

Restorative Horticulture in Tropical Dry Forest, Colombia



*A report produced for the Royal Horticultural Society,
as part of the travel bursary scheme.*

By Olivia Lockyear

Contents

Acknowledgements.....	2
Introduction.....	3
Aims of the Project.....	5
Itinerary.....	6
Site Information.....	7
Key Species of Tropical Dry Forests of Colombia	9
Main Activities.....	14
Key Outcomes.....	22
Evaluation and Personal Growth.....	24
Breakdown of Costs.....	25
Further Flora.....	26
References.....	29

Acknowledgements

I would firstly like to thank the incredible colleagues I worked with in Colombia on this project. Most notably, Maria Paula Contreras, horticultural director of Cartagena Botanic Gardens, Guillermo Piñeres, helped me organise this placement and supported me throughout the placement, even inviting me to join her team for an expedition. The team at JBGP were equally positive and generous with their time, making me feel completely welcome and answering any questions.

I would also like to thank Bibiana and Fulmar Salamanca, owners and managers of the Jaguar de Carrizal reserve. Your unwavering dedication to conservation of dry forest is inspiring. I would also like to give thanks to the Kogi people, traditional owners of the regions in which I have been lucky enough to work, for their protection and deep knowledge of the forest.

Finally, I give thanks to the Royal Horticultural Society and the Great Dixter Gardens for their generous bursaries that enabled this trip to take place. Between them, they have inspired and continue to inspire horticulturalists across the UK and abroad to deepen their knowledge of plants.

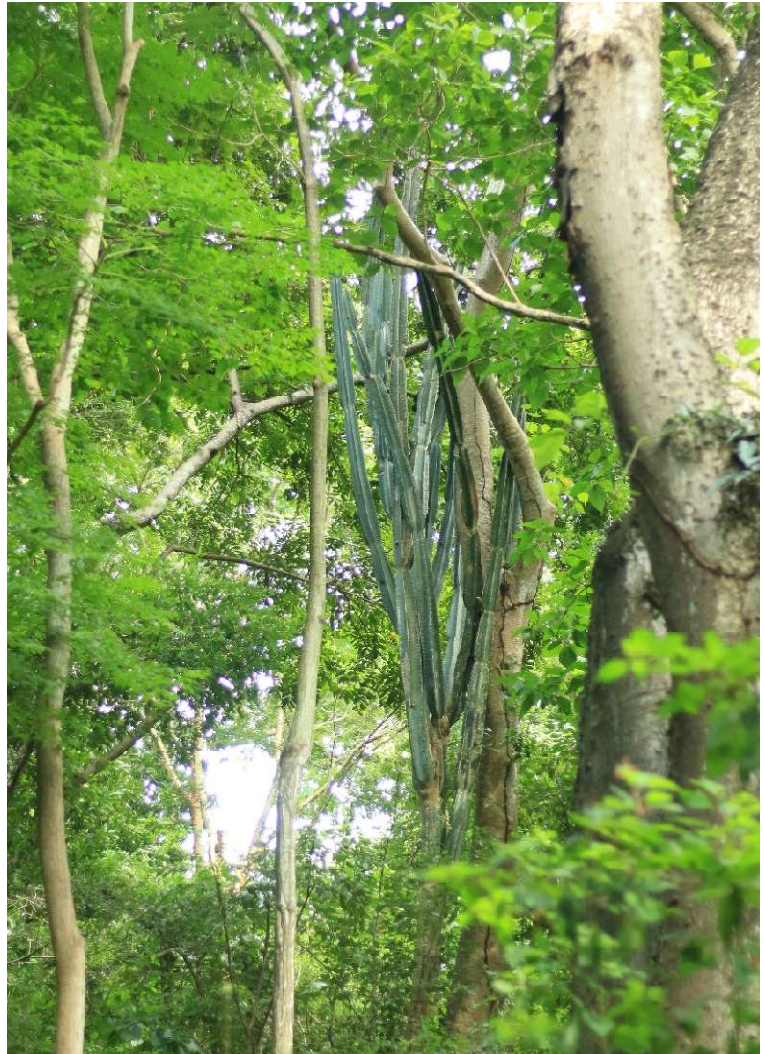


Introduction

Tropical dry forests can be defined as woodland with an average temperature above 17°C, 250-2000 mm annual rainfall and partial drought for 4-9 months during a year (Murphy and Lugo, 1986). During this drought, many species lose their leaves to conserve water, creating a strong seasonality that is almost completely absent in humid rainforests. The forest structure therefore is less complex, with far less epiphytes such as ferns and mosses, a mix of deciduous tree species, and some xeric species such as cacti, palms and grasses. Examples of tropical dry forests can be found in Mexico, Central and South America, Madagascar, India and Northern Australia (Rivero-Villar et al., 2022).

Despite high levels of endemism in many tropical dry forests and unique plant adaptations to survive the extreme conditions, they have barely received academic attention, compared to humid tropical rainforests (Santos et al., 2011).

More gravely, they face extreme degradation, with current estimates of intact dry forest remaining at only 5% with 71 million hectares of dry forest having been lost since 2000 (Buchadas et al., 2022). Causes of tropical dry forest degradation are varied globally but in Latin America, it is driven primarily by expansion of cattle farming and wood extraction. It is estimated that 60% of Colombia's dry forest has thus far been lost (Romero-Duque et al., 2019).



