

The Galapagos of the Orient

A horticultural study trip to observe the native and endemic flora of the Ogasawara Islands, Tokyo, Japan.



Fig. 1 – View from Sekimonyama. Author

By Alice Taylor,
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Introduction

The visit to the Tokyo involved an 11 day round trip to the Ogasawara Islands with remaining days visiting horticultural and botanical institutions across Tokyo. It allowed me to study the habitats of the endemic, native and non native (invasive) flora and to witness the variation of flora from island to island on this remote Island archipelago. This then enabled me to expand my knowledge about the history and sensitivity of this particular endemic flora and its cultivation, and to gain a better understanding of in-situ and ex-situ plant conservation focusing on the reasons and causes of the challenges characteristic to remote island flora. It was both on the Islands and in the institutions I visited that I was able to gain a greater understanding of the

plants environmental requirements, with the hope of implementing this in regards to the horticultural curation of collections and displays at the Royal Botanical Gardens, Kew.

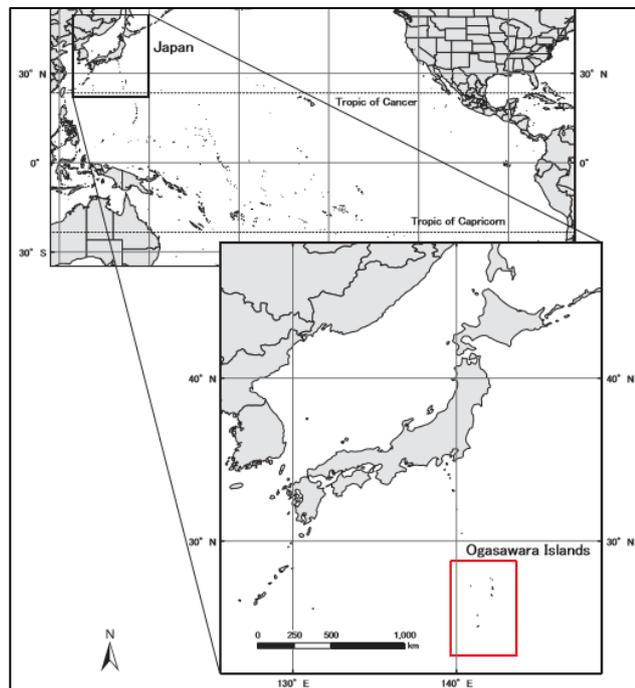


Fig. 2 – Map of location of the Ogasawara Islands.
http://ogawara-info.jp/pdf/isan/recommendation_en.pdf

The Ogasawara Islands (also known as The Bonin Islands) is a term that collectively refers to groups of islands located at the north of the Tropic of Cancer in the Western Pacific, 1,000km south of Tokyo, Japan. The islands comprise more than 30 subtropical islands spread over 400 square kilometres (Fig. 2). They consist of the Ogasawara Archipelago (Mukojima, Chichijima and Hahajima Island Groups), the Kazan Island group (Kita-Iwoto, Iwoto and Minami-iwoto) and several isolated Islands.

The flora of the Ogasawara Islands is noted for a high degree of endemism. Out of approximately 500 species, the endemism rate is 40.1%, compared to a 42.3% ratio in the Galápagos. This has led to the islands' nickname of the "The Galápagos of the Orient". Just over 75% of the native tree species (73 of 97 species) are believed to be endemic. There are two endemic monotypic genera, *Dendrocacalia crepidifolia* (Asteraceae) and the taxonomically unresolved *Boninia glabra* (Rutaceae) that occur in both the Ogasawara and the Volcano Islands. Among 309 indigenous plant species, 124 species are endemic to Ogasawara. The Japanese Red Data Book of Plants listed 4 extinct, 20 endangered, 38 vulnerable, and 1 unknown species of 58 rare species from Ogasawara. Ogasawara is home to '...a total of 138 families, 445 genera and 745 species of vascular plants have been recorded, of which 441 native, and 161 are endemic.' (Fujita et al., 2008). This is in an area less than 0.0001% of the total land area of Japan.

The entire collection of islands has a total area of 84 square kilometres (32 sq mi) over which the climate ranges from humid-subtropical to tropical savannah. The Islands were formed around 48 million years ago. Because the Ogasawara Islands have never been connected to a continent, many of their animals and plants have undergone unique evolutionary processes. Fifty-eight percent of the total area of Ogasawara has national park status and is protected by legislation and physical barriers.

The diverse flora of the Ogasawara islands include plants species with origins in the Southeast Asia, Oceania and the main island on Japan, as well as other endemic plants with unknown origin. (Toyoda, 2003; Ono and Kobayashi, 1983) Plant species reaching the Ogasawara Islands are thought to have been carried by ocean currents, winds and birds. About 70% of the component species of flora on the Ogasawara islands are of southeast Asian origin.

Characteristic genera include *Boninia*, *Dendrocacalia* and *Marattia*. There are also several genera with at least three endemic species each, *Pittosporum*, *Boninia* and *Machilus*. Juniper is the only native conifer to Ogasawara. Growth types vary, sometimes creeping, sometimes growing straight to heights of several metres.

Among the 269 native flowering plants, 74.7% are hermaphroditic, 13.0% are dioecious and 7.1% are monoecious. Classification by flower colour revealed that 36.0% were white, 21.6% green and 13.8% yellow. Woody species (trees and shrubs) comprised 36.5% of the flora and were associated with dioecy and white flowers. Solitary, endemic small bees were the dominant flower visitors and visited 66.7% of the observed species on satellite islands where the native pollination networks are preserved.

Threats

Most of the dense subtropical evergreen forest, which once covered the islands, was cleared or seriously degraded over the last hundred years. The islands are now severely threatened by human presence, mainly due to the conversion of habitats and invasive alien species. The latter present the most significant immediate and future threat, with the main pest animals being goats, cats, black rats, green anoles, pigs, the predatory flatworm, bullfrogs and cane toads, in all, more than 300 recorded species. Another possible future threat might arise from the establishment of air services to the islands, which is currently under discussion and would most likely lead to increased tourism and development. Furthermore, the Ogasawara Islands will likely be affected by climate change, influencing species compositions, ranges, seasonal cycles and habitat preferences, combining with a higher frequency and intensity of natural disasters.

History

The Islands were formed around 48 million years ago, close to the Mariana Trench, the deepest part of the world oceans. Human occupation of the islands is relatively recent with a small group of Westerners and Pacific Islanders settling on Chichijima in 1830. Today, only two of the islands (Chichijima and Hahajima) are inhabited, with a combined residential population of less than 3,000 people. The first recorded visits to the islands were by Europeans in 1543, at which time the islands were not inhabited. Chichijima was first permanently inhabited in 1830. So relatively, extremely recently exposed to human activity, movement and impacts. The highest recorded population only totalled 7,000 people. At present only two islands are populated, with a total population of only 2,000 on Chichijima and 440 on Hahajima. The Battle of Iwo-Jima in 1945 was one of the fiercest battles of World War II. And took place on Iwo-to. Across all of the islands are relics from the war from rusted iron guns, trenches and bomb shelters.

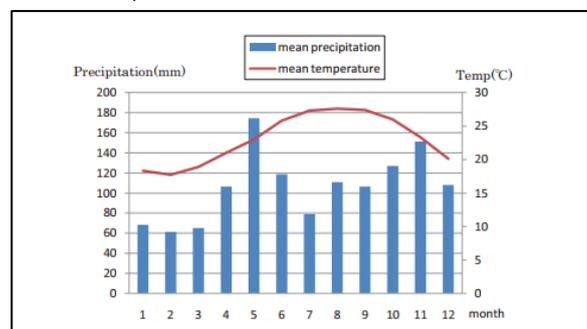


Fig. 3 – Mean temperature and mean precipitation by month on Chichijima
http://ogasawara-info.jp/pdf/isan/recommendation_en.pdf

Vegetation types

As the islands have had a relatively short history of human activity, this has helped to preserve a diverse natural vegetation on each island. Different vegetation types dominate the different islands. The main vegetation types include:

Sclerophyllous scrub, dominated by *Distylium lepidotum*, *Raphiolepis indica* var. *umbellata*. Mainly including small trees reaching around five to eight meters suited to dry climates is spread across north-eastern and south-western Anijima and Chichijima, southern most parts of Hahajima and all of Mukohjima, Mejima, Anejima and Imotojima.

