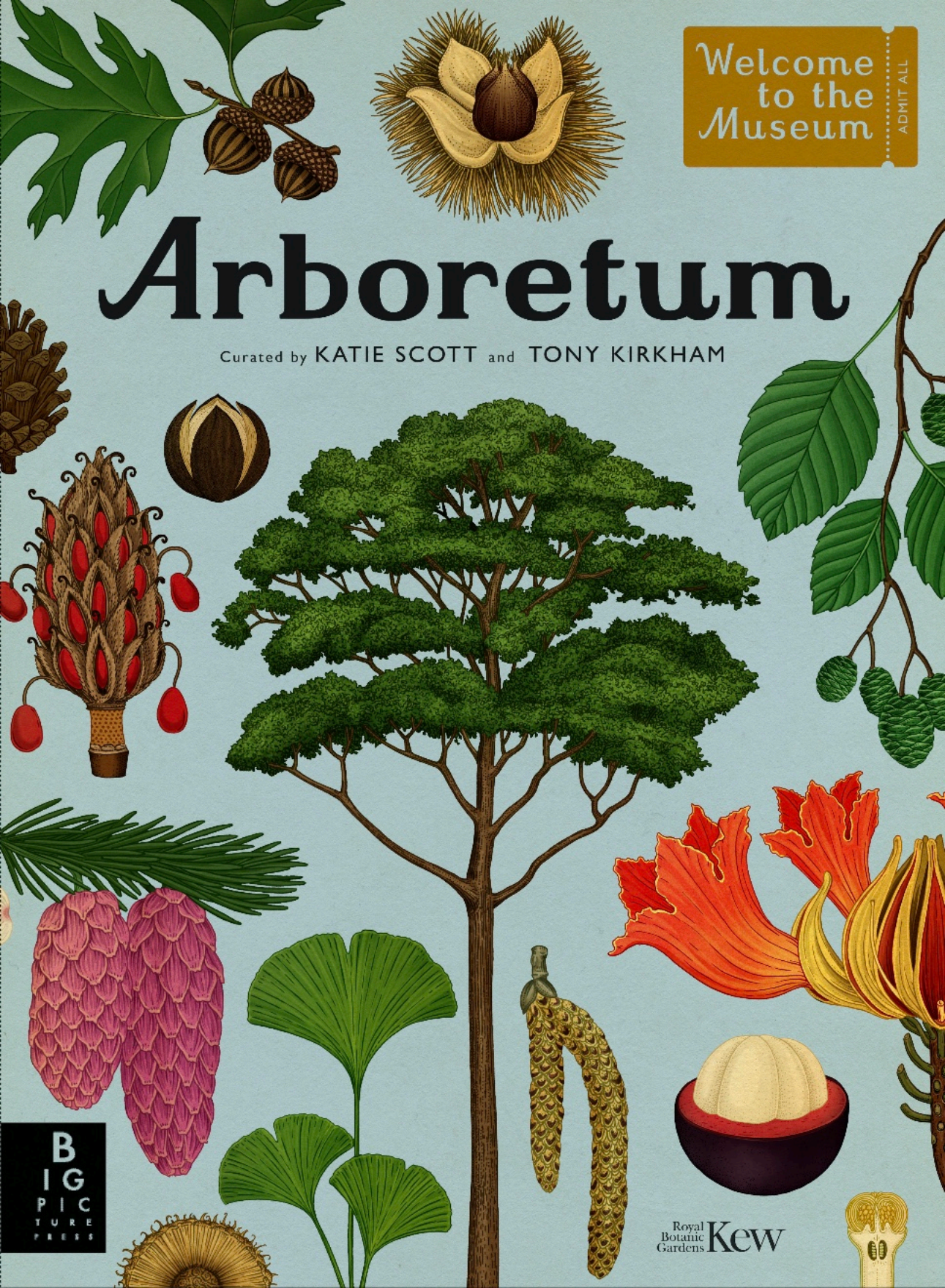
Welcome to the Museum
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Arboretum
Curated by KATIE SCOTT and TONY KIRKHAM
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The First Trees

Between 359 and 299 million years ago, in a time known as the Carboniferous period, Earth was covered in dense forest – but not the kind we'd recognise today. Towering fern-like plants covered the land, extending their shallow roots into swampy pools and spongy peat. By the end of this period, these dense forests included giant tree ferns.

