Asombro Institute
FOR SCIENCE EDUCATION

Asombro Institute for Science Education
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Asombro Institute for Science Education is dedicated to increasing scientific literacy by fostering an understanding of the Chihuahuan Desert.

ACKNOWLEDGMENTS

The trail you have just enjoyed is yet another project made possible through the dedication of hundreds of Asombro Institute for Science Education volunteers.

We are especially grateful to the Asombro Institute's Site Development Committee chair Justin Van Zee, whose vision, sweat, and hard work made dreams for the trail, benches, plant identification signs, and other amenities into realities.

Finally, we thank the dozens of other volunteers who created and help maintain the Chihuahuan Desert Nature Park for all to enjoy.

Desert Discovery Trail

A Self-Guided Tour at the
Chihuahuan Desert Nature Park

Managed by the Asombro Institute for Science Education
A Nonprofit 501(c)(3) Organization
www.asombro.org
575-524-3334

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Help us keep costs low!
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Welcome to the Desert Discovery Trail at the Chihuahuan Desert Nature Park. This moderate-difficulty, 1.2-mile loop trail crosses the piedmont slope of the Jornada Basin, overlooks and arroyo that carries runoff from the Doña Ana Mountains, and circles a low hill. You also have the option of taking either the more difficult 0.3-mile spur trail to the top of the hill or the Arroyo Trail that ends at the entrance road and small parking area.

I invite you to use this self-guided booklet to help unlock some the desert's many secrets. As you walk the trail, you'll learn about archaeology, geology, soil, plants, animals, and much more. If you have only limited time, read the bulleted list in the box at the top of each page. If you want more details, read the rest of the text. Welcome to the Chihuahuan Desert Nature Park. Enjoy your visit!

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YES! I want to support the Asombro Institute's efforts to increase natural science literacy through engaging, place-based education. All donations are welcome; the minimum donation to receive a printed copy of the newsletter is $10. Please sign me up in the following category:

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Asombro Institute
FOR SCIENCE EDUCATION

Mission:
The Asombro Institute for Science Education (home of the Chihuahuan Desert Nature Park) is dedicated to increasing scientific literacy by fostering an understanding of the Chihuahuan Desert.

About Us:
The Asombro Institute for Science Education is run by a volunteer Board of Directors, five staff members and more than a hundred volunteers who donate more than 2,500 hours each year.

Education Programs:
- Field trips for local schoolchildren
- Classroom education programs featuring hands-on, inquiry-based science
- Schoolyard ecology projects at local schools
- Annual events like the Butterfly Flutterby
- Teacher workshops
- Lectures for local organizations and clubs
- Field tours for adults
- Quarterly newsletter

How You Can Get Involved:
- Volunteer your time
- Become a member - As a private, nonprofit organization, we rely on our members' contributions to maintain the site and continue our education programs. Please pick up an envelope in the box by the trailhead and become a member today!