Typical dry forest vegetation with a mix of deciduous broadleaf tree species and some xeric species such as this giant 20 m cactus, photo taken from the Jaguar Reserve.

In this project, I set out to understand what makes tropical dry forest so unique and how horticulture can assist with reforestation efforts of this precious and neglected habitat. What can the role of botanical horticulture play in ecosystem restoration? Colombia, the third most biodiverse country globally after Brazil and Indonesia (*World Atlas, 2023*), is an excellent base to study tropical dry forest. Along the Northern coast, there are pockets of dry forest lying between coastal mangroves and higher altitude cloud forest at the base of the Sierra Nevada Mountain range. There is a large indigenous Kogi population in this region and thus some dry forest is well protected within their reserves (*Atlas of Humanity, 2022*). Within a two-month period I worked at a nature reserve and dry forest reforestation project, Jaguar de Carrizal, and the botanic gardens of Cartagena, Guillermo Piñeres. Between these two sites, I could compare horticultural approaches to tackling deforestation, the first being more applied, active restoration, and the latter a combination of restoration, research and education.

Aims of Project

During this project, I planned to work with two restoration facilities to compare how horticulture can play a role in ecosystem restoration. I also planned trips to observe nearby primary tropical dry forest as a reference site for restoration. In doing so, I hoped to gain new understanding and skills to feed back into my career in the UK. My specific aims are listed below, posed as key questions:



A view from within the Jaguar de Carrizal nature reserve showing secondary tropical dry forest.

What is a typical South American tropical dry forest?

First and foremost, I want to learn the keystone species that make up this unique habitat and equally any highly endangered native plants. I want to observe the structure of the forest and how this differs to tropical rainforest. Finally, I want to understand how humans interact with this forest. Which plants are most useful and what pressures may lead to its deforestation?

How can it be restored?

I want to gain skills in tropical restoration horticulture, for example tree planting and nursery propagation. I want to compare an academic and educational approach of a botanic garden with a larger scale nature reserve restoration project. I want to experience the common challenges faced in Colombian ecological restoration and understand how community engagement can be achieved.

How can we help?

My final aim is to translate my findings into UK centered action that can assist our partners in the Global South with restoration efforts. This includes gathering information to share in educational displays in the UK to increase awareness around this habitat. Additionally, it involves gaining contacts in Colombia for future partnerships and collaborations moving forwards. Finally, I want to gain practical skills relevant for restoration projects around the UK to increase forest cover here too.

Itinerary



A map of North Colombia coastline with four points of the study trip marked, labelled chronologically. The smaller map, top left, shows a wider perspective with the black square indicating where in South America this region is situated.

30/09/2023 – 9/11/2023 'Jaguar de Carrizal' Nature Reserve

- 9th October – Community Tree Planting Day
- 14th October – World Bird Day, tracked seed dispersal networks of dry forest
- 16th October – Interview with Reserve Manager
- 20th October – Community workshop on endangered species protection
- 28th October – Creation of herbarium
- 3rd November – Assist with irrigation

10/11/2023 – 11/11/2023 Tayrona National Park

12/11/2023 – 25/11/2023 Cartagena Botanical Gardens, Guillermo Piñeres (JBGP)

- 13th November – Site tour and Induction
- 14th November – Seed Bank
- 15th November – Tree planting
- 16th November – Weeding with Gardens team
- 17th November – Herbarium
- 20th November – Propagation of *Stachytarpheta*
- 21st November – Pruning and Planting , Butterfly Garden

23/11/2023- 25/11/2023 October – Cloud Forest, El Dorado Proaves Reserve

Site Information

'Jaguar de Carrizal' Nature Reserve

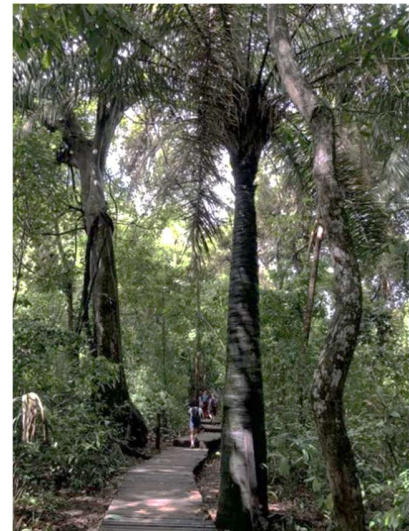
A 36-hectare nature reserve and research station near Santa Marta, consisting mostly of tropical dry forest, some riparian zones and grassland. It is owned by the charity, Fundación Bachaqueros, a small organisation with two other smaller local reserves and three full time staff. The land was bought with a grant from the IUCN (International Union for the Conservation of Nature) five years ago, but the charity has more than 30 years of experience in ecological restoration. It is given its name from the presence of jaguars in this region and a species of *Chusquea* locally known as Carrizo. There is an active tree nursery onsite growing native dry forest species and an agroforestry programme to produce food for volunteers. There are regular engagement days with the surrounding community and it is visited frequently by researchers from local universities.



The view from the Jaguar de Carrizal reserve across the dry forest lowlands of the Sierra Nevada mountain range to the Caribbean coast.

