



# ARIZONA

Arid land plants in  
cultivation & natural  
habitats

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## Introduction

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It is difficult to put into words in a short introduction the enormous benefit and learning experience that I received from this trip. People asked me why I had chosen Arizona out of all the places in the world for my travel scholarship. I told them how the desert and arid lands fascinated me. I wanted to learn about the flora and fauna of these seemingly barren areas and experience the wonder of plants in the wild such as *Carnegiea gigantea*, that is the symbol of the wild west the world over, or see flowering jewel-like *Mammillaria* growing out of rock crevices. I wanted to see beyond the cliched tumbleweed images of the Southwest.

My research prior to leaving the UK did not prepare me for the vast bounty that was on offer. Arizona is the sixth largest state in the USA with a land mass of 113,990 square miles and it was a tantalising prospect to choose where to visit. I travelled over 1,800 miles and saw a range of different plant communities, from north to south, spending most of my time in the Sonoran Desert region in the south. This is one of three desert areas in Arizona, along with the Mohave and the Chihuahuan Deserts. I spent some time in Tucson, the second largest city in Arizona, visiting parks and gardens and neighbourhood planting initiatives and learning how Tucsonans are being educated to save water and use drought-resistant plants. I visited the nurseries providing the native and non-native arid adapted plants.

With the kind financial assistance of the RHS, Merlin Trust and Kew Guild I was able to experience this beautiful state. My future wish is to continue my journey in the desert.

## Boyce Thompson Arboretum

Boyce Thompson Arboretum (BTA) was my first stop. The park and botanical garden is located on Superior Highway to the east of Phoenix. After the sprawl of Phoenix the road opens up onto beautiful views of the Superstition Mountains, Four Peaks, the Sierra Anchas and Pinal Mountains. BTA is located in the foothills of the Pinal Mountains.



Fig. 1 The naturalistic setting of Boyce Thompson Arboretum

Colonel William Boyce Thompson was a mining magnate with philanthropic and political aspirations. He obtained the Colonel title when he was sent to Russia by the Wilson administration in 1917 as a Lt. Colonel in the American Red Cross. Tired of politics after the war he concentrated his energies into his newly built house in Superior, Picket Post House (named after the mountain peak overlooking the arboretum, Picket Post Mountain). He purchased 400 acres of land in this area which is now home to the BTA, of which approximately 100 acres is open to the public. It was called an arboretum as it had originally come under the control of the Crook



Fig. 2 Picket Post house



National Forest and the house built under the permit of the Forest Service. The BTA was officially dedicated and opened in 1929.

I met Mark Siegwarth, the director, who generously took me on a three hour tour of the arboretum showing me the collections and talking about his plans for the future. Mark explained the goal of BTA has been to feature desert and semi-arid land plants from around the world in as natural a setting as possible. There are few interpretation boards as you move away from the visitor areas out onto the various trails such as the Chihauhuan trail and Upper Sonoran Desert trail (the natural vegetation of the area). The Australian Garden contains towering eucalyptus trees, planted around 1925, and aloes, among others, represent arid land flora of South Africa. Mark showed me various ongoing long-term projects including the Boojum Canyon, *Fouquieria columnaris*. The arboretum also inherited some palms which are being planted around a natural rock amphitheatre or mini canyon. Mark has endless projects he wants to get off the ground, money being the only constraint to his enthusiasm.

There is a riparian area with a natural stream running through the arboretum. Queen Creek runs along a canyon running above ground for a short distance then disappearing underground. During the rainy seasons the creek will swell to huge volume temporarily. The lush area has cottonwoods, *Populus* sp, ash and arizona black walnuts, *Juglans major*, growing along its banks and is a haven for wildlife.

I spent the night at BTA in the guest accommodation. No staff live on site. I only had the ‘snowbirds’ for company, next to their RV’s. I was allowed to wander around the garden after hours and saw many birds including vermilion flycatcher, yellow warbler, phainopepla, white crowned sparrow, hummingbirds, cactus wren, quail, and the turkey vultures coming in to roost as the sun went down.



Fig. 3 *Fouquieria columnaris*



Fig. 4 *Echinocereus fasciculatus* var. *boyce-thompsonii*



Fig. 5 *Opuntia macrocentra*



Fig. 6 *Aristolochia watsonii*



Fig. 7 *Funastrum cynanchoides*

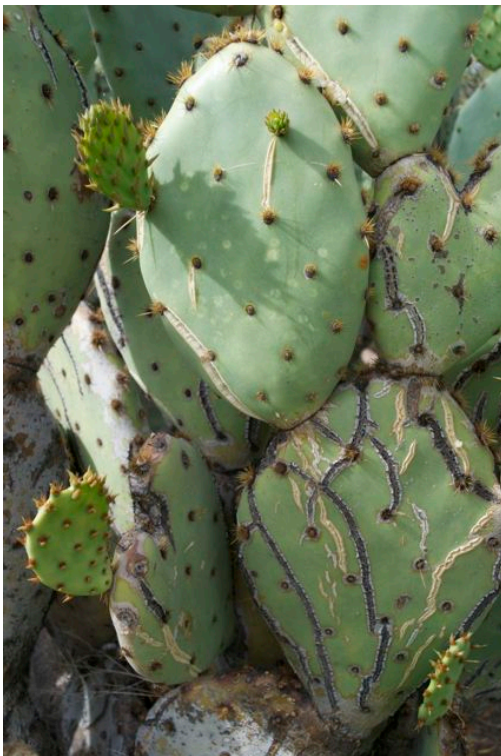


Fig. 8 *Opuntia* sp.