Contact the Asombro Institute office (575-524-3334)
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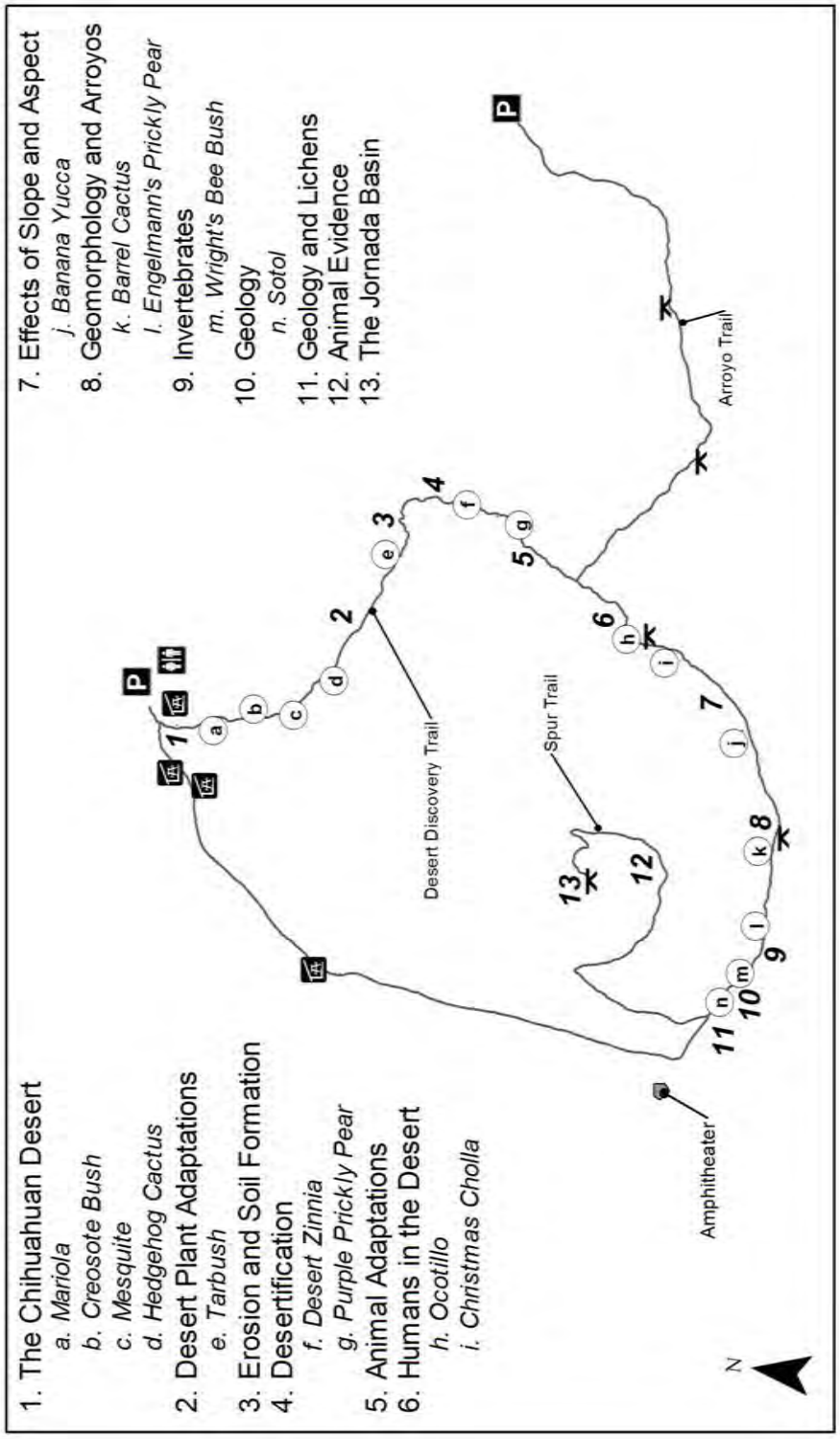
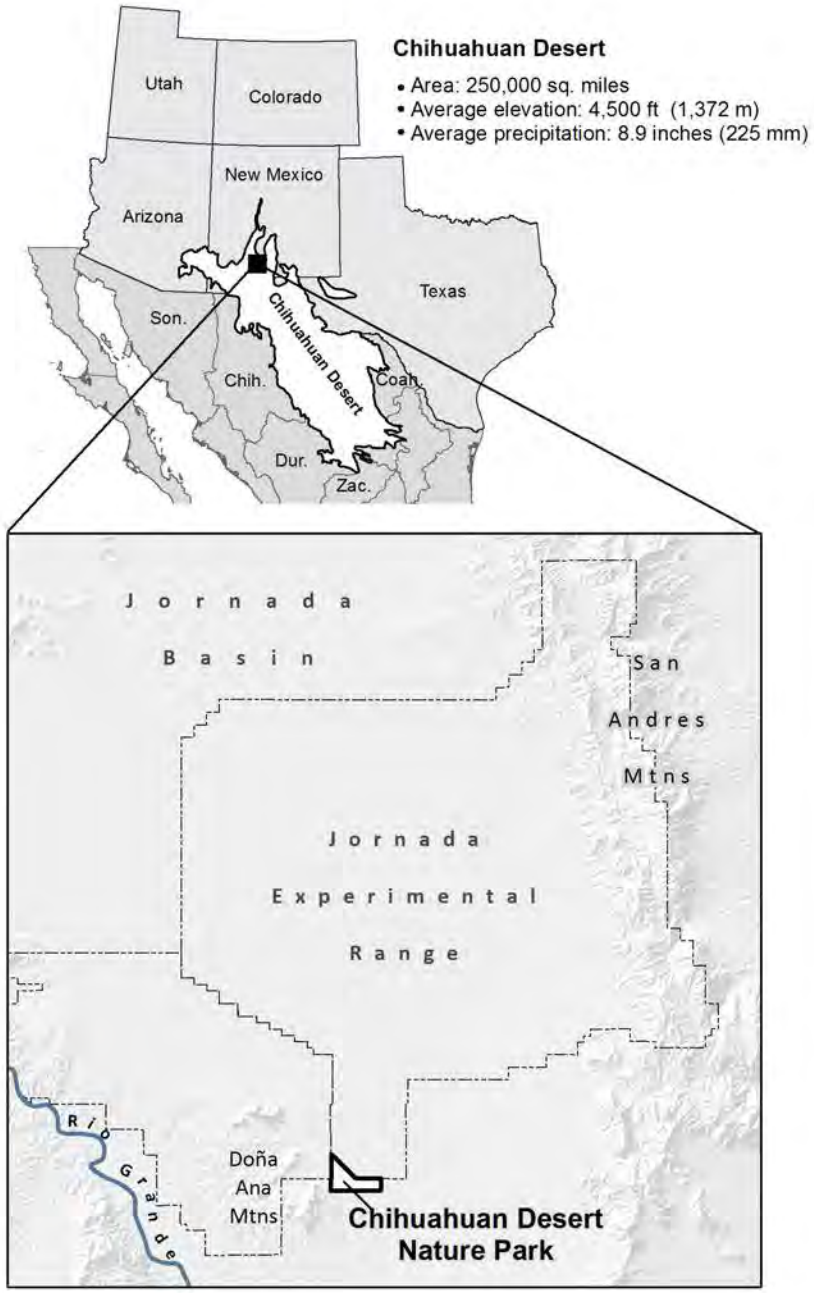


The Jornada Basin



The landscape below you is part of a closed basin. None of the rain that falls into this basin ever flows out of it. The southern rim of the basin is ten miles to the south, near Highway 70.

Geologic events spanning 280 million years produced the Jornada Basin. The first event was the deposition of sediments on the floor of a shallow ocean that covered the continent until about 70 million years ago. The resulting sedimentary rocks (sandstone, limestone) were then deformed, tilted and uplifted to form hills that were precursors to the Doña Ana and San Andres Mountains. A number of volcanoes, including the Doña Ana Mountains and the Organ Mountains, erupted during the period from 33 to 45 million years ago, adding igneous rocks (lava, andesite, rhyolite, and monzonite) to the mountains. Faulting along the base of the Doña Ana and San Andres Mountains and downwarping of the structural block between the mountains formed the Jornada Basin.

The mountain-building events ended about 33 million years ago. Since that time, erosive forces of water and wind have worn down the lofty mountains, forming the much lower skyline visible today. The rocks eroded from the mountains were deposited in the valley, essentially burying the base of the mountains in their own debris. The deposits in the basin are more than 5,000 feet thick.

Approximately 2 million years ago, an ancient channel of the Rio Grande crossed into the Jornada Basin north and west of the Doña Ana Mountains. It dumped more than 18 feet of river sediments into the basin until it eventually became choked in its own sediment. When this happened about 300,000 years ago, the Rio Grande migrated to the west and began to entrench in its current channel. In the Jornada Basin, the rivers's ancient path is marked by rounded, river-worn pebbles and sediments from northern New Mexico that could only have been deposited by the river.

Below you and to the east and northeast, the shrub-dominated fan-piedmont terminates abruptly at the edge of a plain that is often bright green in late summer. The runoff water from the entire basin accumulates during high rainfall years in Isaacks Lake, forming a shallow water area. Although most of the water evaporates, it helps the desert grasses and other plants flourish.

Animal Evidence

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- Piles of sticks and other materials in rock crevices and under plants are often packrat middens.
- Look for prickly pear cactus with bite marks. These cacti are an important food source for several rodents as well as rabbits.

As you proceed along the trail, look in rock crevices or under prickly pear cactus and mesquite for piles of sticks, cactus pads and other materials. These piles are called *middens* and are created by packrats (also known as woodrats). Middens are occupied by successive generations of solitary packrats and are often also home to beetles, crickets and a variety of small mites and collembolans (springtails).

