ANTA 504 Supervised Project

GCAS 8

Gondwana Project for Christchurch Botanic Gardens

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1 INTRODUCTION

In February 2001 David Given completed a Scoping Report for the Christchurch Botanic Gardens, which gave details of a Gondwana Project [Appendix Three].

This outlined the proposals for an area of the Christchurch Botanic Gardens for a Gondwana Section linking, particularly, the plants of the former southern continent.

Money has been set aside for the development of this area [shown in Appendix 1]. The final project will involve many completely new plantings and the moving of several other plants, some earthworks, a long time frame and new information displays. After an initial discussion with Jeremy Hawker, Operations Manager, Christchurch Botanic Gardens and with Angus Allen, Plant Curator, we decided on some practical, achievable goals to continue with the work of the late David Given.

The aim of this project is to set up some educational aspects for this Gondwana Project which can be incorporated in the final display, taking into account that this will be a major project for the Botanic Gardens. In particular it was decided to try and link different aspects of Gondwana and to try and make the information available at different levels to the whole public as it is also near the Children's Playground. It is desired that children and adults gain knowledge and information as they go through the Gondwana area display, as well as it being an interesting area with a wide variety of different plants and displays.

Gondwana ("Land of the Gons" – a tribe in India[3]) was first named by Eduard Suess, an Austrian geologist, describing some of the formations in central India which show typical developments of shared geological features. This concept was further developed by a German scientist, Alfred Wegener[1]. He envisioned a single great land mass Pangaea, consisting of a Southern land mass Gondwana to the South and Laurasia to the north[1 2]. His work was partly based on the physical shape of the different continents "fitting" together, with western Africa fitting against eastern South America.
The more recent evidence linking the different parts of the former Gondwana has come from geological features, flora fossils and fauna fossils.
I have initially described some of these in the next three different chapters.

As the Botanic Gardens Gondwana plan is not yet designed or laid out, I cannot describe the illustration methods and links for the different part of the project. These must be done with a common system for all plants, materials and links when the project is more advanced.
The whole project should have a brochure with a map for people to follow and gain further knowledge, if they wish. The material set out here is available to be inserted in the brochure when further details of plantings, pathways and features are decided upon.

I have set out background knowledge, some of which will be transferred to the project brochure, in sections 1, 2 and 3, followed by my suggestions for specific parts of the project.
In each case I have set these up electronically so they can be transferred to information boards, or smaller information posts like the fossil connections and the botanic origins connections.

The aim was to create a series of such ideas, in consultation with Jeremy Hawker, that could be used directly in the Gondwana project.

2 GEOLOGY BACKGROUND

The earth is currently estimated to be about 4600 million years old[3 4 5]. The age of rock can be found by looking at the relative age of surrounding rocks, suppositions, fossils and unconformities and by using radioactive decay. Plate tectonics explains the past and continuing movement of the continents over the last periods of time.

The oldest Antarctic rock is about 3930 million years old but the story of Gondwana began about 545 million years with subduction continuing until 450 million years ago[3].

Continental sedimentation on Gondwana occurred from 400 to 180 million years ago[3]. This sedimentation layer, up to 2.5 km thick, has many of the fossil remains found to date and shows the links between this layer in what is now the different continents of Africa, South America, Australia, New Zealand, India, Iran etc[4 5]. Fossils found in present day Antarctic of plants, trees and marine reptiles show clearly that the Antarctic continent in the past has had cool temperate swamps along with warm and semi arid periods, and fossils from these eras are found over all the parts which made up Gondwana[4].

Brian Storey, Gateway Antarctica, ANTA 101 Lecture notes [3]

This diagram shows the way the present continents fitted together and the initial rifting stage in the disintegration of Gondwana in early Jurassic times, about 180 million years ago. This lead to a seaway forming between West Gondwana (Africa, Madagascar and South America) and East Gondwana (Antarctica, New Zealand, Australia and India) [3 4].

In early Cretaceous times, about 130 million years ago, the South Atlantic began to open and South America separated from the African-Indian plate.

In mid-late Cretaceous times, about 100 million years ago, Australia and New Zealand began to separate (rift) from what is now Antarctica[3 4].

Brian Storey, Gateway Antarctica, ANTA 101 Lecture notes [3]

The opening of the Drake Passage, about 35 million years ago in mid Tertiary times, lead to the development of the polar current about Antarctica, the cooling of the Antarctic continent and the development of the ice sheet[3 4].

Brian Storey, Gateway Antarctica, ANTA 101 Lecture notes [3]

3 FLORA BACKGROUND

3.0 Introduction

The Permian period occurred after an ice sheet period, about 260 million years ago.
As the ice sheet completely disappeared there was a rapid evolution of rich flora with cool temperate swamps and thriving plant communities including *Glossopteris*.
Ginkgos, conifers and tree fern fossils from this period are also found[5].

At the end of this period was the Permian extinction, where all *Glossopteris* disappeared from fossil records, followed by a warm arid phase. The Triassic period (245 to 208 million years ago[28]) was typified by *Dicroidium*, a new flora, with Ginkgos, forked - frond seed-ferns, ferns and *Cycadophytes*[5] also widely spread.