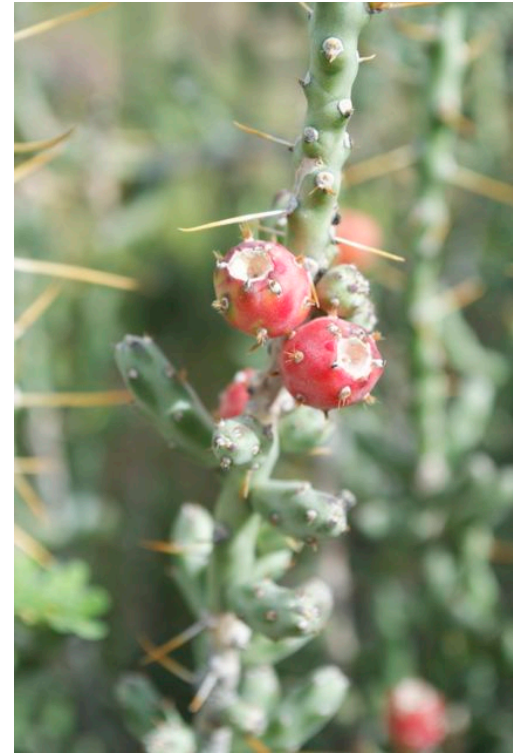


Fig. 9 *Cylindropuntia leptocaulis*

## Tonto National Forest

I left Boyce Thompson Arboretum and headed north east on the AZ-188, the scenic route to north Arizona and the Grand Canyon. This was an eight hour drive through the beautiful scenery of the Tonto National Forest. The vegetation had changed from cacti, ocotillo (*Fouquieria splendens*) and palo verde (*Parkinsonia* sp.) to junipers and pines as I had increased in elevation. I did a short hike to Tonto Natural Bridge, which is thought to be the largest natural travertine bridge in the world, a chemical sedimentary rock derived from the evaporation of spring water rich in calcium carbonate which stands at 183ft high. The hike was rough and rocky and perfectly manageable along a small creek valley with only discreet arrows marked on the rocks to show the way. Some examples of the dominant vegetation are: *Quercus arizonica*, *Juniperus deppeana* and *J. osteosperma*; *Pinus edulis*; *Alnus oblongifolia*; *Celtis reticulata*; *Garrya wrightii*, *Opuntia macrorhiza*; *Agave parryi*; *Nolina microcarpa*.



Fig.10 Tonto Natural Bridge

I crossed over the I-17, the main highway between Phoenix and Flagstaff, and onto the scenic AZ-89A through Sedona and Oak Creek. The rocks of Sedona are bright red, luminous against the dark azure blue of the sky. The reddish rocks are dotted with plants at lower elevations giving a rich tapestry of colours. After leaving Sedona the road descends through a series of hairpin bends into a lush riparian river area called Oak Creek Canyon, a river gorge between Sedona and Flagstaff that forms part of Coconino Natural Forest along the Mogollon Rim. Dappled sunlight comes through the cottonwoods, *Populus fremontii*, on the valley bottom which is surrounded by high walls of rock. The road rises up steeply out of the valley ascending to 7,000ft, the elevation of Flagstaff and Williams. The next day would bring cold weather and snow.

## Grand Canyon

My Grand Canyon experience began at South Kaibab Point on the south rim where I hiked down below the rim for 1.8 miles to Ohh Ahh Point. Unprepared for the cold weather and wearing five layers of clothing and my newly purchased “Grand Canyon National Park” hat and fleece gloves, I began my descent on the trail down the switchbacks. The cold kept me moving swiftly but it was hard not to stop and marvel at the views and to botanise. With a huge chasm revealing itself in front of me it was hard to keep an eye on the flora. There were junipers clinging to the side of rocks, agave spilling out of cracks in the canyon walls and many small herbaceous plants including *Castilleja* sp., *Cryptantha* sp. and *Phlox* sp. I made it to Ohh Ahh point as small snowflakes started to fall and the wind picked up as I saw beautiful views and swooping condors.

The highlight of the Grand Canyon experience was undoubtedly Shoshone Point, a peninsula with a rock formation resembling an Easter Island figure. The mile walk through a pinyon pine forest leads to a spectacular viewing point, unadvertised and unknown by most and I saw the 180 degree views alone. Walking back through the forest I took more notice of the huge amount of blackened pine stumps and the litter of twigs on the ground, reminiscent of David Nash art installations and the result of lightning strikes. According to the National Park Service there are an average of 26,073 lightning strikes a year at the Grand Canyon.



Fig. 11 Shoshone Point, Grand Canyon south rim



Fig.12 *Castilleja* sp., Indian paintbrush



Fig.13 *Agave* sp.



Fig.14 *Phlox* sp., possibly *tenuifolia*.



Fig.15 *Cryptantha* sp.



Fig.16 *Ephedra trifurca*



Fig.17 *Thlaspi montanum*



Fig. 18 Remains of a tree hit by lightning

## Hassayampa River Preserve



Fig. 19 Hassayampa River Preserve visitor centre

The following day I drove south along I-17 and stopped off at the Hassayampa River Preserve, near Wickenburg, to see a riparian river corridor. For most of its 100-mile course the Hassayampa flows underground but comes above ground at this preserve, the name itself literally meaning “upside down river” when translated from the Yavapai language. The waters are crystal-clear and are lined by cottonwood-willow forest. There are easy trails to follow along the river, a hike up to a look-out point over the preserve and a spring fed Palm Lake. There is a trail through a mesquite bosque, *Prosopis velutina*, which also contains *Populus fremontii*, an indication of the ever-changing nature of the riparian corridor due to flood events over time. The ephemeral nature of water in the desert can lead to dramatic or minor change in these areas. Cottonwoods require wet sand to germinate whereas mesquite have long tap roots and can draw on water further down in the ground. A large flood in 1993, an exceptional 100 year event, led to clusters of cottonwood saplings establishing themselves in the bosque.

This preserve is a haven for bird watchers with over 280 species of bird found here. Throughout my walk many birds were darting back and forth between the trees and I spotted red-winged blackbirds, yellow warblers, vermilion flycatcher and the ubiquitous hummingbirds. It was a jewel of a place.



Fig. 20 Looking over Hassayampa Preserve



Fig. 21 *Fouquieria splendens*, Ocotillo.



Fig. 22 *Fouquieria splendens*, flowers.