This can then be further broken up into:

- **Distylio-pouterietum dubiae**, communities, which are on gentle slopes of Chichijima and Anijima –*Distylium lepidotum*, *Machilus kobu*, *Schima metersiana* and *Osteomeles lanata*. Occurring on Mt Chuosan and Higashidaira area.
- **Wilkstromio-pouterium-dubae**...*planchonella obovata* var *dubia*, *raphioepus indica* var *umbellata* , steep slopes and wind beaten terrain with poor soils.

Subtropical rainforest. Like Sekimon, with tree up to heights of 20m, consisting of many plants of south-east asian origin, eg. *Eleocharis photinaefolus*, *Pisonia umbellifera*, *Ardisia sieboldii*, *Morus boninensis*, *Celtis boninensis*, *Melia azedarach*. On the limestone rocks of Sekimon. extremely limited examples that can be seen, include *Asplenium cardiophyllum*, *Procris boninensis* and *Ochrosia nakaiana*.

Also in the Sekimon area the *Ardisia sieboldii* forests can be found, which include *Fatsia oligocarpella*, *Colysis pothifolia*, *Cyathea spinulosa*, and this vegetation is very rich in epiphytes.

Aims

- To exchange horticultural knowledge with Japanese professional horticulturists and researchers
- To learn about Japanese cultivation techniques in botanic gardens in Japan
- To visit a variety of natural habitats which are home to endemic flora of Ogasawara and native Japanese spp.
- To study local Ogasawara's sub-tropical flora that the endemics are associated with
- To find inspiration for the Japan/Asia displays in Temperate House once restored
- To improve knowledge of plants, ecology, habitats and environments
- To collate cultivation information for the benefit of Kew's collections and botanic garden collections alike
- To act as ambassadors for Kew and its work
- To share information with colleagues at Kew; where I will give a presentation about my travel scholarship
- To create a good photographic record
- To investigate the opportunity for collecting in the future
- To study Ogasawara flora in-situ (incl. habitats, plant habits, environment, conservation value) with Prof. Kato and other accompanying botanists and National Park Guides
- To investigate how local institutions promote their conservation efforts, which I will be able to do both on the island and at the connected Botanic Gardens
- To promote and maintain contacts between Kew and Japanese institutions

Objectives

- To visit the two botanic gardens and attached herbaria located in Tokyo
- To work alongside experts at Koishikawa Botanical Garden
- To visit different plant habitats and see the endemic island flora on Haha-jima and Chichi-jima and their surrounding islands and islets, accompanied by the expert of the Ogasawara's Flora, Prof. Kato and other National Park Guides.
- Chich-jima Study native plant habitats with National Park Staff (as access to National Park is restricted, except where special dispensation is granted) See *Metrosideros boninensis*, endangered endemic, only found on this island.
- Haha-jima Study native habitats of endemic flora on Mt Chibusayama.
- Satellite islands These islands have never been inhabited and are not usually accessible, only because Prof. Kato has close links with the Ogasawara and has been studying the flora of these islands for nearly 30 years will I be able to gain access by accompanying him.
- Re-visit sites where Botanist E.H.Wilson visited 1917.
- To record data and photograph (plants, habitats, environments...)

Personal profile

I began studying horticulture in 2009 with the 2 year BTEC National Diploma at Capel Manor in London after gaining an interest in trees. During my time at Capel Manor I was nominated by my tutors to be interviewed for a placement at the Gardens of Buckingham Palace. I was successful. This was my first gardening job and one which I have many memories of. After this amazing experience I worked at Clifton Nurseries which is the oldest garden centre in London with a large indoor plants greenhouse. I worked here until I took up a place on the Kew Traineeship in the Arboretum in 2013. It was here able to look after the Japanese Gateway for half of my time there. After a year at Kew I then moved on to the RHS to do the Wisley Diploma in Horticulture before I came back to Kew to take a job in the Tropical Nursery, where my interest in island flora began.

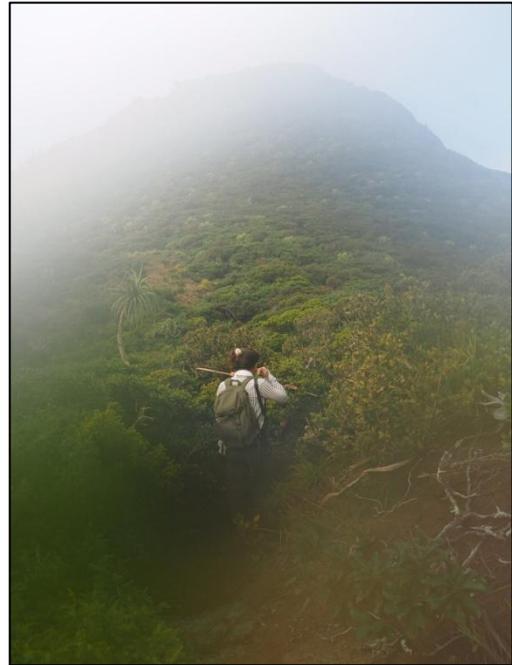


Figure 4 : Alice Taylor on uninhabited Anijima Island.

My desire to study the native Japanese flora arose naturally as I am half Japanese, half English and have always been interested in Japanese plants. Following a recent trip to Yakushima, another small island in the south of Japan, I became more interested in other sub-tropical islands of Japan as I am have been working in the Tropical nursery at Kew for the last 2 years, looking after ferns, herbaceous and woody tropical plants, aquatic plants and propagation. I wished to use my Japanese heritage, language and links with Japan to develop my work and especially the relationship between Kew and Japanese Botanic Gardens and Organisations.

Itinerary

Day	Date	Detail
1	Sunday 27 th Aug	Fly from London Heathrow to Tokyo
2	Tuesday 29 th Aug	Visit Koishikawa Botanic Garden
3	Thursday 31 st Aug	Visit Jindai Botanic Garden
4	Saturday 2 nd Sept	Board ferry 1 day later than schedule due to Typhoon
5	Sunday 3 rd Sept	Arrive in Chichijima
6	Monday 4 th Sept	Mt Chuosan, Higashidaira
7	Tuesday 5 th Sept	Ferry to Hahajima. Chibusayama
8	Wednesday 6 th Sept	Hahajima. sekimon
9	Thursday 7 th Sept	Mt Kofuji leave hahajima
10	Friday 8 th Sept	Anijima.
11	Saturday 9 th Sept	Ogasawara tourist centre, Agricultural research Centre, Marine Conservation Centre
12	Sunday 10 th Sept	Iwo-to cruise
13	Monday 11 th Sept	Yoakeyama, Denshiyama, Mikazukiyama
14	Tuesday 12 th Sept	Leave Chichijima
15	Saturday 16 th Sept	Seminar Tokyo university, Richard Barley attending
16	Tuesday 19 th Sept	Makino herbarium, Tokyo Metropolitan University