The Jurassic period, from 208 to 144 million years ago, was warm to hot and wet with a luxuriant flora of conifers, Cycads, ferns, lycopods and horsetails[2 5 28]. Ferns seem to have been dominant, especially tree ferns[2]. Fossils representing some of these species are common[5]. This flora is the last to be composed of ancient groups only – after this the changeover to modern-aspect flora commenced[5].

The Cretaceous period, from 144 to 65 million years ago, heralded a sudden change in conditions and flora[2 5 28]. Rapid cooling and Gondwana changes caused sea level changes[2 5]. The flowering plants had the flexibility to make the adaptations and did so, whilst Ginkgos, cycads and conifers (with some conifer exceptions) declined in importance[2 5]. Angiosperm fossils from New Zealand are found throughout the country[2]. The sequence of events in the Gondwana split-up determined the distribution of the Angiosperms – distinct modern floras are the products of evolution in isolation[5].

The Tertiary period, from 65 to 2 million years ago, included New Zealand severing the final links with the other constituent Gondwana areas[5 28]. Australia became an island continent and developed in isolation without significant input from migrants[2 5]. New Zealand went through many climatic, volcanic and land size changes[2 5].

From Antarctic Schools Pack 1999. Published by Foreign and Commonwealth office together with British Antarctic Survey ISBN 0-85665-188-5 [4]

This photograph shows a 3 metre thick coal layer in the Pecora escarpment in the Trans Antarctic Mountains from the Permian period (260 million years old) [4] .
This is convincing evidence of the existence of plant life in Antarctica and would be a good illustration for the brochure.

It may also be possible to include in the Gondwana project area a “cliff area” as part of the landscaping with potential to include coal seams, animal fossils and plant fossils. This was briefly discussed with Jeremy Hawker, but the overall project ideas were not advanced sufficiently at this stage to know whether to develop this idea further or not.

