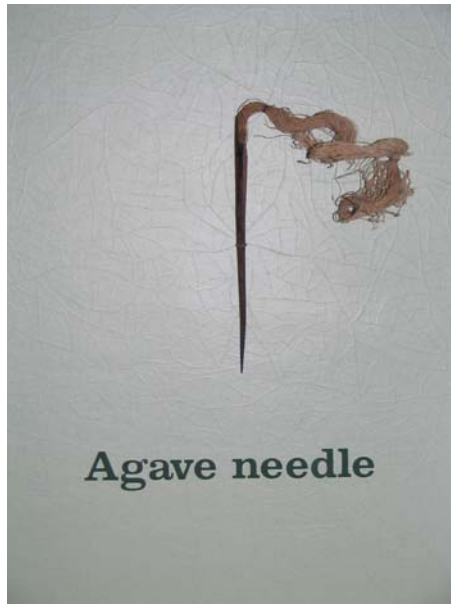
cultivated in stepped areas of slopes. The terraced fields helped capture rainwater while ensuring excellent drainage for the plants.



The Arizona Sonoran Desert Museum has replicated an ancient agave garden.

Agaves are also extensively cultivated in both Mexico and Central America for fiber.³³ But this, too, is nothing new. Evidence from sites in Mexico indicates that agave fibers were used more than 9,000 years ago.³⁴ Fibers from the lechuguilla, common in the Chihuahuan Desert, can be made into nets, baskets, mats, soap and sandals.³⁵ The sharp tips of species like *A. neomexicana*, native to New Mexico and *A. parryi*, native to Arizona, with fibers still attached, made excellent needles and thread. Archeologists found examples of these in the ruins at the Gila Cliff Dwellings National Monument, near Silver City, New Mexico.³⁶

The needle shown on the next page was found in the largest cave in the ruins of cliff dwelling in the Gila Cliff Dwelling National Monument, in New Mexico. According to Ranger Sonya Berger, the Chief of Interpretation at the monument, it is thought to be at least 700 years old.³⁷



The photo on the left shows a 700-year old agave needle, while the image on the right shows its relative size in comparison to yucca fiber sandals also found in the area.

The finest agave fibers are found in the bud. Weaving with this fiber is still practiced in Mexico and the resulting fabric can be woven very tightly. It is so pliable and smooth it rolls like cloth.³⁸ This made it a perfect source when Spanish explorers in the new world needed fiber for rope and twine. Indeed, some of the finest lariats still used today were made from agaves.³⁹ The agave has other uses as well. Lechuguilla stems produce a soap-like substance and their pulp has been used as a spot remover. But these plants are also toxic. The Tarahumara Indians of Mexico used the poisonous juice of the plant on their arrows while hunting and they put it in water to kill fish. .⁴⁰

Mankind is not the only creature dependent upon the agave for food. The leaves of the desert agave, found in southwestern Arizona and southeastern California, may be the only source of water for bighorn sheep during dry periods. Its yellow flowers provide nectar for hummingbirds, bats and insects. Even carpenter bees make tunnels in the flower stalks to build their nests. The giant skipper, and certain other butterflies, feed exclusively on the desert agave and its relatives in mountainous regions.⁴¹

In the United States, agaves are used most often as potted plants both inside and outside the house and as additions to the landscape. When grown indoors, agaves should be placed in a sunny window. They thrive when the temperature remains between 65 and 75 degrees, but even the less hardy varieties will tolerate temperatures as low as 45 degrees.⁴² Just make sure they don't touch the window glass when temperatures dip in the winter and protect them from sunburn in the summer with a screen or light shade. Remember, too, that agaves in pots require more supplemental water than their siblings who reside in the garden.⁴³

Agave root systems are wide but shallow, so agave containers should also be wide and shallow.⁴⁴ The larger varieties, like *A. vilmoriniana* or *A. angustifolis* will need a pot about 36 inches in diameter. Soil used in a container must drain well. Mary Irish recommends a ratio of 1 part organic matter to 5 parts inorganic matter, although an even higher content of organic matter may also yield good results.⁴⁵ Container grown plants welcome fertilizer about once a month during the growing season. Fish emulsion is a good choice, but a variety of both soluble and insoluble fertilizers also work well.⁴⁶

Several species are especially attractive in pots.⁴⁷ *Agave filifera* have decorative narrow olive green leaves that bear loose curled threats at the margins. *Agave pecta* have narrow pale green leaves with white margins and small black teeth. Probably the quintessential agave for containers is *A. victoria reginae*. It is a striking plant with olive green leaves beautifully penciled with white edges. It grows to only about a foot across and will maintain its compact, geometric form for many years before flowering and dying.⁴⁸



This *A. victoria reginae* is growing out of doors in a pot at the Arizona Sonoran Desert Museum.

