

Exploring Desert Plants



(March, 2023)

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Introduction

Author

A love of plants, people, and the natural world combined with a desire to change the direction of my career led me to embarking on the BSc Horticulture (Plant Science) course at Eden Project University Centre (EPUC) in 2021. I am grateful to have been encouraged to seek out and undertake work placements to explore my interests outside the classroom with the aim of gaining practical experience in authentic surroundings from professional people who are passionate about what they do.

I have a long-held passion for desert plants which was cultivated by my dad. He was fascinated by plants from warmer climates and in our small conservatory in Suffolk he collected different species of yuccas, agaves, and cacti. I developed a particular affection for plants from the charismatic Cactaceae family and recently, more specifically, the keystone species *Carnegiea gigantea* (saguaro). Throughout every module of the first two years of my degree *Carnegiea gigantea* had been discussed. From the importance of *Carnegiea gigantea* both culturally and historically to Indigenous people of the Sonoran Desert to their critical role in desert ecology, supporting a wide variety of wildlife as both habitat and food. I felt drawn to learn more and inspired to see them in their natural environment.

In November 2022, I emailed the Desert Botanical Garden (DBG) in Phoenix, Arizona asking if I could volunteer with their Cactus Specialist during the 2023 summer break. Within two days, Tina Wilson (Senior Director for Horticulture) replied saying 'Let's see if we can make this work for you'. I was beyond excited and set about raising funds.

Project overview

DBG in Phoenix, Arizona is a world class, contemporary and diverse botanical garden with a mission to 'advance excellence in education, research, exhibition, and conservation of desert plants of the world with an emphasis on the Sonoran Desert' (Desert Botanical Garden 2023a). I knew that working at DBG would deepen my understanding of effective methods of maintaining, propagating, and managing living collections and their importance in plant conservation. I also hoped to gain knowledge from experts to inform my third year Honours Project and gain specialised knowledge relating to desert plants which I could share with others through this report and presentations to fellow students, horticulturalists, and hobbyists.

Furthermore, I planned to spend time at the Saguaro National Park (SNP) to see *Carnegiea gigantea* in-situ and visit the nearby Boyce Thompson Arboretum.

Aims and objectives

- Volunteer at DBG, Phoenix, Arizona alongside Noemí Hernández Castro, Cactus Specialist for two weeks to deepen knowledge of desert plants, specifically those from the Cactaceae family.
- Work within a world class, contemporary botanical garden which is a global leader in the research of desert plants and habitats.
- Gain experience in the care of plants within the Cactaceae collection at DBG and explore effective methods of maintaining, propagating, and managing living collections and their importance in plant conservation.
- Investigate possible areas of research to inform third year Honours Project.
- Gain as much practical experience and knowledge as possible from professional horticulturalists.
- Share knowledge gained with the wider horticultural community including fellow students, professional horticulturalists, and hobbyists.
- Visit local National Parks, Monuments, and gardens to further deepen knowledge of the area.

Itinerary

13/06/23 – Visit SNP.

15/06/23 – DBG -Introduction to the garden.

16/06/23 – DBG - Cactaceae collection: Managing pests and diseases.

18/06/23 – Visit the Heard Museum

19/06/23 – Visit Tonto National Monument.

20/06/23 – DBG - Cactaceae collection: Caring for the collection.

21/06/23 – DBG - Cactaceae collection: Seed collecting and cleaning.

22/06/23 – DBG - Day in the garden: Center for Desert Living trail.

23/06/23 – DBG - Agavaceae collection: An education in succulents.

25/06/23 – Visit Boyce Thompson Arboretum.

26/06/23 – DBG - Schilling library: The History of the garden.

27/06/23 – DBG - Cactaceae collection: Caring for the collection.

28/06/23 – DBG - Garden: Moving plants.

29/06/23 – DBG - Tissue Culture Workshop.

Work programme

Saguaro National Park

SNP covers over 140 square miles to the east and west of the city of Tucson, Arizona (National Park Service, 2023a). Situated in the Sonoran Desert, visitors are offered an opportunity to walk through the desert landscape amongst the iconic and breathtaking *Carnegiea gigantea*. On 13th June I visited the western park, located on slopes of the Tucson mountains and covering over 39 square miles. The park contains dense populations of younger *Carnegiea gigantea* amongst scrub and desert grassland. It is situated at lower elevation compared to the eastern park which covers a larger area and contains older *Carnegiea gigantea* forest (National Park Service, 2023b) (Figure 1).