Of these giants, *Archaeopteris* emerged. Considered one of the first true, modern trees, and thought to be an ancestor of all seed plants, this important species evolved over a period of 100 million years to produce trunks up to 1m thick. *Archaeopteris* established deep roots to support the increasing height and weight of its crown, and developed vascular tissue, enabling it to take water and nutrients up through the trunk to the leaves and outer branches. It became the dominant species.

By the Permian period (290–248 million years ago), trees had evolved to bear seeds and feature branching crowns. Many of them are still recognisable today, including cycads, monkey puzzles (*Araucaria araucana*) and ginkgoes. Although just one species of ginkgo remains – *Ginkgo biloba* – it is remarkably similar to its ancestors, with fan-shaped leaves identical in size and shape to 250-million-year-old fossil records.

With the arrival of the Jurassic period (between 199–145 million years ago), the climate had become warmer and wetter, providing perfect conditions for life to flourish. New dinosaur species emerged, including *Stegosaurus*, *Brachiosaurus* and *Allosaurus*, who prowled, stomped and chewed their way through the lush vegetation. The wollemi pine (*Wollemia nobilis*) and dawn redwood (*Metasequoia glyptostroboides*) dominated this period, and both still grow today in our temperate forests.

Angiosperms were among the last plants to evolve. These included broadleaved flowering trees such as magnolias (*Magnolia* spp.), figs (*Ficus* spp.) and plane trees (*Platanus* spp.), which appeared during the Cretaceous period and went on to dominate the planet's ecosystem by the Tertiary period, around 66 million years ago. Despite being driven back by at least four ice ages, trees have maintained their ecological niches and have adapted to every habitat on Earth, in an enormous variety of shapes and sizes.

Key to plate

1: **Tree fern**
Psaronius
Height: 10m
a) tree b) new unrolling fronds
This tree fern did not have a true tree trunk, but something known as a 'mantle'. Made up of hundreds of rootlets, the mantle could reach over 1m in diameter.

2: **Sweetbay magnolia**
Magnolia virginiana
Height: 30m
Flower
Magnolias are one of the most primitive angiosperms, with fossil records showing that they existed over 95 million years ago.

3: **Oriental plane**
Platanus orientalis
Height: 30m
a) leaf b) covered bud
The end of the leaf stalk shrouds the bud like a glove, only exposing it in autumn when the leaves fall, protecting the bud from pests and fungal diseases.

4: ***Archaeopteris***
Height: 30m
Looking like a Christmas tree, this earliest known and now extinct tree is very close to the seed-bearing trees that we know today.

5: **Maidenhair tree**
Ginkgo biloba
Height: 40m
Bi-lobed leaves
The ripe, fleshy outer parts of the seeds smell strongly of vomit, which was once attractive to now-extinct carrion-eating dinosaurs and large mammals that would feed on the fruits and disperse the seeds.

6: **Monkey puzzle**
Araucaria araucana
Height: 50m
Tree
The monkey puzzle tree was so named because the congested branches and spiralling prickly leaves would be puzzling for any monkey attempting to climb it! These leaves would have discouraged hungry herbivorous dinosaurs from feeding on the foliage 200 million years ago.

Gallery 1

Temperate Conifer Forests

Habitat: Boreal Forest
Boreal Broadleaves
Boreal Conifers
Temperate Conifers
Redwoods
Cypresses
Unusual Conifers
Douglas Fir

Habitat: Boreal Forest

The boreal forest, or 'snow forest', is one of the most hostile locations in the world for a tree to live and grow in. The forest is thick, but because of the harsh conditions, is made up of only a few hardy species, mainly spruces (*Picea* spp.), pines (*Pinus* spp.) and firs (*Abies* spp.). Found only in the northern hemisphere, between the freezing Arctic tundra to the north and the temperate broadleaved forests to the south, this is the most northerly forest on the globe, covering huge areas of Canada, Alaska, Scandinavia, Russia and Siberia. It's Earth's largest land biome, taking up about 17% of its land surface and representing around a third of its forest area.

The forest experiences long, six-month winters, during which the average temperature remains below freezing and there are just a few hours of sunshine meaning the nights are longer than the days. The forest is covered in a blanket of snow for up to eight months of the year. Its growing season – the period when plants can grow successfully – is therefore very short: just 50–100 days. Summers in the forest can see up to 20 hours of sunshine a day and a good amount of rainfall. This gathers and creates shallow bogs on the forest floors known as 'muskegs'. Muskegs are wet, largely infertile and highly acidic, and so only a limited number of small-leaved conifer species can thrive in this special habitat.