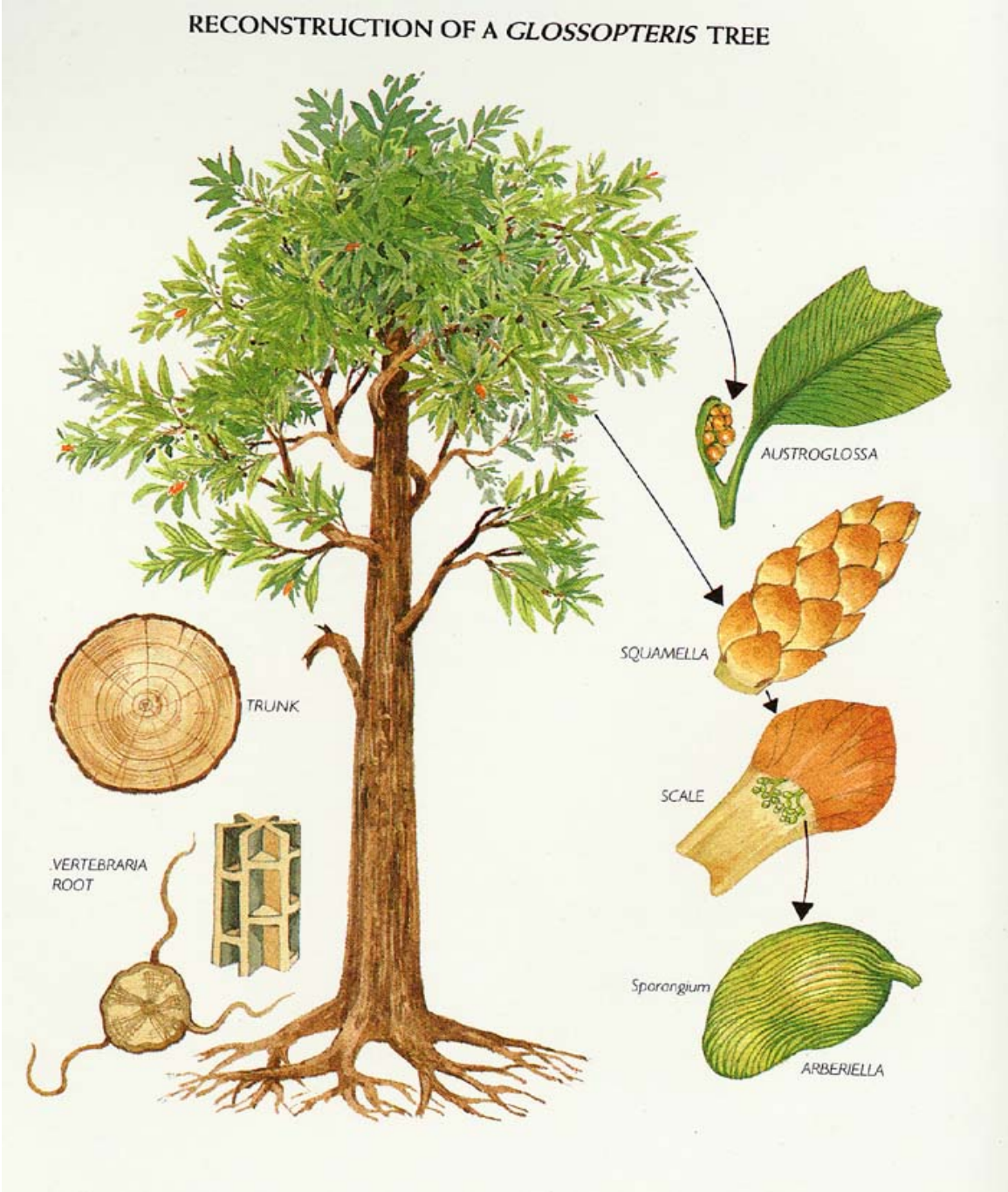
3.1 *Glossopteris*

The name *glossopteris* comes from Greek meaning “tongue” and “fern”. Glossopteris type flora is found in Australia (extensively), South America, Africa, India, and New Zealand, as well as the Antarctic continent, and are widely quoted for a former land connection between the currently separated continents[7]. Most of New Zealand has limited remnants, as, at the height of the Glossopteris era, New Zealand was part of the sea floor[2].

The *glossopteris* leaves are still among the least satisfactory plant fossils in terms of their classification and nomenclature[5]. It is certainly true that the leaf-forms of *glossopteris* are very diverse. By the end of Permian times, some leaves had a midrib and a network of secondary veins like Dicotyledons, others had parallel veins (like monoctyledons and some Conifers), some were taeniopteroid (like Cyclads), and some were very small, probably growing on small woody herbs[7]. All the leaf types were here in this order, probably providing a genetic reservoir for the evolution of plants which arose later in the Mesoizoic era and which may be a direct line to modern plants[7].

There are a very large number of fossils of *glossopteris* which have come from the Antarctic and other constituent parts of Gondwana.

I have included some illustrations of *glossopteris* in the recommendations to be used in the beds of different groups of plants.



The possible reconstruction of a *Glossopteris* is shown[5]. The different parts of the plant have been found fossilised in different areas.

The possible lines of evolution of *Glossopteris* are illustrated on the last page of David Given's report[2] and in Mary White's "The Greening of Antarctica", page 51[4].

3.2 *Dicroidium*

The seed fern *Dicroidium* dominated lowland areas during mid to late Triassic times[8 5].
Dicroidium were forked seed ferns with much smaller leaves than their earlier counterparts in the *glossopteris* family[9]. They may have evolved because of the changing climate as the weather grew hot and dry[9]. The leaves show a great range in pinnule form[5]. The forms show increasing adaptation to arid conditions with a decrease in the size of the lamina, thickened cuticle and reduction of leaves to narrow spikes[5].
Dicroidium fossils have been found in Antarctica and many other parts of the former Gondwana.

3.3 Conifers

It is believed that the southern conifers evolved from the seed fern group of southern *Glossopterids* previously mentioned, through the change in climate and the topography of the land[9]. It is therefore likely that *Glossopteris* and *Dicroidium* species crept from the wet, marshy ground and came to occupy drier and more exposed hillsides. This evolutionary step is one of great advance: efficient root systems, leaves adapted for water conservation and reproduction from seed enabled the transition[9]. It is here on these drier hillsides that early southern conifers, *Ginkgophytes* and early Cyclad ancestors have their origin[9].
Among the conifer families the *Podocarpaceae* and *Araucariaceae* were dominant in Gondwana[10]. It would be expected that there would be plantings of the modern species would be in the project.

3.4 Fossils

There is much fossil evidence and the different fossils could be used around each planting area.

An extensive collection of fossils, especially of New Zealand and Antarctic origin, is held in Canterbury Museum. These can be accessed via Norton Hiller, Geology Curator, who was extremely helpful in letting some of the extensive collection be seen by me.

Some fossils are illustrated in section 5.5 of this report and others are illustrated in various texts especially in “The Greening of Antarctica” by Mary White[5] (particularly Australian fossils) and in “Life etched in stone” by Colin McRae (South African fossils)[29].

It is worthy of note that Capt Scott and party carried some 16 kg of rocks, including coal, and fossils, including *Glossopteris,* found in the Beardmore Glacier area right to the very end of their journey[18] and these rocks and fossils that Wilson collected (“beautifully traced leaves in layers”[19]) were eventually found on their sled. With Captain R F Scott’s links to Christchurch, it would create a nice display to have some of these fossils on display and link this to Canterbury Museum’s Antarctic display. Scott’s party’s actual rocks and fossils are in the National History Museum, London[30]. However Canterbury Museum has an extensive collection of rocks, including some fossils, collected by other people in the 1910-1913 *Terra Nova* expedition[31]. An example in the Museum is exhibit RA10, collected by Priestly[31].

The fossil illustrations with different origins (Antarctic, Australia and New Zealand) should be either on an illustrative board or display, while actual models of the fossils could be placed with the appropriate plant groups.