Some packrat middens are more than 50,000 years old and have been important for making paleoecological reconstructions of an area. The leaves, seeds, bones and other debris collected for the midden are often found well-preserved by crystallized packrat urine. Examining these fossil middens tells scientists about the plant community and climate of the area thousands of years ago.

In this area, also look for prickly pear cactus with large bite marks. Prickly pear is an important resource for many animals because of its high water and nutrient content. During winter, black-tailed jackrabbits and desert cottontail rabbits eat the pads, somehow avoiding the spines or biting the spines from the pads. Packrats feed on prickly pear by peeling the surface layer off the prickly pear pads. During the winter months, rodents and rabbits frequently dig near the base of prickly pear in order to eat the roots. In most cases, the animals do not eat all of the pads, and the cactus produces new pads in the spring and early summer. Pads that fall off can sprout roots from any place the areoles (where spines are attached) touch the soil.

You may also notice a dark, shiny coating on some nearby rocks. This is called “desert varnish,” a thin coating of manganese, iron oxides and clays formed by colonies of bacteria on the rock surfaces. It takes thousands of years to form a complete coating of desert varnish. The unweathered interior of these andesite rocks is dark gray.

The Chihuahuan Desert

1

Despite its clarity and simplicity, however, the desert wears at the same time, paradoxically, a veil of mystery. Motionless and silent it evokes in us an elusive hint of something unknown, unknowable, about to be revealed.

- Edward Abbey

- The Chihuahuan Desert is the largest desert in North America.
- The Chihuahuan Desert is one of the most biologically diverse deserts in the world.

As you walk this trail, take time to notice the desert’s many secrets - lichens that reduce air pollution by preventing wind erosion; plants that are tough enough to survive intense droughts; mammals that can live their lives without drinking a drop of free water; and hawks that can detect the movement of a tiny mouse while soaring hundreds of feet overhead. The Chihuahuan Desert is the largest of the North American deserts. From where you now stand, it extends almost 200 miles (322 km) north and 600 miles (966 km) south. Most of this 250,000 square mile desert is located in Mexico.

The climate of the Chihuahuan Desert is relatively mild compared with other deserts, partially due to an elevation that averages 4,500 feet (1,372 m) above sea level. Summers are hot, while winters can be cold. The most important wet season, from July through September, brings more than 50% of the average annual precipitation. In this region of the Chihuahuan Desert, the average annual precipitation is 8.9 inches (225 mm).

The Chihuahuan Desert is one of the most biologically diverse deserts on the planet. It ranks #1 among deserts for the number of aquatic species and the number of mammal species. More than 300 species of cacti are found here. How many different kinds of organisms can you count along the trail? Use all of your senses as you walk this trail and see if the desert becomes part of you.

Welcome to the Chihuahuan Desert!

Mariola *(Parthenium incanum)*
Family: Asteraceae (Compositae)

Mariola is found in parts of Arizona, southern New Mexico, southwestern Texas, and throughout northern and central Mexico. Notice the oblong leaves with rounded lobes and fine, white hairs giving the plant a "woolly" appearance. These reflective hairs may help reduce heating by shading the leaves. Creamy yellowish white flowers generally appear on aromatic mariola between July and October. Mariola contains rubber, which has been used infrequently for commercial purposes.

Creosote Bush (*Larrea tridentata*)
Family: Zygophyllaceae Spanish: Gobernadora

Do you enjoy the smell in the desert following a rain? If so, thank a creosote bush, the source of this aroma. This evergreen shrub is characteristic of the Mojave, Sonoran and Chihuahuan Deserts. The inverted cone shape of the shrub enhances the capture of rainfall as water runs down the stems and enters the soil at the plant's base. Older shrubs develop a hemispherical shape and capture wind blown leaves and plant fragments that form a litter layer.

As the litter decomposes, it produces a "fertile island" of nutrient-rich soil under the plant. Individual plants can be as old as several thousand years. In fact, clones of creosote bush may be the earth's oldest living organisms. Creosote bush produces small yellow flowers and small, hair-covered fruits during the spring and late summer. Creosote bush has been used in various remedies for arthritis and stomach pain.

Geology and Lichens

- In front of you is an exploratory mine shaft, probably excavated in search of copper, silver, lead or gold.
- Brightly colored patches on nearby rocks are lichens, an association between fungus and algae.

This exploratory mine pit was probably excavated to look for riches of copper, silver, lead or gold. Veins of precious minerals form at the contact zone of the dike, where younger molten rock extrudes into older rocks. Where the mineral content is high, ore-grade rock can be found, but not here!

Look nearby for the bright yellow, red-yellow, and green patches on the rocks on the south side of the trail. These brightly colored lichens are actually two organisms - fungus and algae - in one. The association between the organisms within lichens is so complete that scientists give genus and species names to the lichens; the different colors of lichens you see are different species. Within a lichen, the fungus provides a structural web that protects the alga and provides a suitable environment. In turn, the alga photosynthesizes and provides the fungus with food. When moist, lichens release small amounts of acid that dissolve the rock. This is called chemical rock-weathering and is extremely slow.

This is the last stop on the main trail.
Go another 30 feet (9.1 m) to the fork in the trail.

Right at the fork- Continue on the 0.3-mile (0.5-km) Vista Trail to the top of the hill. Along the way, visit stop #12 and #13 and see a fantastic view of the Jornada Basin.

Left at the fork - Follow the Desert Discovery Trail back to the trailhead and parking area.

Sotol (*Dasylirion wheeleri*)

Family: Agavaceae Spanish: Sotol

Sotol is often seen on rocky slopes from southern Arizona to west Texas. Hooks on the margins of the long, thin leaves help distinguish it from the smooth leaf margins of soaptree yucca. Thousands of small whitish flowers appear as a cluster at the top of a stalk between May and July. Sotol leaves are used in baskets, and a liquor can be produced from the plant.

