

Royal Botanic Gardens
Kew

Chile:

A Journey to the end of the world in search of Temperate Rainforest Giants



Valdivian Rainforest at Alerce Andino Author May 2017

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Introduction

In May 2017 I set off on a 3 week travel scholarship to Central and Southern Chile exploring wild flora within botanic gardens and national parks. The focus of the project was on native trees growing in unique temperate rainforest ecosystems. One of the major reasons for travelling to Chile was to explore the rich and diverse flora with emphasis on the trees of southern Chile. With around 5,000 plant species (relatively few compared with the richness

of some neighbouring countries such as Brazil) Chile has the highest percentage (46%) of endemic species in South America. The geography of Chile is extremely diverse - the country extends from a latitude of 17° South to Cape Horn at 56° South. Chile borders the South Pacific Ocean and a small part of the South Atlantic Ocean. From north to south, Chile extends 4,270 km (2,653 mi), and yet it only averages 177 km (110 mi) East to West. Chile's northern neighbours are Peru and Bolivia, and its border with Argentina to the east, at 5,150 km (3,200 mi), is the world's third longest. Unfortunately, a considerable amount of Chile's flora is under great threat; estimates of around 40% decline in the forests of Central and Southern Chile. Diversity is mainly contained within Central Chile, with approximately 60% of the flora and endemic species occurring here. The Valdivian ecoregion is comprised of a relatively narrow coastal strip between the Pacific Ocean to the West, and the Southern Andes Mountains to the east, from roughly 37° to 48° South latitude. The Chilean conifers include some of the tallest and oldest forest trees; *Fitzroya cupressoides* is one of the oldest living plants in the world, estimated to live in excess of 3,600 years. A series of site visits were undertaken to observe naturally occurring conifer habitats of the nine indigenous conifers of Chile - *Araucaria araucana*, *Austrocedrus chilensis*, *Fitzroya cupressoides*, *Pilgerodendron uviferum*, *Lepidothamnus fonkii*, *Podocarpus nubigenus*, *P. salignus*, *Prumnopitys andina* and *Saxegothaea conspicua*. Biodiversity assessments indicate that the Valdivian temperate forest ecosystems are globally outstanding both in terms of biodiversity and endemism.

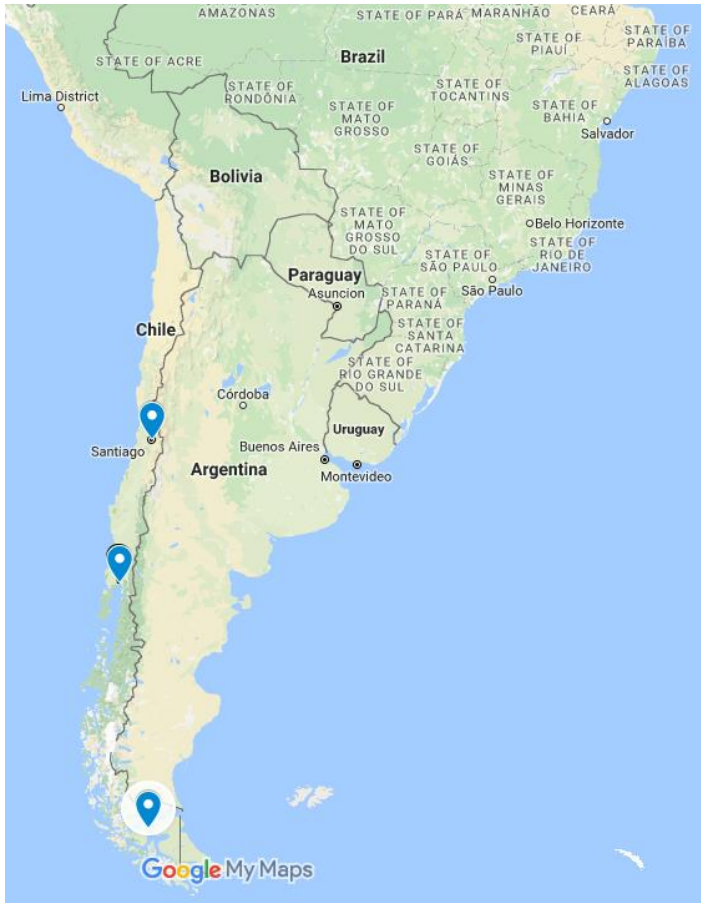
Central Chile extends from about 32° South latitude to about 37° south latitude. The climate is temperate Mediterranean, with the amount of rainfall increasing considerably and progressively from North to South. In the Santiago area, the average monthly temperatures are 19.5 °C in the summer months of January and February and 7.5 °C in the winter months of June and July; the average monthly precipitation is insignificant January and February but 69.7 mm in June and July. The numerous rivers greatly increase in their volume of water moving through as a result of the winter rains and the spring melting of the Andean snows. The south is one of the rainiest areas in the world. Valdivia is one the wettest places in the region with an annual rainfall of 2,535.4 mm.