Figure 1. *Carnegiea gigantea* in the western district of Saguaro National Park (March, 2023).

I entered the park through the Red Hills Visitor Centre and headed to the Desert Discovery Nature trail, a short 0.4-mile easy loop walk. Due to time of year temperatures ranged between 32°C and 43°C and I was advised to hike early in the day and carry plenty of water (National Park Service 2023c). Entering the trail, the sound struck me immediately. The desert was teeming with life, something I had not been prepared for. The combination of the soundtrack of cicadas and birdsong, the amazing scent of the desert and the image of the giant *Carnegiea gigantea* rising out of the desert scrub surrounded by plants including the striking *Fouquieria splendens* (ocotillo), *Opuntia* spp. (prickly pear), *Cylindropuntia* spp. (cholla), *Prosopis velutina* (velvet mesquite) and *Larrea tridentata* (creosote) was an overwhelming delight to all my senses. It was an incredible experience to witness these plants in their natural, stunning environment and one I will never forget (Figure 2).



Figure 2. Surrounded by native plants including *Carnegiea gigantea*, *Opuntia* spp., *Cylindropuntia* spp. and *Fouquieria splendens* in the western district of Saguaro National Park (March, 2023).

The rich variety of plants and animals supported by the Sonoran Desert, which covers approximately 100,000 square miles across two countries and five states (Figure 3) can be partially explained by the amount and seasonality of rainfall receives. It enjoys two rainy seasons annually: summer monsoonal and cold winter storms equating to approximately eight inches a year and frosts are rarely experienced. SNP is thought to protect more than 1700 species of plants and animals within its boundaries (Phillips *et al.*, 2015).



Figure 3. The area covered by the Sonoran Desert (Mirocha, 2023).

The landscape is dominated by the giant columnar *Carnegiea gigantea*, the largest cactus in the United States reaching an average of 12 metres in height and living up to an estimated 250 years (Quinn, 2019). Branches start to grow at a height of four to five metres after 50-70 years. *Carnegiea gigantea* flowers are white and bloom from late spring and are pollinated by birds, bees and nectar seeking bats. My visit coincided with fruiting season and the appearance of fruit on the plants looked like they were wearing beautiful headdresses. The birds, in particular doves, could be seen feasting on the ripe fruit of numerous plants. Witnessing this caused me to reflect on what I heard learnt about the Tohono O’odham, a large tribe that currently inhabits portions of south-western Arizona and north-western Mexico. *Carnegiea gigantea* is of fundamental importance to the Tohono O’odham whose calendar starts with the month of fruit harvest and creation stories tell of how *Carnegiea gigantea* were originally humans and must be treated with respect, something that has always resonated with me as a plant lover (Quinn, 2019: Royal Botanic Gardens Kew, 2023). Historically fruit was collected using long poles made from the woody ribs of dead *Carnegiea gigantea* and used to make wine for the rain making ceremonies as well as preserves of the fruit for later use (Erickson, 1994).

I observed many striking *Carnegiea gigantea* skeletons at SNP (Figure 4) and researched possible causes of their death. Alongside old age *Carnegiea gigantea* die prematurely due to weather events such as strong winds, lightning strikes and sunburn and desiccation caused by increased prolonged high temperatures as the planet warms. Furthermore, the extended reach south of freezing temperatures caused by climate change is likely to threaten more plants in the future. Human activity has driven habitat loss due to urbanisation and poaching of plants for their dried ribs to produce designer furniture is another major cause of loss. The introduction and rapid spread of invasive grasses including *Cenchrus ciliaris* (buffelgrass) has caused major devastation to native vegetation and biodiversity due to fire (Yetman *et al.*, 2020).



Figure 4. A *Carnegiea gigantea* skeleton observed at Saguaro National Park (March, 2023).

