Introduction

Finished school with A-levels in 2011, I moved to Tutzing at the Starnberger See in Bavaria, to absolve an 8-month internship in the Tabaluga Kinder- und Jugendhilfe, a children's home. After that in 2012, I went on to start a 2-year apprenticeship in the Botanic Gardens of the Rheinische Friedrich-Wilhelms-University Bonn, and during this time went to college at the Berufskolleg Bonn-Duisdorf. During this apprenticeship, I had the chance to do a 3-week internship in the Royal Horticultural Society's garden in Wisley in 2015. Finished the apprenticeship in 2014, I then went on to study the Kew Diploma at the Royal Botanic Gardens, Kew in course 52.

For my travel scholarship, I chose to go to India to mainly study the world of medicinal plants. I was always fascinated by India, and with its cultural differences and being the home of Ayurveda, one of the oldest medicines of humankind, it seemed to me like a fascinating country to study the use of plants in medicine, the role they still play within the population and how the horticultural focus is cultivating medicinal plants, considering the popularity of Eastern medicine nowadays in the Western world.

To meet my set aims and objectives, I created following itinerary:

- Sunday, 26th June: Arrival in Dehradun at the Wildlife Institute of India
- 27th June: Visit the Herbaria and Botanical Gardens at the Botanical Survey of India, visit the Forest Research Institute Dehradun
- 28th June: Day trip through the outer Himalaya, visiting places such as the Rishikesh Herbal Garden, Chamba and Dhanaulti
- 29th June: Visit the Centre for Aromatic Plants
- 30th June: Visit of a local medicinal plant healer including its own factory which makes its own medicines
- 1st July: Wrap up, talking to botanists of the Wildlife Institute of India
- 2nd July: Journey to Bangalore
- 3rd July: Visit of the Banherghatta National Park
- 4th July: Visit Lalbagh Gardens, Cubbon Park & the Regional Ayurvedic Research Institute for Metabolic Disorders (RARIMD)
- 5th & 6th July: Cambium Biotechnologies
- 7th July: Visit the FRLHT Ethnomedicinal Garden
- 8th & 9th July: Visit of Mysore, Brindavan Gardens
- 10th July: Wrap up
- 11th July: Journey back to London-Heathrow

Visited Locations

Dehradun (North India)

Fig. 25: https://www.google.de/maps/place/Dehradun,+Uttarakhand+248001,+Indien/@29.2960681,70.1507487,5z/data=!4m5!3m4!1s0x390929c356c888af:0x4c3562c032518799!8m2!3d30.3164945!4d78.0321918?hl=de

Dehradun, is lying in the so-called Doon Valley which belongs to the gangetic plain, the area that surrounds the river Ganges. This zone is said to be one of the most fertile areas of the world. Therefore, the area is rich in agriculture so that only 1 % of the area is protected. This leads to a loss of species, for example elephants in the last few years. The ecology is quite interesting as it includes a mix of species from the Himalayan region as well as from the gangetic plain.

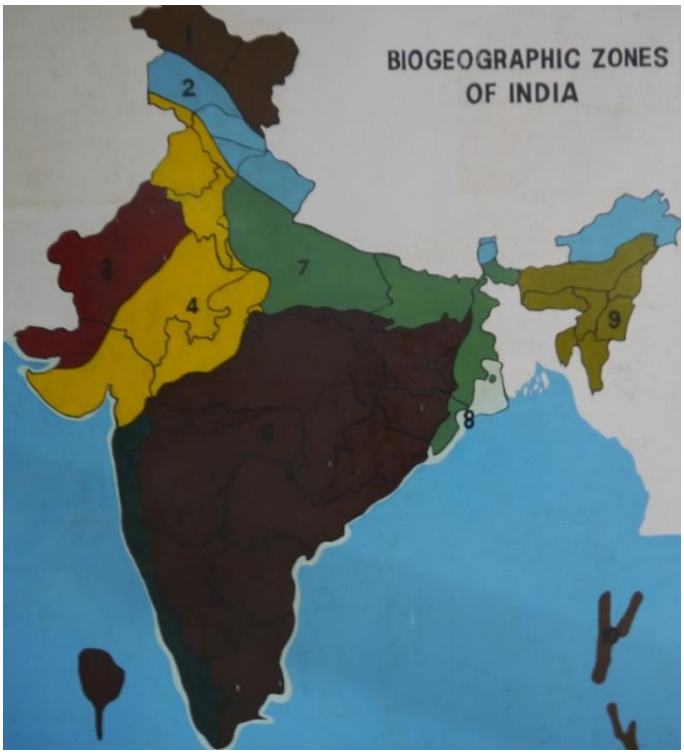

Fig.1: Poster of the biogeographic zones of India in Wii, Dehradun lies in zone 7