Maps, routes taken and places visited

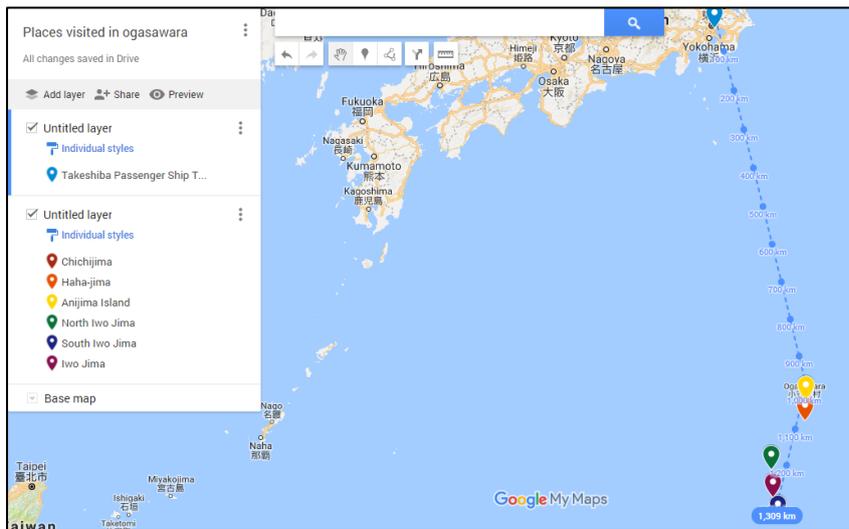


Figure 5 : Places Visited in Ogasawara

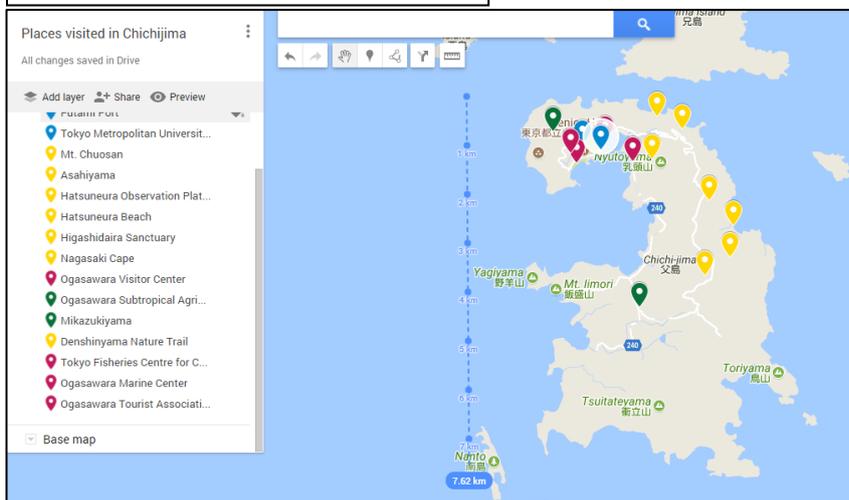


Figure 6 : Places Visited in Chichijima

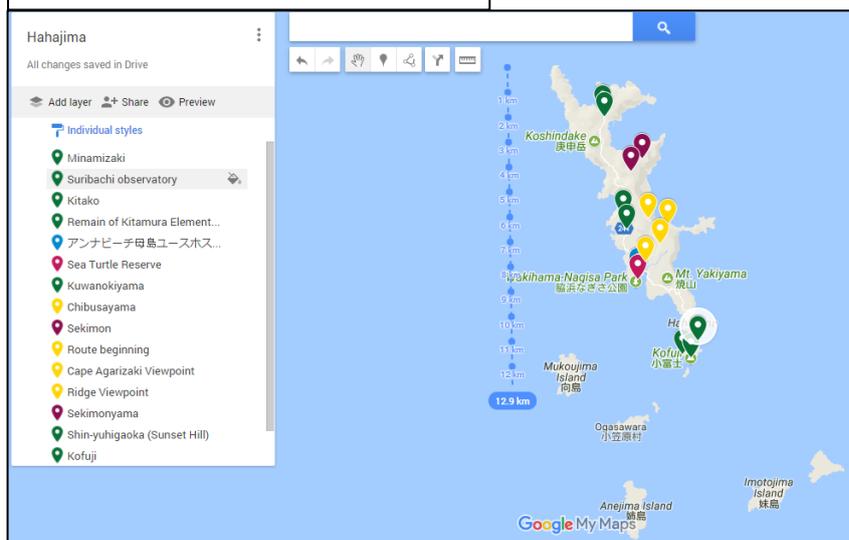


Figure 7 : Places Visited in Haha-jima

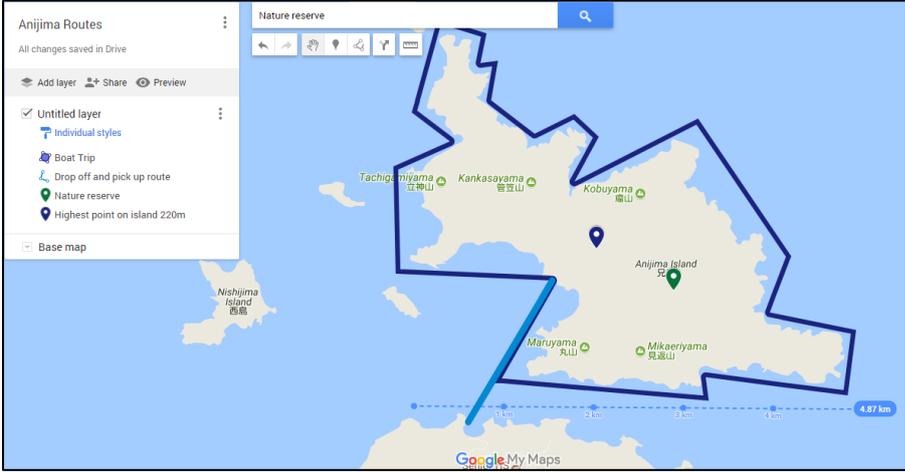


Figure 8: Points visited and route taken in Anjima

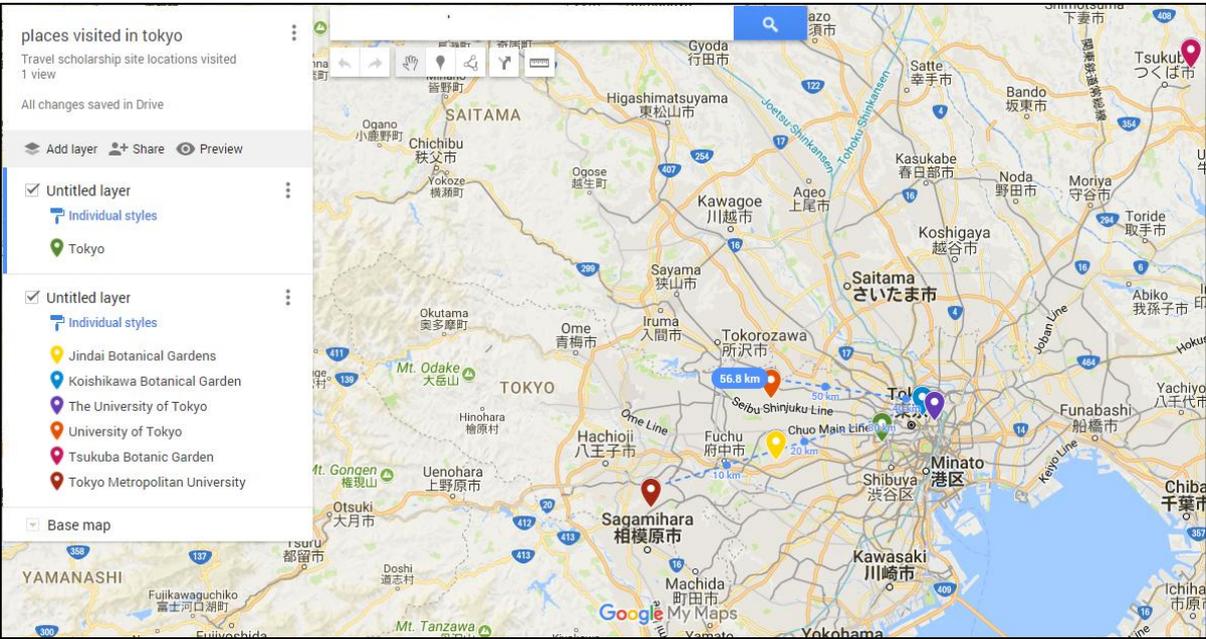


Figure 9 : Places Visited in Tokyo

Koishikawa Botanical Garden (Tokyo University)

This 40 acre, ¥400 admission, Botanical Gardens is not only the oldest in Japan, but also has a prominent and long history. The Botanical Gardens originated as the Koishikawa Medicinal Herb Garden, which was established in 1684 and was the birthplace of modern scientific research in botany in Japan after the Meiji Restoration.



