PLANTS OF THE PINACATE BIOSPHERE RESERVE. AN OVERVIEW

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The El Pinacate y Gran Desierto de Altar Biosphere Reserve (the "Pinacate Biosphere Reserve") is in the heart of the Lower Colorado River Valley subregion of the Sonoran Desert. It is also a U.N.-UNESCO-designated World Heritage Site. With an average annual rainfall of less than 10 cm, this is one of the driest places in North America, although rain is highly episodic and some areas go without any precipitation for years, only to eventually be drenched with several inches of torrential rain. The botanical landscape of the Pinacate Biosphere Reserve reflects this aridity and irregular precipitation. Botanists from Forrest Shreve (in the 1950s) to Richard Felger (in the 1980s) have noted that plant ground cover in the Lower Colorado River Valley portion of the Sonoran Desert is very sparse, averaging only around 15 percent. The highest level of plant endemism within the Pinacate Biosphere Reserve occurs on the sand dunes of the Gran Desierto de Altar, where Felger (1980) recorded 11 species (~15 percent of the dune flora) with "some level of evolutionary differentiation." Notable among these are dune spurge (*Chamaesyce platysperma*), dune croton (*Croton wigginsii*), spectacle pod (*Dimorphocarpa pinnatifida*), desert buckwheat (*Eriogonum deserticola*), and sandfood (*Ammobroma [=Pholisma] sonorae*), the last being a parasitic plant with long tuberous edible roots that are highly esteemed by the O'odham and Cocopah People, and also by Mexicans in the Gran Desierto (who call it *camote de los medanos*, or "sweet-potato of the dunes").

The vegetation of the Pinacate Biosphere Reserve can be generally classified into six recognizable plant habitats, or communities (excluding the riparian habitat of the largely dry Río Sonoyta): basins and sand flats, upland desertscrub, sand dunes, the arroyo-playa community, the coastal halophyte community, and freshwater inland spring (*pozo*) communities. These are briefly described below, with some of their most conspicuous plant species listed.

Basins and Sand Flats. The low-elevation sand flats, or basins, which are often crossed by lava flows (often hidden beneath the sand), are dominated by plants adapted to poor drainage, notably creosote bush (*Larrea tridentata*), white bursage (*Ambrosia dumosa*), teddybear cholla (*Opuntia bigelovii*), silver cholla (*Opuntia echinocarpa*), chain-fruit cholla (*Cylindropuntia fulgida*), diamond cholla (*Cylindropuntia ramosissima*), ashy limberbush (*Jatropha cinerea*), and desert datura (*Datura discolor*). Visually, the landscape often appears to consist of monospecific stands of creosote bush or cholla, and these areas are sometimes called "creosote flats" or "cholla flats." In areas that have gone several years without rain, the plants in these creosote or cholla flats may appear dead, only to spring "back to life" with the next substantial downpour (although over multi-year droughts many plants can die).

Upland Desertscrub. The rocky slopes of the many cinder cones, as well as the Sierra Pinacate, Sierra Blanca, Sierra del Rosario, and other small ranges host an upland Sonoran Desert flora that is typical of rocky and well-drained soils. Even the slightest rise in elevation can create a shift toward more rocky soils (including desert pavements) and associated changes in plant cover. In the moister north- and east-facing upland canyons, plant ground cover can rise to nearly 30 percent (and in this habitat Bigelow beargrass, *Nolina bigelovii*, can occasionally be found). Dominant plants of the upland desertscrub community include: two trees, desert ironwood (*Olneya tesota*) and foothill paloverde (*Cercidium microphyllum*); a host of smaller plants including *sangrengado*/limberbush (*Jatropha cuneata*), white bursage (*Ambrosia dumosa*), holly-leaf bursage (*Ambrosia ilicifolia*), ocotillo (*Fouquieria splendens*), brittlebush (*Encelia farinosa*), flat-top buckwheat (*Eriogonum fasciculatum*), chuparosa (*Justicia californica*), desert fir (*Peucephyllum schottii*), and cheesebush

(*Ambrosia salsola*); and seven conspicuous species of cacti, saguaro (*Carnegiea gigantea*), senita (*Lophocereus schottii*), organ pipe cactus (*Stenocereus thurberi*), pincushion cactus (*Mammillaria grahamii* var. *grahamii*), biznaga/barrel cactus (*Ferocactus cylindraceus*) many-headed barrel cactus (*Echinocactus polycephalus*), and teddy bear cholla (*Opuntia bigelovii*).