Wildlife Institute of India

The Wildlife Institute of India is a governmental institution that was founded in 1982 and is now mainly working in research and management. It contains 8 departments, for example Animal ecology & conservation biology, endangered species management and habitat ecology. The work of the WII is mainly focused on the wildlife such as in animals, for example tigers and elephants, but they also have a small team working on the flora of India and they have even got a small herbarium which is very nicely maintained.

The campus of WII is surrounded by a nature trail that I got to visit, along with some plants Amit showed to me, including a small story of these plants. He believes, that it does not help to just know the name of the plants as that gives no connection to it- he thinks the story behind it makes the plant much more easy to see and to remember, and the name would then just come automatically. We saw Sal – *Shorea robusta* – which is a tropical hardwood of the family Dipterocarpaceae and is one of the main plants in these tropical and subtropical forests that we find around Dehradun. He mentioned that this wood is used for railways for example. Other plants we saw and he explained to me were *Pyrus pashia*, which is also found in the valleys of the Himalaya, *Lantana camara*, which is an invasive that came over from the South Americas and can really be seen everywhere here and plants that are especially medicinally used such as *Rauvolfia serpentina* which is used against hypertension and high blood pressure, and *Evolvulus nummularius* which is used as a memory enhancer (see Fig.2).

Fig.2: *Evolvulus nummularius*

Speaking to Dr. Rawat, who is the dean, FWS of WII, I got to know that people in India still really rely on medicinal plants, not just in using them, but also in producing them, as there are still a lot of farmers that sell plants to the industry. There is also a huge range in medicine depending on the region (for example Chinese and Tibetan medicine), own knowledge from the inhabitants, the altitude (which plants are and have been available to the people). The cultivated plants are the ones that are generally used in more medicines. He explained that Ayurveda is the typical Indian medicine.

The campus of WII would be my base from which I visited all the following places in the first week in and around Dehradun.

Botanical Survey of India & the Forest Research Institute

The Botanical Survey of India (BSI) is a governmental institution that is spread all over India and has a main function in the documentation of the surrounding flora. They carry out genetic surveys of plants, and they have a small herbarium.

I had a tour through their outside area where amongst others the following plants where shown and explained:

- *Santalum album* – high value as timber (tropical hardwood) and has been smuggeled a lot in the past
- *Asparagus adscendens* – the oil derived from the seeds is used against skin abscises and this plant is used for biodiesel
- *Acacia catechu* - chewed it is useful for teeth hygiene and used as a die for reddish walls
- *Bixa orellana* – used as the red dot on women's forehead
- *Sapindus mukorossi* – used as a hair wash
- *Trachycarpus* – used dried in Currys
- *Xanthoxylum* – used for a good mouth hygiene, seeds are chewed and the bark is used as a toothbrush
- *Exbucklandia populnea* – one of the most primitive vascular plants

Fig. 3: Trees at the BSI, showing labels with plant names in latin and sanskrit

After this, we visited the Forest Research Institute (FRI) that is very famous for its building which can be seen in a lot of travel guides. It is basically a university with a huge campus and it includes museums, a Botanical Garden, a Herbarium and more than 20 departments such as entomology, pathology and silviculture. It also has got the 2nd largest library in India and the 2nd biggest Herbarium of India. We had a small tour around the herbarium, which has recently been started to be digitised.

Fig. 4: Forest Research Institute

Fig. 5: Oldest herbarium specimen at the herbarium of the FRI

We went over to the Botanical Gardens, which counts 10 acres and which was founded 1924-1926. It contains more than 500 plants of which are mostly Australian and South African trees, such as *Aesculus indica, Bauhinia glabra, Cassia javanica* and a 46 m tall bamboo which is holding the Guinness World Record.