<http://www.pacifichorticulture.org/articles/an-introduction-to-the-geography-climate-and-flora-of-chile/>

In the far south, Chile Austral extends from between 42° South latitude to Cape Horn, the Andes and the South Pacific. The area generally is cold and wet, and has a combination of channels, fjords, snow-capped mountains, and islands of all shapes and sizes. The Southern part of the far south includes the city of Punta Arenas which receives much less precipitation; its annual total is only 438.5 mm. This precipitation is distributed more or less evenly throughout the year. Temperatures are colder than in the rest of the country. The summer month's average 11.1 °C and the winter month's average 2.5 °C.

The area's other main economic activity is oil and natural gas extraction from the areas around the Strait of Magellan. This strait is one of the world's important sea-lanes because it unites the Atlantic and Pacific oceans through a channel that avoids the rough open waters off Cape Horn. A trip to the most southerly point of any continent in the world demonstrated to me the ability of temperate trees to survive and even thrive, when their environment is sub optimal. A finale to the trip was to follow by boat along the Strait of Magellan in the footsteps of Fitzroy and Darwin on the HMS Beagle's second voyage.



www.googlemaps.com

Aims

1 – Aim: To view the native tree and shrub species of Chile.

Objective: Chile has some 5105 species of vascular plants with 51% endemism. 60% of these are located in Central Chile – one of the world's 25 key biodiversity hotspots. Plant species, location, topographical, geological and climatic information will be documented.

2 – Aim: To develop my horticulture skills in propagation and cultivation of native Chilean species.

Objective: Source current conservation techniques conducted by botanical gardens, WWF, CONAF and Rainforest Concern. Learn how propagation and cultivation can contribute to ex situ conservation and how repatriation programmes reintroduce native species.

3 – Aim: To document information and create a picture library of native tree species.

Objective: Forge links between botanical institutions and share photographs of tree species and their habitats. Sharing the information in the form of a lecture and making it available to aid future trips

4 – Aim: To visit botanical gardens and national parks and experience trees growing in their natural environment.

Objective: To gain a better understanding of ex situ conservation projects especially the importance of seed banking in other countries.

Itinerary May 2017

Tuesday 9th May 2017 – Wednesday 31st May 2017

Day 1 (9th) – Travel from Heathrow to Santiago.

Day 2 (10th) – Santiago – Arrive and then rest day.

Day 3 (11th) – Visit Jardín Botánico Chagual and Santiago Metropolitan Park Mapulemu Botanic Gardens to view collections of native plants looking specifically at natives of Central and Southern Chile.

Day 4 (12th) – Visit Viña del Mar Botanical Gardens to view native trees growing in the arboretum. Visit P.N Campana to view native *Jubea chilensis* in a stand of one of the last remaining strongholds of this species.

Day 5 (13th) – Travel from Santiago to Puerto Montt (internal flight).

Day 6 (14th) – Drive From Puerto Montt to Huilo Huilo.

Day 7 (15th) – Huilo Huilo Biological Reserve Valdivian Temperate Rainforest.