I observed my first in-situ examples of nurse plants at SNP including *Prosopis velutina*, *Larrea tridentata* and *Parkinsonia aculeata* (palo verde). *Carnegiea gigantea* and other species cope with increasing temperatures by establishing beneath the protective canopy of nurse plants which provide shade and prevent sunburn and frost damage. They also provide physical protection from herbivores and in the case of the leguminous trees such as *Parkinsonia aculeata* provide a nitrogen enriched soil (Yetman *et al.*, 2020). These plants are becoming increasingly important at a time of rising temperatures and heat waves caused by anthropogenic climate change. I had learnt about nurse plants and their significance throughout my course but there was something extremely special about seeing them in-situ performing this role (Figure 5).



Figure 5. Examples of a variety species performing the role of nurse plants at Saguaro National Park (March, 2023).

I continued my trip around the six-mile Bajada loop drive and took a gentle hike to the top of Signal Hill. Signal Hill is a minor summit, rising approximately 50 feet above the surrounding plains. The view from the top is breathtaking as are the petroglyphs carved into the rocks, dating from the Hohokam period that peaked in the 13th and 14th centuries (The American Southwest, 2023) (Figure 6).



Figure 6. Petroglyphs dating from the Hohokam period carved into rock at the summit of Signal Hill located in Saguaro National Park (March, 2023).

I was fascinated and enchanted by the desert, the scenery, the species richness, and the incredible mutualisms I witnessed in an environment that I was expecting to be a relatively desolate. I left SNP full of awe at the beauty of this magical place.

The Desert Botanical Garden

DBG is situated in Papago park in South Scottsdale, Phoenix, Arizona (Figure 7). It is a private not-for-profit organisation which opened to the public in 1939 following years of passion and determination from co-founders Gustaf Starck, plantsman and Gertrude Webster, philanthropist.

Gertrude Webster stated in her opening speech in 1939 that the purpose of the garden was three-fold;

- To conserve the Arizona desert flora, fast being destroyed.
- To establish scientific plantings for students and botanists
- To make a compelling attraction for winter visitors.

(Blanc, 2014).



Figure 7. The entrance to the Desert Botanical Garden located in Phoenix, Arizona (March, 2023).

Today, despite turbulent times caused by global events, DBG is still aligned to these goals. It is a global leader in the research of desert plants and habitats with a focus on conservation of threatened and endangered species. Covering 55 acres the garden is filled with thousands of species of desert plants from across the world and includes trails such as the Desert Discovery trail, Plants and People of the Sonoran Desert trail and the Center for Desert Living trail (Desert Botanical Garden, 2023b). In 2022 the garden attracted over 870,000 visitors from 32 countries (Desert Botanical Garden, 2023a). I felt incredibly fortunate to be spending two weeks alongside Noemí Hernández Castro, Cactus Specialist, caring for plants in the living collection.

First impressions

My first impressions of DBG were striking. The plants were beautifully exhibited, well maintained and looked incredibly healthy in their habitat (Figure 8).



Figure 8. A selection of the plants situated near the entrance of the Desert Botanical Garden including *Agave* spp., *Opuntia* spp. *Stenocereus thurberi* (organ pipe cactus) and *Carnegiea gigantea*.

I met Noemí at the entrance and we walked the garden trails. We talked a lot, getting to know each other and I obtained an insight into her vast and varied role. I could already sense there was a lot of knowledge to be gained from this experience and Noemí was keen that I spent time understanding as many aspects of the plants and the garden as possible in the limited time available.

The range of plants was huge and included some stunning cacti (Figure 9). I was pleased to recognise some species while also being introduced to many I had limited or no knowledge of and had certainly not seen outside of a book. Noemí's knowledge of the plants was extensive, and she had a lovely way of teaching me about them through fun facts and stories which really helped me retain the knowledge.



Figure 9a) A variety of species in the Cactus Gallery including *Opuntia sulphurea* and *Echinopsis terscheckii* (Argentine saguaro). b) The majestic *Pachycereus pringlei* (cardón). c) *Feroactus cylindraceus* (compass barrel cactus). d) *Opuntia aciculata* (chenille prickly pear) (March, 2023).

I observed a thriving ecosystem supporting numerous species of flora and fauna including hummingbirds, quails, doves, goldfinches and numerous lizards and butterflies (Figure 10). Once again, my senses were bombarded with joyful sounds, smells and sights but this time I was in this incredible place in the middle of a city.