Despite the freezing conditions, boreal forests are still full of life. Rodents such as muskrats and beavers live in the muskeg, while moose, reindeer and brown bears graze on young shoots and berries, and wolves and lynx prowl. Boreal forests are also a very important resource for the survival of indigenous communities who hunt and fish there.

The boreal forest is a vitally important carbon sink, which means it absorbs more carbon than it releases. Most of the carbon is found in the permafrost (a frozen underground layer), but, as Earth warms up, the permafrost is in danger of thawing and releasing carbon dioxide into the environment, contributing to climate change. Logging – and specifically clear-cutting (removing all trees) – also releases carbon and destroys habitats. Around a third of the world's timber and 25% of its paper is exported from these valuable ecological forest regions.

Key to plate

North American boreal forest

1: **Black spruce**
Picea mariana
Height: 15m

2: **Tamarack**
Larix laricina
Height: 20m

3: **Lodgepole pine**
Pinus contorta
Height: 20m

4: **White birch**
Betula papyrifera
Height: 20m

5: **American mountain ash**
Sorbus americana
Height: 12m

6: **Quaking aspen**
Populus tremuloides
Height: 21m

Boreal Broadleaves

Although boreal forests, or 'taiga', are dominated by conifers, there is also a very small but hardy selection of broadleaved trees present, including poplars (*Populus* spp.), willows (*Salix* spp.) and birches (*Betula* spp.).

While generally short-lived species, rarely reaching 100 years, these trees have many characteristics that help them survive in the taiga. They can all grow, flower and fruit during the short summer, and then shed their leaves at just the right moment to prepare for the long winter. Their compact leaves have a small surface area, which means they can be produced quickly – ideally suited for a forest with a short growing season – and they are also able to withstand strong winds. Position is important too. The broadleaved trees grow near water, making the most not only of the available moisture there, but also the light levels around lakes and rivers where there is no competition from the dense-leaved conifers. In the northern tundra, these trees are short and stunted but further south, towards the temperate broadleaved forest, they have straighter trunks and grow taller.

Boreal broadleaves are pioneer species which means they are the first to appear in disrupted environments, such as a fire-ravaged forest. While a forest fire might kill off conifers, broadleaves can resprout from their trunks or regrow new trees from their underground roots, which are not damaged by fire. Their lightweight seeds are easily spread, either by a breeze or by birds and other animals, which means the broadleaves can establish themselves in an area before the conifers have even begun to recolonise.

Key to plate

1: **Speckled alder**
Alnus incana subsp. *rugosa*
Height: 22m
a) branch b) flower
Both male and female flowers are called catkins but they look very different. They bloom in early spring before the leaves arrive.

2: **Large-toothed aspen**
Populus grandidentata
Height: 25m
Leaf
The leaf stalks (petioles) of the aspen are flattened from side to side along the entire length, which makes them tremble when the wind catches them. This gives them the common name of quaking or trembling aspens. *Populus tremuloides* (see page 12) has a similar trembling leaf effect, giving rise to this species' scientific name.

3: **American mountain ash**
Sorbus americana
Height: 12m
Leaves
This tree is a food source for lots of forest creatures. Moose and white-tailed deer (*Odocoileus virginianus*) feed on the leaves, twigs and branches.

4: **Balsam poplar**
Populus balsamifera
Height: 30m
Flower
The sticky pointed leaf buds of this poplar are covered with a resinous sap that has a strong turpentine aroma. It is the source of 'balm of Gilead', an ointment traditionally used to treat chest infections.

5: **White birch**
Betula papyrifera
Height: 20m
a) trunk/bark b) male flower c) leaf
The paper-thin bark has a high oil content and is extremely waterproof. In fact, native Americans and early fur trappers used the bark as paper to write messages on and to make lightweight canoes.

6: **Moosewood**
Acer pensylvanicum
Height: 10m
a) leaf b) twig and buds c) trunk/bark
The moosewood is so-named because its bark is consumed by moose in winter. The tree is also known as 'goosefoot maple', because its leaves are shaped like the foot of a goose, and 'striped maple', due to its distinctive stripy bark.