Figure 10 : *Calanthe hoshii*



Figure 11 : *Melastoma tetramerum*



Figure 12 : Trained *Zanthoxylum armottianum*

The main collections in Koishikawa Botanic Garden contain wild collected species of higher plants from eastern Asia (e.g. Japan, Korea, Taiwan, and China). The 4,000 species of plants in the living collection contain 1,100 tropical and subtropical species. Much of their behind the scenes glass houses contained natural source plants from Ogasawara.

Since the 1980s, an intensive species recovery project has been carried out in Bonin when an emergency survey carried by the Ministry of Environment in 1985 showed that 80 species, about half the endemic species were on the edge of extinction. The species recovery project was called the Bonin Rare Plants Recovery Project, it has been carried on by the Ministry Of Environment in cooperation with the Tokyo Metropolitan Government and the University of Tokyo targeting 11 species: *Melastoma tetramerum*, *Rhododendron boninense*, *Calanthe hattorii*, *Calanthe hoshii*, *Pittosporum parvifolium*, *Callicarpa nishimurae*, *Piper postelsianum*, *Asplenium cardiophyllum*, *Malaxis boninensis*, *Luisia boninensis*, and *Bulbophyllum boninense*. I hoped to see most if not all of these growing in the wild in Ogasawara. In addition to research and monitoring, re-introductions of plants cultivated at the Botanic Gardens of Tokyo University have been undertaken, since the remaining populations have seriously lost their viability.

Ex situ plant conservation is one of the main activities of the Botanical Gardens. Some extremely endangered species have been propagated and propagules returned to their original localities. Many endangered species are cultivated for conservation biology. At

present, special attention is focused on conservation of endangered species endemic to the Ogasawara Islands and Yakushima Island.

It was here with my friend and interpreter that I met with two of the Horticulturists that look after the plants under glass. They had a keen interest in Ogasawara and they told me about the collection there in Koishikawa. They showed me their natural source collection which was my first time seeing the plants from Ogasawara after researching them for months. This



Figure 13 : *Ziziphus jujuba* var. *spinosa* . Introduced and planted in 1727

was very exciting for me to finally see them in real life, some of which were in flower like *Calanthe hoshii* and *Melastoma tetramerum* (see figure and). I noticed that very little was grown in plastic pots but in terracotta or more decorative pots or even trained instead. (see figure).

The most noticeable difference I saw is that they only use akadama as a growing medium, which is a naturally occurring (in Japan), granular, clay-like mineral used as soil for container-grown plants. It is surface-mined, immediately sifted and bagged, and supplied in

various grades. Akadama's colour darkens when moist which can help the grower determine when to water a tree. I saw this medium being used for everything from seeds, woody plants and ferns to cacti. They claimed it was the best growing medium even though it is more costly than alternative soil components, it is prized by Japanese horticulturists for its ability to retain water and nutrients while still providing porosity and free drainage.

In another area of the garden there was a tree which reminded me in more ways than one of Kews' 'Pagoda Tree', *Styphnolobium japonicum*. Which is one of Kews' 'Old Lions' being planted in 1707. The Ziziphus was growing mostly horizontally, with a fence around it and an interpretation sign (see figure)

Jindai Botanic Garden (Tokyo City Government)

Jindai Botanical Garden is a world-class, 105 acre garden in Chofu City, in the west of Tokyo, that offers seasonal beauty all year round. Jindai Botanical Garden is Tokyo's main botanical garden, being the only one operated by Tokyo Metropolis. It has the biggest rose garden in Tokyo, and is famous too for its plum and cherry trees, which blossom in spring. The Garden includes adjacent free-entry facilities like an aquatic plant area and a plant information center.



Figure 14 : Entrance to Tokyo Metropolitan Jindai Botanical Gardens

Jindai Botanical Garden became a public botanical garden in 1961. Its botanical connections go back to before the Second World War when it was a nursery for trees to line the streets of Tokyo, and then, after the war, when it became the Jindai Green Zone. It costs ¥500 admission which is just over £3 and has the highest visitor numbers of all the botanic gardens in Tokyo.

On arrival I was introduced to the Director of Jindai Botanic Gardens, Mr. Yukio Iida and offered some refreshments and an information pack for the garden. Then I was collected by the Manager of the Plant Diversity Center of Jindai, Mr. Shinsuke Terui. They gave me a tour of the main glass house, (see figure) where they have impressive displays of Begonias, Orchids, Arid plants and a large waterlily zone with three ponds full of them (see figure). Waste heat from an incineration plant is used at their Yumenoshima Tropical Greenhouse Dome, which also features scenes and landscapes of tropical wetlands, those of tropical villages, and vegetation in Tokyo's subtropical Ogasawara Islands (see figure).



Figure 15 : Yumenoshima Tropical Greenhouse Dome.

Then we went to visit the Plant Diversity Centre, opened in April 2012, which preserves and propagates Tokyo's endangered species, collects and disseminates information, and promotes the importance of botanical diversity. Mr. Terui gave us a tour and also a power point presentation about Jindai and a discussion with the director. They were very keen to show me all the different collections they have including their *Euryale ferox* plants, which they are able to grow outside, and their collection of Chrysanthemums that they have begun to start training for a display next year as well as what seemed like hundreds of different variegated Camellia cultivars. I came to understand in Japan, variegated plants are extremely popular!



Figure 16 : Ogasawara Room in the Yumenoshima Tropical Greenhouse Dome. (Yumenoshima translates to 'Island of Dreams')

Makino Herbarium, Tokyo

Makino Herbarium was founded in 1958, in commemoration of the late Dr. Tomitaro Makino (1862-1957), whose specimens, some of which we hold at the Herbarium at Kew, were donated to Tokyo Metropolitan University after his death. He is one of the pioneer botanists in Japan, and his collection (approximately 400,000 specimens) was donated to Tokyo Metropolitan University after his death, for utilizing his valuable specimens as the basic research materials for plant science. There are a lot of specimens collected in all parts of Japan, including Ogasawara from the late-19th century to the early-20th century, along with many type specimens. They hold, 299,075 sheets of vascular plants, moss and lichen: 16,300 pockets of moss and lichen and 21,610 sheets of algae.

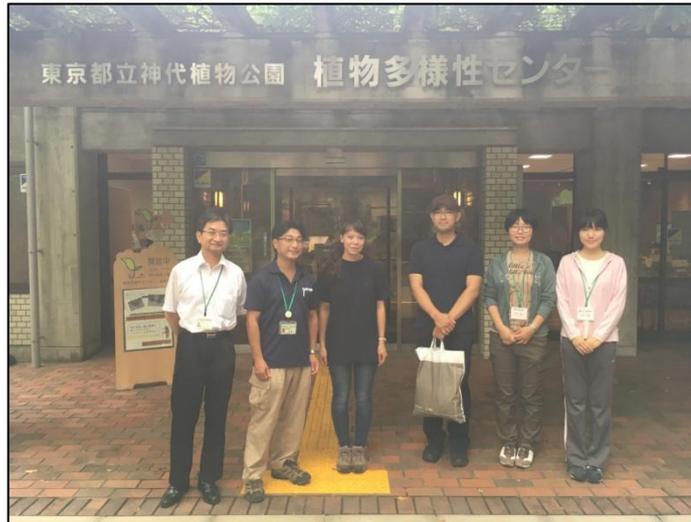


Figure 17: Group photo. (left to right) Mr Yukio Iida, Mr Shinsuke Terui, Myself, Mr Yuichi Murayama and two Undergraduate students from Tsukuba University.

Ogasawara Islands

Chichi-jima

I arrived at the ferry terminal feeling quite anxious about the 1000km journey ahead of me, I waited at an agreed meeting place to meet Mr. Kato (whom I had yet to meet but had been exchanging emails for almost 10 months). He arrived. We boarded, not before having our shoes checked for mud and seeds. Everyone had to scrub the soles of our shoes through a shallow puddle of water on a rough mat so as not to inadvertently bring in and plant seeds from outside. I then didn't see Mr. Kato until I disembarked the boat, he told me that he was very sensitive to rough seas, he went to his private room and I claimed my patch of boat in economy.

After a turbulent 25 hour ferry journey that was postponed by one day due to a bad typhoon (sea conditions were still less than ideal, consequently I spent the entire journey feeling quite ill) which was moving north from Ogasawara to Tokyo. I embarked from Takeshiba Pier in Tokyo and finally arrived in Chichijima, Ogasawara.