Fig. 23 *Cylindropuntia* sp., flower buds



Fig. 24 *Erodium cicutarium*



Fig. 25 *Verbena gooddingii*



Fig. 26 *Sphaeralcea ambigua*



Fig. 27 *Phacelia distans*

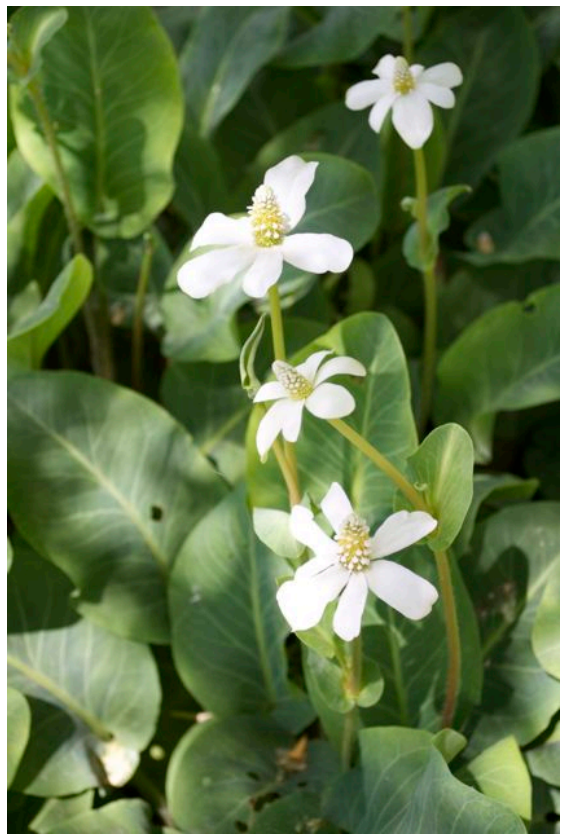


Fig. 28 *Anemopsis californica*





Fig. 29 Frog at Hassayampa

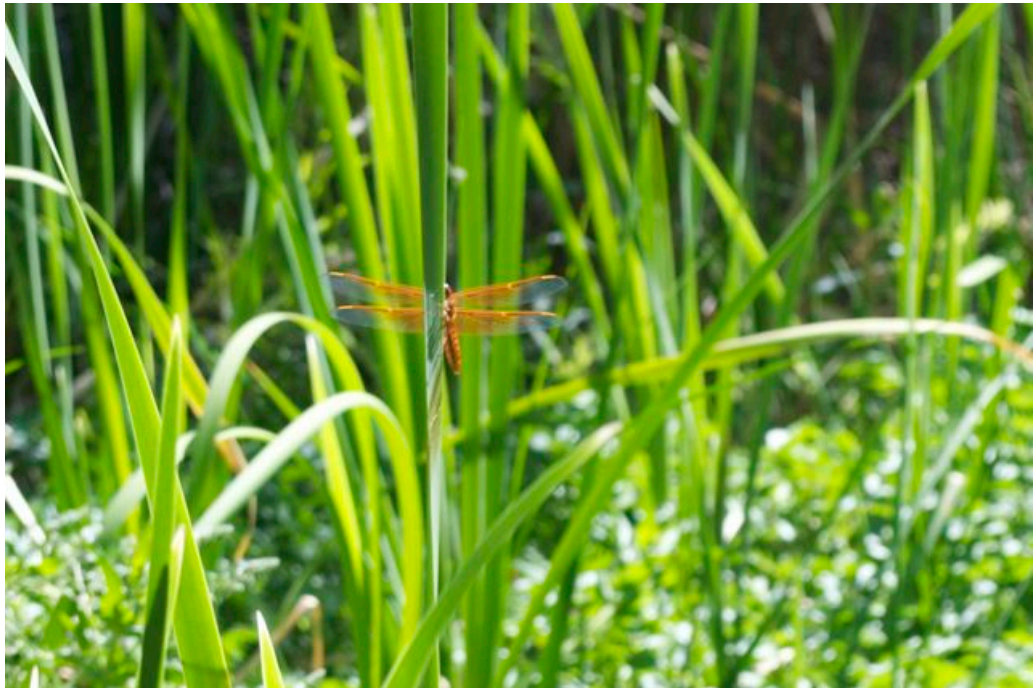


Fig. 30 Dragonfly at Hassayampa

## Tucson

Tucson is a modest city nestled in the valley of five mountain ranges: Tucson, Santa Catalina, Santa Rita, Rincon and Tortolita. When viewing from the top of Tumamoc Hill the city comfortably sits in the surroundings with very few high rise buildings to spoil the view, unlike Phoenix. The desert never feels far away when walking along downtown streets. The city has largely eschewed green front lawns in favour of native or arid adapted plants, very different from the flood irrigated lawns I saw in Phoenix suburbia.



Fig. 31 View of Tucson from Tumamoc Hill

## Tucson Botanical Garden



Fig. 32 *Agave havardiana* and *Fouquieria columnaris*, on the right

I met Michael Chamberland, Director of horticulture, and Emily Rockey, curator, who took me on a tour of the 5.5 acre garden. The garden and house were originally the home of the Porter family who bequeathed the property to Tucson City Council in 1974. Porter House was built in 1929 and the Porter Patio historical garden contains many shrubs that were popular in Tucson in the 30s and 40s such as *Myrtus communis*, *Olea europaea*, *Punica granatum*, *Citrus* sp. and a rose garden.

The botanic garden contains many different themed gardens including the Native American crops emphasizing plants grown by the Tohono O'odham; xeriscape demonstration beds showing home owners drought tolerant plants and types of irrigation systems including water harvesting; a wildflower garden with southwest annuals and perennials. The cactus and succulent garden features plants from desert regions around the world and is arranged geographically.

The Nuestro Jardin was of particular interest to me and honours the traditional Tucson barrio or “neighbourhood” garden, a US/Mexican garden with edible and useful plants, recycled containers and bed edging and shrines. This garden is surrounded by an ocotillo, *Fouquieria splendens*, fence, which appears dead but some of the stems have small young leaves and after the rains in the summer it will burst into bud and leaf and become a “living fence”.