Honey Mesquite (*Prosopis glandulosa*)

Family: Fabaceae (Leguminosae) Spanish: Mezquite

The honey mesquite is found from California to Kansas and south to Nuevo Leon, Mexico. This winter deciduous legume has nitrogen-fixing bacteria associated with its roots. Shed leaves have a high nitrogen content that fertilizes the soil under the plant when the leaves decompose. Mesquite may serve as a nurse plant (see definition under "Desert Plant Adaptations"), especially for plants that require nitrogen-rich soils. Look for a large number of desert holly (*Acourtia nana*) plants under the canopies of several mesquite along the trail. Mesquite taproots are commonly 40 feet (12 m) deep. Long lateral roots are common on plants growing above a cemented calcium carbonate (caliche) soil layer. Notice the large thorns on the honey mesquite; many animals burrow under mesquite to benefit from the protection offered by the thorns. Mesquite produces edible pods that are rich in carbohydrates and protein. The seeds and seed pods are collected by several species of large ants, kangaroo rats and wood rats. Native Americans and early Spanish settlers also ground these pods into a flour that was used for making breads and cakes.

Claret Cup Hedgehog Cactus
(*Echinocereus triglochidiatus*)
Family: Cactaceae

Found from Nevada, Utah and Colorado south through the desert southwest, the claret cup hedgehog cactus got its common name from early European settlers who thought the plant resembled spiny hedgehogs native to Europe. This cactus often has many stems, and its bright orange-red flowers open for 2-3 days in April or May. They form cylindrical red fruits about 3/4 inches (2 cm) long.

- Exfoliation is the peeling away of layers of rocks, leading to rounded boulders and eventually formation of soil.
- Two distinct volcanoes produced much of the landscape you can now see at the Chihuahuan Desert Nature Park.

The large boulders on the trail's edge are peeling away layer by layer. This is called *exfoliation* and is an example of a physical rock-weathering process. Water moves into cracks in the rocks, freezes and expands, causing the rock to flake apart. Expansion and contraction from hot desert days and cold nights can also cause the rock to split. As the edges of this coarse-grained monzonite rock break away, it develops into rounded boulders. The process of exfoliation is the first step in soil formation from these large boulders. Physical, chemical and biological processes will continue to break down the flakes of exfoliated rock into soil-sized particles.

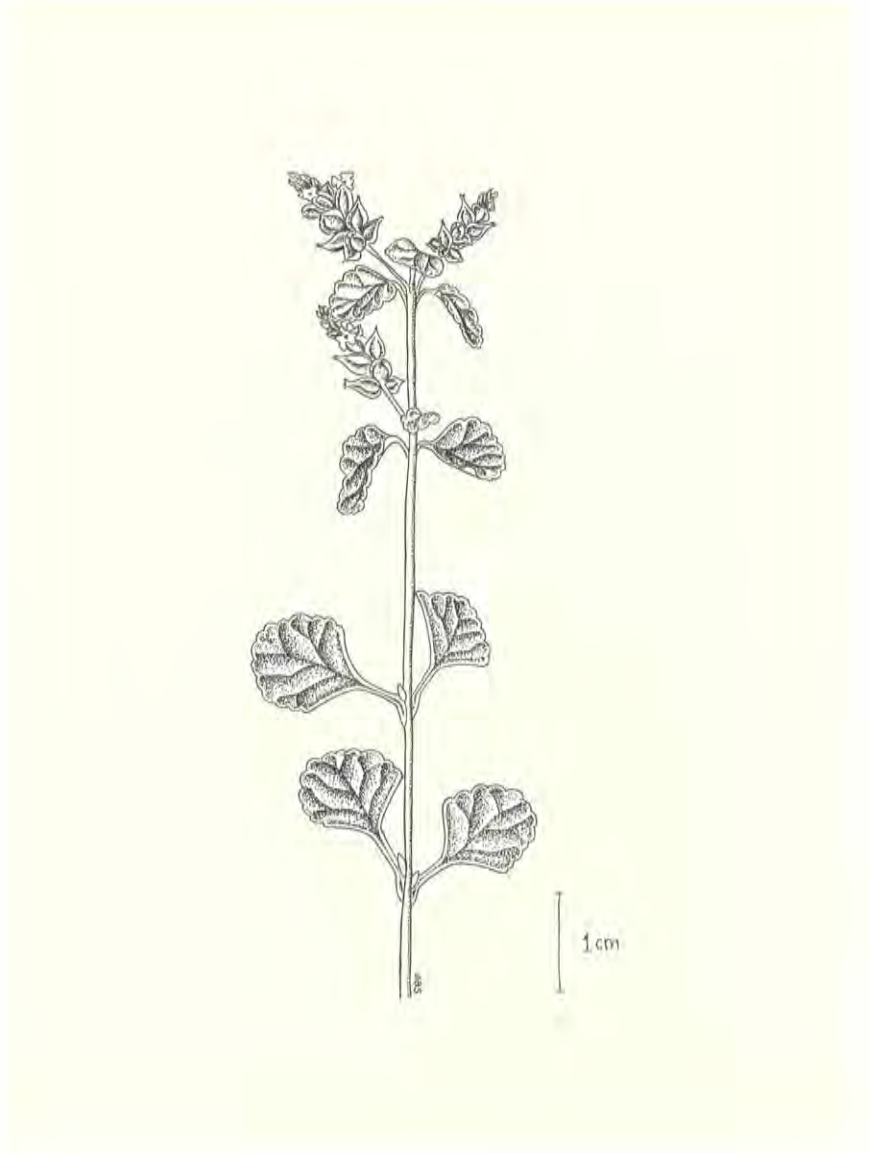
The formation of the different rock types and the mountainous topography within the Chihuahuan Desert Nature Park resulted from two distinct volcanoes. The hill that this trail encircles is the eroded remnant of a volcano that formed about 45 million years ago. the lave flows and mudflows that resulted from this volcano are collectively called the Palm Park Formation. The dark gray angular rocks in the hill are andesite.

The second volcano was active approximately 35 million years ago. After erupting, the remaining dense magma intruded into cracks in the earlier Palm Park lava. Over time, the surrounding softer rock weathered, eroded and washed away, leaving a *volcanic dike*, a linear projection of hard rock resembling a dam or dike, now visible to the west in the vertical ridge. This dike is Doña Ana monzonite, a type of granite.

Wright's Beebush "Beebrush" (*Aloysia wrightii*)

Family: Verbenaceae Spanish: Oreganillo

This woody perennial bush can be found from west Texas to California and into Utah and Nevada. Beebush can also be found in northern Mexico. The leaves are serrated with little hairs. These leaves are often used as an herb in cooking and have a flavor much like oregano. Flowers are small white or a light lavender color on long stems. The common name refers to this plant serving as a nectar source for solitary bees.