On arrival, it was 11am and raining quite heavily (luckily it was the only day of rain I was to experience in Ogasawara). I then also met Asahi-san who was a 22 year old Masters student that Mr Kato was supervising from Tokyo Metropolitan University. Her thesis was to be on, 'Mycorrhizal associations with endemic fern gametophytes'. I was intrigued. I shared a room with Asahi-san for my entire stay and we went on our hikes and excursions as a trio.

We then walked with our luggage uphill to the Tokyo Metropolitan University Ogasawara Research Centre, which would be my home for the time on Chichijima. Mr. Kato gave me a tour of the facilities of which included a large kitchen, a lab, a drying room, two offices, a library, 4 bedrooms, a car and two bicycles. He then Told us we must go food shopping, as all the islands fresh supplies come on the weekly Ferry (Ogasawamaru), that we had just alighted, of course the boat was one day late and Mr Kato thought the two supermarkets would be very busy as the islands inhabitants wait for the ferries' arrival for new delivery of fresh food. Mr Kato was right, it seemed like the entire island was there doing their grocery shopping.



Figure 18 : First view from the boat of the



Figure 19 : Tokyo Metropolitan University, Ogasawara Research Centre

Mt. Chuosan

The following day, our first full day, we awoke early and drove a little way towards Mt Chuosan which is situated in the centre of the island. The top and slopes of Mt Chuosan is covered in dry sclerophyllous scrub and had not been particularly disturbed by human activity. Chuosan is the highest peak in Chichijima, standing at 319m. The lower part of the mountain is a Dry Mesic Forest, dominated by *Schima*, *Livistona* and *Machilus* with shallow soils and a closed canopy of up to 8 meters.

It was extremely hot and humid, even in the early morning. Here we saw many endemic plants (see Figure). In this area, they are actively capturing feral cats as they inhabit the breeding ground of the rare endemic wood pigeon.



Figure 20 :Professor Kato hiking up Mt Chuosan

Plants seen on Mt. Chuo

Schima mertensiana
*Leucobryum boninense**
Sphenomeris biflora
*Callipcarpa subpubescens**
*Machilus boninenses**
Machilus kobu
*Psychotria boninensis**
Psychotria homalosperma
*Carex hattoriana**
*Carex augustini**
*Carex boottiana**
Pinus luchuensis †
*Ficus boninsimae**
*Fatsia oligocarpella**
*Pittosporum boninense**
Hedyotis leptopetata
Arenga engleri †
*Meterosideros boninensis**
*Pandanus boninensis**
*Zanthoxylum boninsimae**
*Calanthe hattori**
Cinnamomum pseudopedunculatum
*Ilex mertensii**
Ctenitis lepigera
Psidium cattleianum f. *lucidum* †
*Sellaginella boninensis**
Blechnum orientale
*Hibiscus glaber**
*Photinia wrightiana**
Asplenium nidus
*Ardisia sieboldii**
*Loxogramme boninensis**
*Eleagnus rotundata**
Freycinetia formosana
*Lepisorus boninensis**
*Osteomeles schwerina**
*Ligustrum micranthum**
*Distylium lepidotum**
Planchonella obovata var. *dubia*
Vaccinium bonin
Dodoneae viscosa
Hedychium coronarium †
Eleaocarpus photinaefolius
Bischofia javanica †

Key

* - endemic

†- non native invasive

Figure 21 : List of plants seen on Mt. Chuo

Among the notable plants I saw here was *Metrosideros boninensis*. *M. boninensis* is classified as 'endangered' in the Japanese Red Data Book and 326 plants recorded in 2004, with genetic diversity of *M. boninensis* being extremely low. Only 215 individuals are left as of 2014. Now only found in Chichijima, except for two remaining trees in neighbouring Anijima Island. Most trees stand between 2-10m in height. The genus includes about 50 species and is distributed throughout the Pacific islands, South Africa, New Zealand and Hawaii. Interestingly, *Metrosideros* is not found at all in Australia and it is not understood why this is. The Hawaiian species, *M. polymorpha* is the next most northern species of *Metrosideros* after *M. boninensis*. *M. boninensis* is most closely related to the Fijian species *M. ochrantha*, 6300km away. Both are very old species.

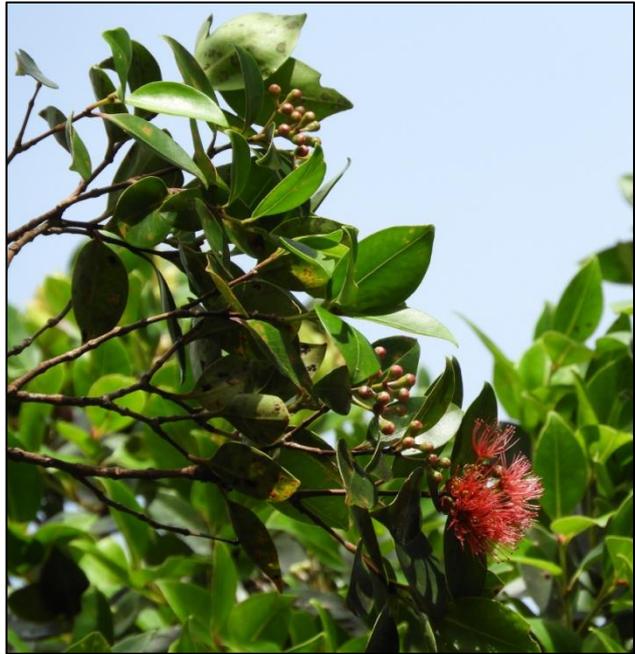


Figure 22 :Rare endemic *Metrosideros boninensis* in flower

The seeds are very light and easily dispersed by wind and can survive freezing temperatures and up to 30 days submerged in salt water, which explains how it had managed to distribute itself across vast distances. It is the only red flowered tree in all Ogasawara. Unfortunately, we did not see many flowers due



Figure 23 : *Osteomeles lanata*



Figure 24 : *Zanthoxylum ailanthoides*

to the typhoon the previous day, all the flowers had been blown off and it is difficult to see them from below the canopy. We did manage to see one with open flowers in a clearing (See Figure).

In Figure , all of the *Livistona chinensis* subsp. *boninensis*, one of two endemic palms on Ogasawara, can be seen clearly amongst the canopy of the forest. In the foreground is the invasive pine from the Ryukyu Islands of Japan, *Pinus luchuensis*.



Figure 25 : View of vegetation from Mt, Chuosan

Higashidaira



Figure 26 : Rules and regulations of Eco sanctuary



Figure 27 : Information boards showing borders of sanctuary



Figure 28 : Mr. Kato demonstrating how to clean boots and trousers

After Mt Chuo we went to the eco-sanctuary of Higashidaira, this sanctuary cannot be entered without a licensed guide and special care must be taken not to inadvertently bring in non native plant seeds and also and invasive predatory flat worms. We had to scrub and spray our shoes with vinegar which kills the flatworms (see figure 28). They are very damaging to the endemic snail populations in Ogasawara as there are over 100 endemic species. The boarder of the sanctuary can be seen in figure 27. This represents a fence which cost over ¥100,000,000, its main purpose is to keep out feral cats and goats.

Plants seen in Higashidaira

Shizaea digitata
 Korthalsella japonica
 Callicarpa nishimurae*
 Bryophyllum pinnatum †
 Malaxis boninensis*
 Calanthe hattorii*
 Piper postelianum*
 Scutellaria longituba *
 Planchonella boninensis*
 Ajuga boninsimae*
 Clinostigma savoryana*
 Luisia boninensis*
 Callicarpa glabra*
 Pandanus boninensis*
 Freycinetia boninensis*
 Calanthe hoshii*
 Callicarpa parvifolia
 Ficus boninsimae*
 Tarenna subsessilis*
 Symplocos sp.
 Cyathea mertensiana*
 Cyathea ogurae*
 Morus boninensis*
 Psilotum nudum
 Marattia boninensis*
 Lindsaea repanda*
 Nephrolepis cordifolia
 Angiopteris lygodiifolia
 Crepidomanes minutum
 Neolisteia sp.
 Smilax sp.
 Osmunda japonica
 Melastoma tetramerum
 Viburnum sp
 Boninia glabra*
 Wilkestromia sp
 Distylium sp

They also set up a nice system to keep track of visitors to the sanctuary by having different coloured rocks and corals for tourists, researchers, guides etc. and tubes labelled with the different trails so that staff can keep track of numbers of visitors and who is visiting the sanctuary (see figure 26).