<u>Himalaya</u>

Our day trip lead us with the car through the outer Himalaya, by going past the cities Rishikesh, Chamba and Dhanaulti. Amit explained to me that the Himalaya is geographically divided into 3 parts: the outer or lesser Himalaya, which is the part that we visited, the greater Himalaya and the trans Himalaya, furthermore it is divided into the western, the central and the eastern Himalaya, of which especially the western and eastern parts are biodiversity hotspots. In the western outer Himalaya, the part that we visited, he explained there are predominantly oak forests and the species of oak depends on the altitude that we are at:

Altitude	**Species**
400-600 m	*Quercus serrata* (lower one, also found around Dehradun)
1800-2500 m	*Quercus oblongata* (Syn.: *Quercus leucotrichophora*) (Sanskrit name= Banj)
2400-2800 m	*Quercus floribunda* (Moru)
>2800 m	*Quercus semecarpifolia* (Kharsu, coming to the tree line)

Fig. 6: Myself at our first stop in the Himalaya

Some conifers, such as *Pinus roxburghii*, started to occur in the lower altitudes as well.

It could be clearly seen, as Amit explained to me, that there are the south facing slopes which are generally much steeper and have less vegetation due to too high temperatures. The north facing slopes on the other hand are not as steep and are much more dense populated by *Quercus* and *Cupressus* species, especially in higher altitudes much more conifers are found.

With higher altitudes and a more temperate climate, we started to see loads of *Rhododendron* which was amazing. Amit said this species is predominantly *Rhododendron arboreum*, but that there are more than 60 species found in the eastern Himalayas.

Also, more conifers where found in the higher altitudes, woods of *Cedrus, Picea, Pinus* and *Abies* were starting.

Fig. 7: The forest at the highest altitude we visited that day, with mostly Cedrus species

I experienced that people in India, especially in the Himalayas, value nature a lot and worship it quite a lot. So it is believed for example that bringing a branch of *Abies spectabilis* home and worshipping it gives good luck. The trees in these areas are mostly covered in moss and lichen, which is very common for a temperate rainforest.

Fig. 8: *Abies spectabilis*

Also we found an example of *Cornus capitata*, which seeds are distributed by blackbirds. This is also a common species for temperate forests.

Some more plants that we saw included:

- *Pinus roxburghii* – especially occuring as a forest in the subtropical Himalayas
- *Berberis* – Bark and roots are good for the eyes
- *Erigeron* – wildly distributed as ground cover vegetation in all altitudes
- *Cedrus deodora* – especially found on the north facing, temperate slopes
- *Indigofera* – also wildly distributed
- *Abies spectabilis, Abies pindrow*
- *Picea smithiana*
- *Pinus wallichiana* – blue pine carrying 5 needles
- *Rubus niveus* – There are a lot of different Rubus species found in the Himalayas
- *Rumex nepalensis*
- *Rubia cordifolia* – important medicinal plant
- *Arisaema intermedium* – called the cobra plant in India
- *Geranium nepalense* – especially along paths
- *Impatiens glandulifera* – the european invasive
- *Cotoneaster* – works as a good soil binder in steep slopes of the himalayas
- *Artemisia* – there are more than 20 species of this genus found in the Himalayas
- *Rumex hastatus* – very distinctive with ist bow-arrow leaf structure, widely used for chutneys in India
- *Bergenia ciliata* - the sanskrit name means that this plants can break stones, so it is used for kidney stones

Fig. 9: *Geranium nepalense*

Some of these plants are aromatic, such as *Nepeta* and *Artemisia*. These aromatic plants were occurring more with an increasing altitude, also Amit explained to me that the higher the altitude, the better the aroma. He experienced that whereas he really needed to rub plants from lower altitudes to smell them, he did not even had to touch plants from higher altitudes to smell these. This, as he thinks, is probably due to a lower pollution level and more fresh water and air due to the high altitude.