Sand Dunes. The ~5000 sq km of sand dunes in the Pinacate Biosphere Reserve and adjacent regions of the Gran Desierto de Altar are heterogeneous, often showing little similarity from one dune to the next. Felger (1980) surveyed the dunes of the Gran Desierto de Altar and recorded a total of only 75 plant species (compared, for example, with 105 species in the small and isolated, 610 m-high Sierra del Rosario alone). However, the total number of dune plant species in the Pinacate Biosphere Reserve probably exceeds one hundred. Active (moving) dunes typically host white bursage (*Ambrosia dumosa*), desert milkweed (*Asclepias subulata*), sandpaper plant (*Petalonyx thurberi*), joint-fir/Mormon tea (*Ephedra trifurca*), ajo/desert lily (*Hesperocallis undulata*), galleta (*Hilaria rigida*), pleated-leaf crinkle mat (*Tiquilia plicata*), dune sunflower (*Helianthus niveus*), dune croton (*Croton wigginsii*), Emory indigo bush (*Psorothamnus emoryi*) and desert buckwheat (*Eriogonum deserticola*). The buckwheat is one of several host plants for the rare, parasitic, sandfood (*Ammobroma sonorae*); clusters of sandfood flowering heads tend to occur on the northern side of the larger buckwheat plants in the spring (both buckwheat and sandfood can be found in the dune fields north of the border as well). Partially stabilized, lower-elevation sand dunes are also colonized by dune primrose (*Oenothera deltoidea*), four-wing saltbush (*Atriplex canescens*), Mojave threeawn (*Aristida californica*), creosote bush (*Larrea divaricata*), and blue sand lily (*Triteliopsis palmeri*), joint-fir/Mormon tea (*Ephedra trifurca*), pleated-leaf crinkle mat (*Tiquilia plicata*), and galleta (*Hilaria rigida*). Low dunes with a freshwater aquifer near the surface can host the deep-rooted blue paloverde (*Cercidium floridum*) and western honey mesquite (*Prosopis glandulosa*) trees. Joint-fir/Mormon tea is one of the key dune stabilizing plants in the Gran Desierto; their large spreading roots can be seen holding sand in place while winds erode the sand around them to create *Ephedra* hummocks.

During most years, ground cover by plants in these dunes is below 15 percent. However, during high rainfall years (typically associated with El Niños) the dunes (and uplands) of the Gran Desierto in late winter and spring may support spectacular displays of wildflowers, with large areas covered by sand verbena (*Abronia villosa*), dune primrose/devil's lantern (*Oenothera deltoides*), and Arizona lupine (*Lupinus arizonicus*). The last large El Niño that substantially affected the Gran Desierto was in 1997-98, but 2014-15 is shaping up for a good El Niño prediction. During these events, the easterly trade winds of the Pacific weaken, allowing large masses of warm water to drift westward across the Pacific—from the Western Pacific to the Eastern Pacific. When this happens, the coastal waters of western Central America and South America warm substantially, altering weather patterns and affecting fisheries. Warm water takes up more space than cold water, and this expansion results in a detectable rise in sea levels in the Eastern Pacific. Sea surface temperatures in the Central and Eastern Pacific actually affect weather globally. The huge 1997-98 El Niño brought one of the warmest and wettest winters on record to North America, Mexico, and much of Central and South America. (But this same El Niño brought disastrous droughts to Indonesia and parts of Asia.)

Arroyos and Playas. These low-lying regions (e.g., Playa Díaz, north of Cerro Colorado) are distinguished by the presence of Baja nightshade (*Solanum hindsianum*), rock hibiscus (*Hibiscus denudatus*), fairy duster (*Calliandra eriophylla*), desert wolfberry (*Lycium andersonii*), and desert lavender (*Hyptis emoryi*). Other plants, more typical of other communities may also be present, such as ocotillo, creosotebush, and even saguaro and foothill paloverde.

Coastal Halophyte Communities. Although largely outside the bounds of the Pinacate Biosphere Reserve (but within the Alto Golfo de California y Delta del Río Colorado Biosphere Reserve), the coastal region of Bahía Adaír hosts a well-developed halophyte (salt-loving plant) community. Dominants include Virginia pickleweed (*Salicornia virginica, = S. pacifica*), saltwort (*Batis maritima*), iodine bush (*Allenrolfea occidentalis*), several species of *Atriplex*, several *Suaeda*, and four grasses—saltgrass (*Distichlis spicata*), nipa (*Distichlis palmeri*), shoregrass (*Monantochloe littoralis*), and alkali sacaton (*Sporobolus airoides*). In several places along the coast, salt flats penetrate deep into the sand dune region of the Pinacate Biosphere Reserve, and here one finds a depauperate representation of the coastal halophyte community (largely dominated by iodine bush and *Atriplex*). Most of the pans fill with rainwater and become short-lived shallow brine "lakes" during the summer monsoon season.