Here I saw *Shizaea digitata*, which was a very strange fern (see figure 31). It is in an order of its own, Schizales, and its common name is comb fern. It looked a lot like a grass but the fertile parts were on the tips of the frond. Another odd plant I saw was



Figure 29 : Beautiful rare terrestrial orchid
Calanthe hattorii

Korthalsella japonica (see figure 32) in the family Santalaceae. It is a parasitic plant similar to Mistletoe and used to be classified in Viscaceae.



Figure 31: Fern, *Schizeae digitata*



Figure 32 : Parasitic plant, *Korthalsella japonica*



Figure 33 : Epiphytic orchid, *Luisia boninensis*

The family contains about 25 species distributed in Asia, Africa, Australia, and some Pacific Islands. The other half of the species are found almost exclusively on remote islands, as a group, ranging eastwards across the Pacific as far as Hawaii, and westwards across the Indian Ocean to Madagascar and nearby islands. *Korthalsella* seeds are minute and the fruits weakly explosive. Seeds may be dispersed on the plumage and feet of birds, which gives us a clue as to how it reached Ogasawara. It has been suggested that when a perching bird touches a *Korthalsella* plant the ripe fruits may be triggered, ejecting the sticky seeds on to the bird. The distribution pattern of the second group of species, across remote islands, conforms with the movements of sea birds such as boobies and tropicbirds (both of which breed in the Ogasawara Islands), which range widely over sea, nest on islands, and rarely visit the mainland. These plants were not endemic, but we found interest in them none the less.

It was in this nature reserve that I saw some *Callicarpa* species - all of them are endemic and rare. The endemic butterfly that pollinates them is also extremely rare and very small.

Three species of *Callicarpa* are endemic to the Ogasawara Islands, *C. glabra*, *C. nishimurae* (see figure 34), and *C. subpubescens* (see figure 35), The last species has the widest distribution in the islands and occupies rather wet habitats in the tall evergreen forests in Chichijima. In Hahajima, it grows in various habitats from coastal scrub areas up to higher montane mist forests. The other two species are restricted to specific habitats in Chichijima: *C. glabra* is found in dry sunny forest margins (now only 50 individuals on Anijima and only 10 on Chichijima), whereas *C. nishimurae* is known only from very dry windy hilltops. Mr. Kato showed me some planting done by the environment agency to support the endemic bees on the island, which feed on the pollen of *Callicarpa* (which all have different flowering



Figure 34 : *Callicarpa nishimurae*



Figure 35 : *Callicarpa subpubescens*

Hahajima Island

The next day we boarded the Hahajimamaru, which is a smaller ferry that takes journeys to and from Hahajima and Chichijima twice a week, taking 2 hours. On this journey I was told we were quite



Figure 37 : Bottle nose Dolphin

likely to see dolphins and possibly even Sperm Whales. Sure enough, about half an hour into the ferry journey we saw bottle nose dolphins! (see figure 37). This was very exciting.

Chibusayama

As we began our ascent on the trail, one thing that was immediately obvious was that there was significantly more damage to the plants on Hahajima. All along the trail the floor was strewn foliage from the trees in the area, making it all look like a green carpet. (See figure 38) Chibusayama is the tallest mountain in Hahajima and Chichijima at 463m. It is extremely species rich around the top of the mountain. The view was spectacular, we could see Minamizaki Cape and Higashizaki Cape (see figure). On the decent we saw many trees covered in epiphytes (see figure), *Melastoma tetramerum* var. *pentapetalum*, *Dendrocacalia crepidifolia* as well as the Bonin Honey Eater.



Figure 38 : Mr Kato on trail ascending Mt Chibusayama



Figure 39 : View from summit of Mt. Chibusayama



Figure 40 : *Hibiscus glaber* covered in epiphytes



Figure 41 : View of Higashizaki Cape

Melastoma tetramerum and its varieties are one of the most seriously endangered of the endemic species of the Ogasawara Islands. *Melastoma* is a genus comprising 50 species that are distributed from the Indo-Malesian region to the Pacific Ocean. Around the Japanese archipelago, 10 taxa (seven species and three varieties) grow wild, four of which are vulnerable, endangered, or critically endangered. In Ogasawara, three *Melastoma* taxa are of conservation concern. *Melastoma*



Figure 42 : *Melastoma tetramerum* var. *pentapetalum*

tetramerum var. *tetramerum* is a critically endangered shrub, endemic to Chichi-jima.

To determine the genetic variation and differentiation of in situ and ex situ populations and to maintain genetic diversity in future populations, they have identified 20 polymorphic microsatellite loci to genotype all available individuals of *M. tetramerum* var. *tetramerum*. Three are closely related, namely, *M. tetramerum* var. *pentapetalum*, *M. candidum* var. *candidum*, and *M. candidum* var. *alessandrense*.

Melastoma tetramerum var. *pentapetalum* is an endangered variety, endemic to two mountains on Haha-jima Island, which is 37 km from Chichi-jima Island. This variety has

flowers with five petals, whereas *M.*

tetramerum var. *tetramerum* has flowers with four petals. *M. candidum* var. *candidum* is a common variety native to Okinawa, Taiwan, China, and Indochina. *M. candidum* var. *alessandrense* is endemic to Kita-Iwo-To Island, an uninhabited island isolated 200 km from Chichi-jima Island. This variety is vulnerable, with a total of several hundred individuals known in 2007.

We were also very lucky to see *Leptopetalum mexicanum* in full flower. The genus *Leptopetalum* was described in 1838

Plants seen in Chibusayama

*Tarrena subsessilis**
*Cyathea mertensiana**
*Cyathea ogurae**
Cyathea spinulosa
*Morinda boninensis**
Nephrolepis auriculata
Ficussp.
Hibiscus tiliaceus
Malaxis boninensis
Pterissp.
Ardisia sieboldii
Gonocormus minutum
*Fatsia oligocarpella**
Boehmeria sp.
Syzygium cleryfolium
Wilkestromea sp.
Leptopetalum mexicanum
Lppetopetalum grayi
Eleagnus sp.
Corymorchis subdensata
Psycotria sp.

Figure 43 : Plants seen in Chibusayama



Figure 44 : *Leptopetalum mexicanum*

by W. J. Hooker and G. A. Walker-Arnott based on *L. mexicanum*. The original material was collected from Ogasawara but mistakenly supposed to have been collected from Mexico, which is why this endemic species has a confusing epithet.

Sekimon

Sekimon is located in the eastern part of Mt Sekimon with the altitude of 250. To 290m is characterised by its plateau-like geography including doline topography which is a shallow usually funnel-shaped depression of the ground surface formed by solution in limestone regions. It is a



Figure 45 ;
Limestone Lapies



Figure 46 : *Crepidomanes minutum*

mesic forest area.

From a flat terrain of the doline bottom to surrounding gentle slopes, the vegetation consisted of tall evergreen trees such as *Pisonia umbellifera*, *Elaeocarpus photinaefolius*, which represent the Ogasawara subtropical rainforest. Moreover, there are outcrops of limestone (lapies) which are weathered limestone surface found in karst regions. Consisting of etched, fluted, and pitted rock pinnacles separated by deep grooves. This rugged surface is formed by the solution of rock along joints and areas



Figure 47 : *Crepidomanes minutum*

of greater solubility by water containing carbonic and humic acids. The grooves of the lapies may vary in depth from a few millimetres to several metres. Lapies (see figure 45) commonly forms on tilted rocks, and the limestone base becomes extremely hard. They call it the “rock of needles” at the bottom of the doline, providing an important habitat for the endemic plants such as *Asplenium cardiophyllum* and *Procris boninensis*



Figure 48 : *Crepidomanes latealatum*

To enter Sekimon, you are required to be accompanied by a certified Tokyo Nature Guide who has completed a course to enter the Forest Ecosystem Reserve, The number of people per guide is limited to 5.