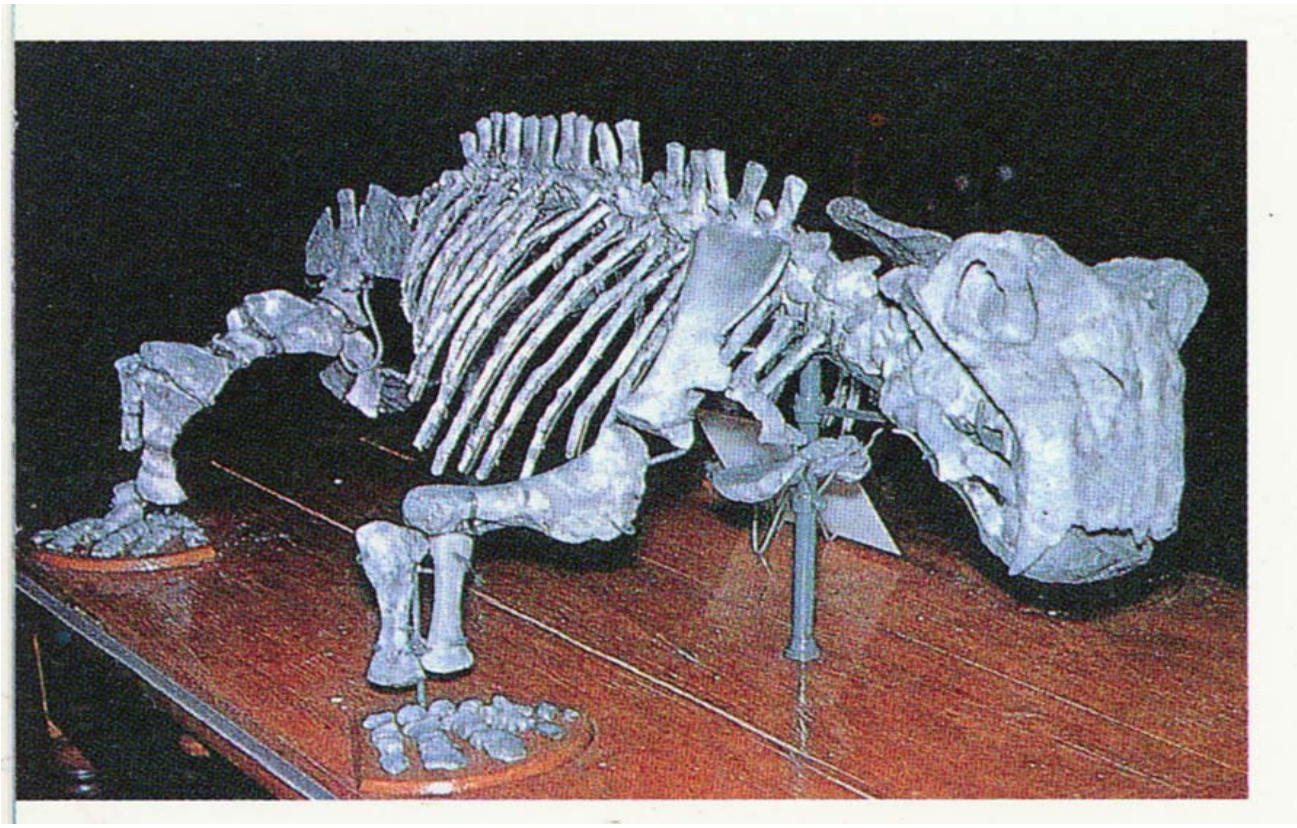
4 FAUNA BACKGROUND

4.1 *Lystrosaurus*

Lystrosaurus (spoon lizard) was a sturdy 4 legged plant eating animal (herbivore) that had two tusks and a horny beak[11 12]. It was not a dinosaur but a mammal like reptile[11 12]. There is some disagreement about whether it was semi-aquatic and spent much of its time in the numerous pools and ponds of its watery environment or whether it spent more time eating vegetation on land. The second view seems to be supported by functional morphology and indicates that Lystaurus was fully terrestial and capable of burrowing[13].

Its fossils have been found across South America, Africa, India and Antarctica and it is a very strong link to Gondwana[14]. Lystrosaurus was about two metres long and about one metre high.

In Lystrosaurus we see the characteristic barrel-shaped body and the reduction of teeth (to two tusks) typical of dicynodonts and there almost certainly was a turtle-like beak as well[15 16]. This is illustrated in the fossil reconstruction below.



Brian Storey, Gateway Antarctica, ANTA 101 Lecture notes

I suggest using Lystrosaurus as a key link with the vegetation by having a model in amongst the plantings. I have included artists' reconstructions of Lystrosaurus in section 5.3

The model should be full scale and linked with footprints from the childrens' playground to the model. The full scale model could be such that the children could climb on it, as it is of such a height to be safe.

4.2 *Mosasaurs [Mososaurus]*

Martin et al found fossil remains suggesting at least 5 different mosasaurs existed on the Antarctic Peninsular, with the possibility of more still to be found[17]. Mosasaurs are a group of giant marine reptiles (up to 20 m) which dominated the oceans during the Cretaceous era.
The ones identified often have a wide distribution including Africa, South America and Israel with the exception of *Moanasaurus*, which is limited to New Zealand[17 20]. There are mosasaur remains, found locally in North Canterbury, that are displayed in the dinosaur section of the Canterbury Museum. It would be good to link the museum to the gardens if mosasaur connections are used.

Reconstruction of mosasaur[21].

4.3 *Dinosaurs*

A species of Theropods, a carnivorous dinosaur related to tyrannosaurs, were found by Martin et al off James Ross Island in 2004[22]. These 4 legged dinosaurs survived longer in the Antarctic than elsewhere and the fossils indicate that they stood about 1.8 to 2.4 m tall and were in the Cretaceous age (144 to 85 million years ago)[22 23].