Fig. 33 Ocotillo fence



Fig. 34 Detail of ocotillo fence showing some growth

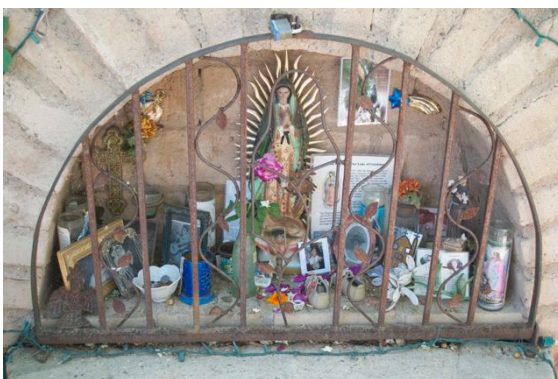


Fig. 35 Shrine in Nuestro Jardin



Fig. 36 Bottles used as path edging in Nuestro Jardin



Fig. 37 & 38 *Oenothera berlandieri* in the wildflower garden



Fig. 39 Shadecloth to protect young plants



Fig. 40 *Aloysia lycioides* in the wildflower garden



Fig. 41 Desert spiny lizard

## Tohono Chul Park

I visited this garden on an exceptionally hot day, 40 degrees plus, but was rewarded with another well-maintained and educational collection. My main interest was the Sin Agua garden, or “without water” garden. This garden shows the public how to construct features to maximise water runoff to avoid the use of supplementary water in gardens. Berms, contoured mounds of earth, surround and define each planting plot, containing and directing the flow of surface runoff. Channels have been dug around the garden with gates installed to direct the flow of water to areas where it is needed. In between the plots are graded slopes allowing excess runoff to flow into and between each plot. Any excess water will spill out onto the surrounding land. At this time of the year the garden was quite dry and barren, but once the rains arrive in late July the garden will spring to life with lush growth. July to mid-September is the main growing season in Tucson. Winter rains will enable spring annuals to flower. May through July are the driest and hottest times of the year.



Fig. 42 Vulture sculpture at Tohono Chul



Fig. 43 Sin Agua garden



Fig. 44 Channel with gates to control the flow of water

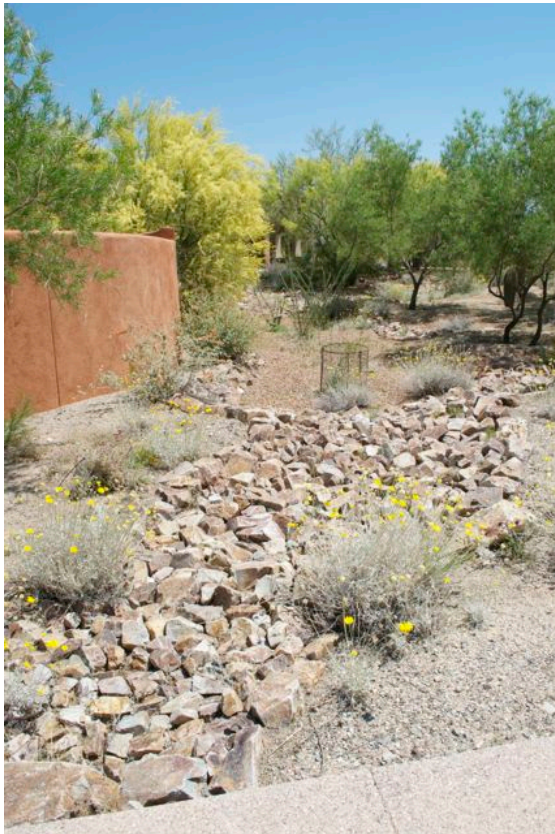


Fig. 45 & 46 Berms

## Water Use in Tucson: Rincon neighbourhood Green Infrastructure

After the heat of the day I took a walking tour through the Rincon neighbourhood in Tucson to look at work done by the Watershed Management Group and local residents to plant the neighbourhood with drought tolerant plants watered by runoff captured by basins and other landscaping features, similar to those seen in the Sin Agua garden at Tohono Chul Park. The self-guided walking tour took about an hour using a map for reference.



Fig. 47 Unusual plant container seen on a Tucson sidewalk

Chicanes and curb cuts direct the stormwater run off into basins which feeds the vegetation and infiltrates into the soil or flows back onto the street. It was interesting to see how differently each resident had planted up the area outside their house. I spoke to a local resident who greatly supported this initiative but one of her concerns was the maintenance of the vegetation. She said there were problems with weedy growth which would spill out into the road making it difficult for cyclists and it looked unattractive. I did see some badly maintained vegetation areas and with any public planting scheme this would be one of the main issues to address.

All the public gardens I visited in Tucson have some information regarding water usage and water harvesting. The City of Tucson offers online information on water harvesting, watercourse maintenance and guidance on Right of Way planting (the areas between the pavement and the street or the residence and the pavement). Similar to the Watershed Management Group it discusses how to utilise runoff from rainwater to water these plants rather than potable or mains water.



A gardening radio show I was listening to one morning, Rosie on the House, was discussing low-water use plants and how over the past 20 years the attitude to using drought tolerant plants has drastically changed. Gone are the water-loving bougainvillea, *Pyracantha*, *Punica granatum*, replaced by plants found in the surrounding Sonoran Desert as well as other arid adapted plants from around the world. I saw many *Aloe* sp. planted along the public highways and streets in Tucson and species of cacti, *Agave*, *Yucca* and native herbaceous perennials and annuals can be seen in front yards throughout Tucson.



Fig. 48 Curb cuts and basins at road intersection



Fig. 49 Curb cut to allow water to flow in



Fig. 50 Berm and gravel filled trench



Fig. 51 Chicane with flush curbs and depressed basin



Fig. 52 A residential water harvester in Tucson

## Arizona-Sonora Desert Museum



Fig. 53 Saguaro National Park seen from Gates Pass Road

The Arizona-Sonora Desert Museum (ASDM), a zoo, natural history museum and botanic garden nestled in the Saguaro National Park, was my next stop for five days. The museum is spread over 21 acres and is the prime place to learn about the ecology of the Sonoran Desert. The drive to the museum is an event in itself along Gates Pass Road which snakes up through the Tucson Mountains and opens up to reveal the Saguaro National Park, thick with gigantic cacti.

I was met by George Montgomery, Curator of Botany, and one of 110 employees at ASDM. There are nine horticulturists (botany department), 15 animal keepers, four research/conservation staff, 10 education staff (this includes docent programs; school education e.g ‘Sonoran Supermarket’ teaches about wild foods found in the desert; agricultural training and art classes) and 400 volunteers. ASDM holds the national collection for *Agave*. ASDM is at the forefront of research and education on the Sonoran Desert and was hosting a conference titled “The next generation of Sonoran researchers”, bringing together experts and students mainly from Arizona and Mexico but also from further afield.

A full program had been arranged for me which included tours of the nursery and propagation areas from botanist John Wiens, also head propagator. He has just revised the “Flora of Arizona” by Anne Orth Epple, the only comprehensive field guide available on the native flora. I was shown the misting benches, the media used for propagation and the various native and non-native plants grown. Desert soil has a basic pH of 7 and above so to increase the pH calcium carbonate is added to potting mixes. There is a locked shaded outdoor area for endangered plants including

*Coryphantha sheerii* and *Echinocactus horzonthalonious* var. *nicholii*. There were also endangered plants that had been seized by customs officers at the Mexican border such as *Mammillaria sartorii*, a Mexican native.