Fig. 10: Slopes in the Himalaya that are used for agriculture

Another interesting thing to observe was the high agricultural use of land in these Himalayan areas we visited. I was quite surprised by seeing huge areas planted with tomatoes, harvested by hand and picked up by the next truck to be sold at the market in the next town. Other crops we saw were cucumber, potatoes and of course rice. Also there were quite a few orchards with for example apples or apricots seen during the trip. Amit told me that every region of the Himalayas has its special crop that it is growing. Especially looking at the tales from higher, the fields could be seen that are formed into the slopes. This is quite hard work for people, but due to a lack of education people here are still mostly dependant on small-scale agriculture.

Fig. 11: Tomato fields in the Himalaya

Fig. 12: Temperate rainforest in the Himalaya

Centre for Aromatic Plants

The Centre of Aromatic Plants (CAP) is a governmental organisation that is specialised in plants that are used for essential oils. The main objectives of this organisation are to promote conservation, cultivation, processing and quality assessment of plants that are used for essential oils, to teach this knowledge to local farmers and to develop market linkages for these farmers to secure their life. Cap is focused on ca. 13 commercial plants that are widely used in the aroma industry. On a tour through their outside area we saw plants such as *Cymbopogon flexuosus* (lemongrass), *Pogostemon cablin* (patchouli) and *Melissa officinalis* (lemonbalm).

Fig. 13: *Ocimum gratissimum* = Tulsi, grown in Indian gardens and temples to worship

We also got to see the huge distillery machine, which is relatively easy to build but very efficient, and also farmers do have these on site so that the oils can be directly derived from the plants so that they are as fresh as possible and have the most aroma.

Buyers of these oils are predominantly the perfume industry.

Vaidya Balendu Prakash

Vaidya Balendu Prakash finished his studies of commercial medicine with the B.Sc. The addition 'Vaidya' to his name is the ayurvedic counterpart to the doctors degree, which means that he has studied ayurvedic medicine as well, which is the typical medicine of India.

His ayurvedic treatments against cancer, chronic pancreatitis and migraine have shown some great success so far, even in Europe and the United States.

He mentioned that he is the only doctor in India who is documenting his outcomes, as he learned in Europe but as it is not common at all in India.

He founded the Cancer Research Institute, where he has got a factory for medicines; also he just started a high altitude nursery in the Himalaya that will be serving plants for his medicines. Next to this, he uses plants from the local markets around Dehradun and from big markets around Delhi.

He mentioned that there is not a recipe of plants for a disease or a person, but that he is choosing this by his own instinct.

Some of the plants he mentioned are listed below. He mentioned that a lot of medicines are coming out of the kitchen, such as *Piper nigrum, Tamarindus indica, Cinnamomum verum or Zingiber officinale*. This shows the strong connection between food and medicine in Ayurveda, and that a healthy diet is part of the medicine.

To conclude the first week, I think I found that the topic medicinal plants in India is such a broad topic that I am really starting to understand now I am here. Ayurveda, seen as a wellness program in the west, is accepted as a proper medicine and therapy in India. And whereas this is the typical and probably most common medicine type in India, there are so many other little tribes and inhabitants living in this huge country, that have derived their own knowledge, which makes it seem for me now like a field that can be endlessly explored.

Also, people rely horticulturally on medicinal plants as a lot of people, for example as in the Himalaya as I have seen, as these are the cultivators from which the big industry is getting their products. Regarding cultivation, plants also differ in their substances, as different soils, altitudes and temperatures influence the products a plant is producing, and that are following used for medicine.

Bengaluru (South India)

Fig. 26:
https://www.google.de/maps/place/Bangalore,+Karnataka+560001,+Indien/@17.5741317,69.895817,5z/data=!4m5!3m4!1s0x3bae1670c9b44e6d:0xf8dfc3e8517e4fe0!8m2!3d12.9715987!4d77.5945627?hl=de

Bengaluru is a big city in the south of India, where the monsoons just stopped when I arrived, therefore the climate is very pleasant here compared to Dehradun, where the monsoon season just started and had therefore quite a high humidity. In current times known as the IT city of India, Bengaluru used to be the 'Garden City' of India. People from Bengaluru that I met on my way say that it is not necessarily like that anymore, but I think it is a very green city, with many street trees, a lot of little parks, mostly around important buildings and its 2 biggest gardens/parks: Lalbagh Botanical Gardens and Cubbon park.