Agave ocahui with dark green leaves with brown margins, *A. parryi* var. *truncata*, and *A. potatorum* are extremely symmetrical and are also excellent choices for containers that receive full sun.⁴⁹ Agaves in containers are usually resistant to insect attacks. But mealy bugs can sometimes be a problem. They may be held at bay with insecticidal soap.⁵⁰

Landscape professionals have long recognized the agave's extraordinary ability to create a particularly beautiful focal point in the garden. The *A. americana*, with its six-foot rosette packed with sword-shaped leaves and sharp teeth is as indestructible as it is eye catching. *Agave attenuata* is also big and bold. It grows to five feet across with soft grey-green saber like leaves with smooth leaf margins. And my favorite, *A. parryi huachucensis*, is a spectacular granite-like botanical sculpture. Its leaves have black spines at the margins.⁵¹



This *A. vilmoriniana* is happily growing at the Arizona Sonoran Desert Museum. At higher elevations, protection from cold weather may be needed.

It is not difficult to plant agaves. Both in the mountains and in the cultivated landscape at lower elevations, they thrive in alkaline, well-drained soils. Sunny slopes or raised beds ensure that their roots stay dry between rainfalls or watering. When they must be installed on level or nearly level ground, dig the hole beneath them to a depth of at least two feet. Replace the excavated soil with a light gritty mixture.⁵² Dig a well around the plant. This prevents water from moving away from the plant and allows it to penetrate the ground slowly. As the plant grows, the well around it must be enlarged as well.⁵³

In climates with very hot summers, it is best to plant agaves in the fall so that the root system can grow during the mild winter months. If plants are installed in the spring, they should be hardened off, then carefully watered and shaded from direct sun to prevent sunburn and heat stress.⁵⁴ After the plant is installed, mulch the area around the plant with small gravel to protect the roots.⁵⁵ Agaves need some supplemental watering when first installed in the landscape. In hot weather, and for the first month if planted during

the spring or late summer, water every four days.⁵⁶ Withhold water during the fall and winter. Watering during the winter will make the leaves more susceptible to damage during cold weather.⁵⁷ Even mature plants may benefit from water once a month during the warmest months of the year.⁵⁸ The hardiness of agaves depends upon the variety, the age of the plant, the location in landscape, the soil type and moisture. Because some species are more cold tolerant than others, purchase plants from a local supplier who knows the plants well and can give you accurate information about cold tolerance.⁵⁹

The larger varieties may come under attack by snout weevils. The snout weevil uses the bud as a nursery for young. Younger plants are less susceptible to the snout weevil, but as they mature and prepare to bloom, the more at risk they become. The telltale signs of a weevil attack are small holes in the leaves at the base of the plant. First the leaves spread and fall, leaving only the bud standing; but it will eventually yield and collapse as well.⁶⁰ Using an insecticide when the plant is installed, and later while the plant is growing, may prevent an infestation.

If an infestation is discovered, remove the plant and its offspring that have not bloomed. Those that have bloomed show a resistance to the weevil and may be retained with confidence of resistance to the weevil. Those who prefer not to add strong chemicals to the garden find another strategy is simply to avoid the varieties that are especially vulnerable to attack: *A. americana*, *A. angustifolia*, and *A. chrysantha*. Of course, after blooming, many agaves die anyway, so some gardeners merely leave the infested plant in the garden if they have no other plants that may be effected.⁶¹

Medium and small varieties of agaves are less susceptible to the snout weevil. Our native *A. parryi huachucensis* is, of course, a perfect choice for those living in Cochise County. But the *A. parryi var. truncata*, a Sonoran Desert native, may require some protection from the cold during the winter months.⁶² *Agave murpheyi* is also ornamental. It grows 3 to 4 feet tall and about as wide. The leaves are narrow and dark blue-gray. It will thrive in full sun in the hottest Arizona climates and seems to be doing well in my front yard at 4,900 feet, without winter protection. *Agave colorata* have stunning bud imprints that remain intact through out the life of the plant. The bud impressions make it an exceptional focal point in the landscape.⁶³