Tayrona National Park

19,000-hectare National Park designated in 1964 on the Caribbean coastline consisting of both dry and humid forest. Now a huge spot for ecotourism, this area is also home to the Tayrona indigenous people that are protectors of the land. With accessible boardwalks and trails, it is an excellent example of primary dry forest with 'parent' native tree specimens, of up to 30 metres in height.

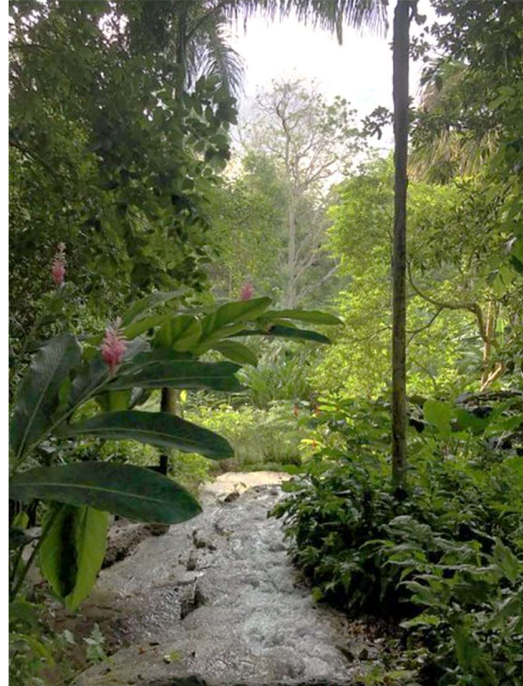


A sign at the entrance to Tayrona Park and boardwalks constructed to make the park accessible for large numbers of tourists without damaging the forest, especially in rainy season.

Cartagena Botanical Gardens, Guillermo Piñeres (JBGP)

Founded in 1974, this beautiful 9-hectare botanical garden consists of curated collections of native and exotic flora, an arboretum, orchidarium and fernery and a wild dry forest section. In 2016, a nursery, herbarium and seed bank were added with the mission to conserve Colombian flora and assist with dry forest restoration projects locally through supply of trees and research. There

are around 8 full time gardeners and 5 office and herbarium staff currently employed onsite. It is linked to the University of Bogota and regularly hosts local students from universities nearby for research projects as well as being a well-known bird watching spot.



The curated collections of the JBGP site and myself walking around with the horticultural director, Maria Paula Contreras, MHort.

El Dorado Nature Reserve, Minca

A large 1,300-hectare reserve at 2500 meters altitude, owned by the charity ProAves who are focused mostly on bird conservation. JBGP have a parcel of land designated for themselves jointly with the University of Miami to conduct research on the unique species of Colombian cloud forest. The temperature is much closer to temperate regions, averaging around 17 degrees Celsius. Precipitation is high all year round and branches are dripping with epiphytes and moss colonies. I was invited on a three-day field trip here with the team at JBGP to help collect samples of fruiting and flowering trees.



With the team of JBGP botanists entering the El Dorado cloud forest reserve for a three-day field expedition.

Key Species of Tropical Dry Forests of Colombia

Names verified in Plants of the World (POWO)

A personal note that as I type up these species, I am amazed how familiar I am with them. What was once such a foreign landscape to me, I can now talk about each of its key inhabitants as if they are good friends. I have loved spending time with the smooth bark of Ebano, or the joyful leaflets of Palo de brasil, they all have a place in my heart.

All photos are my own unless specified otherwise, in bottom right corner of image. Ordered alphabetically by scientific name. A full list of species spotted can be found in the appendix.



Images from INaturalist user: rosabelmiro

CARACOLI (*Anacardium excelsum*)

Known as Wild Cashew

ANACARDIACEAE

Commonly the tallest tree species found in dry forest with large, rigid leaves.

Uses: Nut can be eaten, after roasting

Native Range: Guatemala to Ecuador

IUCN rating: Least Concern



CARRETTO (*Aspidosperma polyneuron*)

APOCYNACEAE

Shiny, dark green leaves arranged in whorls around main axis. Slow growing and small, reaching 15m.

Uses: Noted to reduce fever, however sap and sawdust can cause major irritation.

Native Range: Brazil, Colombia, Peru, Argentina, and Paraguay

IUCN Rating: Endangered



Image from One Love
Holistic wellness company

PALO SANTO (*Bursera graveolens*)

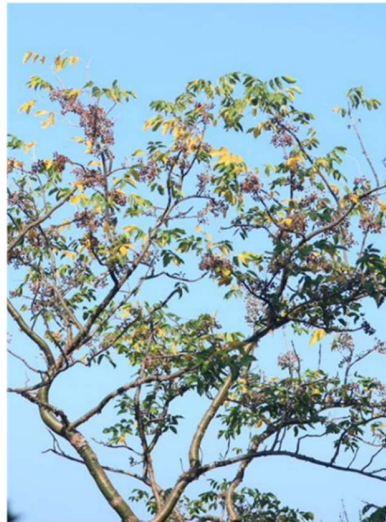
SAPINDACEAE

Unique leaf shape with 5 leaflets arranged parallel and vertical to leaf axis.

Uses: Holy wood, it is burnt to keep away bad energy as an incense traditionally in Peru and Ecuador.

