
COVER NOT FINAL
FORESTS
Written by
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With FOLD-OUT PANORAMA PAGES of SIX GREAT FORESTS

COLD FORESTS:
The Great Northern 'Boreal' Forest

NORTHERN CANADA IN DECEMBER. A winter wonderland of snow-covered spruce trees and leafless silver birches. The snow has been lying for months. The air is freezing cold. Some nights the temperature drops as low as -54oC. Everything is still. Dormant. Waiting..

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Insects fill the air and birds like ***warblers*** *migrate in to take advantage of the abundance of food and raise their young.*

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Life in the tree tops

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(Dendrobates pumilio)
Location: Central America
Size: 2 centimetres long
This frog's tadpoles develop in the pools of water trapped in bromeliad plants. The female lays the eggs on leaves on the forest floor, leaves them to be guarded by the male until they hatch then carries them on her back one at a time to the rainforest canopy

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Location: Central America
Size: 1 centimetres long
This tree hopper mimics being a thorn to hide from predators

THREE-TOED SLOTH *(Bradypus variegatus)*
Location: South America
Size: 55 centimetres long
Sloths grip onto branches with their hooked claws, moving slowly and so needing little energy to survive. Sloths feed on leaves and come down to ground around once a week to go to the toilet.

CLOUDED LEOPARD *(Neofelis Nebulosa)*
Location: Southeast Asia
Size: 120–200 centimetres from head to tail
Clouded leopards can swivel their feet, allowing them to descend trees headfirst as they chase monkeys and squirrels in the tree tops

RAINBOW LORIKEET
(Trichoglossus moluccanus)
Location: Australia
Size: 30 centimetres
These colourful parrots have brush-like tongues that let them to lap up sugary nectar from flowers.

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Location: South & Central America and the Caribbean
Size: XX centimetres
Some species are poisonous. Over types have evolved to look like them which helps them avoid being eaten.

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(Malagasya antongilensis)
Location: Madagascar
Size: 3 centimetres
These crabs eat leaves and scavenge from dead animal carcasses

FLYING LIZARD *(Draco Volans)*
Location: Southeast Asia
Size: 20 centimetres
Draco Volans have specially modified ribs with skin stretched across that allow them to glide between rainforest trees. They feed on ants and termites.

AYE-AYE *(Daubentonia madagascariensis)*
Location: Madagascar
Size: 100 centimetres
Nocturnal aye-ayes use their long, bony middle fingers to pull grubbs out of holes in trees.

TERMITE NEST *(Family: Rhinotermitidae)*
Location: South America
Size: 0.3 centimetres
The tree termites that built this nest stay undercover, protected from too much heat, sun or rain as they eat away at the wood beneath.

A World of Forests

A MASS OF TREES GROWS UP A HILLSIDE, their tops rippling in the breeze. Beams of sunlight pierce through the high canopy of leaves, picking out bright green moss, ferns and bluebell flowers on the ground below. This ancient woodland has been growing here for thousands of years.

The buzzing of insects and twittering of birds are the outward signs of life but in the branches and under the leaf litter on the forest floor there's plenty of life that goes unnoticed, such as the fungal fibres that link the trees together. The forest is so much more than just its trees. It is a super-organism where animals, plants and fungi all have their part to play.

This forest is not as wild as it looks. For centuries, people have been here too. Some of the trees have masses of twigs bursting out at head-height where woodcutters once chopped off branches to burn. The hazel bushes below have been pruned too. Their rapidly growing shoots used to be woven into baskets and fences. The hazelnuts, which at this time of year are just buds on hazel branches, will be ready in autumn to feed animals and humans alike.

This is Smithy Haw Wood in Cumbria, Northern England. Hundreds of years ago, wood from its trees was burned to forge iron tools. By the Industrial revolution of the late eighteenth century, the fast-growing birch, alder and hazel trees were being cut down every few years to make bobbins for weaving cotton cloth. In 1835, a mill was built – powered by water from a lake in the hills above – to cut and trim the bobbins. Today the mill is a museum and hundreds of people enjoy walking the woods at weekends and during their holidays.

Forests grow on every one of the Earth's continents apart from Antarctica. They cover much of the land and provide homes for most of its wildlife. Forests store rainwater and regulate the flow of rivers. The leaves of their trees evaporate water into the air and cause much of the rain that falls. The oxygen they produce gives us much of the air that we breathe.

PART ONE:
What is a Forest?

WITH A THICK LEAFY CANOPY ABOVE BLOCKING OUT THE FULL FORCE OF THE RAIN AND THE SUN'S RAYS, and a rotting mulch of leaves and deadwood on the floor, forests are great places to live. Eight out of ten of all the Earth's land plant and animal species lives in one.

Forests cover nearly a third of all the land area of our planet, but what counts as a forest? Covered in trees – yes – but how tall do the trees have to be? How close together must they grow? And how large an area must they cover?

