Self-Guided Tour - April 2012
The Geologic History of Plants

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To begin the tour, walk down the ramp, turn left and follow the path along the lake. You will see on both sides of the path several **(1) *Ginkgo biloba*** trees. ***Ginkgo*** is a "living fossil" because fossil records indicate the species has remained virtually unchanged for over 250 million years. (See the geologic time chart on the back.) The species name "*biloba*" refers to the double-lobed shape of their leaves. Ginkgos are dioecious, meaning they have separate male and female trees. Males produce pollen cones, while the females produce seed. The seeds have a rather unpleasant odour and therefore female trees are not usually grown in public places, although we grow both male and female trees at VanDusen. As its long history attests, this is a very resistant tree. Disease, pollution, cold weather and even radioactivity do not kill it - a ***Ginkgo biloba*** growing about a kilometer from the epicentre, survived the atomic bombing of Hiroshima!

Further along the path is a trail off to the right (see arrow), into the Woodland Garden. Follow the path for a few feet and turn right at the next arrow onto the side path leading to a large **(2) coast redwood (*Sequoia sempervirens*)**. This species boasts the tallest tree in the world at 379 feet, found in Northern California in 2006. It was named 'Hyperion' by the team that discovered it. Coast redwoods can live for 2000 years, with trunks up to 21 feet in diameter. This one is just a baby! Its prehistoric ancestors thrived with the dinosaurs during the Jurassic Era, ~160 mya (million years ago).

Return to the path and turn right. You will come to a large **(3) southern magnolia (*Magnolia grandiflora*)**, native to southeastern USA, on your right. Magnolias exhibit what is called a disjunct distribution. They were once widespread throughout the world but, due to climate change, are now restricted to two widely separated regions - southeast Asia and southeastern North America and adjacent Central America. Magnolias evolved 60 million years ago, before bees evolved, and they are pollinated by beetles. This accounts for their very tough petals, resistant to crawling and chewing! This species produces large scented white flowers in spring. Beneath this magnolia, and in many other areas of the garden, are various kinds of ferns. This one is our native **(4) deer fern (*Blechnum spicant*)**. Ferns are amongst the oldest land plants, arising ~360 million years ago in the Carboniferous period. They are widespread and range in height from a few centimetres to tree ferns, which can be several meters tall. Later in this tour you will see some tree ferns.

Continue along the woodland path towards Cypress Pond and turn left. On the other side of the pond you see a grove of deciduous **(5) bald cypress (*Taxodium distichum*)** trees, with feathery pale green foliage. These beautiful conifers, members of the pine family, were widespread on earth as far back as the Jurassic period ~150 mya. Continue along the main path and across the little stone bridge. Ahead on your right are (**6**) **the true cedars (*Cedrus* species)**, not to be confused with western redcedar, which isn't a cedar at all but a species of *Thuja*. True cedars have needles in whorls of ~15 to 20. Three of the four species of *Cedrus* are represented at VanDusen. A useful way to distinguish them is to remember that ***Cedrus atlantica*** has **a**scending branches, while cedar of Lebanon (***Cedrus libanii***) has **l**evel branches, and ***Cedrus deodara*** has **d**escending branches. True cedars belong to the pine family and

arose in the Tertiary period.

Turn left along the gravel path into the Southern Hemisphere Garden. On your right is a somewhat scraggly tree, **(7) Antarctic beech or ñire (*Nothofagus antarctica*)**. The genus *Nothofagus* has provided evidence to help prove the theory of continental drift. Today species of *Nothofagus* are found in South America, New Guinea, New Zealand and Australia. Pollen fossils have been found in Antarctica, indicating it must have existed on the super continent, Gondwana, between 180 and 510 mya. Continue along the path. Ahead of you are several **(8) Tasmanian tree ferns** (***Dicksonia antarctica*)**. They are native to Australia and they can survive our winters if they are well wrapped to protect them from frost. Their ancestors date back to the Jurassic period. Turn left. Note on your left, just off the path next to the water, an enormous, beautiful, evergreen **coigüe (*Nothofagus dombeyi*)** from Chile and Argentina.

Also from the Jurassic is the **Wollemi pine (*Wollemia nobilis*)**. Its existence was unknown until 1994 when it was discovered by accident in an almost inaccessible canyon in the Blue Mountains of New South Wales, Australia. Since this extraordinary discovery, fossils of the tree have been found in Antarctica, adding to the evidence of continental drift. We feature this tree in our living collections as part of a world-wide effort to preserve the species, but, sadly, this specimen, to your right in front of the large monkey puzzle tree, has been badly damaged by the cold over the past two winters and may not survive. Ahead you will see several **(9) monkey puzzle trees, (*Araucaria araucana*)** which belong to the same family as the Wollemi pine (and the Norfolk Island pine) but are native to Chile and Argentina. The spiny leaves are extremely sharp! Ancestors of these trees lived 160 mya and, like ginkgos, the male and female reproductive structures are on separate trees. At VanDusen we grow both sexes, distinguishable by the size and shape of their cones - the female cones are large and rounded while the male cones are smaller and more oblong.