There are other medium sized agaves that are perfect for the Arizona landscape. *Agave pelona* and *oahui* have linear dark leaves without large teeth. The leaves are lined in a dark wine color or in white, respectively.⁶⁴ *Agave scabra* has deep green leaves bordered with multifaceted teeth. *Agave havardiana*, native to Texas, and a. *neomexicana*, native to New Mexico, have wide blue-gray leaves that are beautifully formed and very similar to the *A. parryi huachucensis* variety. Both the *A. deserti* and *lechuguilla* tolerate the hottest, driest areas of the landscape. One species that tolerates shade especially well is *A. macrochantha*. It has light blue-gray leaves accented by maroon leaf edges and terminal spines. This plant is comfortable with winter temperatures in Phoenix, but in Cochise County it may need protection during the colder months of the year.⁶⁵

Smaller agaves are perfect for either a container or the landscape. One of the smaller agaves, *A. gracilipes*, whose common name is the slim-footed agave, is native to the Guadalupe Mountains and sand dune areas of west Texas. It thrives at higher elevations and can commonly be found at about 5,000.⁶⁶ *Agave lechuguilla*, an indicator plant of the Chihuahuan Desert, is common in thick concentrations on hillsides and well-drained slopes in western Texas. One observer noted that it is usually sunburned in nature and not attractive.⁶⁷ Indeed, as pictured below, that is what we found when we observed these plants at the Chichuachuan Desert Nature Center and Botanical Gardens just outside of Ft. Davis, Texas. When planted in the garden, given extra water and a little fertilizer, Texas gardeners find that this plant becomes a vivid green and grows larger than when found in the wild. Because it lives about 10 to 15 years, it can be relied upon to survive in a container or garden for many years.⁶⁸



These *Agave lechuguilla* are in the Chihuahuan Desert.



This exhibit at the Boyce Thompson Arboretum shows that agaves offer form, color and texture.

Although they are eye-catching focal points for the garden, agaves also combine especially well with other plants and provide visual relief from billowy desert or desert-adapted perennials. The long curves of their broad leaves contrast with the softness of other plants.⁶⁹ To help with garden design, I've provided a chart of agave species and their characteristics. It is derived from the work of Mary and Gary Irish.⁷⁰ The species marked with a star are native to Arizona. Where information is missing in the chart, it is because that data was not readily available. There is still much research work to be done on agaves. Adios, and good gardening.

Agave Species	Size Ht x Width	Leaves	Leaf Margins	Age at Flowering	Propa- gation	Cold Hardiness Comments
<i>americana</i>	6 – 10' 12'	Gray to blue gray, dark green and variegated	Dark brown to gray teeth	10 – 35 years.	Seeds Offsets	15°F Plants in cooler climates flower later in life

<i>augustifolia</i>	3-5' 6.5 – 8'	Light green to gray green	Dark brown teeth, may also be garnet or black		Offsets bulbils	25°F
<i>attenuata</i>	2-4' 1.5-5'	Pale green to blue green	Smooth or finely serrated teeth		Seeds Offsets	28°F
<i>bovicornuta</i>	2.5-3' 5-6.5'	Yellow green to green	Straight or curved teeth		Seeds	20°F Strong bud imprint
<i>bracteosa</i> *	1' 1'	Pale green	No teeth		Blooms many times	15°F Found in mountains and low desert of AZ. In low desert may need shade in summer
<i>chrysantha</i>	20-39" 31-71"	Blue gray to yellow green	Small teeth			17°F
<i>colorata</i>	5-7" 10-23"	Blue gray	Prominent teeth	15 years	Seeds Offsets Bulbils, but rarely	Rough skin Strong bud imprint
<i>deserti</i> *	12-1" 16-24"	Gray, blue gray, green	Small teeth		Seeds Offsets	15°F Found in south and western AZ; broad range grows from 300' – 5,000'
<i>desmettiana</i>	27 – 35"	Greenish yellow to dark blue green	No teeth or fine teeth at base	8 – 10 years	Seeds Offsets Bulbils	25°F
<i>filifera</i>	20 – 26"	Dark green	Fine		Seeds Offsets	17°F Recurved filaments
<i>fourcroydes</i>	3 to 5.5' trunk	Gray to green	Slender dark teeth		Offsets	25°F
<i>gemeniflora</i>	2-3' tall	Dark green			Seeds only	25°F Narrow flexible leaves with fine filaments
<i>gigantensis</i>	1.5-3' 2.5-4'	Light green to gray green	Teeth widely spaces		Seeds only	
<i>guiengola</i>	10" 13.75"	Gray to gray green	Small teeth		Seeds Offsets	
<i>harvardiana</i>	16-24" 20-31"	Gray to dull green,	Teeth		Seeds Offsets	-10°F