I was given a behind-the-scenes look at the reptile and amphibian enclosure where I met the native gila monster, Arizona coral snake and Sonoran Desert toad, and saw many native mammals on the tour around the museum including coyote, mountain lion, javelina and prairie dogs, just some of the many mammals found in the Sonoran Desert. All the while I saw lizards skittering across paths or sunbathing on rocks.



Fig. 54 Gila monster

George had a meeting in the morning which I was invited to attend. A woman from a technological company had developed acoustic sensors that she believed might be of use for studying the saguaro. She proposed running some tests using ASDM cacti. The saguaro is over 90% water and she was intrigued to know if the movement of water could be heard using acoustic sensors. The saguaro could be monitored for stress to hear if it “screams” under particular stressful conditions, for instance when suffering from lack of water. The sensors are placed on the surface of the cactus and are non-invasive. George suggested the acoustic sensors could also be used for *Opuntia* sp. There is a huge, lucrative industry in Mexico based around the Coccineal insect, a scale insect growing on *Opuntia* sp. Coccineal is used as a natural dye. The sensors may be able to determine how much scale can grow on the plant before it gets stressed and plant health is affected.

After this meeting George gave me a short lesson about the saguaro, the endemic columnar cacti of the Sonoran Desert. *Carnegiea gigantea* is a very important plant for the ecology of the desert. The flowers only open for one day and are traditionally pollinated by bats from Mexico. These “bat corridors” are being increasingly disturbed so now the main pollinators in Arizona are white-winged doves, birds and insects. Gila and gilded flicker woodpeckers make holes in the saguaro for their

nests and once vacated are used by up to 10-15 other species of birds including cactus wrens, finches and the purple martin for nesting. The fruit is not only a source of food for the birds and mammals of the desert but also for the native peoples who hold ceremonies associated with fruit collection. Saguaro take many years to grow and after 3 years young seedlings will only be 15mm high, provided they are not killed by winter freezes and receive sufficient summer rain. Young saguaro are most often seen growing in the shelter of “nurse plants” such as palo verde, mesquite (*Prosopis* sp.) and other shrubs to protect them from mammals and strong sunlight. Saguaro grow in age cohorts so you will see those of similar ages in groups. This is because seeds tend to all survive or do not survive at all, it is uncommon to see saguaro of different age groups together. By 70 years the saguaro will have reached 2-3m in height and at this age they start flowering after which time branches start to develop. Their lifespan is approximately 150-200 years. Evidence of dead saguaro are littered throughout the desert where you see the woody internal “ribs” and “boots” which are old woodpecker holes scattered around. Each saguaro has a character and according to interpretation boards I saw at Tohono Chul Park, the native Tohono O’odham believe “saguaro are people, too” and are taught never to harm them.



Fig. 55 Saguaro flower



Fig. 56 Saguaro and nurse plant, King Canyon



Fig. 57 Saguaro flowers, ASDM



Fig. 58 Saguaro with many holes made by birds, ASDM



Fig. 59 Saguaro ribs, Boyce Thompson Arboretum

One of the many highlights of my stay was accompanying Erik Rakestraw, a horticulturist, on his twice monthly phenology survey in the Saguaro National Park, which turned into a three hour hike of King Canyon. The survey notes the timings of flowering, the condition and size of the natural plants, compared with those in cultivation. Erik was a wonderful, knowledgeable guide about the flora and the native tribes that had lived in the area. We saw an ancient grinding hole and a natural rock tank called a tinaja, which stores water after the rains, and natural dry washes that channel water during the summer and winter storms.

As well as the above I met a group of botanical artists studying on the Sonoran Desert Florilegium program; Steve White discussed the modified septic system in use at ASDM which in the future may provide all water for horticultural use and Julie Wiens explained the plant database system, the accession numbering system and the information that is collected including phenology, propagation records and the seed database. There is a small herbarium which is maintained by John Wiens.



Fig. 60 *Parkinsonia* sp. in a desert wash, King Canyon



Fig. 61 Saguaro, King Canyon

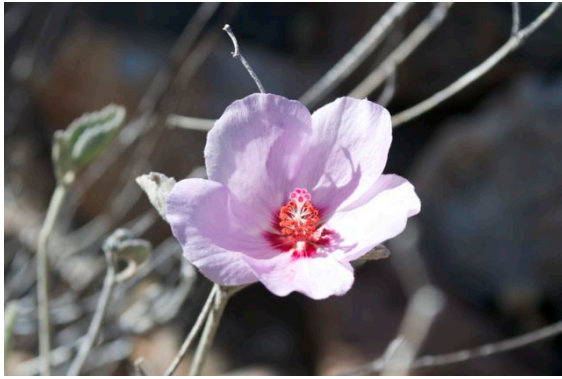


Fig. 62 *Hibiscus denudatus*



Fig. 63 *Krameria grayi*



Fig. 64 *Carlwrightia arizonica*



Fig. 65 *Eschscholzia californica* ssp. *mexicana*



Fig. 66 *Penstemon parryi*



Fig. 67 *Streptanthus carinatus* ssp. *arizonicus*



Fig. 68 A medley of desert plants

## Nurseries:

### Miles' to Go; Plants for the Southwest

While staying at ASDM George Montgomery arranged visits to two local nurseries.

Miles' to Go in Cortaro, is a mail-order plant nursery where Miles Anderson maintains single-handedly 4-5 polytunnels housing mainly non-native cacti and succulents. His home is adjacent to the nursery and is not open to the public. Miles showed us grafted plants, the rootstock he favours using are *Harrisia justbertii* and *Stenocereus griseus* because they have a longer growing season and are long lived. There was a huge array of plants with the majority being non-native but perfectly adapted to survive the harsh conditions of the Arizona climate.



Fig. 69 Grafted cacti at Miles' to Go

Plants for the Southwest, run by Gene and Jane Joseph in central Tucson, specialises in *Lithops* and other arid land plants. Gene Joseph was a former propagator at ASDM. This is a retail nursery and far smaller than Miles' to Go but just as impressive with the array of plants on offer. Non-natives such as *Adenium* are very popular with growers in Arizona, indeed the previous Director of Natural History at ASDM, Mark Dimmitt, is an authority on *Adenium* cultivation. There are nine greenhouses and shade houses on the premises housing cacti and succulents from around the world and uncommon desert shrubs and wildflowers from the Sonoran region such as the Sonoran fig tree, *Ficus palmeri*. All plants are grown from seed or propagated from root cuttings on the premises with very few exceptions.