Proceed down the path and across the little zig-zag bridge. In Livingstone Lake there are many water lilies. Most of the pond is covered with the yellow blossomed ***Nuphar lutea***, found throughout the northern hemisphere. Their ancestors date back about 60 million years. Frogs and insects love them - humans not so much. Invasive, they clog the lake and must be removed regularly. On your right as you step off the bridge is a **(10) Japanese umbrella pine (*Sciadopitys verticillata*)**. It is not a pine at all and has no close relatives amongst present-day plants. It branched off from the other conifers ~250 mya, spreading throughout Eurasia, northern Europe and northern North America. Today it is restricted to a small area in Japan.

Proceed along the path beside the lake. On your left by the water's edge are several spectacular **(11) giant rhubarb plants (*Gunnera* species)**. These have one of the largest leaves of any plant in the world! Be careful if you touch them as the leaves are very rough. The flower stalks are enormous (you will find them underneath the leaves) but the tiny red flowers are inconspicuous. *Gunnera* species date back nearly 100 million years to the middle of the Cretaceous period. One of the fascinating things about these plants is that **cyanobacteria** live within their leaf cells. These single-celled organisms carry out photosynthesis and "fix" nitrogen, converting it from an inert gas to nitrate or ammonia, forms of nitrogen which plants can use. Because of this 'in house' nitrogen supply, *Gunnera* can grow in nitrogen-poor swampy areas. In turn, the cyanobacteria have a sheltered place to live. This is a nice example of symbiosis, similar to the way legumes obtain nitrogen from nitrogen-fixing bacteria living within their root

nodules. The most amazing thing about cyanobacteria is their ancestors were the first living things on Earth, dating back ~3.4 billion years! These ancestors colonized the leaf cells of early plants and evolved into chloroplasts, the organelles which carry out photosynthesis. Meanwhile, non-photosynthesizing bacteria colonized both plant and animal cells and evolved into mitochondria, the organelles which convert food into energy. Without these, advanced forms of life on Earth as we know them could not exist.

Proceed along the path beside the lake and watch for turtles sunning themselves on the rocks. At the end of the path turn right into the Phyllis Bentall Garden surrounding a rectangular pool. Across from the pool are pots containing various kinds of **(12) carnivorous plants**. These plants obtain nitrogen by trapping and digesting insects, and can therefore grow in nitrogen-poor soils. Also growing in these pots are miniature horsetail (***Equisetum scirpoides***)***,*** another living fossil. The genus ***Equisetum*** is even older than ***Ginkgo***, dating back to the Devonian period ~400 mya. During the Carboniferous period some horsetail relatives were 65 feet tall, but they did not survive. Today horsetails are widely spread throughout the world, except for Australasia and Antarctica. Some are invasive and difficult to remove and gardeners consider them to be to be nuisance weeds, beautiful though they are.

This is the end of the tour. We hope you enjoyed your trip into the geologic past! To return to the garden entrance go back towards the path beside the lake and over the wooden bridge.

GEOLOGIC TIME PERIODS - not to scale -	MILLIONS OF YEARS AGO (mya)	ORGANISMS:
Quaternary		
	1.6	Humans (5-7 mya)
Tertiary		***Magnolia, Cedrus, Nuphar*** , ***Veronica***, ***Gunnera***
	66	[1]***Equisetum*** (≈65mya)
Cretaceous		***Nothofagus*** (≈80 mya),
		Gunnera (≈95 mya)
	138	First flowering plants
Jurassic		***Taxodium*** (Bald Cypress), ***Dicksonia*** (tree ferns), Wollemi pine
		Monkey puzzle tree
	205	***Ginkgo biloba*** (≈200 mya, living fossil)
Triassic		First dinosaurs (≈230 mya)
	240	
Permian		***Sciadopitys*** (≈250 mya)
	290	First conifers
Carboniferous		
	360	First ferns
Devonian		
	410	Early horsetails (≈400 mya) (Coelacanth fishes ≈390 mya - living fossils)
Silurian		
	435	
Ordovician		First land plants (≈470 mya) - mosses, liverworts
	500	
Cambrian		First marine animals - e.g. sponges, earliest fishes
	545	
Pre-Cambrian		
		First fungi (≈1300 mya)
		Cyanobacteria - first living things (≈3400 mya) - photosynthesizers
	3800	
Hadean		
Formation of earth	4600	