Figure 10. A dove nesting in *Cylindropuntia fulgida* (jumping cholla) at the Desert Botanical Garden (March, 2023).

The garden is beautifully designed with native trees such as the *Parkinsonia* spp. and *Olneya tesota* (ironwood) offering shade from high temperatures to plants and visitors. I met members of the horticulture team and several of the gardens valued volunteers. In 2022 the garden had 508 volunteers who dedicated over 38,000 hours of work across a wide variety of tasks in the garden (Desert Botanical Garden, 2023a). Everyone I met was welcoming and genuinely interested in the reason for my visit. I gained a sense of community involvement and passion for the plants which seemed fully entrenched in the success of the garden

The Collections

DBG is designated as the National Collection of the Cactaceae and Agavaceae families by the Plant Collections Network of the American Public Gardens Association (Desert Botanical Garden 2023c). An element of DBG's strategic plan is the expansion of these two collections. The primary focus is on living plants but also includes herbarium specimens, seeds, DNA sequences and digital images. DBG currently holds approximately 70% of all Cactaceae and Agavaceae taxa called for in the collection plan and the aim is to reach 85% of these families.

The Cactaceae Collection

The Cactaceae collection at DBG contains over 15,000 accessioned plants. 80% of the species in the collection are represented by at least one individual of wild origin, greatly increasing the value of the collection for scientific research, as well as for display and education (Desert Botanical Garden, 2023c). The collection is currently housed across two areas due to ongoing construction work at the garden: a shade house and a large glass house (Figure 11).



Figure 11. The shade house and glass house where the Cactaceae Collection at the Desert Botanical Garden are currently housed.

Seeing the collection for the first time was magnificent. I wondered how Noemí kept track of all the plants in the collection and we discussed the use of accession numbers alongside a well-managed GIS system. It struck me very early on that Noemí had a deep respect and affinity for the plants in her care. Each morning we would walk around the collection making observations and planning tasks for the day including plants that needed potting on or seeds collecting. It was an opportunity to monitor how the plants were adapting to their new temporary environment, assess irrigation needs and check for any issues relating to pests and diseases.

Potting on

Managing such a large collection means plants always need potting on including those which have been gifted, collected, or simply outgrown existing pots. Throughout my placement I learnt about the methods used at the garden including the optimum substrate for plants depending on species. I re-potted plants that were new to the collection including *Rhipsalis paradoxa* (chain cactus), *Selenicereus wercklei* (moonlight cactus) and *Tacinga inamoena* and a variety of plants that had previously been used for research purposes including

Turbinicarpus alonsoi, *Copiapoa gigantea*, and *Turbinicarpus jauernigii* (Figure 12). The research by Jessica Huss investigated how cacti use their pointed surfaces and what lessons we can learn from them for development of technology. It is a fascinating read and can be found at:

<https://scilog.fwf.ac.at/en/environment-and-technology/17784/pointy-water-gatherers>



Figure 12a) Re-potted *Rhipsalis paradoxa* (chain cactus), *Selenicereus wercklei* (moonlight cactus) and *Tacinga inamoena*. Re-potted *Turbinicarpus alonsoi*, *Copiapoa gigantea*, and *Turbinicarpus jauernigii*.

After repotting all the plants were labelled and placed in quarantine to be monitored before adding to the collection.

Seeds

I gained experience collecting and cleaning seed during my placement neither of which I had previously undertaken in a professional setting. I collected seed from *Thelocactus bicolor* (glory of Texas), a solitary plant which grows up to eight inches high and is common throughout the Chihuahuan Desert and Tamaulipan thornscrub along the Rio Grande (Quinn, 2019). Once collected, seeds were placed into containers labelled with name and accession number and taken to the seed bank located at the Ahearn Desert Conservation laboratory. The collection contains more than 4,000 seed accessions representing some of the rarest plants in the world and is primarily focused on the conservation of desert plants, particularly those of the Cactaceae and Agavaceae families (Desert Botanical Garden, 2023d). I spent a morning at the laboratory learning how to clean seeds including those from *Pseudorhipsalis ramulosa* (red mistletoe cactus), a succulent epiphyte. I really enjoyed learning a new skill and although the work itself was detailed and fiddly I felt a great sense of accomplishment and would feel confident undertaking this task in the future.