## Chiricahuas

Midway through the trip I visited the “sky island” of the Chiricahuas accompanied by George Montgomery, from ASDM. “Sky islands” are mountainous areas with cool, moist conditions that are isolated by the surrounding arid landscape. This national park is known for the rock pinnacles or “standing up rocks”. There had been a fire here in 2011 and many areas had been completely burnt. It was called the Horseshoe Two fire and started May 8 in Horseshoe Canyon, believed to be the cause of human activity. The fire was made worse by strong winds and dry fuel from the death of many trees, particularly oaks, the previous winter due to the “Big Freeze” (an event which saw temperatures dip to  $-17^{\circ}\text{C}$ ). 223,000 acres were destroyed. Many of the burnt plants we saw had re-growth at the base. The slight variation in elevation, slope, moisture or temperature can create a different vegetation type. Southern slopes have *Pinus engelmannii*, *Pinus cembroides*, *Yucca schottii* and *Opuntia* sp. Cooler northern slopes have *Pinus ponderosa* and *Pseudotsuga menziesii*.



Fig. 70 Rock pinnacles, Chiricahua National Monument



Fig. 71 Fire damaged mountains

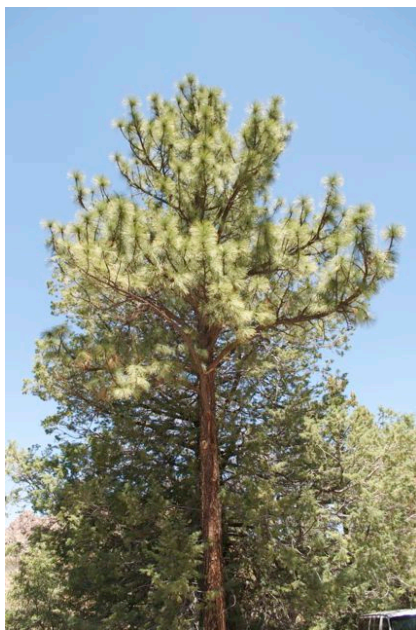


Fig. 72 *Pinus engelmannii*



Fig. 73 *Yucca toumeyana*



Fig. 74 A fire damaged *Agave* with re-growth at the base

## Sabino Canyon

Sabino Canyon is located a short drive outside Tucson in the Santa Catalina mountains. This was one of my favourite hikes along the 4.5 mile Phoneline trail which gives a good view over the canyon and over Tucson. I stopped every few minutes to marvel at the flora such as the torch cacti growing out of soiless crevices and take photos of exquisite flowers. One macro photo session led to my sunglasses tumbling down into the canyon - bounty for a mountain lion perhaps?



Fig. 75 *Cylindropuntia bigelovii*, Teddy bear cholla



Fig. 76 *Opuntia* sp. flowers



Fig. 77 *Anisacanthus thurberi*

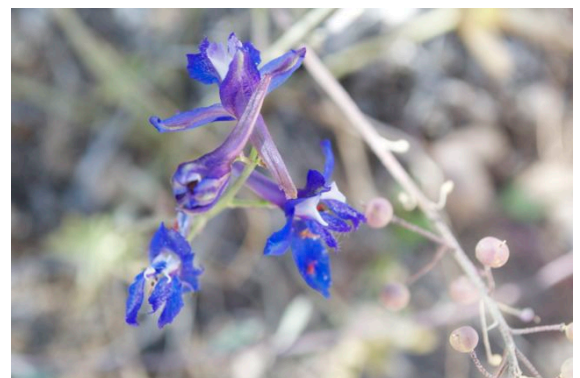


Fig. 78 *Delphinium scaposum*



Fig. 79 The Phoneline trail, Sabino Canyon, with Tucson in the distance



Fig. 80 Flower of a hedgehog cactus, *Echinocereus* sp.

## Brown Canyon, Baboquivari Mountains

Near the end of my visit I was extremely lucky to be able to accompany a group of botanists and ecologists from US Fish & Wildlife Service, Bureau of Land Management, Arizona State University, Tohono O'odham nation and the eminent botanist Dan Austin, to Brown Canyon in the Baboquivari Mountains to monitor populations of the endangered *Amsonia kearyneana*.



Fig. 81 *Amsonia kearyneana*, Baboquivari

This area of land comes under the auspices of the Buenos Aires National Wildlife Refuge, the Bureau of Land Management (BLM) and the Tohono O'odham Nation. This plant is considered endemic to the area and populations were introduced in 1988/89. A decline in this population was noted after floods in 1990 and more recently natural populations were discovered. The hike started out fairly easily with botanising along the way. I was lucky to see a golden eagle far away, but the huge wingspan could be appreciated. Brown Canyon arch, a natural rock arch marked the end of the trail which can be hiked by appointment only. Thereafter we would be on BLM land and there would be no trails. This area is known as the Baboquivari Wilderness and is undisturbed. We started off along a creek on Brown Canyon floor where I saw *Quercus oblongifolia*, *Morus microphylla*, *Platanus wrightii*, *Ptelea trifoliata* and herbaceous plants including *Bouvardia ternifolia*, *Stachys coccinea*, *Aquilegia chrysantha* var. *chrysantha*. We soon started clambering up rocks trying to find a natural route. Ominously Dan said this was nothing compared to what was coming. We kept going for a while up steep slopes, stopping now and again, it was slow going as every footstep was crucial otherwise you could end up sliding down the hill. On the slope was *Mimosa aculeaticarpa* and *Agave schottii*, and after impaling my shins on it many times I understood why it is commonly known as the shindagger agave. We came to a rest for lunch after three hours. Then an advanced party including myself, were to continue over the ridge looking for populations. It was a strenuous hike but we were rewarded with plants at new locations as well as those previously surveyed. We finally met up with the rest of the group who were waiting for us only a few metres away from a black tailed

**Maija Ross**

rattlesnake, the first I had seen in the wild. We headed back slowly stopping to botanise and to marvel at two gray hawks resting in the trees. When we drove off we saw a male wild turkey displaying to two seemingly nonchalant females.