Therapod skeletal mount at Mesa Southwest museum, USA[23]

A sauropod about 1.8 to 2.1 m tall and up to 9m long was found on Mt Kirkpatrick near the Beardmore glacier at about the same time by W Hammer et al [24] . Sauropods are a group of four legged herbivores with very wide dispersion throughout the world and one is shown here [25] .

Some of these could be used in the gardens to help create the Gondwana link, as well as attracting interest for children and adults alike.
I have suggested Lystrosaurus as the model for children to climb on because of its relatively small size and easy accessibility for youngsters.
The later suggestions could be part of a display – but not able to be climbed on because of health and safety requirements.

5 RECOMMENDATIONS

5.1 Information at each entrance to the project area.
5.2 Footprints linking different areas
5.3 Lystrosaurus in the plantings
5.4 Lystrosaurus information page
5.5 Plant fossils
5.6 Gondwana plant species distribution
5.7 Mosasaurs, dinosaurs and moas
5.8 Museum links

5.1 Information at each entrance to the project area.

Information is part of the key to the Gondwana Project. The information should be visible, informative and readable whilst trying to entice people to see more (plant displays and other exhibits) and learn more (clear information about the exhibits).
The key information areas are
(a) at the Information Centre, where there will be the new brochures, posters on notice boards and the beginning of the footprints, all to raise the awareness of what is available on display
(b) at the entrance to Gondwana area with information boards. I have included the introductory information for each entrance entitled “Gondwana”. It is an A1 poster which is made using Corel draw. I have included a full size poster as well as electronic version. As the project develops, more information could be added to the background of this poster to bring it fully up to date.

(c) at each notable planting area, model etc. I have included some ideas in later sections 5.3, 5.4, 5.5 and 5.6

5.2 Footprints linking different areas.

One of the key components to tie the whole area together by using the children's, and adult's, curiosity, is to use footprints on the paths. The footprints should be distinctive and begin at the information area, go through the children's playground, go past the *Lystrosaurus* model where the young members can clamber, and continue through to the other Gondwana project area exit**.** Following the footprints would take the visitors around the complete display. After discussion with Botanic Gardens staff, the layout and, more importantly the material type, of the paths are not yet decided. Initially the areas around the Information Centre are concreted and a coloured foot on the concrete is easy to construct using a stencil and paint. If the paths are gravel then an alternative will have to be used.

The question then arose as to what footprints to use.
I couldn't find a *Lystrosaurus* foot print. However I have attached two different possibilities.

This is an actual fossil foot print – of a small dinosaur – housed in Canterbury Museum. The dinosaur is unnamed but it is of the late Triassic period (about 222 million years ago) and sourced from Portland, USA.

This second possibility is from an Allosaurus (lizard like dinosaur) [27] , which I photographed in the Canterbury museum. It is a large dinosaur 20 m long.

The footprint could be a model made either using *Lystrosaurus* fossil pictures, or indicative using a footprint like either of the above two.

The key is to have the footprints clearly marked and beginning in obvious places to attract attention and then to take the visitor through the whole display via the footprints.

5.3 *Lystrosaurus* in the plantings

Below is a reconstruction of *Lystrosaurus* by dinosaur artist John Sibblick [26] .

http://www.nationalgeographic.com/media/ngm/9607/0112.html [26]

Another reconstruction of similar shape but different colour is illustrated at www.dinoworld.net/lystro.htm [12] .

www.dinoworld.net/lystro.htm [12]

A third reconstruction of *Lystrosaurus* is illustrated in Canterbury Museum, in the Antarctic display. This reconstruction comes from the Museum of Northern Arizona, USA.

I have not made a model as the project is not that advanced yet, but this could be a really key feature in the gardens. A life size model would bring the children, and their parents, to the displays of plants and other exhibits shown via the footprints. The model can be relatively easily constructed (compared to dinosaurs), is a very appropriate size for younger children, and would be easy to comply with OSH type regulations as its height is only one metre.

This would be a great attraction for children as it is envisaged it would be a “play on” model, sturdily constructed.

I would use the first model (illustrated) as the basis for the Botanic Gardens model .

5.4 Lystrosaurus information page

This is the information available for near the exhibit of the model(s).
The full size A3 poster is attached. An electronic version is on CD

Plant fossils

It would be good to connect the old and the new flora. Extensive fossils have been found throughout Gondwana, including Antarctica, New Zealand, Australia, Africa and South America, with similar species showing up in fossil records. There are excellent photos of these available and these records should be displayed as part of the modern display in small exhibits and in the brochure. The displays could be in the form of photos, as illustrated here, or in actual mock up fossil models. I prefer the second option.

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I have included a sampling of what is available over some of the different species. An extensive collection of fossils, especially of New Zealand and Antarctic origin, is held in Canterbury Museum. Those not on public display can be accessed via Norton Hiller, Geology Curator, who was extremely helpful in illustrating a small part of the available range.

Others are illustrated in various texts especially in “The Greening of Antarctica” by Mary White [5] (particularly Australian fossils) and in “Life etched in stone” by Colin McRae (South African fossils) [29] .

Glossopteris fossil from Permian period:
Canterbury Museum exhibit AF355 collected from Ohio Range, Antarctica

Glossopteris fossil from Permian period:
Canterbury Museum Exhibit AF 756 collected from Mercer Ridge, Ohio Range, Antarctica.