Inland Springs (*Pozos*). This unique habitat, more common along the coast of Bahía Adaír, occurs where natural springs erupt at a few locations in the westernmost Gran Desierto de Altar. The source of underground water for these springs is still being debated, but it is likely to be the large watershed that runs south across the border from the U.S., enhanced by runoff from the uplands of the Pinacate Biosphere Reserve area. There is evidence that along the coastline springs are created by underground water channeled southward along the Cerro Prieto Fault, and this might also bring water to some of the springs in the reserve that are as much as a kilometer from the sea. Some of the springs nearest the coast provide wetlands that are small refuges for the desert pupfish (*Cyprinodon macularius*), which once had a broader range within the now largely dry Lower Colorado River wetland region. These springs (locally called *pozos*) are fresh water, although in some cases they occur in salt flats so they are slightly brackish. These are freshwater "islands" that support vegetation not seen elsewhere in the region, representing refugial pockets of ancient Colorado River riparian flora such as screwbean mesquite (*Prosopis pubescens*), tule/bulrushes (*Scirpus americanus* and *S. maritimus*), *yerba mansa/hierba del manso* (*Anemopsis californica*), and other freshwater delta species.

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Some Common Plants of the Pinacates Biosphere Reserve

Saguaro cactus (*Carnegiea gigantea*) and ocotillo (*Fouquieria splendens*)

Organ pipe cactus (*Stenocereus thurberi*)

Silver cholla (*Opuntia echinocarpa*) can be found in lowlands throughout most of the Gran Desierto de Altar

Senita cactus (*Lophocereus schottii*), flanked by creosote bushes and in front of an ironwood tree, on the Ives Lava Flow with the Sierra Blanca in the background

Many-headed barrel cactus (*Echinocactus polycephalus*), frequently seen on rocky flats and desert pavement, is endemic to the Gran Desierto de Altar (large plants reach 20 in (50 cm) in height)

Desert buckwheat (*Eriogonum deserticola*) growing on dunes in the Gran Desierto de Altar. Flowering heads of sandfood (*Ammobroma sonorae*) can be seen emerging from the sand near the base of the buckwheat (the host plant)

***Ferocactus cylindraceus* (both photos) differs from the other common biznaga, *F. wislizeni*, in the Gran Desierto in that it rarely leans to the south, the largest spine in each areole may or may not be hooked and is often twisted, and it prefers rocky soils of hills and mountains. *Ferocactus wislizeni*, on the other hand, commonly leans southward, its largest areolear spine is usually hooked, and it prefers sand flats.**

Desert (or Ajo) lily is the only known species in the genus *Hesperocallis*. It can be abundant during wet years on sand flats and dunes as well as rocky uplands.

The dry remains of dune primrose (also known as devil's lantern, or birdcage plant) are unmistakable and can be found on sand dunes throughout the Gran Desierto de Altar.

Brittlebush (*Encelia farinosa*) is one of the most common and abundant plants on rocky slopes throughout the Sonoran Desert

The creosote bush *Larrea divaricatea tridentata* flourishes in basins and sand flats of the Gran Desierto de Altar

Bushlike in form, desert fir (or pygmy cedar) is neither a fir nor a cedar, but an angiosperm in the monotypic genus *Peucephyllum*. It is widespread on rocky soils throughout the Southwest.

With its long abundant stems, *Asclepias subulata* may be the most conspicuous of the 3 species of milkweeds in the Gran Desierto de Altar, where it is found on sand flats and dunes.

***Jatropha cuneata* (*sangrengado*/limberbush), with its spatulate leaves that are twice as long as wide, is easily distinguished from the ashy limberbush (*Jatropha cinerea*) that has kidney-shaped leaves that are as broad or broader than long. These two photos are both *J. cuneata*, with and without leaves. The stems and roots ooze bloodlike sap when cut ("*sangrengado*" is a corruption of "*sangre de drago*"—dragon's blood).**

Two species of joint-firs (Mormon tea) live in the Gran Desierto de Altar. The species shown here is *Ephedra trifurca*, common on sandy soils and dunes. The other species, *E. aspera*, prefers rocky slopes. Both are widespread in the Southwest. Note the papery cone of this shrubby conifer.

An ironwood tree (*Olneya tesota*) in bloom

Bladderpod (*Cleome isomeris*)

Exposed flowering heads of the strange, parasitic sandfood plant (*Ammobroma sonorae*) are often found beneath the host plant desert buckwheat (*Eriogonum deserticola*) (Photos by A. DiGiulio)

The sand dunes of the Gran Desierto come alive with wildflowers during wet years

Dry yellow grasses, and other plants mark Playa Díaz, north of Cerro Colorado—the largest playa in the Pinacate Biosphere Reserve

These remarkable photos by Victor del Rio Delgadillo, former Biologist at the Pinacate Biosphere Reserve, document uncommon flood events, and even extremely rare snow in the region. Upper photos: heavy rains at entry to Reserve (2012), and snow storm the same year (Cerro Colorado in background). Lower photo: Sonoyta River flowing past entry to Reserve in 2010.