The United Nations says that to count as a forest, an area of at least half a hectare (about two-thirds the size of a football pitch) must have trees five metres tall covering over a tenth of the space.

To grow, a forest needs enough sunlight, water, warmth and soil nutrients. The type of forest that grows depends on the balance of these factors. With the right combination, trees will grow thick and tall, and all the other life that depends on them thrives.

GROWING IN DIFFICULT CONDITIONS

When there is not enough sun, rain or warmth, trees may still grow, but not as a forest. There might be open woodland with widely spaced bushes, grassland or even desert.

Plants in many forests around the world have adapted to cope with less than perfect conditions. These include the 'taiga' of the far north with its intensely cold winters and South America's Gran Chaco where for much of the year it is too hot and too dry for most plants to grow.

Different types of forest can grow on a single hill or mountain, depending on how much sun, wind and rain its slopes receive. Dense jungle may grow on one side of a valley where the sun shines and rich soil has built up while, on the other side, the trees are stunted through lack of light, water and nutrients.

To understand how these forests grow we must first understand how trees work.

The Wood Wide Web

DAMP FORESTS SMELL MOULDY. In Europe or North America this is most noticeable in the autumn when the summer's growth starts to rot. Tropical rainforests smell rotten throughout the year.

A forest is made of much more than its trees. There are all the other plants that live in or on it, and there are the animals too. But just as important are the fungi and microscopic organisms such as bacteria. These are the recyclers of the forest.

Fungi send out filaments called mycorrhizae into fallen leaves, into dead wood and often into the living trees, feeding themselves but also releasing the nutrients that plants need to grow healthily.

Toadstools and bracket fungi (which stick out of tree trunks) release tiny spores into the air to spread the fungi far and wide.

Without fungi, dead leaves and fallen branches would build up. Fungi rot these down and put the nutrients back into the soil for the forest's plants to grow.

The bulk of the fungi is in the wood of the trees or just underground, threading through the soil and the litter of fallen leaves.

WORKING TOGETHER

Some fungi attach themselves onto the roots of the trees. Their threads help the trees take up more water from the soil. In return, the fungus takes some of the glucose sugar that the tree makes by photosynthesis. Different living things helping each other like this is called symbiosis.

In old-growth forests, the *mycorrhizae* fungal threads link trees up, passing nutrients between them, usually (but not always) between trees of the same species. Scientists working in European forests have found that beech trees can use the network of fungal threads between them to provide their saplings with extra nutrients and water to make them grow faster.

These threads can also pass messages. For instance, if caterpillars are eating the leaves of one tree, it can warn others to send foul-tasting chemicals into their leaves to prevent further damage. The scientists have likened these fungal networks to an internet for trees, calling them the 'Wood Wide Web.'

PART TWO: TYPES OF FOREST

Why Do We Need Forests?

THERE ARE ROUGHLY EIGHT THOUSAND MILLION PEOPLE IN THE WORLD. More than half of them live in cities and that number is predicted to rise to nearly seven out of ten by 2050. In our cities, we humans find work as well as education, health care, entertainment… the list goes on. So, do people need forests? Would it really matter if we cut them all down?

If the Earth had no forests, thousands of species of animals and plants would die out. Over three quarters of all land animal and plant species live in forests. Sure, humans could survive if clouded leopards or spider monkeys or mahogany trees went extinct, but the world would be a poorer place to live.

Without forests, it would also be harder for us humans. Three hundred million people would have to find somewhere else to live.

More than a quarter of all modern medicines come originally from rainforest plants.

Forests put water vapour into the air that affects weather patterns.

Forest plants produce oxygen that we breathe. They absorb carbon dioxide from the air. Too much carbon dioxide in the air is leading to global warming and climate change. Destroying forests leads to more carbon dioxide in the atmosphere. We need forests to keep our climate survivable.

Over 40 per cent of the atmosphere's oxygen come from forests.

Forests store the rainwater that falls on them. They purify it too.

Found in the Forest

Without forests, we would lose all the products we get from their plants and trees, from rattan and expensive hardwood to make quality furniture to the chemicals found in jungle plants that cure diseases.

Cork, for stoppering wine bottles, is made from the bark of the cork oak, which lives in Mediterranean forests.

Maple syrup, the sweet sap from maple trees, comes from temperate forests in North America.

Rattan, used to make wicker furniture, comes from Asian rainforests.

Rubber is made from the sticky white sap of certain rainforest trees.

Curare, the sap of an Amazonian vine, is used by people living there to tip their arrows. It is a muscle relaxant which causes animals hit by the poison darts to go limp and fall from the trees. Doctors now use curare to relax people's muscles during surgery.

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Reindeer Herders of the Taiga

AS WINTER TURNS INTO SPRING, a 'brigade' of Siberian Evenki people move their reindeer herd northwards to feed on the moss and grass that will soon be uncovered by the melting snow. The Evenki have spent the winter in cosy log houses but now they will pack up their belongings and live in temporary camps for the summer, hunting squirrels and sables along the way to sell their fur.