Desert Plant Adaptations

- Desert plant adaptations may include shallow, dense roots; long roots; small leaves; a waxy coating on leaves; accordion pleating; and a special version of photosynthesis.
- The modified environment under "nurse plants" allows for the establishment of other plant species.

Near this sign post are four dominant plants of the Chihuahuan Desert - creosote bush (*Larrea tridentata*), honey mesquite (*Prosopis glandulosa*), tarbush (*Flourensia cernua*) and crucifixion thorn (*Koeberlinia spinosa*). These plants, along with other plants of the Chihuahuan Desert, have developed numerous adaptations that allow them to cope with the extreme temperatures, low water availability, and high solar radiation found in this environment.

Roots and leaves are often specialized for desert conditions. For example, perennial grass roots that are shallow and dense collect water quickly when it rains. Other plants, like honey mesquite, have deep roots that can tap into longer-term water sources. Since leaves are a primary source of water loss, it is not uncommon to find desert plants with small or no leaves (e.g., crucifixion thorn). Many desert plants have a waxy coating on the leaves to reduce water loss. The familiar barrel cactus (*Ferocactus wislizenii*) has accordion pleating that allows it to expand and store large quantities of water when it is available. Finally, cacti and some succulents use a special type of photosynthesis that functions only at night when temperatures are lower and humidity is higher, thus enabling plants to lose less water to evaporation.

Desert shrubs may inadvertently serve as "nurse plants" for other plant species. The nurse plant's canopy provides shade, reduces evaporation of soil water, captures litter that subsequently decomposes and enriches the soil with nutrients and intercepts raindrops, thus reducing erosion and allowing faster water infiltration into the soil below. Shrubs thereby produce microclimates that are suitable for the establishment of other species. Shrub canopies also protect seedlings from herbivores. On the other side of the trail, you can see a creosote bush serving as a nurse plant for Christmas cholla *(Opuntia leptocaulis)*.

Tarbush (*Flourensia cernua*)
Family: Asteraceae (Compositae) Spanish: Hojasén

Tarbush is found only in the Chihuahuan Desert; it is a Chihuahuan Desert endemic. It is a partially winter deciduous shrub (it sheds all leaves in some winters and retains some leaves in other winters). It will remain leafless into the summer months until there is adequate soil moisture. This deep-rooted shrub gets its name from the resins in the leaves, which have a distinctive, tar-like odor. These resins keep most animals from feeding on the shrub. Scientists have discovered more than 100 chemical compounds in tarbush leaves. Some tarbush plants have more compounds than other, nearby tarbush plants. This may explain why animals chew on some plants and not others. Small, inconspicuous flowers are produced on tarbush in late fall. In northern Mexico, tarbush leaves and flowers have been used to treat indigestion.

Invertebrates

- Harvester ants and other invertebrates provide critical services like pollination and soil aeration in the desert environment.

On the edge of the trail just behind you, notice the mound, approximately three feet in diameter, of uniform size pebbles. This is a nest of a species of large harvester ants (*Pogonomyrmex rugosus)*. These ants live in colonies with up to a thousand workers. They collect seeds that are subsequently stored in the nest to feed the larvae. They also collect termites and other insects whenever these are available.

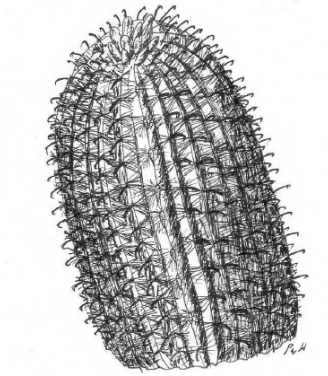
Harvester ants have a potent sting. In fact, for mammals, the harvester ant's venom is ten times more toxic than a rattlesnake's venom. Fortunately, the dose carried by a single ant is small, so one sting is painful but not medically significant. Multiple stings, or the rare case of an allergic reaction to the venom, should be taken seriously.

These harvester ants are just one species in a diverse set of invertebrates (animals without backbones) that live here. There are at least 36 recognized families of spiders and 170 families of insects. Within the order Lepidoptera (moths, butterflies and skippers), there are at least 130 species in our immediate area.

This mind-boggling array of invertebrates is essential to providing critically important services, including cycling energy and nutrients through the system. They carry out these vital functions by eating and being eaten, pollinating most of the desert's plant life, distributing seeds, creating holes that aerate the soil and increase water infiltration, and recycling dead plants, animals and animal wastes.

Fishhook Barrel Cactus (*Ferocactus wislizenii*)
Family: Cactaceae Spanish: Biznaga

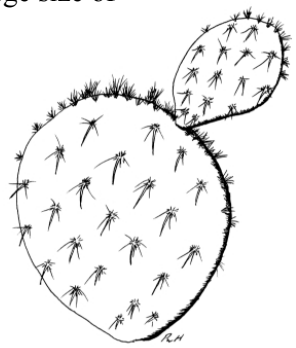
The fishhook barrel cactus is one of the largest barrel cactus species in North America. It is found in desert grassland and desert shrub habitats of the Sonoran and Chihuahuan Deserts. This frost-sensitive species is usually solitary but sometimes branches into multiple stems. It generally has a life span of 50 to 130 years. The accordion-type pleating of the stem allows the barrel cactus to expand and store water in the form of a slimy alkaline fluid. So contrary to popular myth, the water is not readily available for drinking.



Yellow to reddish flowers generally peak from July through September, and the yellow fruits can remain on the plant for up to a year. The apex of the barrel cactus sometimes leans to the southwest where heat is the strongest. This allows strong sunlight to hit the top of the plant where dense spination shades the growing stem. Seeds are dispersed by birds and rodents. Native Americans used barrel cactus pulp to make candy and jelly. The flowers were used to create a yellowish pigment, and the hooked central spines were used as fishhooks.

Englemann's Prickly Pear (*Opuntia engelmannii*)
Family: Cactaceae Spanish: Nopal

Engelmann's prickly pear is one of the most recognized plants in the southwest. It is common throughout much of the desert southwest and Mexico from approximately 1,000 to 4,500 feet. Most spines are flat at the base and white to grayish. Because of the large size of these plants and the stout pads and spines, small mammals frequently dig burrows under them for protection. Yellow flowers appear between April and June. Burgundy fruits (also called "tunas") are the largest of any cactus fruits in this area and are edible (after the glochids are removed!). They are still often harvested to make jelly and syrup.