Day 8 (16th) – Huilo Huilo Biological Reserve Valdivian Temperate Rainforest.

Day 9 (17th) – Huilo Huilo Biological Reserve Valdivian Temperate Rainforest.

Day 10 (18th) – Huilo Huilo Biological Reserve Valdivian Temperate Rainforest.

Day 11 (19th) – Drive to Puerto Montt.

Day 12 (20th) – Visit Vicente Perez Rosales National Park.

Day 13 (21st) – Visit and hike Volcano Osorno

Day 14 (22nd) – Visit lake Llanquihue and view the Llanquihue National Park.

Day 15 (23rd) – Visit to P.N Alerce Andino to view native *Fitzroya cupressoides*, *Crinodendron hookerianum*, *Fuchsia magellanica*, *Eucryphia spp.* and document and record the flora of this protected environment. View the Alerce Millenario (*Fitzroya cupressoides*) estimated to be 3600 years old.

Day 16 (24th) – Travel from Puerto Montt to Punta Arenas (internal flight).

Day 17 (25th) – Francisco Coloane Marine Park, Magellan Strait following in the footsteps of Darwin and Fitzroy to view and document not only the most Southerly growing deciduous tree on this planet (*Nothofagus antarctica*) but also view the last of the endemic conifers of Chile (*Pilgerodendron uviferum*) along with some tundra flora.

Day 18 (26th) – Francisco Coloane Marine Park, Magellan Strait following in the footsteps of Darwin and Fitzroy to view and document not only the most Southerly growing deciduous

tree on this planet (*Nothofagus antarctica*) but also view the last of the endemic conifers of Chile (*Pilgerodendron uviferum*) along with some tundra flora.

Day 19 (27th) – Travel from Punta Arenas to Santiago (internal flight).

Day 20 (28th) – Return Santiago to London.

Objective

Eighteen days were spent visiting the national parks, biological reserves and botanical institutions of Central and Southern Chile. Observations were recorded and a picture library was comprised of managed native plant collections, focusing on cultivation. Where possible, tours and interaction with members of staff involved with the management of these collections were organised. The majority of the time was spent visiting, observing, photographing, trekking and identifying plants in the global eco-region of the Valdivian temperate rainforest, one of the world's five major temperate rainforests and the only one in all of South America. Millions of years of isolation have created these unique habitats and abundant number of endemic plants especially taxonomically isolated genera belonging to monogeneric families such as Aextoxicaceae, Gomotergaceae, and Misodendraceae species. Discovery into how evolutionary adaptations have enabled them to adapt continually to shifting environmental conditions, such as changes in pest populations, climate change, and other environmental factors and observation of conservation techniques was carried out allowing knowledge to be acquired relating to the role that in situ and ex situ conservation can play in safeguarding biodiversity within these ecosystems. Consultation with experts to increase knowledge of the role botanic gardens can play in ex situ conservation programmes especially for the tree species *Araucaria araucana*, *Gomortega keule*, *Fitzroya cupressoides*, *Prumnopitys andina* and *Saxegothea conspicua* and the role seed banking plays in securing sufficient genetic diversity was carried out. Finding out how botanic gardens use their expertise in cultivation and propagation can help establish plant communities that are becoming endangered in the wild. Conserving species diversity and maintaining healthy genetically diverse collections within gardens could help in restoration and rehabilitation programmes.