Hymenophyllace and ferns

In the Sekimon area it was very humid and rainforest like. Due to the conditions there, I was able to see all three filmy ferns occurring in Ogasawara, *Crepidomanes minutum*, *Crepidomanes latealatum*, *Trichomanes tahitense*.(see figures 46, 47,48 and 49) . The *C. minutum* was seen growing on a vertical



Figure 49 : *Trichomanes tahitense*

rock face. *T. tahitense* was seen on the bark of *Pisonia umbellifera*. I was especially pleased to see these as I look after the small collection we have at Kew.



Figure 50 : *Asplenium cardiophyllum*

Once we had arrived in the sekimon area which is the sunken limestone bowl area, we had lunch and explored the area. It was especially humid in this area and the air was thick with mosquitos. Mr Kato knew the exact spot to find certain plants like *Asplenium cardiophyllum* (see figure 50), a highly specialized saxicolous calciphile distributed disjunctly in near-continent Asian and western Pacific islands. It has not been found in Taiwan or the Asian mainland. It is known from Hainan Island, Kitadaito Island, the Ryukyu Islands, and Hahajima of



Figure 51 : Epiphytes growing on the different tree ferns

Ogaswara Islands. It was originally described in 1883.

Anijima Island

The next morning at 5am we headed off to the north of Haha-jima where we waited for our local fisherman to drop us off in Anijima, an uninhabited Island less than 8 km².



Figure 52 : Early morning boat to Anijima

Anijima Island has never been inhabited and much of the flora has not been disturbed. It was noticeably windier and more exposed. Plants I had seen in Hahajima and chichijima looked completely



Figure 53 : View of landscape of Anijima still in early morning mist

Plants seen in Ani-jima

Juniperus boninensis*
 Osteomeles lanata
 Scaveola
 Terminalia
 Hernandia
 Ipomoea pes-caprae
 Callicarpa gabra*
 Myrsine miximowiczii
 Myrsine okabeana*
 Drypetes integerrima
 Pennisetum sordidum
 Aristida boninensis*
 Pasalidium tuyumaea
 Finmbristylis longispica var. boninensis*
 Machaerina ribiginosa
 Rinchospora boninensis*
 Rynchosora chinensis var. curvo-aristata*
 Casuarina!
 Planchonella boninensis*
 Vaccinium boninensis*
 Evodia nishimurae*
 Boninia crassifolisa*
 Geniostoma glabrum*
 Wilkestroemia pseudoretusa*
 Distylium lepidotum
 Schima mertensiana
 Mahilus kobu*
 Ilex matanoana*
 Neolitsea
 Ochrosia nakaiana*
 Crepidiastrum grandicollum*

Figure 54 : List of plants seen in Anijima

different here in Anijima, due to conditions, they were much more compact, mat forming, with prostrate habits.

Another noticeable thing here were the expansive lengths of fences to contain the spread of the invasive Green Anole, We saw hundreds of sticky traps in the shrubs and 'un-climbable' fences, standing at about 75cm.

We saw individuals of rare endemic *Crepidiastrum grandicollum* all with a circle of rocks around them so that they would not get trodden on or lost as they are perennials.

Crepidiastrum is a small east Asian genus of Asteraceae. *Crepidiastrum* includes about ten species found in the Japanese Archipelago, Korea, Taiwan, and the Ogasawara Islands.

Three species, *C. ameristophyllum*, *C. grandicollum*, and *C. linguaefolium*, are known from Ogasawara, where each is endemic to a separate restricted area and endangered. *C. grandicollum* is a herbaceous perennial about 10-30 cm tall, whereas the other two species are woody with soft, semi-succulent stems less than 1 m tall. Studies have shown that the Ogasawara species are more closely related to each other than they are to the Japanese species, which shows that they had evolved separately to any on the main body of Japan.



Figure 55 : *Crepidiastrum grandicollum* in stone circle

There are two species that both used to be *Myrsine*, *Rapanea maximowiczii* var. *okabeana* (reclassified to *Myrsine okabeana*) (see figure 56) and *Myrsine maximowiczii* which has remained how it was; both shrubs in Primulaceae. Mr. Kato had never seen them with so much fruit before. They exhibited especially compact growth, forming round hummocky shapes.



Figure 57 : Boninite Pillow lava

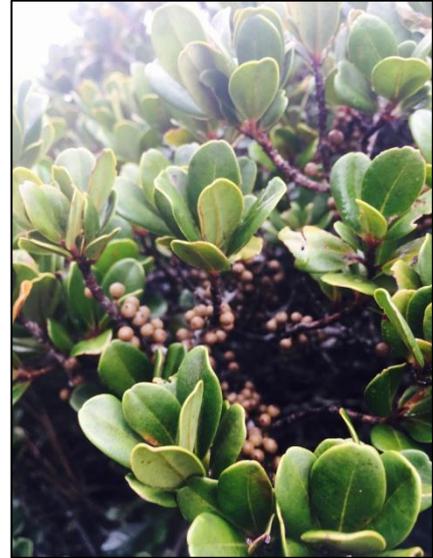


Figure 56 : *Rapanea maximowiczii* var. *okabeana* (Syn. *Myrsine okabeana*) with many fruits

After looking at the plants we had time before the fisherman was going to come and collect us. Mr Kato told us it was one of the best spots for snorkelling around a shipwreck not far off the beach we arrived on. So with one set of a snorkel and flippers we took it in turns. I saw everything from pipefish, jellyfish, octopus, corals and giant clams with fluorescent blue lips. After we each had four turns the fishing boat came back for us. Mr. Kato asked him nicely if he could go once around the whole of Anijima. The fisherman said “li-yo!” (which means ‘no problem’) and off we went. The water was exceptionally clear and the sight of the exposed rocks and cliff faces of the Island was stunning. We were able to see unique ‘Boninite pillow lava’. Pillow lavas are lavas that contain characteristic pillow-shaped structures that are attributed to the extrusion of the lava under water. Pillow lavas form the upper part of Layer 2 of normal oceanic crust.



Figure 58 : Interesting rock formations

Iwoto Cruise

Minami Iwoto

The Volcano Islands are:

-Kita Iwo Jima (北硫黄島 Kita-lō-jima or Kita-lō-tō, literally North Sulphur Island), 5.57 square kilometres (2.15 sq mi), 792 metres (2,598 ft) (Sakaki-ga-mine)

-Iwo Jima (硫黄島 Iō-jima or Iō-tō, literally Sulphur Island) 20.60 square kilometres (7.95 sq mi), 166 metres (545 ft) (Suribachi-yama)

-Minami Iwo Jima (南硫黄島 Minami-lō-jima or Minami-lō-tō, literally South Sulphur Island) 3.54 square kilometres (1.37 sq mi), 916 metres (3,005 ft)

This is a special cruise happening only once a year on the Ogasawara-maru that people from Japan and all over the world travel the 25 hours to Chichi-jima to be able to be on this 24 hour cruise to the Volcano Islands. It was very lucky that this cruise was on at the same time that I was there in Ogasawara. Mr. Kato strongly recommended I go with Asahi-san to see view the three remote Islands, two of which are still botanically interesting, although nobody is allowed to step foot on these islands except for Military personnel on Iwo-to and scientists and researchers on North and South Iwo-to. Mr Kato has been one of the handful of people in the world to go on the expeditions to these islands spending up to ten days with more botanists, ornithologists, entomologists, geologists and chiropterologists (researchers of flying mammals) as well as people studying cetaceans and further marine life. I would say that 90% of the people that were on



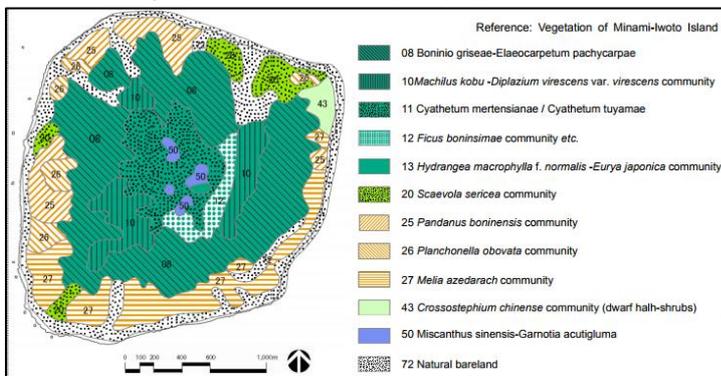
Figure 59 : First sight of Minami Iwoto. 10 hours after boarding the



Figure 60 : Full view of Minami Iwoto with cloud hat on.