Native Range: Mexico to Peru

IUCN Rating: Least concern



RESVALDAMONO (*Bursera simaruba*)

SAPINDACEAE

Easily recognisable in a forest from its smooth (resvaloso = slippery), papery orange bark over green. Leaves pinnate. Rapid growing.

Uses: Good 'starter tree' for restoration projects due to rapid growth time. Wind protection and living fence posts.

Native Range: Mexico to Venezuela

IUCN Rating: Least concern



CEDRO (*Cedrella odorata*)

MELIACEAE

Also known as Spanish cedar, it can grow up to 30m in height. Large pinnate leaves, leaflets more numerous, slightly paler and thinner than Caoba.

Uses: A fragrant wood, light and pliable that is naturally termite and rot resistant.

Native Range: Mexico to North Argentina

IUCN Rating: Vulnerable



CEIBA BONGA (*Ceiba pentandra*)

MALVACEAE

Although more common in rainforest, they can grow near river sources in dry forest. Reaching up to 70m, these are one of the largest tree species in South America. Trunk with large spines.

Uses: Cultivated for wood, bark is an aphrodisiac, leaves offset dizziness, sacred in multiple indigenous religions.

Native Range: Tropical South America

IUCN Rating: Least concern



MATARATÓN (*Gliricidia sepium*)

LEGUMINOSEAE

Pale grey bark and compound leaves, small leaflets. Profusion of pink pea-like flowers during dry season. Nitrogen fixing and rapid growing.

Uses: Living fence posts, companion crop planting as nitrogen supply

Native Range: Mexico to Brazil

IUCN Rating: Least concern



PALO DE BRASIL (*Haematoxylum brasiletto*)

FABACEAE

Compound, heart shaped leaflets and distinctive stringy black bark, Leaves are bright, light green.

Uses: Hardwood, bark can be used as a red tint for clothes

Native Range: North Mexico to Colombia

IUCN Rating: Least concern



CAÑAHUATE (*Handroanthus chrysanthus*)

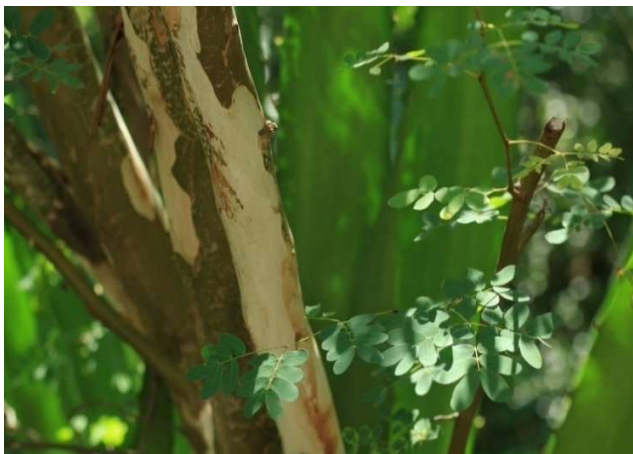
BIGNONIACEAE

Palmately compound leaves, deciduous. Also found in wet tropical forests.

Uses: Produces hard, durable wood popular for furniture making

Native Range: Mexico to Peru and Trinidad and Tobago

IUCN Rating: Vulnerable



EBANO (*Libidibia punctata*)

synonym - *Caesalpinia ebano*

Large tree with pinnate leaves and distinctive peeling white, grey bark.

Uses: Extremely hard wood, popular for woodturning

Native Range: Venezuela to Colombia

IUCN rating: Vulnerable



CEIBA ROJA (*Pachira quinata*)

MALVACEAE

Spiny trunk and palmate leaves, slightly reddish petiole in younger leaves. Slow growing.

Uses: Grown for timber in Costa Rica

Native Range: Costa Rica, Venezuela, Panama, Colombia

IUCN Rating: Vulnerable



Image from the
Smithsonian
Tropical
Research
Institute



MAJAGUA (*Pseudobombax septenatum*)

MALVACEAE

Swollen trunk that allows water storage in drought with bright green lines and palmate compound leaves. Flower white with many stamens and large (15cm). Easily recognisable from trunk and deciduous.

Uses: None found

Native Range: Costa Rica to Bolivia

IUCN Rating: Least concern



SANGREGADO (*Pterocarpus acapulcensis*)

FABACEAE

Distinctive grey rough bark and compound leaves. Red resin gives the name 'sangre' meaning blood. A highly resilient species able to withstand drought.

Uses: Medicinal and Fuel

Native Range: Mexico, Venezuela and Colombia

IUCN Rating: Vulnerable



Image from Flickr user jayeshpatil912

CAOBA (*Swietenia macrophylla*)

MELIACEAE

In the west, known as mahogany. Rough bark and large compound leaves. Seedlings are slightly reddish.

Uses: Hugely valued in timber industry and mass produced in tropical Asia and Africa. Proved scientifically to treat neurodegenerative conditions.