The Santiago Metropolitan Park is an urban park located within the centre of Santiago consisting of the San Cristobal, Chacarillas and Los Gemelos hills, and the areas of Tupahue, Lo Saldés, Pirámide and Bosque Santiago. It covers around 722 hectares, making it the largest urban park in Chile and one of the largest in the world being described by experts as 'the green lungs of Santiago'. The park was created in April 1966, when incorporating the Chilean National Zoo and the San Cristóbal Hill. It is managed by the Ministry of Housing and Urban Development which maintain the park. In September, 2012, the Chilean government launched a plan to significantly refurbish and expand the park between 2012 and 2016, a plan which included new buildings new footpaths, expanding the National Zoo and the planting of over 100,000 more Chilean native trees. The park and its management also maintain 16 other urban parks distributed throughout 13 communes in Santiago, a total area of almost 150.1 hectares. The maintenance work is carried out through the Urban Parks Conservation, Maintenance department and it is this team which manages the botanical garden. In 1984 the 4-hectare botanical garden which is located on Cerro San Cristobal was established and named Mapulemu, the indigenous word for 'Garden of the Earth'. It displays mainly the native flora of Chile and it is accessed by cable car. The views looking down and across Santiago are spectacular and indigenous trees and shrubs line the roads and hillsides. More than 70 species

endemic to Chile, are distributed throughout the garden and all geographical regions are well represented from the North to South of Chile.



View from Santiago Metropolitan Park looking down on Santiago, Author May 2017



Podocarpus salignus Author May 2017

Aextoxicon punctatum Author May 2017



The Santiago Metropolitan Park *Jubea chilensis* (Author May 2017)

Jardín Botánico Chagual is a 33.9-hectare Chilean botanical garden in the process of development, focusing on the preservation of plants native to the Mediterranean climatic zone of Chile (between 30° and 38° S latitude). It is a member of Botanic Gardens Conservation International (BGCI). Together with the national botanic gardens and Viña del Mar, they both offer and complement each other with their collections of native and endemic plants. Unfortunately, more time could have been spent at this garden but the primary focus was to see good collections of Nothofagaceae such as (*Nothofagus macrocarpa*, *N. obliqua*, *N. glauca*, *N. alessandri*) as well as some of the native Chilean conifers which was carried out. Even though it was a long day, what was planned was accomplished, and nonetheless it was still a great way to start the scholarship.

Jardin Botanico Nacional, Viña del Mar was created in 1951. The Garden has a total area of 395 hectares open to the public. There is around 280 species of trees contained within the park, with some excellent mature specimens. *Sophora toromiro*, a species of flowering tree in Fabaceae and endemic to Easter Island. Due to heavy deforestation, most of the island's forests were eliminated by the first half of the 17th century. This once common tree became rare and ultimately extinct in the wild. A fine collection of plants from Juan Fernandez archipelago and a Cactarium with an estimated 670 cacti in the collection and around 60 Chilean species. This was closed at the time, but access was gained to walk around and see the collection. Chilean Myrtaceae was well represented and all the native conifer trees of Chile were photographed and documented from the collection. In total el Jardin Botánico Nacional has around 1168 plant species and its 363 hectares of natural hills grow 269 native species. This park certainly offers recreation for the public and also a proactive environmental education program in which courses are taught outdoors and caters for educating children between the months of March and December, benefiting around 7,000 children per year.



Jardin Botanico Nacional, Viña del Mar Author May 2017 *Embothrium coccineum*



Jardin Botanico Nacional, Viña del Mar Author May 2017 Araucaria



Viña del Mar *Jubea chilensis* nursery Author 2017

La Campana National Park is located in the Cordillera de la Costa, Quillota Province, in the Valparaíso Region of Chile. La Campana National Park and the Vizcachas Mountains lie northwest of Santiago. This national park covers approximately 31 square miles and is home to one of the last palm forests of *Jubea chilensis*. Unfortunately the distribution of *Jubea chilensis* has shrunk considerably since the turn of the century than at the present day. The Chilean Wine Palm was the main reason to visit the park, even though there were other plants noteworthy of a visit such as *Persea lingue*, *Nothofagus macrocarpa*, *Aristotelia chilensis*, *Maytenus boaria* and *Austrocedrus chilensis*. The Cerro La Campana, in 1834 Charles Darwin was said to have climbed the mountain, during the second voyage on HMS Beagle.