Glossopteris fossil specimen about 225 million years old (Australia) [5].
Illustration from P 98 in Mary White's "The Greening of Antarctica" [5].

Dicroidium fossil (probably from Triassic period):
Canterbury Museum Exhibit AF 9/182 collected from Shapeless Mountain, Antarctica.

Dicroidium zuberi, a fork frond seed fern fossil about 225 million years old, from Beacon Hill, Australia.
Illustration from P 142 in Mary White's "The Greening of Antarctica" [5].

Agathis jurassica a Kauri Pine fossil about 175 million years old.
Illustration from P 30 in Mary White's "The Greening of Antarctica"[5].
The leaves are very similar to the New Zealand species.

Fossil from mid Cretaceous period found in Clarence Valley, Marlborough displayed in Canterbury museum exhibit.
The fossil shows *Nelsonia elegance*, araucaria, agathis and podocarp (bottom right – like present Rimu)

Fossil in Canterbury Museum exhibit, about 100 million years old, showing more recent species including angiosperms.

The lower diagram names the varieties of species found.

5.6 Gondwana plant species distribution

I have drawn up a “Gondwana” template to insert the present day distribution of any of the modern Gondwana plant species used in the plantings.
The software used is Corel Draw and the appropriate parts can be coloured using this software.
It is also available for other fossil distribution, etc, as seen on the Lystrosaurus poster.
When the final plantings are decided, a map can be drawn for each species as appropriate and etched/copied onto the species labels as used for the project and displayed in the planting..

For illustration I have completed four completed species dispersion maps that will be used in the plantings – for *Nothofagus*, *Winteraceae*, *Proteaceae* and *Loranthaceae* to copy, use and to illustrate.

Present distribution of *Nothofagus* throughout Gondwana [2 4].

Present distribution of *Winteraceae* throughout Gondwana [2 4].

Present distribution of *Proteaceae* throughout Gondwana [2 4].

Present distribution of *Loranthaceae* (mistletoe) throughout Gondwana [2 4].

5.7 Mosasaurs, dinosaurs and moas

There is a potential place for dinosaurs, mosasaurs and possible even moas amongst the plantings. This would depend on the overall plan for Gondwana project. This could be simple display boards in appropriate vegetation areas, or possibly even models.

5.8 Museum links.

There is an opportunity to link the Gondwana project to Canterbury Museum, enhancing both sets of displays with references to the other organisation. For instance the Museum displays could refer to Botanic Gardens Gondwana Project (Natural History) and to Lystrosaurus (Dinosaurs and Antarctic), and the Botanic Gardens display could refer the observer to the museum specific areas for more information. The two organisations could improve visitor numbers and knowledge using these links.

6 REFERENCES

1 Wegener A 1924. The origin of continents and oceans. Methuen, London

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32 http://www.rbgsyd.nsw.gov.au/mount_tomah_botanic_garden/garden_features/feature_gardens

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7 APPENDICES

7.1 Map of Christchurch Botanic Gardens Gondwana Project Site

The black area indicated by the arrow shows the placing of the Gondwana area. This is not yet finalised and the southern side is approximate. Most of the existing pathways are gravel.

7.2 Auckland Regional Council – contact Steve Benham, Steve.Benham@arc.govt.nz

Hi David,
Please find some attached files with regard to our Gondwana Arboretum which I hope you will find useful.
The arboretum is progressing really well.
Steve Benham
[Steve.Benham@arc.govt.nz] Emails received 26/1/2006

Document 1 – Arboretum Collections Policy

Gondwana Arboretum Collections Policy

Collection type: Geographic, Conservation, Education, Research and Display

Description:

The vision is that of a place to stroll through, feel and experience the wonder and majesty of trees and gain a sense of their pre-historic connections and evolutionary history

Background:

A feasibility study for a Gondwana Arboretum was undertaken in 1993. Five years later a project team was established and a vision, primary goals and objectives were formerly adopted.

The main objective since 1998 has been to work with a Landscape Architect on designs and to source germplasm, mainly gymnosperms of known provenance from temperate and sub-tropical Southern Hemisphere origins. Their ancestral origins are related to those archaic species that occurred in Gondwana aeons ago.

Planting commenced with the Australian component in 1999 and continued with the Southern African and Papua New Guinean during 2001

Objectives:

To display plants from temperate and sub-tropical Southern Hemisphere whose ancestral origins
are related to those archaic species that occurred in Gondwana

To create unique environments including wetland communities, group trees and ecologically associated Gondwana species in a geographic thematic arrangement, and where feasible create breeding populations

To use trees to frame vistas and to lead visitors through the various geographical areas

To use Gondwanan thematic sculptures

To create a place of discovery and enjoyment for visitors

To understand and interpret the cultural values and traditional uses of these species by Maori, Aborigine, Zulu, Inca etc.

To enhance visitors experience and knowledge of New Zealand's geological and botanical evolution with an emphasis on demonstrating the co-evolution of our primitive flora with other Southern Hemisphere landmasses.

To have a conservation focus. Naturally occurring conifers worldwide have been declining since the evolution of Angiosperms, their decline is being hasten by human impact on the environment.