Native Range: Mexico to Peru

IUCN Rating: Endangered

Main Activities

At The Jaguar Reserve and JBGP

Tree Planting

At both sites, extensive planting of native species took place during my placement time window, falling at the end of the wet season. Water retention is a major problem at the Jaguar Reserve, where staff do not necessarily have the resources to regularly water and monitor new planted trees. To combat this, they use Hydrogel, before planting the tree on top. It is planted with a mixture of compost and dried leaves for drainage. In contrast, new plants in the native dry forest area of JBGP gardens will still be monitored and watered. Thus, while

water is less of an issue, the garden faces heavily alkaline soils, hitting hard chalk less than a meter down. Therefore, all trees must be planted over a thick base layer of compost. Both sites use thin plastic black bags to grow their saplings in. Upon questioning, both sites explained this is because there simply aren't the suppliers available to obtain large



Tree planting, top left in the reserve as part of a community tree planting day with volunteers and locals and top right at JBGP with staff and much bigger trees!

numbers of reusable pots, affordably. Bags aren't ideal as they disintegrate quickly, leaving microplastics in the soil and must be replaced. Finally, all trees in dry forest area must be planted with a completely intact root system. While in UK wet soil, you might get away with cutting some roots, the intense droughts experienced in North Colombia means a sapling relies on a deep root network system.

Nursery work

The nursery is arguably the heart of any horticultural site. At the Jaguar Reserve, collected seeds of six native species are sown, monitored for around two years and finally planted around the reserve. Space was not used efficiently, and watering systems often were faulty or, around the seed propagation area, watered by hand. Although seed was propagated successfully, I saw low transplantation rates, especially in *Pterocarpus acapulcensis*. This may have been due to

lack of full shade or pest issues. I helped dig new areas for saplings and replace old plastic bags. Pest control was completely organic, using a mix of fermented garlic as a spray twice a week on all affected plants. The JBGP nursery was around four times the size, acting not only as a replenishment source for plants around the garden, but also supplying large quantities of native trees to neighbouring restoration projects. They used fast growing bamboo as supports for their climbing plants, growing right next to the nursery. Our equivalent of coppiced hazel I suppose! I helped carry out seed bank propagation trials and, despite a misting unit, germination rates were often low, below 50%, perhaps suggesting better storage practice may be required to keep seeds viable. Other tasks included transplanting seedlings, filling bags with compost and rice husk for new plants and aquatic pond species care. The staff here used chemical pesticides to combat nursery pests.



Images from the nursery at the Jaguar Reserve, from top left to bottom right: adding new plastic sheeting, transplanting large sapling with intact root system, seed germination on table tops, changing over bags with team of volunteers.



Images from the nursery at the JBGJ, from top left to bottom right: Aquatic plant care with Nymphaeae species, germination tests for seed bank, commercial nursery production of native species, talking soil mixes horticultural director, Maria Paula Contreras.

Herbarium Curation

A herbarium is a collection of pressed, dried plants that acts as a library of floral diversity. It is an important record of species that can be used for future taxonomic research, if stored correctly, often lasting for 100s of years. The Jaguar Reserve did not have a herbarium when I arrived, but did have a press and all material, so I could begin one. The main challenge came from the humidity which was often up to 100%. This meant mould quickly grew on the specimens, so needed to be treated with pure alcohol. We also couldn't find proper herbarium tape so used glue to secure the specimens in place, which with time will break down and need to be replaced.



Setting up a new herbarium at the Jaguar de Carrizal Reserve with volunteers and limited resources. We used a herbarium press and mounted on paper, recording location and further details about the surrounding habitat and plant type.

In contrast, the Botanic Gardens of Cartagena had a well set up herbarium, with temperature-controlled facilities. I helped to secure dried mangrove samples using tape, string and needle. Additionally, I assisted the team collecting and pressing new samples from a field expedition to a nearby cloud forest. Interestingly, the method of pressing, using newspaper and weight in a press was much the same between the two sites.



Herbarium at JBGP, housing over 2000 samples of species from Colombia. Middle image showing mounting of dried mangrove samples and right, collecting new samples from a cloud forest reserve,

JBGP Only Tasks

Propagation

The gardens have a large collection of *Stachytarpheta mutabilis* varieties. While the hot pink is the native species, the darker purple colour is a cultivar. The curator has cross pollinated the native species and the cultivar to create a new cultivar in lighter purple. To increase numbers, I took cuttings for all three colours. Although I was following best propagation practice to take mostly semi-ripe material, we decided also to experiment with taking ripe cuttings and hardwood, just to compare the success rate. While I enjoyed this activity, I didn't stay long enough to see the results!



Propagation by vegetative cuttings of Stachytarpheta mutabilis native species, cultivar and new hybrid at JBGP nursery.

Formal Tropical Garden Maintenance

I also spent time maintaining the curated plant collection. This included pruning back the butterfly garden, consisting mostly of *Stachytarpheta* and adding new *Senna* bushes. I also helped the team weed through a giant bed of Taro and *Tradescantia spathacea* plants. These activities were entertaining as they resembled my job at home but with small yet significant differences... For example, the extreme heat and humidity, the warning of poisonous snakes among the bushes or the giant scale of 'weeds', the same species we would pay dearly for in a house plant shop in the UK!



General garden maintenance with the horticultural team at JBG, left on a curated bed of *Tradescantia* and *Colocasia* plants, right pruning in the butterfly garden of *Stachytarpheta*.