La Campana National Park Author May 2017

Huilo Huilo Biological Reserve An internal flight from Santiago to Puerto Montt was taken, the hire car was picked up a visit to the Huilo Huilo biological reserve was made. The major reason to stay at the reserve was to be able to trek into the rainforest and study the flora in its natural habitat to record information such as edaphic factors, light levels, and the plant communities and to record the data as well as making a photographic library. A series of treks were undertaken and trees were discovered and keyed out to species especially the *Nothofagus* sp. where a tour of the project to regenerate damaged ecosystems through botanical ex situ conservation was given. The Valdivian temperate forest is a vast ecoregion found mainly on the west coast of Chile but also extending into Argentina. The Valdivian temperate rainforests are characterized by their dense understories of bamboos - mainly *Chusquea* species and ferns.



Huilo Huilo Biological reserve Valdivian Temperate Rainforest Author May 2017

There are four main types of forest ecosystems and ideally wanted to see the main tree species associated with these different environments in the Valdivian ecoregion. At the northern end of the ecoregion there are deciduous forests, and the two major deciduous trees are *rauli* (*Nothofagus alpina*) and *roble* (*N. obliqua*); this is a transitional zone to the Mediterranean-climate forests to the North. The second type are the Valdivian laurel-leaved forests, and it was this type of forest that was mainly focussed on with broadleaf evergreen trees, including *Laureliopsis philippiana*, *Aextoxicon punctatum*, *Eucryphia cordifolia*, *Caldcluvia paniculata*, and *Weinmannia trichosperma* with an understory of *Myrceugenia planipes*, and *Luma apiculata*. The third forest type is the Patagonian Andean forests, which are distributed at higher elevations along the Andes mountain front, and are dominated by evergreen conifers, including *Araucaria araucana* and *Fitzroya cupressoides*. The *Fitzroya cupressoides* looks like a giant sequoia, and is a rival in longevity to the bristlecone pine, some with growth rings recording over 3,625 years. Closer to the treeline, the conifers give way to Andean scrublands of deciduous *Nothofagus* sp. The fourth and last type is the Northern Patagonian forests, which dominate the southern half of the ecoregion, with evergreen species such as the broadleaf *Nothofagus dombeyi* and *Drimys winteri* and the coniferous podocarps, including *Podocarpus nubigenus*.

The Huilo Huilo Biological reserve is part of a unique and little explored ecosystem in the Patagonian Rainforest territory, set right in the Austral Andes. The territory has several areas of international scientific interest and conservation as it is considered one of the most valuable and threatened natural regions in the world. UNESCO declared these Temperate Rainforests a Biosphere Reserve in 2007. In the forests of Huilo Huilo there are four ecosystems, all of them

home to large variety of animal and plant species: the Pilmaiquen Grasslands, the Temperate Rainforests, high mountain peaks and aquatic ecosystems.

The understory was made up of ferns, Bamboos, numerous types of bryophytes, the trees were festooned in lichens, and some amazing fungi. Some of the Valdivian temperate rainforests significant trees and shrubs that were seen and recorded included winter's bark, *Drimys winteri*, Chilean myrtle *Luma apiculata*, all the major *Nothofagus* species but standing out were the Antarctic beech *Nothofagus antartica*, Dombey's beech *Nothofagus dombeyi*, and the lenga beech, *Nothofagus pumilio*. *Podocarpus nubigenus* was also seen as well as the first time I had ever seen trees of 20 plus metre's tall of *Laureliopsis philippiana*, *Eucryphia cordifolia*, Tineo (*Weinmannia trichosperma*), Persea lingue, Gevuina avellana, *Saxegothaea conspicua* and *Dasyphyllum diacanthoides* which were all recorded and photographed.



Eucryphia cordifolia Author May 2017

Among the smaller trees seen were the Meli (*Amomyrtus meli*), Luma (*Amomyrtus luma*), Fuinque (*Lomatia ferruginea*), Pinol (*Lomatia dentata*), Notro (*Embothrium coccineum*), Arrayan (*Luma apiculata*), Tiaca (*Caldcluvia paniculata*) and Chinchin (*Azara microphylla*).