Main users:

Garden visitors, schools, tertiary students, and local community

Key stakeholders:

New Zealand Botanical Research Institute, RBG Edinburgh – Conifer Conservation Programme

Accessions criteria:

Species of known recorded provenance that have their ancestral origins in Gondwana

Research programmes:

Research, record and source other woody plants that had their ancestral origins in Gondwana for possible Arboretum inclusion together with understorey plant families with ancient lineages

Facilitate research into the evolution and development of the New Zealand podocarp from its tropical origins to today's cold tolerant species

Monitor the species that have tropical affinities and those with cooler temperate affinities

Annual growth rates to be recorded

Management regime:

The Arboretum will be a low key collection as regards to infrastructure development, with the minimum of hard surfaces and structures

Broad open vistas of differentially mown grass will be created. Plant material of known provenance is one of the criteria for inclusion but where this is unavailable then unknown provenance will be used

Where material of known provenance is subsequently sourced, the material of unknown provenance may then be culled

Document 2 – Outline proposals for Arboretum

AUCKLAND REGIONAL BOTANIC GARDENS

OUTLINE PROPOSALS FOR THE GONDWANA ARBORETUM

Preamble :

The Auckland Regional Botanic Gardens (ARBG) is presently embarking upon one of the most exciting and ambitious development phases since the official opening of the Gardens in 1982 *viz.* the establishment of a Gondwana Arboretum.

The ARBG is a modern and dynamic botanic garden covering 65 hectares and is administered by the Auckland Regional Council.

Since 1973 thirty hectares of land has been developed with the establishment of extensive plant collections ranging New Zealand Native Plants and Conservation Collections to Southern African, Asiatic, Magnolia, Camellia, Palm, Rose and Herb Collections.

Situated at the northern end of the Gardens is one of the largest remaining natural broadleaf/conifer forest remnants in the Manukau Ecological District. The area managed by the ARBG extends to approximately 10 hectares and Totara Park which is contiguous with the ARBG forest covers 20 hectares and is managed by the Manukau City Council.

The area designated for the Gondwana Arboretum lies between the indigenous forest and the established ARBG Plant Collections.

A feasibility study for a Gondwana thematic arboretum was undertaken in 1993 by John S.M.Cleland.

During 1997 the ARC was approached by the organisers of New Zealand's premier flower show enquiring as to whether the Ellerslie Flower Show could be accommodated on 5.5 hectares of the 24 hectares of pasture land. This severely modified landscape is interdispersed with specimens of naturally occurring totara (*Podocarpus totara*) and was originally reserved for the proposed Gondwana Arboretum.

The arrival of the Ellerslie Flower Show has proved to be the answer for providing the long awaited momentum for the redevelopment of the site and in doing so, will increase our profile as a centre of horticultural and botanical excellence.

At the time of writing the necessary infrastructure for the Show is nearing completion. A concept design for the remaining area remains at the initial planning stage. The Gondwana Arboretum will encompass the entire area and will initially focus on Gymnosperms to be followed by ecological plantings of taxa having their origins in Gondwana.

I believe it would be helpful at this point to state the ARBG Mission Statement :
" to be the regional centre for the display, study, conservation and enjoyment of plants which reflect the character of, and are capable of enhancing the Auckland environment.

The Vision :

a place to stroll through, feel and experience the wonder and majesty of trees and gain a sense of their pre historic connections and evolutionary history, and to understand the cultural values and traditional uses of these species by indigenous peoples.

Primary Goals :

to create an arboretum of temperate and sub-tropical Southern Hemisphere trees whose ancestral origins are related to archaic taxa of that great landmass *viz*. Gondwana

to provide a scientific repository of taxa of conservation concern in a Bio-geographic context

to provide and promote educational and botanical opportunities throughout all stages of the development

to significantly contribute to the ARBG's scientific plant collections

Objectives :

to adhere to the ARBG Mission statement

to create unique environments of outstanding merit, including wetland communities

to group trees and associated ecological plantings in a geographical thematic arrangement rather than in taxonomic groupings

the Arboretum will have a strong conservation focus

interpretational signage throughout the Arboretum will emphasise the importance of the trees uses and spiritual values by the indigenous peoples of their country of origin. These would include Maori, Aborigine, Zulu, Inca etc.

to create a place of discovery and enjoyment for visitors

In summary, the main collective objectives will be Conservation, Education and Recreation.

Progress to date

In January 1998 Philip Thomas, Scientific Officer of the Conifer Conservation Programme based at RBG. Edin. visited the ARBG and offered technical assistance.

The ARBG project team involved in the planning and sourcing genetic material for the Arboretum has compiled a list extant species, primarily Southern Hemisphere gymnosperms belonging to the Araucariaceae / Podocarpaceae / Taxodiaceae / Phyllocladaceae / Cupressaceae.

A draft species list was forwarded to the Conifer Conservation Project Team at RBG Edinburgh for editing.

Seed sources are already being investigated and efforts will be made to eco - source seed wherever possible.
Where taxa occur naturally in warmer latitudes than Auckland (37 deg. S.) seed will be sourced from higher altitudes to compensate for our cooler winter temperatures.

The recording of provenance data etc. and the use of the ARBG Living Collections Database will reflect and endorse our strong conservation objectives and goals.
It is envisaged that several collections of one species will be made thus ensuring that we maintain genetic diversity of each taxon with the aim of eventually creating self sustaining breeding populations within the Arboretum.