Regional Ayurvedic Research Institute for Metabolic Disorders (RARIMD)

This institute in the neighbourhood of Lalbagh Gardens belongs to the Central Council for Research in Ayurvedic Sciences, which is the head office for RARIMD and other institutions around India. In this institute, roughly 150 people are working and collecting data, identifying plants, writing PhDs and doing field visits.

Their main aim is to identify plants, collect information, especially ancient knowledge, and inform about how plants can be used. They are following the ayurvedic system and are also linked to an ayurvedic hospital, so that their work is directly used further.

Fig. 15: Plant materials kept for display

On a tour through their facilities including a library, a small herbarium and the inner courtyard of their building where they are growing a huge range of plants used in Ayurveda, I learned that making a medicine out of a plant is including different factors. For example there is mostly a certain part of the plant that is used, plant material can be used either fresh, or dried, and it is important at which time of the season (preferably after flower) and at the right time of the day, which differs from one to another plant.

Fig. 16: Example of the display of ayurvedic plants in the courtyard

Cambium Biotechnologies

Cambium Biotechnology is a company that is focussing on micropropagation. Its unique characteristic is that this company is taking part in all parts of the value chain, from production to the selling of the plant. They are working together with local farmers, who are growing on the plants that have been propagated in the laboratories of the company.

Plants that are propagated depend mainly on what is wanted at the moment on the market, and I was shown some collections.

FRLHT Ethnomedicinal Gardens

The FRLHT ethnomedicinal garden is an independent organisation, located in Dehradun around an ayurvedic hospital. There is a nursery growing around 1500 plants from India of different medicines. These are also used-either fresh or preserved-in the ayurvedic hospital.

The offices of the Central for Herbal Gardens & Landscaping Services, which belongs to the FRLHT, is on site, and the main aim of this concept is to incorporate traditions and the traditional knowledge of medicinal plants into modern, aesthetic design ideas, and to create a way of bringing these traditions more back into the society again.

Fig. 17 & 18: The surroundings of the FRLHT & ethnomedicinal garden, showing design ideas

Regarding the maintenance of the place they told me that they have no waste, so everything will be used, furthermore they are not using any chemicals but neem-based products and that they also try to use mainly native plants, that are of use and also good for pollinators.

Fig. 19: A healing giant – Where has one seen this before?

On the whole site, we also visited their other facilities where they are doing a lot of work in documenting, researching and inform about medicinal plants of India. Also, they have some conservation projects going on there.

Lalbagh Gardens

Lalbagh is the famous Botanical Garden of Bangalore, currently holding 673 genera and 1854 species[1] of plants. It was founded in 1760, and its main glasshouse was built after the example of Kew's Palm House. The garden is situated around a lake and makes an oasis for a lot of people of the city, especially as there is no entry fee at weekdays. Following parts of the garden have been seen:

Fig. 20: The glasshouse, built after Kew's example

Fig. 21: The Bonsai garden

[1] http://www.horticulture.kar.nic.in/lalbagh.htm#The Garden

Fig. 22: *Ceiba pentandra* – the White Silk Cotton Tree (Bombacaceae)

The garden, just as some other public places I visited at the time, where just getting ready for the independence day of India on the 15th August, so a lot of people were digging beds, planting and cleaning out spaces such as the glasshouse for example, as for this day the whole of the city will be decorated and will be in bloom.

Fig. 23: One of the topiary gardens

Fig. 24: The rose garden in preparation for the independence day of India

Overall summary

Have the aims and objectives been met?

The main aims of this project were:

- To further ones understanding about the cultivation of medicinal plants and how they are used in horticulture on both a purposeful and ornamental level in a country where their use is highly valued and is vastly different to Europe.
- Compare and contrast the importance of medicinal plants in horticulture and society, how they are prescribed in for example, ayurvedic medicine and the entire horticultural process from cultivation through to using a crop for beneficial purposes.
- After learning the basics of micro propagation in horticulture during lectures, one hopes to augment understanding of how micro propagation is used as a way of commercial propagation to produce large numbers of plants. One hopes to find out what the advantages of using micro propagation are in this case, compared to using 'macro propagation' and to link this to the European horticultural world.
- To investigate the importance that gardens (botanic and amenity) and horticultural organisations such as the Wildlife Institute and the Forest Research Institute have within their culture and how valued conservation is.