Erosion and Soil Formation

- Look in this channel for deposits of sand and gravel against rocks. This is evidence of water erosion.
- Soil forms from rock through a combination of five factors - climate, organisms, topography, parent material, and time.

Runoff water moves quickly across steep slopes. The force of the water erodes soil and carves small drainage channels, such as this one, by removing soil along its side slopes and stripping the channel bottom. The processes of erosion and channel-cutting are active during rain storms. Look in the channel bottom for deposits of sand and gravel that accumulate against larger rocks during extreme runoff events. The soil and rocks worn away from the surface are carried by runoff water through these small channels and large arroyos. The eroded material is eventually deposited on the land below us (the lower fan-piedmont; see stop number 8) where it becomes the "parent material" for new soil.

The Nature Park has at least eight different kinds of soil. The differences exist because of the variety of ways that the five soil forming factors (climate, organisms, topography, parent material, and time) interact. These factors, acting together, form soil by altering the physical and chemical nature of the original geologic deposits and rock. At this site, the steep slope (topography factor), the small amount of vegetative cover (organism factor) and the heavy rainfall intensity (climate factor) cause most of the water to run off. Only a small amount of water goes into the soil, and the sand, silt, and rocks (parent material factor) are less likely to break down through chemical weathering processes than in a soil that stays moist for long periods (time factor). As a result, this soil contains more rocks than it would if it was wetter.

Desertification

4

- This area used to be covered by grasses and scattered shrubs. Grazing and drought reduced grass cover, increasing erosion and leaving the erosion pavement of gravel seen here now.
- White material on nearby rocks is calcite (also known as caliche), a common feature in arid regions.

Prior to the introduction of domestic livestock, this piedmont slope would have supported several species of grasses with scattered shrubs. Grazing and drought reduced the amount of grass and its capacity to hold soil in place. Consequently, soil on the sloping piedmont eroded, and grasses were replaced by shrubs. This is called desertification.

Notice the "pavement" of rocks on the soil surface. Runoff water stripped away small soil particles (sand, silt, clay) from the unprotected soil and left behind the larger gravel that already existed in the soil. Over time, this produced an erosion pavement of gravel that functions like armor to protect the soil from further erosion. The fertile topsoil that once supported grasses is now gone and nutrient-poor subsoil layers are at or near the surface.

Find white coatings and small pendants that look like miniature stalactites on the rocks nearby. The white material is calcite, a mineral composed of calcium carbonate ($CaCO_3$); some people call this caliche. It is a chemical material similar to the hard water deposits that are left around faucets in your house. Calcite plugs the pores between sand and gravel, making it "nature's concrete." Calcite forms beneath the soil surface giving soils of arid regions a whitish or gray color. It has been accumulating in this soil for more than 250,000 years. The presence of white coatings at or near the soil surface is evidence of soil erosion. Pendants, which only form on the underside of rocks, indicate the rock's original orientation in the ground.

Geomorphology and Arroyos

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Note: This arroyo is subject to flash floods and is not safe during storms.

- Three steps of the fan-piedmont are visible from the trail.
- In the arroyo, high densities of Apache plume and little-leaf sumac provide stopover sites for migrating bird species.

The land surface is sculpted through time by wind, water and earthquakes. Landscapes with similar shapes, the same origin and the same age are called geomorphic surfaces. Landform terms describe the shape. For example, in front of you is a *fan-piedmont*. This is a gently sloping landform that extends from the base of the Doña Ana Mountains to the basin floor. The mountains are the source of the gravel, sand, silt and clay that were carried by water to form the fan-piedmont. In front of you are two levels, or steps, of the fan-piedmont. The closer one is about 8-10 feet above the arroyo floor. It is inset in an older, higher step. The arroyo cut through the three older land surfaces and continues to carve the younger surface.

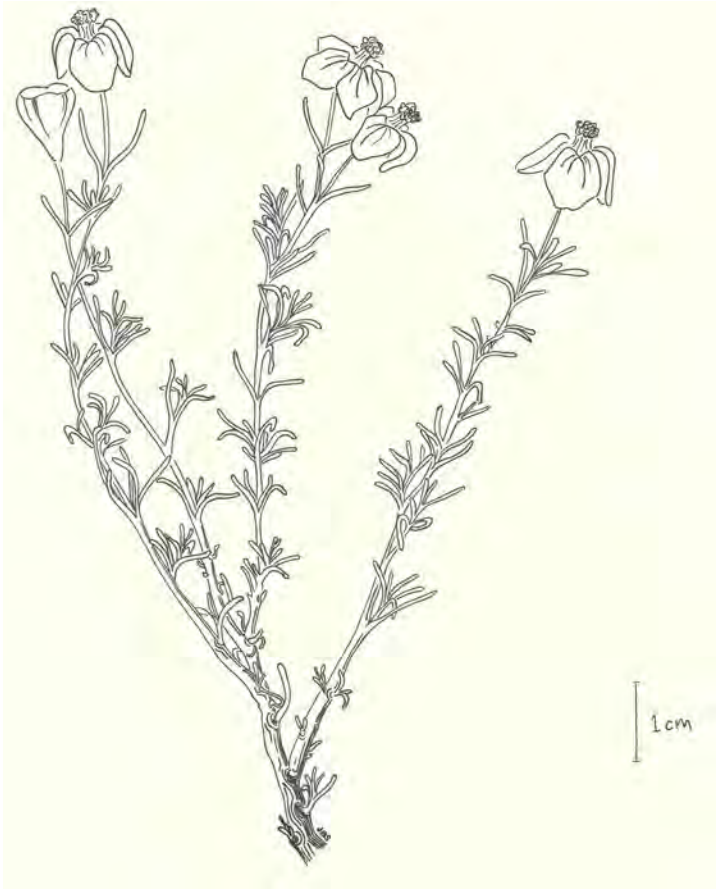
The shrubs lining this arroyo include Apache plume (*Fallugia paradoxa*) and little-leaf sumac (*Rhus microphuylla*). Notice the larger size and greater abundance of shrubs along the arroyos compared to shrubs on the adjacent fan piedmont. These deep-rooted shrubs access water that seeps into the sand and gravel beds in the bottom of the arroyo when it flows. The tall structure of these plants and density of the canopies provide stopover habitat for Neotropical and shorter distance migratory birds. Species you many see in an arroyo during migrations include the spotted towhee, Wilson's warbler, western tanager, and green-tailed towhee. Birds known to use arroyo margin plants as nesting sites include blue grosbeaks and verdins.