Pests and diseases

The main pest issue in the shade house at this time of year was *Dactylopius coccus* (cochineal bug). *Dactylopius coccus* are scale insects native to South America, North America, and Mexico from which the natural dye carmine is derived (iNaturalist, 2023). They live on cacti predominantly from the genus *Opuntia*, feeding on plant moisture and nutrients. Noemí oversees Integrated Pest Management (IPM) within the collection and focusses on prevention of issues through cultural controls and good sanitation practices combined with regular monitoring of the plants. The garden favours non-chemical controls and removal of *Dactylopius coccus* in the shade house was being carried out by hand by volunteers. It was great to see IPM applied in this environment having learnt the theory in Plant Pathology last year.

Plant rescue

If cacti on the trails are showing signs of stress or physical damage, they are reported to Noemí. We investigated two *Opuntia* spp. (prickly pear) which had been planted out recently and had been badly damaged by jack rabbits despite having protective cages in place. We removed a pad from each plant to preserve a copy for the future. The accession number was recorded, and sulphur powder, which acts as a fungicide, was applied to the wound left on the plant to prevent disease. A young *Pachycereus pringlei* was also removed from the trail which had yellowed and was presenting crown damage. We discussed possible causes and agreed it was likely environmental damage caused by a combination of frost damage followed by sun scorch. The slow metabolic rate of most cacti can make it hard to ascertain exactly when a plant was damaged as signs and symptoms can be delayed. All plants were taken back to the shade house, potted on, and will be monitored over the coming weeks and months.

Moving Plants – New exhibit

The whole horticultural team were called upon to help move some large plants to make way for a new exhibit due to open in Spring 2024. I was tasked to help move four plants to an alternative location. I had not previously considered the importance of orientation. When a cactus is moved, it is vital that the sun hits it in the same way as before to avoid exposing more sensitive parts of the plant to UV rays resulting in sun scorch. Therefore, orientation was marked prior to digging the plants up while taking care not to damage the root system. Using a length of hose and some heavy duty gloves the plants were loaded onto the back of a cart and transported to their new location where they were replanted facing in the right direction. These plants would then be closely monitored over the coming weeks to ensure successful transplants.

Flowering season

Due to the time of year, I was lucky enough to witness many species of cacti flowering and every day in the collection there was a new beauty to behold (Figure 13).

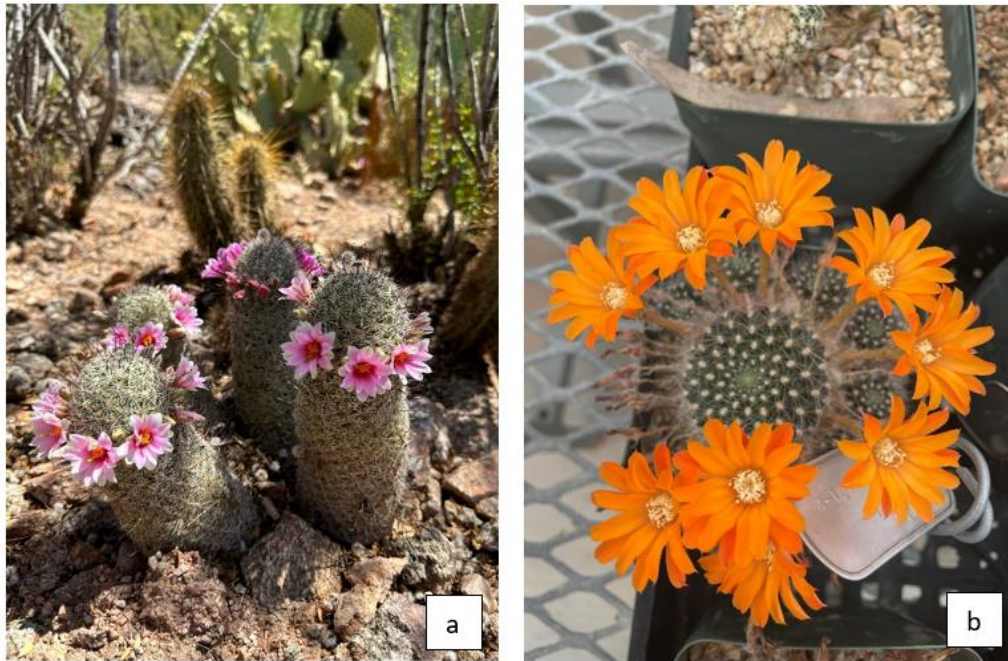


Figure 13a) *Cochemiea grahamii* (fishhook cactus) in bloom at the Desert Botanical Garden. b) *Rebutia fiebrigii* (orange crown cactus) flowering in the glass house at the Desert Botanical Garden (March, 2023).