Figure 61 : Tall sheer sea cliffs. Nesting places of breeding sea birds.



that cruise were there to see seabirds. Many people had very large very expensive looking cameras and binoculars and never left the deck the whole time it was light.

Figure 62 : Vegetation of Minami Iwoto. http://ogasawara-info.jp/pdf/isan/ActionPlan_eiqo.pdf

It is 1300 km south of Tokyo, 330 km SSW of Chichi-jima. Its area is 3.4 km² and the shore length, 7.5 km. Along the shoreline there are few bays and inlets, and it is covered with mostly rocks and little sand. To the rear are sea cliffs that rise to 200m in height (see figure). The peak on South Iwo Jima is the largest in the Ogasawara Islands at 913m and its average slope angle is 45 degrees. The northwest side of this volcano, which has a relatively stable shape and is not eroding much, rises at a gentler incline of 30 degrees. Another defining feature of the island is that it does not have rivers, lakes, marshes or a freshwater system of any kind. A Lycopodium and hydrangea that are not found in Ogasawara have been found here.

Minami Iwoto (South Sulphur Island) is also the location of 'Mahoutokoro'- (Place of Magic) from the Harry Potter world.

'This ancient Japanese school has the smallest student body of the eleven great wizarding schools and takes students from the age of seven (although they do not board until they are eleven). While day students, wizarding children are flown back and forth to their homes every day on the backs of a flock of giant storm petrels. The ornate and exquisite palace of Mahoutokoro is made of mutton-fat jade, and stands on the topmost point of the 'uninhabited' (or so Muggles think) Volcanic island of Minami Iwo Jima.'



Figure 63 : Iwoto Island with Mt Suribachi on the right.

Iwoto /Iwo-jima (Sulphur Island)

After two loops around Minami Iwoto 52km and a few hours later we approach Iwo-to. I had never seen such an odd looking Island, it was extremely flat except for one small Mountain called Mt Suribachi (see figure), which is famous for the photograph of the raising of the flag at Iwo Jima. The site of one of the bloodiest battle of WWII where the losses of men amounted to:
 U.S., 6,800 dead, 19,200 wounded;
 Japanese, 18,000 dead, 216 captured.

Figure 64 : Photograph of Iwo Jima flag raising
https://www.nationalww2museum.org/sites/default/files/styles/wide_large/public/2017-07/Iwo%20Jima.png



The smell of sulphur could be smelt even from the ferry, as the island is somewhat active. Smoke can be seen coming out of the ground. According to Mr. Kato, the island is almost entirely inhabited by alien plant species. It is the only island of all the Ogasawara and Volcano Islands that is not part of their conservation programme.

Kita Iwoto (North Sulphur Island)

Kita Iwota was the final island we would see, this Island was also home to Tropic Birds, Petrels and Boobies. Nesting areas were thought to be damaged in the most recent Typhoon. The water around this island was very deep so the ferry could get quite close. When a Japanese birdwatcher offered to let me look through his binoculars, I could see the crowns of tree ferns and waterfalls. The desire to set foot on the island was great, despite being able to see a lot of plastic rubbish littering the beaches.



Figure 65 : Kita-Iwo-to Island

After our 24 hour round trip, we arrived back in Chichijima and back to the research centre. The next time I would board the Ogasawara maru would be my last.



Figure 66 : Photographers and bird watchers on Iwo-to Cruise

Agricultural Research Centre

One notable plant that I was only able to see in the Agricultural research centre as there are only 5 individuals left in the wild was *Rhododendron boninensis*.(see figure 67) This plant is on the brink of extinction in the wild and there is not much hope for it due to the very low genetic diversity. But it is being conserved in the botanic gardens in Tokyo.

There is 1 wild plant left in Chichijima as of 2005 with 65 surviving plants out of the 500 planted between 1986-2006.

This plant is only one example of many endemic plants of Ogasawara where almost no fruition or seedlings have been observed recently.

The causes of this serious situation are considered to be

- the impacts of dryness,
- typhoons or other climatic factors,
- increased shading by alien trees,
- breeding incapability because of small population size,
- illegal collection,
- impact from alien animals



Figure 67 : The beautiful endangered *Rhododendron boninensis*

Dealing with the threats

The management of the Wilderness Area, National Park and National Wildlife Protection Area is carried out by the Ministry of the Environment, for which it has an annually budget of about 375,000,000 yen. An additional 28,000,000 yen is for the study of how to take effective measures against alien invasive species. This works out to something like £2.5 million a year.

An Ecotourism Master Plan for the islands was prepared in 2005 and revised in 2010. Over the last couple years, there has also been a considerable increase in staffing and resources. Noteworthy progress has been made in the management of alien invasive species, with approaches ranging from control to mitigation to eradication. Best practices from Australia and New Zealand have been adopted and modified to suit local conditions. Academic institutions, Government agencies, at both national and local levels, NGOs and communities are working together to address issues of invasive alien species. However, there is still need to strengthen access and quarantining protocols

Conclusion

For me, this trip has not only been rewarding, and unforgettable. It has been educational and eye opening to see the wonderful flora and fauna of these small islands. I have visited Japan many times before, but these Islands are truly unique and very different from the main islands of Japan, in climate and culture.

I am so grateful for everyone who helped me make this trip possible, especially for Mr Kato and his generosity with his time and knowledge. Without which my trip would not have been so successful.

I was able to see the endemic plants both in the wild and in cultivation and meet some of the people who help to protect, study and conserve these endangered plants. As a result I have been able to come away with a much greater knowledge of Ogaswaras' plant habitats, endemic species and cultural history. On a larger scale I have a greater understanding of Island flora and of all the challenges they face.

At RGB Kew, I now feel I am armed with new knowledge to better look after the Island flora in my care in the tropical nursery and the tropical plants in my unit as I had never been to the tropics before.

I hope to maintain and nurture the relationships with the people and the institutions I met and worked alongside for years to come. I fully intend to visit again one day, hopefully with the aim to one day introduce some of the endemic flora to Kews' living collection or at least seed bank. Currently Kew does not represent any natural source material in our living collection from Ogaswara, except for one palm (*Livistona chinensis* var. *boninensis*) in the palm house.



The traditional Ogasawara farewell was spectacular, the whole village came to the port to wave goodbye to the Ogasawaramaru, they played traditional Japanese drums (Taiko) and people took their boats and followed us miles out to sea whilst shouting and waving for us to come back again soon and wishing us a safe journey to Tokyo.

Thank you for reading my report,

Alice.

Expenses

EXPENSES	COST	TOTAL
Airfare		
London Heathrow to Tokyo Haneda direct	£1,176	£1,176
Tokyo Narita to London Heathrow		
Ferry and Boats		
Tokyo – Chichi-jima (return)	£421	£746
Chichi-jima - Haha-jima (return)	£138	
Haha-jima – Anijima (return)	£120	
Iwo-to Cruise	£67	
Public Transport		
Train within Tokyo	£63	£63
Accommodation (Research Centre, Hostel, Hotel)	£778	£778
Food & Sundries	£292	£292
Miscellaneous	£50	£50
TOTAL		£3105

NB There were no visa requirements and insurance costs were covered by RBG Kew
 Certain costs have been rounded up slightly to account for changes in exchange rate and
 VAT (which is not included but added after pricing in Japan)

FUNDING RECIEVED

AWARDING BODY	AMOUNT
John Scott-Marshall Award	£1700
Royal Horticultural Society	£662.5
The Merlin Trust	£662.5
Personal contributions	£300
TOTAL	£3,325

Signed: Alice Taylor.....

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