Banana Yucca (*Yucca baccata*)
Family: Agavaceae Spanish: Yuca

Banana yucca is found from southeastern California to west Oklahoma and throughout the desert southwest, commonly on rocky soils. Named for the fruits that resemble short, green bananas, the banana yucca's fruit and flowers are eaten by ungulates, rodents, and rabbits. Banana yucca is a trunkless species, and the flower stalks extend only slightly above the leaves, unlike the tall, showy stalks of the soaptree yucca (Y*ucca elata*) that can be seen downslope to the east. White bell-shaped flower clusters generally appear between April and June. The female yucca moth (*Tegeticula yuccasella*) is the sole pollinator of banana yuccas. Small mammals frequently make burrows under this yucca species because the stout leaves with sharp points offer formidable protection from predators. Native Americans ate the fruits and seeds, created fermented drinks from the sap, and used the leaves to create baskets and rope.

Desert Zinnia (*Zinnia acerosa*)
Family: Asteraceae

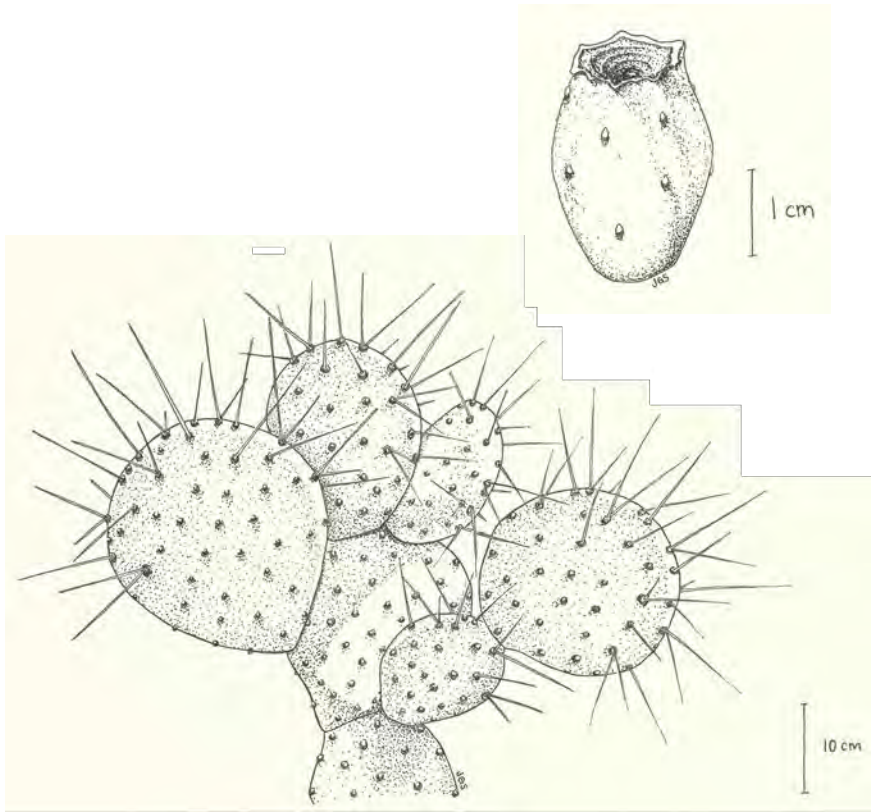
Desert zinnia is found from Arizona to Texas and from Utah down to northern Mexico. Desert zinnia flowers are white with a yellow center. Blooms can appear twice a year (both in spring and late summer) and sometimes dry on the plant and persist for much of the year. It is a perennial with a woody stem and rarely grows more than a foot tall. Leaves are straight and thin. Desert zinnias can be found in open spaces in between larger shrubs. The flower is a food source for butterflies.



Purple Prickly Pear (*Opuntia macrocentra*)
Family: Cactaceae Spanish: Nopal

The purple prickly pear is common throughout much of the desert southwest and northern Mexico. There are only 1-3 spines per areole on the upper edge portion of the pad. Purple prickly pears generally have much longer spines than the other prickly pear species at the Chihuahuan Desert Nature Park. Spines are mostly absent lower on the cactus pad.

The plant's name comes from the striking purple color of the pads. During warm and relatively wet seasons, the pads are a more bluish-green, but under cold and/or drought they become purple. Flowering occurs between April and June, and red fruits (also called "tunas") can be seen on the edge of the pads between June and September. Look under many of these prickly pears and you will see roots that have been dug up and eaten by small mammals.



Effects of Slope and Aspect

7

- Slope and aspect have large effects on plant communities.
- This southern slope is home to many species of plants like prickly pear cactus, ocotillo and banana yucca that are not present on the northern slope of this same hill.

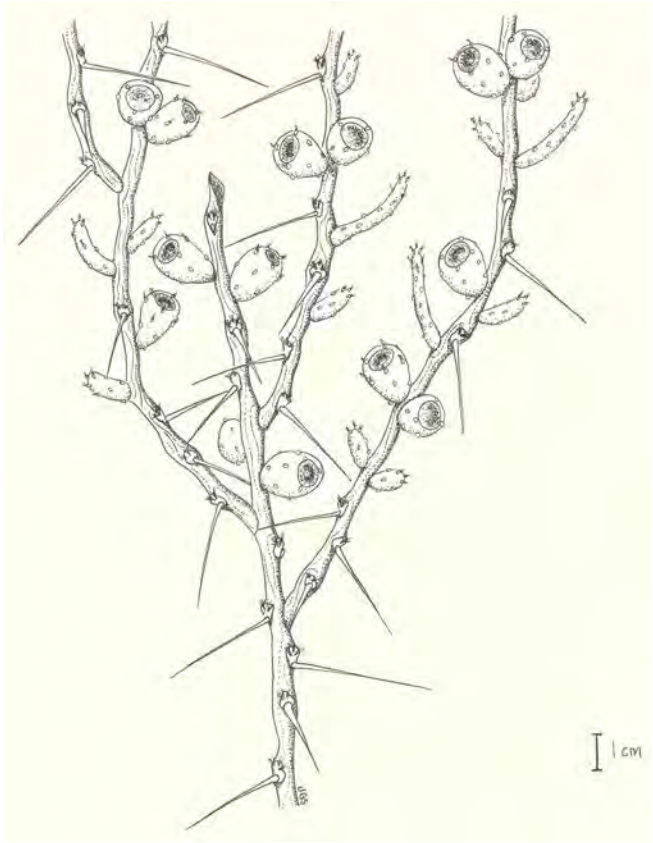
Water availability and temperatures of desert mountain slopes vary with slope angle and aspect (the direction the slope faces). On this south facing slope, look for the high abundance of large prickly pear cactus (*Opuntia engelmannii*), ocotillo (*Fouquieria splendens*) and banana yucca (*Yucca baccata*). These drought-tolerant species require well drained soils so their roots will not have rot damage from too much soil moisture. Compare this view with the plant community you saw on the north side of the hill hear the parking lot and trailhead. Creosote bush (*Larrea tridentata*) predominates, and there are few cacti and other succulents on the north side.