Field Research

I was invited to join the team on an expedition to nearby cloud forest near Minca, Santa Marta. The aim of the trip was to gather fruiting and flowering samples for the herbarium of unidentified tree species, in a labelled predetermined plot. This was an incredible experience, working with local Colombian botanists to gather and identify samples, using a pole pruner and local guidebooks, from trees up to 30m in height.



Myself with colleague Juan-Carlos, gathering specimens in Cloud Forest.

Jaguar Reserve Only Tasks

Agroforestry

The Jaguar Reserve has production of yukka, banana, chillies, pineapple, mango, maize and frijoles, among others to be as self-sufficient as possible. This is planted purposefully in terraces alongside native tree species to create shade and hold soil structure, termed agroforestry. I learnt how to schedule planting in the tropics, following a much less rigid cycle as European food growing (no definitive spring), how to create terracing and effective irrigation. I also learnt the best combinations of companion planting to increase nutrient uptake.



Community workshop

The Jaguar Reserve, owned by the larger organisation, Fundacion Bachaqueros, has a micronursery programme in which smaller sites, such as schools, universities or commercial nurseries are encouraged to grow native dry forest species for reforestation purposes. Often the largest barrier to restoration projects is community engagement. Hence, micronurseries are an excellent way to engage more people with the topic and get people familiar with key native species. I assisted with a workshop attended by representatives of each micronursery to discuss best nursery practice and native IUCN rated endangered species.



Soil Improvement

Creation of appropriate substrate for seed sowing and tree planting was a major challenge at the Jaguar Reserve. It was not practical nor affordable to buy in composts. This meant nutrient conservation onsite was extremely important. During my time, I helped with composting efforts, processing food waste with leaves to create 'abono' (compost). The breakdown of material is much quicker in the tropics, taking a maximum of 3 months to move from solid food waste to usable compost. When making up soil mixes, we used 3:3:1 leaves, soil and ash from the firepit. Leaves had to be sliced using a machete and the whole mix was combined using a shovel. This took a lot of man hours but created nutrient rich, free draining soil that could be used for potting on or planting out. For seed sowing, the mix was made without ash.



Key Outcomes

Tropical Dry Forest is Resilient to Drought but Vulnerable to Land Use Change

During my time at both sites, I learnt of species that are highly adapted to drought conditions. For example, the Mahajua tree, (*Pseudobombax septenatum*) is able to store water in its trunk during rainy periods and swell up in size, much like the hump of a camel. Equally, the Sangregado tree (*Pterocarpus acapulcensis*) will drop 70% of its leaves to conserve water during drought. Generally, this shift in seasonality took a while to get accustomed to, coming from a temperate region, where leaves are lost during extreme cold and lower light levels.

Despite the unique adaptations, I learnt that tropical dry forests are extremely vulnerable to deforestation. With a much thinner forest structure than tropical humid forest, less density and better accessibility, they are much easier to clear for timber or to make way for cattle farming. In the area I was working, the only intact tropical dry forest pockets left were found in indigenous reserves, such as Tayrona National Park or in higher inaccessible steep slopes of the Sierra Nevada Mountain range. The Jaguar Reserve was almost entirely secondary forest vegetation. Their natural ability to grow back after clearance is also poor, facing competition from invasive African grasses (*Brachiaria*) and reduced presence of native seed dispersers such as howler monkeys and toucans (Galindo-Rodriguez and Rao-Fuentes, 2017). This suggests active restoration will be required to expand current forest cover.



Pseudobombax septenatum bulging to store water for the dry season. Photo by Kevin Schafer.

A Role for Botanic Gardens in Restoration – Showcase and Supply Native Diversity

At JBGP, there is a strong focus on tropical dry forest conservation. However, I was intrigued to see how that translated into the botanic garden. Across the 9-hectare site they have 5 hectares dedicated to wild forest walks as well as an arboretum with native specimen trees. These two elements together act as vital educational tools for visiting school groups and the general public to learn about native diversity. This responsibility to educate and create awareness, even a love for native species in visitors I believe lies with any botanic garden, particularly in a world where exotic showy species are valued highly. Similar successful examples can be found in UK botanic gardens, for example the National Botanic Garden of Wales native collections or the Kew Botanic Garden Wilder Area of native broadleaf woodland.

JBGP arguably takes this a step further, using the facilities and staff available to supply large quantities of tree saplings to neighboring restoration projects. They focus on cultivating endangered native species that are then bought or donated to farmers nearby to reforest degraded agricultural land. During my time there, I helped send off 150 native *Caesalpinia ebano* individuals to a farm nearby, listed as IUCN vulnerable. To date, I haven't heard of any UK botanic garden attempting to supply native plants for restoration. This is somewhat surprising as, with reforestation quickly becoming a profitable industry in the UK, it could be a financial income stream for a garden. This might be due to the competition in the UK from other well-established horticultural tree nurseries that have a more specific aim to produce these saplings. Similar competition simply does not exist in the North coast of Colombia yet.



150 individuals of *Caesalpinia ebano*, grown in the JBGP nursery for use in nearby restoration projects.