Fig. 82 Arriving at Brown Canyon arch



Fig. 83 & 84 Baboquivari wilderness



Fig. 85 *Ptelea trifoliata*



Fig. 87 *Aquilegia chrysantha* var. *chrysantha*



Fig. 86 *Mammillaria grahamii*

## San Pedro National Conservation Area

On my last day I visited the San Pedro Riparian National Conservation Area near Bisbee and Sierra Vista, southeast Arizona. It was established in 1988 and is managed by BLM, and contains more than 56,000 acres of public land in Cochise County near the US/Mexican border. It supports over 350 species of birds and 625 taxa and lies at the crossroads of four separate ecosystems: Sonoran and Chihuahuan deserts, Sierra Madre of Mexico and Rocky Mountains. Riparian areas are extremely rare in Arizona constituting less than 1% of the landscape but supporting a disproportionately large portion of the total flora.

A swathe of green amongst the surrounding blonde sacaton (*Sporobolus* sp.) grassland can be seen from miles away as you approach the reserve along Route 90. The contrast is striking as you drive under the majestic *Populus fremontii*. The majority of flora is seen after the summer rains when the San Pedro is in full force.

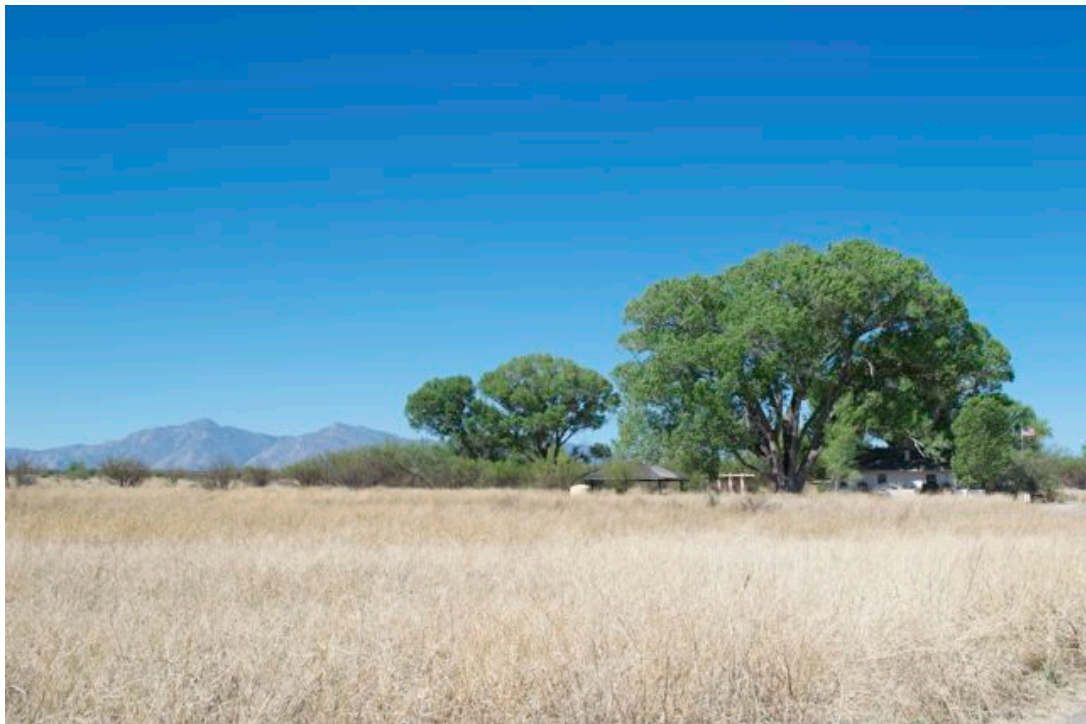


Fig. 88 San Pedro Riparian National Conservation Area

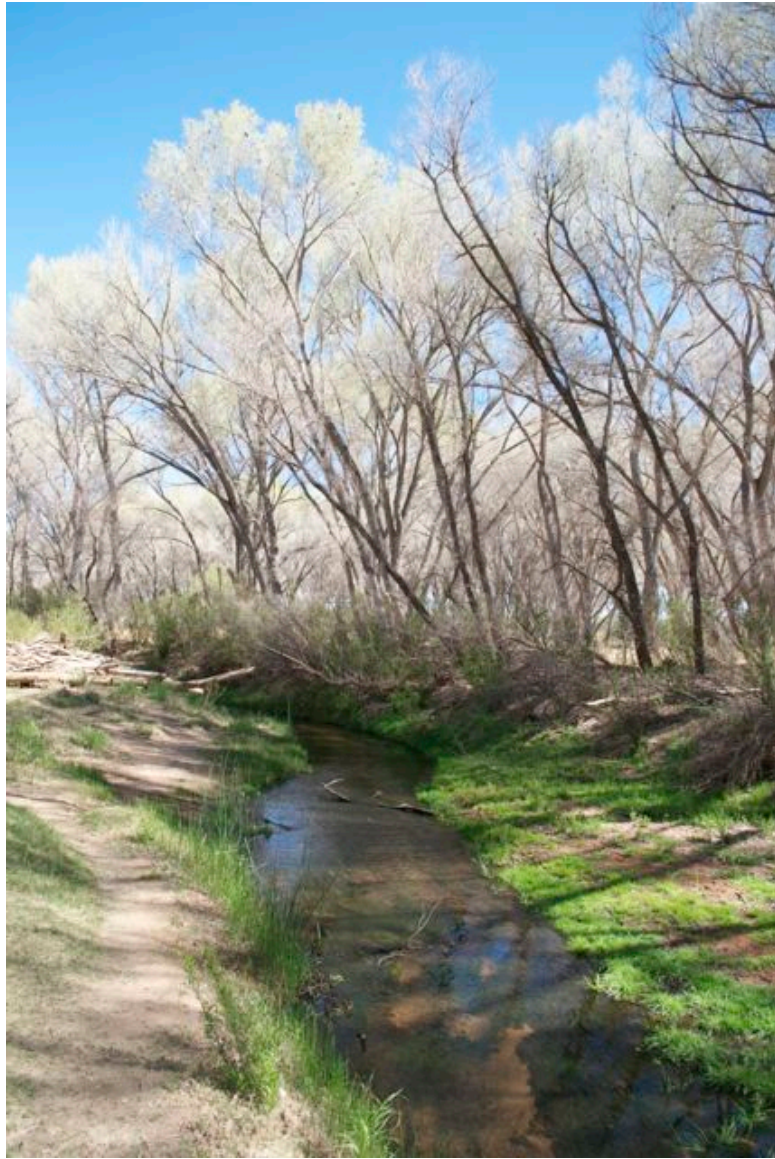


Fig. 89 *Populus fremontii* along the San Pedro



Fig. 90 Sacaton grasslands near Bisbee, Arizona



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## Conclusion

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Over the three weeks I saw a fraction of Arizona, and 2,000 photos later I have only been able to show a snapshot of the beautiful flora, scenery and animals I encountered on my adventure. The goal was to learn about desert ecology, see the plants in their native habitat and to learn how they are cultivated and displayed in botanic and public gardens. I discovered that the public are being widely educated about water use and encouraged to use native and desert adapted plants. Most of my time was spent in south Arizona and in the Sonoran Desert region as this area was the most rewarding for my research. Late winter when I visited is traditionally a good season to see wildflowers if the winter rains have been plentiful, unfortunately this year there had been little rain, but I was lucky to be there just as the saguaro began flowering and many other cacti were in bloom. To fully appreciate the richness of the flora the area should ideally be observed through the seasons, particularly after the summer rains.

I am confident I have received a good grounding in desert ecology which has inspired me to continue researching and learning about this fascinating part of the world.

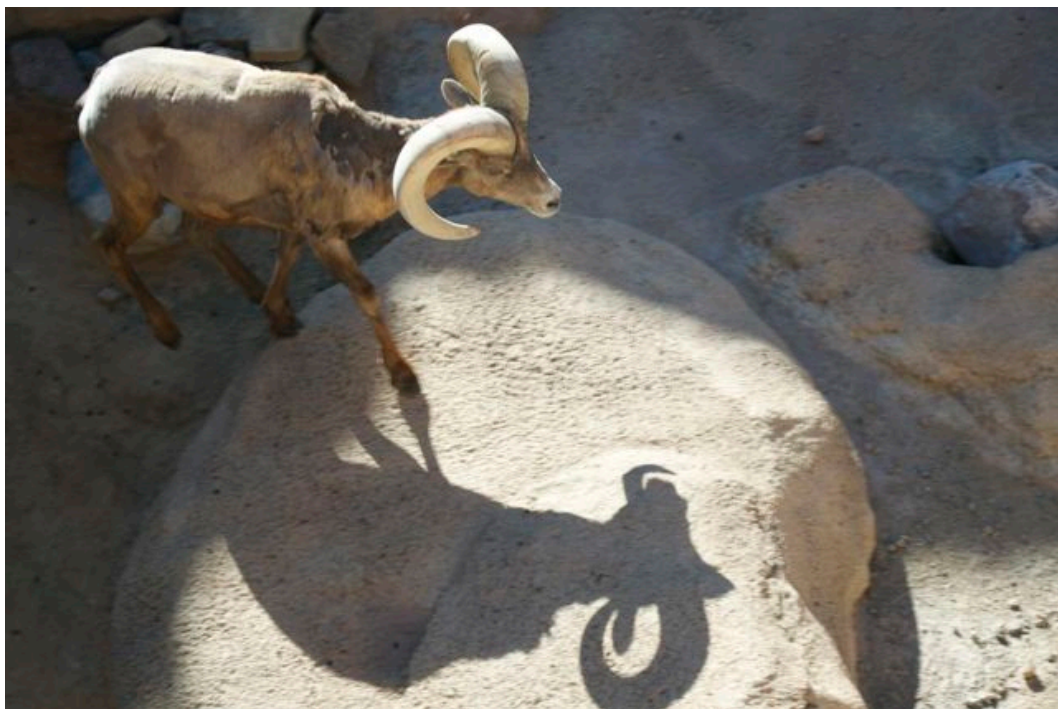