		sometimes yellowish				
<i>lechuguilla</i>	10-18' 16-27''	Yellowish green, strong striations	Gray border, down turned teeth	3-4 years	Seeds Offsets Seeds Offsets	0°F
<i>macrocantha</i>	10-16'' 10-16''	Dusky blue-gray to green	Teeth small and dark brown			25°F
<i>mckelveyana</i> *	8-10''	Green or yellowish green	Few teeth, gray with a reddish tip			0°F Western AZ, 3,000-6,000' in chaparral-juniper. Not often used ornamentally
<i>murpheyi</i> *	3' 24-31''	Light gray to blue green or yellow green	Small brown teeth		Seeds Offsets	10°F Also a yellow variegated form. Central AZ 1,500-3,000'
<i>neomexicana</i>	10-16 12-27	Blue-green to gray	Strong teeth		Seeds Offsets	
<i>ocahui</i>	12-20'' 20-39''	Dark green	Narrow reddish brown border	5-18	Seeds	-20°F
<i>Palmeri</i> *	3-25-4'' 20-47''	Pale green to light green or gray-green	Small regular teeth			10°F 3,000-6,000' SE AZ
<i>parryi</i> *	12-20'' 20-29''	Light gray to light bluegreen			Seeds Offsets	-20°F Good source of mescal. Found in SE AZ
<i>-couesii</i> *	smaller					0°F Central AZ
<i>-huachucensis</i> *		Leaves may be 25'' long				15°F Found in SE AZ
<i>-truncata</i>		Leaves are obovate to ovate; bright blue-gray color	Reddish brown teeth			15°F Durango, Mexico
<i>pariflora</i> *	4-6'' 6-8''	Dark green with white bud imprint	White filaments along the edge	Plants may remain green up to two years after flowering	Seed Offsets	10°F Shade in low desert. Found in extreme SE AZ
<i>pelona</i>	16-24'' 24-31''	Dark green Shiny, with reddish or purple tint	Smooth whitish border		Seed	20°F

<i>salmiana</i>	5-6.5' 10-13'	Dark green to gray-green	Teeth flat and brown to gray		Seed Offsets	5°F Common name maguey de pulque
<i>scabra</i>	2-3' 5-6.6'	Light green to gray	Teeth are heavy and downcurved on bottom half of the leaf		Seed Offsets	10°F Plantings in Denver may be even more cold hardy
<i>Schidigera</i>	27" wide	Dark green, shiny	Smooth with white coarse filaments		Seed Offsets, but rare	15°F Strong white bud imprint
<i>Schotti*</i>	12"	Yellowish green	Smooth brown with coarse filaments		Seed Offsets	10°F Grows in clumps up to 39" wide and forms extensive colonies. Wide distribution in southern AZ above 3,000' in grasslands and on edge of oak woodlands
<i>sobria</i>	19-59"	Gray, blue-gray, yellow-green	Small flattened teeth		Seed Offsets	25°F Leaves rough and strongly cross-banded. Important for making mescal
<i>tequilana</i>	4-6' tall	Blue-gray Gray-green	Small teeth		Offsets	25°F Used to make tequila. Variegated forms, unnamed one with blue-green midlife and creamy yellow margin tinged with pink
<i>Toumeyana*</i>	12"	Green with white bud imprint on top and bottom	Brown, minute teeth at base, white filaments		Seed Offsets Bulbils rare	10°F Dense colonies endemic to central AZ. Great for pots
<i>Utahensis*</i>	7-12" 10-16"	Gray-green	Gray teeth		Seed Offsets	0°F Most northerly agave found in AZ, UT, NV, CA. <i>Kaibabensis</i> bright green

						leaves with white teeth
<i>Victoria reginae</i>	20-27.5"	Dark green leaves with white markings, triangular shape	white markings on smooth horny border		Seed Offsets	10°F Best form in full sun. Plantings in Denver have done well where kept dry.
<i>vilmoriniana</i>	3' 5'	Pale bluish	Fine brown border	7-10 years	bulbils	22°F Frost sensitive. Protect below 32°F
<i>weberi</i>	4-5' 6.5-10'	Gray-green to shiny green	Fine teeth		Offsets bulbils	12°F Native to SW US. Subject to heat stress, may need extra water. Soft pliant leaves

*Arizona Native

Endnotes:

¹ A. Michael Powell, *Trees and Shrubs of Trans-Pecos Texas*, Big Bend Natural History Association, p. 71, 1970.

² Id.

³ Id.

⁴ Id.

⁵ Roland H. Wauer, *Naturalist's Big Bend, Texas*, Texas A & M Univ Press, p.37, 1980.