The Conservation-Through-Use Approach

During this trip, I learnt the value of a conservation-through-use approach, taking humans into consideration of a landscape, instead of excluding them when doing conservation or restoration. By encouraging sustainable extraction of materials from the forest and livelihoods based on a healthy forest for example, honey production, wine making or ecotourism, inhabitants are encouraged to care for and protect the landscape. This is also a more long-lasting culture change that can sustain periods of economic instability that have in the past been linked to huge deforestation events. Taking this approach means that horticultural institutes both in Latin America and the UK must gather and share knowledge on the ethnobotanical value of species, from medicines, materials and nutrition. It also must research how we can make agroforestry work in countries facing rapid deforestation threats. The Jaguar Reserve host workshops for local communities on winemaking from native edible fruits to give them an income source other than deforestation or cattle farming. Through this, value will be added to this unique landscape and thus its conservation will be encouraged.



Ethnobotanical research, investigating use of *Clitoria tematea* as a dye in the reserve with other volunteers.

Evaluation and Personal Gain

This trip has allowed me to become an expert in a habitat type that is as unique as it is undervalued. Tropical dry forest is an incredibly beautiful forest with some highly adapted species. I have been inspired and humbled by the organizations I have worked with in Colombia that are working so hard to restore this important landscape. For the world of horticulture, I believe I am now able to share what makes this habitat unique and also how best it can be preserved. I can communicate the roles of organisations such as nature reserves and botanic gardens in restoration, both in these countries but also in the UK. Future questions that could be added to this research include investigating what form of active restoration and planting is most effective, e.g. seed scattering, sapling planting or island planting (where a small island of individuals are planted with the hope they will disperse and fill a landscape). I would also further like to research ethnobotanical uses of native dry forest and link this with the role of indigenous populations in the Sierra Nevada area in its conservation.

The personal growth I have gone through during this trip has also been immense. I have been able to improve my Spanish to a fluent level, thriving in an all-Spanish speaking workplace, and being able to communicate over complex specific horticultural tasks. I also have important contacts for collaboration going forward, including the horticultural coordinator of JGBP, Maria Paula who will hopefully be visiting later this year. It has also helped me secure a new exciting job position as horticultural technician at the Eden Project, Cornwall. This is an excellent location to put this knowledge into practice with an extensive range of South American flora and a focus on telling the ethnobotanical story behind plants. They also have a linked dry forest restoration project in Costa Rica of which I can now assist and advise on.



Breakdown of Costs

Bursaries	
Royal Horticultural Society	£1,645.00
Christopher Lloyd Travel Bursary	£500.00
Total Bursary	£2,145.00
Expenses	
Vaccinations	£112.50
Flights	£883.49
Travel Insurance	£126.38
ESTA visa	£16.85
Cash	£100.00
Cartagena accommodation and food (2 nights)	£56.00
Reserve Accommodation Costs	£450.00
Food budget during Reserve	£165.30
Tayrona Entrance Cost	£23.50
Tayrona Accommodation and Food	£66.34
JBGP accomodation	£252.00
Food budget during JBGP	£140.00
Accomodation after cloud forest	£28.00
Total bus travel costs	£87.00
Taxis	£45.00
SIM Card	£41.54
Total	£2,593.90
Personal Contribution	£448.90

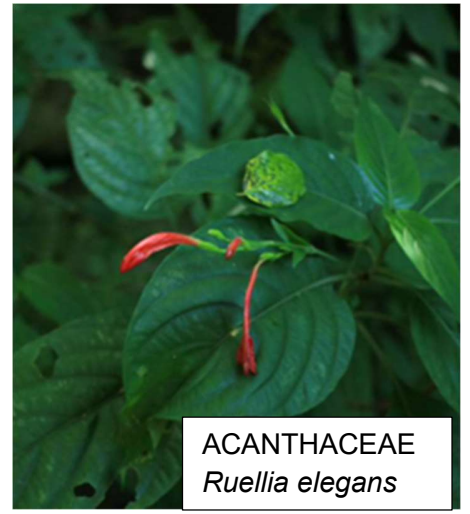
Further Flora



ACANTHACEAE
Aphelandra scabra



ACANTHACEAE
Aphelandra golfodulcensis



ACANTHACEAE
Ruellia elegans



APOCYNACEAE
Calotropis procera (Invasive)



ARACEAE
Anthurium crassinervium
Common name: Changa piedra



ARISTOLOCHIACEAE
Aristolochia anguisida



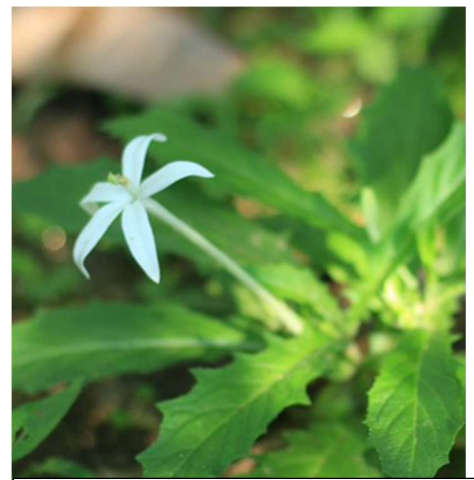
BIGNONIACEAE
Jacaranda mimosifolia



BROMELIACEAE
Tillandsia flexuosa
Common name: Air plants



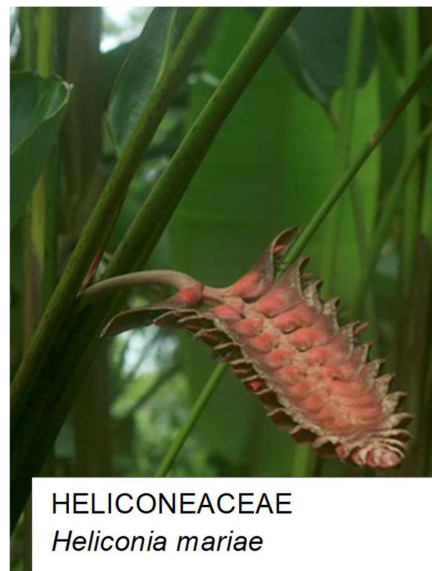
CACTACEAE
Cereus sp.