Fig. 91 Desert bighorn sheep, Arizona-Sonora Desert Museum

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## Final budget breakdown

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| Expenditure                       | Cost          |
|-----------------------------------|---------------|
| Flight: London - Phoenix - London | £632          |
| Accommodation                     | £850          |
| Car rental                        | £560          |
| National park entry               | £50           |
| Food                              | £400          |
| Fuel                              | £250          |
| <b>Total</b>                      | <b>£2,742</b> |

### Grants awarded

|                             |               |
|-----------------------------|---------------|
| Merlin Trust                | £750          |
| Royal Horticultural Society | £1,200        |
| Kew Guild                   | £600          |
| <b>Total:</b>               | <b>£2,550</b> |

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Campus Arboretum: Tanya Quist

Tucson Botanical Garden: Michael Chamberland, Emily Rockey

Tumamoc Hill Desert Laboratory, Cynthia Anson, Owen Davis

Daniel F. Austin

Kath Smith, Science & Collections Co-ordinator, RBG Kew

Phil Griffiths, Conservatories Co-ordinator, RBG Kew

Elisa Biondi, Horticulturist, Cacti Unit, RBG Kew

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## References

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Arizona Rare Plant Committee (2001), *Arizona rare plant field guide: a collaboration of agencies and organisations*, U.S. Government Printing Office, Washington.

Bowers, Nora & Rick & Tekiela, Stan (2008), *Cactus of Arizona: field guide*, Adventure Publications Inc., Cambridge, Minnesota

Brusca, Richard C., Dimmitt, Mark A., & Montgomery, George M., editors (2010), *Desert gardens: a photographic tour of the Arizona-Sonora Desert Museum*, Cool Springs Press, Brentwood, Tennessee

Childs, Craig (2000), *The secret knowledge of water: discovering the essence of the American desert*, Back Bay Books, New York

Epple, Anne Orth (1995), *A field guide to the plants of Arizona*, Falcon Publishing Inc.

Phillips, Steven J. & Comus, Patricia Wentworth, editors (2000), *A natural history of the Sonoran Desert*, Arizona-Sonora Desert Museum Press, Tucson.

Reisner, Marc (1993), *Cadillac desert: the American west and its disappearing water*, revised edition, Penguin Books,

Spellenberg, Richard (2003), *Sonoran Desert wildflowers: a field guide to common species of the Sonoran Desert, including Anza-Borrego Desert State Park, Saguaro National Park, Organ Pipe Cactus National Monument, Ironwood Forest National Monument, and the Sonoran Portion of Joshua Tree National Park*, The Globe Pequot Press, Connecticut.