Vicente Pérez Rosales National park Volcano Osorno



Volcano Osorno Author May 2017



Volcano Osorno Author 2017

Vicente Perez Rosales National Park This National Park is located in Los Lagos Region, Llanquihue Province, of Chile. This national park covers around 977 square miles and is almost entirely in the Andes mountain chain. The adjacent national parks Vicente Pérez Rosales, Puyehue National Park and Nahuel Huapi National Park provide a continuous protected area of close to 5,792 square miles. Todos los Santos Lake dominates the landscape around the national park and the outlet of the lake at Petrohué gives rise to the Petrohue River - a stunning fast running crystal clear water. When following the river downstream, but still within the Park, the Petrohue Waterfalls were viewed. The Park also contains the eastern slope of Volcano Osorno, and it was this side of the volcano and this part of the National park that the time was spent focussing on. The flora at foot of the Volcano is typical Valdivian temperate rainforest with trees including *Nothofagus dombeyi*, *Nothofagus pumilio* and *Nothofagus alpina*. The composition of the forest changes with altitude and substratum. Still the most common tree seen when moving up the slope is *Nothofagus dombeyi*, but *Eucryphia cordifolia* and, *Weinmannia trichosperma* appear in greater numbers. *Berberis buxifolia*, *Ribes magellanicum* were seen in thickets along with, *Drimys winteri*. *Myrtaceae*, was well represented with *Luma apiculata*, *Luma chequen* and *Amomyrtus luma species*. *Embothrium coccineum*, the Chilean firebush were found up in the trees and in the thickets with its beautiful red tubular flowers found almost everywhere at the fringe of the forest. *Avellano*, *gevuin*, *Gevuina avellana* (Chilean hazel) were also trees seen and photographed. Chilean rhubarb *Gunnera tinctoria* was seen everywhere from the forests at the foot of the Volcano (growing at about 1 metre tall with very large leaves) all the way up to and beyond the tree line where it is among the first plants to colonise the open land. They are generally associated with the presence of plenty water but other than the ground being saturated there were no visible signs of lakes or rivers.



Gunnera tinctoria growing high on the slopes of Volcano Osorno Author 2017

Alerce Andino National Park is located in the Andes, in Los Lagos Region of Chile. This national park covers about 393 km². It is bounded by the Reloncavi Estuary on its East and South sides, and by the Reloncavi Sound to the West. To the North lies Chapo Lake with the entire park containing about 50 lakes. Its management as well as the other national parks of Chile is entrusted to Corporacion Nacional Forestal, CONAF. Alerce Andino National Park was a real treasure to visit. *Saxegothaea conspicua* and *Austrocedrus chilensis* identified within 10 minutes hiking into the forest and specimens seen were amazing with a height and girth I thought I would never have seen. It is said that the Alerce tree, *Fitzroya cupressoides* is always green and it can be confirmed that it is such a majestic tree, breath-taking when standing underneath. Unfortunately, a large majority of these trees have been lost through logging as the wood was used for the building of houses and boats and it was noticeable that the walls and roofs of a lot of houses are covered in small tiles are made of Alerce wood. You can still buy them as they are known as Alerce tiles.