Peniocereus greggii (Arizona queen-of-the-night) can be found in southern Arizona, southern Texas, and northern Mexico and is famous for its nocturnal white flower which is strongly scented and only blooms for one night of the year in June or July. The flower opens after sundown and then closes and wastes after a few hours (Arizona-Sonora Desert Museum, 2023). A camera was set up in the shade house to record this plant flowering (Figure 14) and the following morning when I arrived it was evident the flower had blossomed overnight and already closed. The recording of this can be seen at: <https://dbg.org/queen-of-the-night-in-bloom/>



Figure 14. Camera set up in shade house to capture the flowering of *Peniocereus greggii* which only flowers for one night.

I was fortunate to spend three days in areas where my previous knowledge was very limited. This included time with Starr Urbatsch, Agavaceae, Aloaceae and Non-Cactus Succulent Plant Collections Manager; time spent on the Center for Desert Living trail and a day in the lab attending a tissue culture workshop.

The Agavaceae Collection

DBG displays around 60% of the known species and varieties in the genus *Agave*, making it the most prominent collection in the United States. Over half of the plants in the collection have known wild provenance and nearly 80% of the seeds are of wild origin (Desert Botanical Garden, 2023c). My morning with Starr was spent admiring the collection and understanding her role. We discussed the irrigation needs of the plants and Starr had a coding system in place to identify the differing water requirements of different species. We took a stroll around the Succulent Gallery in the main garden, and I was really taken with the beauty of the *Aloe dorotheae* (sunset aloe) illuminated by the sun. *Aloe dorotheae* is native to Tanzania and is classified as critically endangered by the International Union for Conservation of Nature (IUCN) based on its extremely limited distribution (Ojija *et al.*, 2022). It was incredible to see the impressive *Aloe barberae* x *Aloe dichotoma* (*Aloe* x 'Hercules') (Figure 15).



Figure 15a) *Aloe dorotheae* in the Succulent Gallery at the Desert Botanical Garden. b) Impressive *Aloe barberae* x *Aloe dichotoma*.

Starrs deep knowledge and love of the collection was apparent, and I was very grateful to have spent time with her.

In the Garden

My other horticultural love is food growing and arguably the climate in the UK is ideal for this pursuit. I was therefore thrilled to spend a day with Branden Kowalszyn on the Center for Desert Living trail the purpose of which is to give tips to visitors about how to create and design their own robust, water wise home gardens (Desert Botanical Garden 2023b). The trail is buzzing with life and in the centre, there are vegetables growing including tomatoes and artichokes alongside sunflowers and herbs.

We spent the day discussing the challenges the desert climate presents to domestic gardens and Branden freely shared his vast knowledge with me. I was delighted to get the opportunity to plant a *Delonix regia* (royal poinciana) within the trail and took a moment to consider the fact that visitors would see it for years to come. Digging a hole was challenging once we hit the caliche about 30cm from the surface. Caliche is a layer-like accumulation of calcium carbonate that is deposited as part of the formation of soil in arid regions (Nothaft, 2023). It is incredibly hard to dig through, but we persevered with a pickaxe, breaking up the ground until the hole was the correct size and then planted the tree, applied drip irrigation pipes, and heavily watered it in (Figure 16).



Figure 16. *Delonix regia* planted on the Center for Desert Living Trail at the Desert Botanical Garden.

Conservation and Research

Since the establishment of DBG in 1939, research and conservation of desert plants in their habitats have been central to the purpose of the garden. Today DBG research and conservation staff collaborate with academic, research and conservation groups across six countries and four continents. These collaborations are leading to the discovery of new plant species, the conservation of threatened and endangered species and the identification of threats such as climate change and invasive species to desert habitats (Desert Botanical Garden, 2023d).