Many of the world's conifers are threatened in their natural habitats so it is envisaged that the Gondwana Arboretum will be an important genetic repository of Southern Hemisphere conifers.

It is envisaged that sourcing of seed will be lengthy process when taking into account the remoteness of natural populations and the infrequent masting of specific taxa.

During the next few years we will be establishing relationships and collaborating with overseas botanic gardens and other agencies with the view of sourcing and exchanging genetic material primarily from
Australia (incl. Norfolk Id.) New Caledonia, Tonga, Fiji, Vanuatu, Solomon Is., New Guinea, Indonesia, Borneo, Malay Peninsula, Philippines Southern Africa, Madagascar and S. America.
New Zealand will be represented by our rich and diverse conifer taxa and it is envisaged that a major new Native Plant Collection will sit alongside the Gondwana Arboretum.

In the meantime plant material from ex hort.sources has been acquired and accessioned in readiness for the initial planting in autumn 1999 by which time the master plan will have been completed.

Planting of the Australian component commenced in autumn 1999 with the planting of a breeding population of *Araucaria bidwillii*, the Tasmanian *Athrotaxis* x *laxifolia* and *A. selaginoides.*
Araucaria heterophylla seed sourced from Norfolk Id will be planted in autumn 2000 together with a collection of mallee eucalypts.

Planting of the Southern African component will commence in the autumn of 2000 with the planting of the widdringtonias and podocarps.

Refer to Appendix 1 for taxa held at ARBG in readiness for planting in the autumn of 2000 - 2002

Summary

With a project of this magnitude and complexity we look forward to working with other botanic gardens, forestry research institutes, conservation agencies and individuals throughout the Southern Hemisphere.
Technical expertise from institutes such as RBG.Edinburgh will be vital to the success of this project.

It is envisaged that within the next few years ARBG staff will have the opportunity through sponsorship to join with other botanic gardens and biological institutes on field visits to study wild populations of conifers, establish links and collaborate with our counterparts overseas.

The ARBG has undertaken to acknowledge that any plant material received from overseas will only be used
for the common good in areas of Research, Education, Conservation and to the development of the ARBG.
No commercial exploitation will be allowed. This statement underpins our recognition of New Zealand's
position regarding the Convention on Biological Diversity.

The Auckland Regional Botanic Gardens looks forward to forming partnerships with overseas colleagues and welcomes any assistance with this ambitious and exciting project.

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27-7-98 3-3-2000 Gondwana2.doc.

7.3 Mount Tomah Botanic Gardens, New South Wales, Australia.

They have a "Gondwana Forest Walk" [32], as they have described below. I could not get any reply from any contacts via email addresses so have no further details..

13. Gondwana Forest Walk

There is a wealth of evidence that South America, Africa, Antarctica, Australia, New Guinea, New Zealand, and even India, were joined together about 200 million years ago in the ancient 'supercontinent' of Gondwana. Evidence includes the occurrence of similar geological features, similar fossils and some similar modern-day plants and animals, on these landmasses. Many plant groups that now dominate southern hemisphere floras, such as the families Proteaceae and Myrtaceae, had their origins in Gondwana. However, the different sections of these widespread groups have evolved in isolation since Gondwana began to break up (about 120 million years ago). Many modern members of these Gondwanan families are displayed in the plantings at Mount Tomah. [32]

And "Mount Tomah Botanic Garden Southern Hemisphere Plants" as described on their webpage [33].

Early explorers were puzzled to find that not only was the flora of the southern hemisphere substantially different from that of the northern, but that there was a clear relationship between the floras of areas as far apart as South Africa, Australia, New Zealand and southern South America.

This was eventually explained by the recognition that the southern land masses once were joined in the supercontinent of Gondwana. Many of the plant groups which now dominate the southern hemisphere floras, for example the Proteaceae and Myrtaceae, are believed to have had their origins in Gondwana before it began to break up about 120 million years ago, leaving the plants of the various continents and islands to evolve their present distinctive characters in isolation. Modern members of these Gondwanan families have now been brought together in the plantings at Mount Tomah.

Fuchsia procumbens, *a species from New Zealand*

South African members of the Proteaceae in the Rock Garden

The principal areas in which these species have been planted are the entrance drive, the adjacent Gondwana Woodland and Gondwana Walk, the planting of Proteaceae immediately to the east of the Visitor Centre, the Rock Garden, and the Southern Hemisphere Woodland which has been planted below it.

The southern beeches (*Nothofagus* spp.), which have been planted along the entrance drive and which occur in New Guinea, Australia, New Caledonia, New Zealand, and South America, exhibit a typical Gondwanan distribution.

Likewise, members of the conifer families Podocarpaceae and Araucariaceae, which includes the newly-discovered Wollemi Pine (*Wollemia nobilis*), are widely distributed in the southern hemisphere. Similarly, members of the Proteaceae are found from southern Africa east across to South America. Members of all these and other Gondwanan families are well represented in the Garden.

Nothofagus moorei, *a southern beech from eastern Australia*

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7.4 The Gondwana Project

Christchurch Botanic Gardens Scoping Report - David Given, Feb 2001