Fitzroya cupressoides Alerce Andino National Park Author May 2017



Track up to see the *Fitzroya cupressoides* Author 2017

Francisco Coloane Marine Park Created in 2003, it is Chile's first marine park, and is located in the region of Magallanes and Antarctica Chilena, in the Magallanes Strait between Santa Ines and Riesco islands and the Brunswick peninsula, to the southeast of Carlos III Island. The park covers 67.000 hectares, which make up the protected coastal area. There is plenty of vegetation even though this is a harsh landscape, most of the rocky islands are quite dense with low lying bushes and short forests made up of *Nothofagus antartica* and *Nothofagus dombeyi*. The jewel in the crown however came when a unique opportunity arose on the trip to partake in a botanical tour through the Chilean fjords by boat following the exact route in which Darwin and Fitzroy took during the Beagles second voyage. The major reason for myself to travel was not only to see where the Beagle landed but also to see *Pilgerodendron* - there is only one species *uviferum* which belongs to the cypress family Cupressaceae. It is a member of subfamily Callitroideae, a group of distinct southern hemisphere genera associated with the Antarctic flora. It is mainly endemic to the Valdivian Magellanic subpolar forests of southern Chile and southwestern Argentina but also can be found higher up in Valdivian rainforests. It grows from 40 to 55°S in Tierra del Fuego, where it is the southernmost conifer on this earth. The Magellanic subpolar forest ecoregion lies to the west of the Andes Mountains, which run north-south for most of their length but curve Eastward near the Southern tip of South America, terminating at the archipelago of Tierra del Fuego. The Magellanic ecoregion was covered by glaciers during the last ice age, and the landscape is deeply dissected by fjords, with numerous islands, inlets, and channels, including the Strait of Magellan, which separates Tierra del Fuego from the South American mainland and is the route taken by Portuguese explorer Ferdinand Magellan from the South Atlantic to the South Pacific. North of roughly 48° south latitude lies the Valdivian temperate rain forests ecoregion, which shares many affinities with the Magellanic ecoregion in plant and animal life. To the east lie the drier temperate grasslands and shrublands ecoregions of Patagonia, which are in the rain shadow of the Andean and Fuegian mountains.



Strait of Magellan *Pilgerodendron uviferum* and *Nothofagus antartica* on the hillsides.

Francisco Coloane Marine Park



Icy Sound Glacier Francisco Coloane Marine Park Author 2017

The trip began by driving 52km South of Punta Arenas to Punta Carrera where the car was parked at the side of the road. After walking down the beach in pitch black darkness the boarding of the luggage and persons took place onto dingy boats which then drove out to the main boat which would be accommodation for a couple of days. We sailed 8 hours through the night to arrive at the location of the Icy Sound glacier, on Santa Ines Island (Abolutes National Reserve). This was located close to the Sarmiento glacier and the Helado glacier which was spectacular to see. Along the way to view the most southerly growing *Nothofagus Antarctica* and *Pilgerodendron uviferum* there was some spectacular wildlife including sea lions, fur seals, giant petrels, Andean condors, imperial cormorants and the black browed albatross. A short stop to view the tundra ecosystem revealed some fantastic carnivorous species such as *Drosera uniflora*, *Pinguicula antarctica* as well as *Sphagnum magellanica*. After leaving the tundra ecosystem but before heading back, the boat was fortunate enough to sail past a group of 6 humpback whales which was absolutely unbelievable – apparently they feed on king crab, scallops and sea urchins. The return to Punta Carrera in daylight allowed the viewing of the most southern point of any continental landmass Cape Froward.

Travel Costs/ Expenditure

Air Fare International British Airways London Heathrow to Santiago Chile £1,242

Air Fare Internal Flight Santiago to Puerto Montt

Air Fare Internal Flight Puerto Montt to Punta Arenas

Air Fare Internal Flight Punta Arenas to Santiago £213

4 days car hire Santiago £73.29

11 days car hire Puerto Montt £233

Car insurance £379.48

Young driver surcharge £300

Navigation £50.26 Mileage: @ 25p per mile £133.22

Airport Transfers UK - Personal Contribution

Accommodation 19 nights Hotels, Hostels and Forest Lodges Total £796:

3 Nights Santiago £126,

4 Nights Puerto Montt £114,

3 Nights Puerto Fuy £84, Nights

5 Nights Huilo Huilo Biological Reserve £266,

3 Punta Arenas 184,

1 Night Santiago 62.

Food/stores

£20 per day for 20 days Total £360

Total Costs for Travel Scholarship

£ 3,820.25

Grants obtained: Merlin Trust £1500, £600 Bentham and Moxon, £450 Stanley Smith Bursary and £700 Hardy Plant Society

I would like to say many thanks to everyone who helped organise the trip and the funding institutions for making it possible. A special thanks to Tony Kirkham who dedicated a lot of time giving advice to me, making it such a success.