Looking back at my originally set aims and objectives, I can say that those have fully been met on my visit to India.

Obviously, one needs to keep in mind what a big country India is and how little two weeks are to investigate such a big topic as medicinal plants. But even in those 2 weeks, I felt I really learned about how different people's relationships to plants are.

I learned, that a lot of people in India still rely a lot on small scale horticulture, which could be seen by all the fields we found in the Himalayas and driving through the cities, as every little bit of land was used to grow crops such as for example rice.

Visiting for example the ethnomedicinal garden has shown, that there is a market for medicinal plants in both a purposeful way, such as in the hospital, as well as in an ornamental way of creating designs with medicinal plants.

By meeting facilities such as the Centre for Aromatic Plants and Vaidya Balendu Prakash, the ayurvedic doctor, I saw the whole process of growing and cultivating plants up to the production of the end-product, such as essential oils by distillation and medicines. The ethnomedicinal garden supplied the fresh harvested plants even to the on-site ayurvedic hospital.

Meeting Cambium Biotechnology, I saw a company working on commercial micropropagation, and it made me realise what a big potential this area has.

Especially the visit to the Wildlife Institute India showed me, how important conservation is to people that are working there. Especially with the connection to medicinal plants, it is that with

the decreasing knowledge of especially old ancient tribes, the importance of some plants is going missing.

What has been learnt from a personal/horticultural perspective?

From a horticultural perspective, I found it really interesting to see how much horticulture is valued in a country that is so different to Europe. It occurred to me that a few times, people were pointing out that especially the identification of plants is quite difficult, as there are not enough experts around. It seems to me that in India, people are a few steps back in terms of horticultural standards for example, and working on this is increasing, though it is still in very early stages.

In Europe (Germany & England) it sometimes seems to me that people are overdoing things such as quality standards and wasting too much time in finding the right way, whereas it can be seen that in India, even with very simple tools and techniques great results can be achieved. I think the perfect balance would be the middle way of this, for which skill and knowledge exchange is a key factor. I met so many people that had such a great knowledge, in terms of Indian flora, medicinal plants and ancient knowledge, what is not necessarily the standard in India and what makes people like that even more precious.

From a personal point of view, I found that even if it was quite hard for me while I was there, it was even more amazing looking back at it now. I went there on my own and was with locals all the time. I realised how big the culture difference actually is, and how this difference can lead to a lot of misunderstandings in the everyday life, this was probably increased by English not being the first language of either of us, although I found that most of the Indians I met spoke excellent English.

Possibly, this sometimes lead to minor misunderstandings, not only while I was there, but also in the preparation of things. I feel like this is one of the major things that I have learned, and which will majorly help me for future journeys to set up.

Furthermore, another difficulty for me was getting around. Sometimes it felt to me as if I could not make most of the time that I had there, as for getting around, I was always dependent on other people. This made it really hard to do something that was not included in the schedule, and this is a reason why I would not go on my own the next time.

I found it really interesting how it seems that a lot in nature is linked to a spiritual believe, so for example people think that every single plants has a medicinal value. I found quite a lot of people believing in the doctrine of signatures, which means that the plant is helpful for the part of the body that it looks like. This was really surprising for me, but also interesting.

To summarise – all in all I really feel that I learned what a Travel Scholarship is about, and I feel much more confident about future trips that are on my mind. It really helped me to learn how it is carried out properly, and what I might need to improve the next time, especially regarding the preparation.

Future plans

I feel that India has a lot of potential to be studied further for me. Especially the Himalaya inspired me - for a visit back, I would love to discover that area more, including the famous Valley of flowers, for which we did not have time on this trip, also I would love to maybe have

the chance to visit the high altitude garden and nursery with medicinal plants of Vaidya Balendu Prakash that has just been set up relatively new.

In Bangalore, I was really impressed by FRLHT and how much they are doing regarding the topic medicinal plants, that is not just research, but directly linking and affecting to people. As they have guest rooms as well, I would think about doing another trip to stay there for a bit longer.

I would also love to visit Kerala, which is the 'spice state' of India and which is also unique due to its coastal, tropical climate.

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Figure References

- Fig. 1-24: Pictures taken by Anna-Lena Tack
- Fig. 25 & 26 : Google Maps (see electronic references)