The largest rocks occur on the upper portion of the south facing steep slope where, over time, the greatest amount of soil has eroded away. Furthermore, soil-forming processes that break down rock are slowed by the hot, dry conditions on this slope.

Look closely at the sword-shaped leaves of banana yucca nearby. They are often covered with black or brown circles, the results of a mirid bug that uses its mouth parts to pierce the epidermis (outside covering of the leaf) and suck the nutritious contents of the leaf tissue.

Christmas Cholla (*Cylindropuntia leptocaulis*)
Family: Cactaceae Spanish: Cholla

Christmas cholla (pronounced choi-ya) can be found throughout the desert southwest and into Texas and Oklahoma. They tend to grow under or through nurse plants. When hiking, look into the center of many creosote bush and mesquite and you will see Christmas cholla. They have thin pencil like cylindrical stems and branches with many spines. Most branches have long spines (2-5cm) with a sheath over the spine. On some parts of the plant, the spines are fairly short but these areas tend to have many short side branches. Cholla spines are barbed on the ends making them hard to remove. Flowers are pale yellow, and the red fruits measure up to 1/2 inch (1-1.5cm) and can persist into the winter. It is an attractive bit of color in the desert during winter.



- Desert animals have a variety of physical adaptations to prevent overheating and reduce water loss (e.g., jackrabbits' long ears, impermeable body coverings in insects).
- Many behavioral adaptations also enable animals to survive in the desert (e.g., being nocturnal, living in burrows).

The open burrow entrances in the nearby mound are those of Merriam's kangaroo rat (*Dipodomys merriami*), one of three kangaroo rat species found in this area. Kangaroo rats are true desert specialists; due to many water-saving strategies and physical structures, a kangaroo rat could live its entire life without ever drinking a drop of water! Kangaroo rats spend the daylight hours in burrows where relative humidity is very high and temperatures are moderate (around 80° F). They emerge to feed on seeds at dusk and at dawn. A modified kidney allows the kangaroo rat to concentrate its urine, thus reducing water loss. Special nasal passages further minimize water loss as a kangaroo rat breathes.

Other desert animals have interesting adaptations. Spadefoot toads escape the harshest desert conditions by living underground in a state of dormancy during most of the year. When heavy rains arrive, they come to the surface to feed and reproduce quickly before the water disappears again. Many rodents burrow underground during the day and forage for food at night. Other animals (such as snakes and lizards) will occupy abandoned burrows in order to take advantage of the cooler temperatures inside. During the heat of the day, jackrabbits rest in the shade of shrubs. Their long ears provide a large surface area for dissipating body heat to the environment. The outer coverings of insects and reptiles are almost impermeable to water, so little water is lost through their body surface.

Humans in the Desert

6

- Humans have inhabited the local desert environment for at least the last 12,000 years.

Just as kangaroo rats and other animals leave their mark on the desert, so do humans. Human impacts include roads, air pollution, livestock grazing, and introduced species. These disturbances can alter the soil composition and plant and animal communities. The desert environment's resilience (ability to recover) is low compared to more moist systems. Note the decades-old faint vehicle tracks, one track on each side of the post, that are still visible today.

People and their associated changes to the environment have been here for at least the past 12,000 years. Initially, the climate was cooler and wetter. As conditions became warmer and drier, short term fluctuations in the climate had major effects on all life - plants, animals, and people. The earliest cultures in this area were present from about 10500-6000 B.C., during the *Paleoindian* period. People were hunter-gatherers, living solely from wild game and plants. They traveled extensively to pursue herds of animals such as mammoths, bison, mastodons, and giant ground sloths.

During the *Archaic* period, from 6000 B.C. to 250 A.D., the large animal species, except the modern bison, were gone. The climate became warmer and drier, and some of the first desert plants appeared. Grinding stones (*manos and metates*) became more prominent, indicating an increase in the processing of wild plant seeds and nuts. Domesticated plants (corn, beans, and squash) came into use by 3,000 years ago. By no later than 1,700 years ago, fired clay pots, a technology from Mexico, began to be used, marking the beginning of the *Formative* period (250-1450 A.D.). The advent of pottery coincided with increasing reliance on agriculture and increasing sedentism and population sizes.

By about 1450-1500 A.D., pueblos throughout many areas of the southwest were abandoned, pottery traditions ceased and the number of people dropped significantly. Political strife and environmental degradation are two possible reasons for this abrupt abandonment. What became of the people in southern New Mexico is unclear.

Ocotillo (*Fouquieria splendens*)

Family: Fouquieriaceae Spanish: Ocotillo

Ocotillo is a plant that often appears to be "all stems." It is found from southern Nevada through the Mojave, Sonoran and Chihuahuan Deserts, most commonly on dry, well-drained, rocky slopes and bajadas. Ocotillo is a drought-deciduous shrub. It produces leaves following rains that wet the soil to at least 6 inches. The plant drops leaves when the roots can no longer obtain water from the dry soil. Before the leaves are dropped, the plant resorbs nitrogen, phosphorus and other essential nutrients from the leaves. These nutrients are stored in the stem for the next cohort of leaves. Ocotillo may produce as many as five or six crops of leaves in a single growing season. Ocotillo produces red flowers and fruits every spring, frequently several months before the first set of leaves are produced. Ocotillo stems can be planted close together to create a living fence. Some Native Americans ate ocotillo flowers and fruits, and the powdered roots were used to treat wounds.