It is known that many cacti species have been adversely affected by human activity including the destruction of habitats and illegal collection from the wild. The IUCN red list found that 31% of cactus species are threatened with extinction and 47% are affected by harvesting for horticulture and private ornamental collections (Margulies *et al.*, 2022) making the work of DBG critical.

I was invited to a Tissue Culture Workshop on the final day of my placement run by Luis Romero, Conservation Collections Research Assistant. Micropropagation and its role in conservation was something we had touched on in the second year of my degree and it had really interested me, so I was incredibly grateful to have the opportunity to attend this workshop which covered everything from the basic principles through making media to obtaining and sterilising explants. I gained an enormous amount of knowledge from this workshop and would like the opportunity to explore tissue culture further in the future.

History of the Garden

I sensed that the success of DBG was the result of some deep-rooted values which had persisted through time. It was apparent how intertwined the elements of research, conservation, education, and horticulture were. I was amazed by the number of volunteers who worked tirelessly at the garden but did so with enormous skill and passion for the plants. Everyone exuded a genuine love of the desert.

The Schilling library at DBG contains more than 9000 books and 500 journal titles focussed mainly on native desert plants. I met librarian Beth Brand who had enormous knowledge of the history of the garden and encouraged me to read 'Oasis in the City: the history of the Desert Botanical Garden' by Tara. A. Blanc. The book tells the story of the garden from the start of an idea in 1930. On reading the book it resonated strongly with me that the purpose of the garden back in 1939 compared to its purpose today has evolved but not changed. There are many facets of DBG that I have not explored in this report including the impressive annual calendar of events and the educational aspect of the garden including its Desert Landscape School. Needless to say, DBG is, in my opinion an incredible place fulfilling its mission through a team of passionate and knowledgeable people. I am very grateful to have had the opportunity to spend time in this very special oasis in the city of Phoenix, Arizona (Figure 17).



Figure 17. View from the Desert Nature trail overlooking the city of Phoenix, Arizona (March, 2023).

Local recommendations

I would highly recommend visiting the following places if completing a similar placement.

- **Tonto National Monument**
- **Boyce Thompson Arboretum**
- **The Heard Museum**

Summary and Conclusion

This experience has been an enormous inspiration to me both as a student of horticulture but also as an individual. I am very new to the horticultural industry but was welcomed at DBG with open arms by a team of people willing to share their time and knowledge with me. I learnt so much in such a short space of time and that has become even more apparent on writing this report. It has also left me wanting to learn more.

I start the third year of my degree having gained a wealth of knowledge across all aspects of horticulture. The desert has so much to offer us and as a student I am fortunate enough to be able to use some of this newfound knowledge to focus on current environmental issues which felt even closer in the desert heat.

I feel incredibly inspired by the desert landscape and the incredible people I met at DBG. Noemi's willingness and determination to give me the best and most diverse experience of the garden has resulted in the placement massively exceeding my expectations in terms of my initial aims and objectives.

Future plans

I am excited to share the knowledge I gained through various channels including presentations to fellow students, horticulturalists and hobbyists at the Eden Project and my local British Cactus and Succulent Society (BCSS) branch with a view to this report being published in Cactus World magazine which has a wide-reaching audience.

I met some amazing people at DBG who I have remained in contact with, and I intend to continue to seek out their knowledge to inform my study including my Honours Project. I would love to return to the garden in the future but am also determined to visit some Cactaceae collections closer to home. The experience has sharpened my focus on my future career goals and given me the inspiration, confidence, and knowledge to pursue them.

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Appendices

Appendix 1. Final budget breakdown

| Element of Project | Actual Cost |
|---|-----------------|
| Air fare | £556.00 |
| Train fare | £135.20 |
| Car hire and fuel | £1215.00 |
| Accommodation | £1669.00 |
| Food | £293.70 |
| Visa (Esta) | £17.00 |
| Travel insurance | £49.00 |
| TOTAL | £3934.90 |
| RHS Bursary Award | £2394 |
| BCSS Conservation committee: Bill Maddams Travel Award. | £1000 |
| Personal Contribution | £540.90 |