⁶ Mary F. Irish, *Gardening in the Desert*, Univ of Arizona Press, p. 147, 2000.

⁷ Mary and Gary Irish, *Agaves, Yuccas, and Related Plants*, Tiber Press, p. 26, 2000.

⁸ Id.

⁹ Id., at 27.

¹⁰ Id.

¹¹ Id.

¹² Id., at 29.

¹³ Id.

¹⁴ Id.

¹⁵ Id.

¹⁶ Id., at 29-30.

¹⁷ Id., at 30.

¹⁸ Id. 15.

¹⁹ Id. 16; see generally, Howard Scott Gentry, *Agaves of Continental North America*, University of Arizona Press, 1993.

²⁰ Id., at 8.

²¹ Id., at 32.

²² Id.

²³ James A. MacMahon, *Deserts (a National Audobon Society Nature Guide)*, Alfred A. Knopf, Inc, p. 85, 1997

²⁴ *Agaves, Yuccas, and Related Plants*, at 31.

²⁵ Powell, at 72.

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- ²⁶ *Agaves, Yuccas, and Related Plants*, at 59.
- ²⁷ Powell, at 72.
- ²⁸ Id.
- ²⁹ *Agaves, Yuccas, and Related Plants*, at 59.
- ³⁰ Powell, 72-73.
- ³¹ *Agaves, Yuccas, and Related Plants*, at 61.
- ³² *Gardening in the Desert*, at 152.
- ³³ *Agaves, Yuccas, and Related Plants*, at 59; MacMahon, at 85
- ³⁴ MacMahon, at 85.
- ³⁵ Id.
- ³⁶ Conversation with Ranger Sonya Berger, Chief of Interpretation, Gila Cliff Dwellings National Monument, May 20, 2007.
- ³⁷ According to Ranger Berger, this is the official description of the needle from "The Archeology of Gila Cliff Dwellings," published in August 1986. It is from Chapter 12, "Fibrous Artifacts," written by Gloria Fenner: "NEEDLE - This item consists of the naturally sharp tip of an agave or yucca leaf with its cleaned and Z-twisted fibers. The length of the needle proper is 6.8 cm, the diameter is 0.3 cm; the total length, including the fibers, is 21 cm.
- ³⁸ *Agaves, Yuccas, and Related Plants*, at 59.
- ³⁹ *Gardening in the Desert*, at 141.
- ⁴⁰ MacMahon, at 85.
- ⁴¹ Janice Emily Bowers, *Shrubs and Trees of the Southwest*, Western National Parks Association, p. 88, 1988.
- ⁴² *Succulents and Cactus*, Lane Magazine and Book Company (Sunset Books), p. 33, 1970.
- ⁴³ Id., at 42.
- ⁴⁴ *Gardening in the Desert*, at 144.
- ⁴⁵ Id., at 144.
- ⁴⁶ Id.
- ⁴⁷ *Succulents and Cactus*, Lane Magazine and Book Co, p. 33, 1970.
- ⁴⁸ Id., at 32-33.
- ⁴⁹ *Gardening in the Desert*, at 144.
- ⁵⁰ Id., at 145.
- ⁵¹ *Succulents and Cactus*, at 44.
- ⁵² Id., at 42.
- ⁵³ *Gardening in the Desert*, at 145.
- ⁵⁴ *Agaves, Yuccas, and Related Plants*, at 65.
- ⁵⁵ *Succulents and Cactus*, at 42.
- ⁵⁶ Mary Irish, *Arizona Gardeners Guide*, Cool Springs Press, at 50, 2003.
- ⁵⁷ *Succulents and Cactus*, at 42.
- ⁵⁸ *Arizona Gardeners Guide*, at 50.
- ⁵⁹ *Succulents and Cactus*, at 42.
- ⁶⁰ *Gardening in the Desert*, at 148.
- ⁶¹ Id., at 149.
- ⁶² *Gardening in the Desert*, at 152.
- ⁶³ Id., at 153.
- ⁶⁴ Id.
- ⁶⁵ Id.
- ⁶⁶ Barton H. Warnock, *Wildflowers of the Guadalupe Mountains and the Sand Dune Country of Texas*, Published by Sul Ross State University, Alpine, Texas, p. 45, 1974.
- ⁶⁷ Clark Champie, *Cacti and Succulents of El Paso*, Abbey Garden Press, p. 94, 1974.
- ⁶⁸ Id.
- ⁶⁹ *Gardening in the Desert*, at 72-73.
- ⁷⁰ See generally, *Agaves, Yuccas, and Related Plants*.