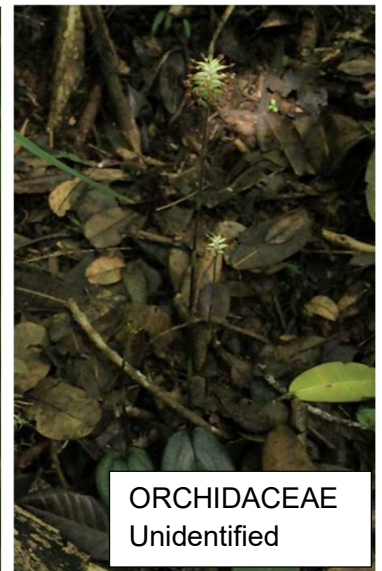
CAMPANULACEAE
Hippobroma longifolia
Common name: Star of Bethlehem



FABACEAE
Clitoria ternatea
Can be used as a purple tint



HELICONEACEAE
Heliconia mariae



ORCHIDACEAE
Unidentified



PASSIFLORACEAE
Passiflora vitifolia



PHALLACEAE (fungi)
Clathrus sp.



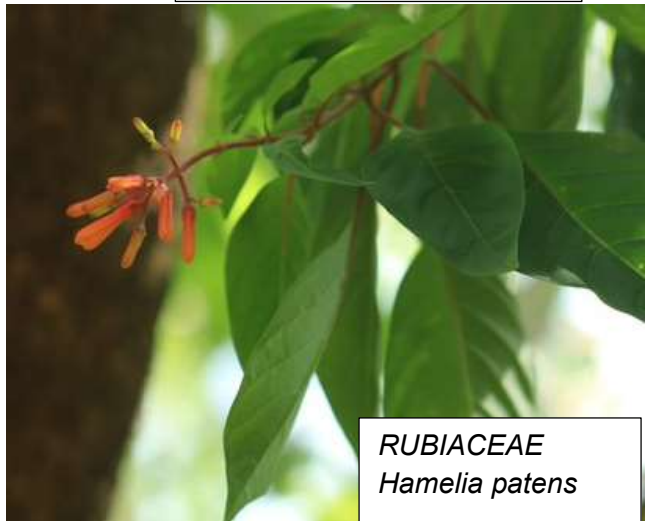
POACEAE
Chusquea sp.
Common Name: Carrizo



PRIMULACEAE
Clavija sp.



RUBIACEAE
Isertia haenkeana
Common name: Coralillo



RUBIACEAE
Hamelia patens



VERBENACEAE
Stachytarpheta mutabilis

References

- Atlas of Humanity, 2022. URL <https://www.atlasofhumanity.org/kogi> (accessed 2.24.24).
- Buchadas, A., Baumann, M., Meyfroidt, P., Kuemmerle, T., 2022. Uncovering major types of deforestation frontiers across the world's tropical dry woodlands. *Nat. Sustain.* 5, 619–627.
- Galindo-Rodriguez, C., Rao-Fuentes, L., 2017. Seed desiccation tolerance and dispersal in tropical dry forests in Colombia: Implications for ecological restoration. *For. Ecol. Manag.* 404.
- Murphy, P.G., Lugo, A.E., 1986. Ecology of Tropical Dry Forest. *Annu. Rev. Ecol. Evol. Syst.* 17, 67–88. <https://doi.org/10.1146/annurev.es.17.110186.000435>
- Rivero-Villar, A., Peña-Domene, M. de la, Rodríguez-Tapia, G., Giardina, C.P., Campo, J., 2022. A Pantropical Overview of Soils across Tropical Dry Forest Ecoregions. *sustainability* 14, 6803–6803. <https://doi.org/10.3390/su14116803>
- Romero-Duque, L.P., Rosero-Toro, J.H., Fernández-Lucero, M., Simbaqueba-Gutierrez, A., Pérez, C., 2019. Trees and shrubs of the tropical dry forest of the Magdalena river upper watershed (Colombia). *Biodivers. Data J.* 7. <https://doi.org/10.3897/bdj.7.e36191>
- Santos, J.E.P., Leal, I.R., Almeida-Cortez, J.S., Fernandes, G.W., Tabarelli, M., 2011. Caatinga: The Scientific Negligence Experienced by a Dry Tropical Forest. *Trop. Conserv. Sci.* 4, 276–286. <https://doi.org/10.1177/194008291100400306>
- World Atlas, 2023. URL <https://www.worldatlas.com/nature/the-10-most-biodiverse-countries-in-the-world.html> (accessed 2.24.24).