In Russia, the Boreal Forest is called the Taiga. The Taiga stretches 6400 kilometres across Siberia in the north of the country and – at its widest – is 2500 kilometres from north to south. Growing in the west are evergreen spruce trees like in North America, but further east, where conditions are colder and drier, most of the trees are Dahurian larches. These conifers grow further north than any other tree. They drop their needles every winter to survive the extreme cold.

But the climate is changing. The last few summers have seen heatwaves with tropical temperatures nearing 40 oCelsius. Fires have ravaged parts of the forest. In other areas, plagues of bark-eating beetles have killed the trees. The permafrost which normally sits frozen a metre or two below the surface has been melting. Sinkholes have appeared as the ground has given way. Sometimes these have uncovered the bones and tusks of mammoths that lived here ten thousand years ago.

With the warmer temperatures, the downy birch trees at the Taiga's northern edge are growing further into the arctic. The trees further south that used to be thinly spaced are now growing taller and thicker. Further south still, the ground is drying, the trees are dying and grassland is taking over. The climate is getting hotter and, year by year, the forest is moving northwards.

AN EVENKI YEAR

MARCH:
Moving herds northwards every two weeks or so, depending on the amount of lichen available for the reindeer to eat.

APRIL- MAY- JUNE:
Snow melting and plants growing. Reindeers calving

JULY-AUGUST: Reindeer grazing on grasses and moss in the open tundra.

OCTOBER- NOVEMBER- DECEMBER:
After the rutting when the males fight for mates, the Evenki leave the reindeer to hunt.

DECEMBER- JANUARY-FEBRUARY:
Gathering in the reindeer and leading them to sheltered valleys for the coldest part of the winter. They survive on lichen which they find under the snow.

Temperate Rainforests

THE COOL CLIMATE ALONG THE MOUNTAINS of Chile in South America, in western Canada, the western parts of the British Isles and in some parts of Australasia is particularly wet and misty. The trees that grow here are covered in water-soaked mosses and lichens. This is the temperate rainforest.

In New Zealand's temperate rainforest, many of the trees like the rimu and kahikatea are conifers called 'podocarps' that are similar to trees that grew in the Jurassic period when the dinosaurs ruled the Earth. Wheki tree ferns add to the prehistoric atmosphere.

Some of the plants growing in these forests are particularly ancient. They evolved over 250 million years ago, before the era of the dinosaurs.

Liverworts and lichens grow amongst the mosses. Lichens are part fungus, part algae, the parts living together in what is called a symbiosis.

Mosses coat the low twisted branches and form into soggy cushions on the forest floor.

New Zealand tui

Southern kiwi

Cherry Blossom Time

SPRING IS A PARTICULARLY COLOURFUL SEASON in the Japanese temperate forests. This is the time of year when the cherry trees blossom. All the trees produce their flowers together and the forest turns pink.

Sakura – cherry blossom – season in late March and April is a key part of the year for many Japanese. It signifies new life after the winter. Also, because the blossom lasts only ten to fourteen days, it is said to show how fleeting and short life can be. The Japanese have long grown cherry trees to have the brightest and most scented flowers, and they have planted these 'cultivars' in their parks and gardens.

Hanami is the tradition for families to go out to view the blossom and have picnics underneath it.

Japanese Honey Bee

Blossoming at the same time gives the cherry trees a higher chance of being pollinated by honeybees. The bees are attracted by the colour and the scent of the flowers and when they enter a flower to drink the sweet nectar held at the base of the flower, they pick up pollen which they then transfer unwittingly to the flowers of other trees, pollinating them. The centres of these flowers then grow into fruit with seeds: cherries.

Warm Temperate Forests

A STORM IS BREWING ABOVE AN AUSTRALIAN FOREST. Low clouds are darkening the sky. Thunder is rumbling. A warm wind is whipping through the treetops and picking at the dead leaves that cover the ground. The air feels charged with electricity and is filled with the scent of eucalyptus leaves. This forest is ready to burn!

Lightning strikes. It only takes one spark. Flames lick along the ground, setting alight dead leaves; a line of fire racing faster than a person can run. Bushes burn. So do fuzzy 'grass trees' which shower sparks like fireworks. Fire tracks up the eucalyptus trunks, igniting strips of bark. Some treetops are consumed in flames. Other are not. By the time the storm's first raindrops hit the ground, the earth is blackened and smoking, and the seed pods dropped by the trees have opened, their seeds ready to grow in the nutrient-rich ash.

FIRE-ADAPTED FEATURES OF AUSTRALIAN EUCALYPTUS FORESTS

- Stringy or 'candle'-bark that sets alight easily.
- Slow-to-rot leaves which sit on the ground, dry and ready to burn.
- Leaves containing flammable 'aromatic' oils.
- Seeds inside hard capsules, triggered by fire to drop off the tree.

TOO MANY WILDFIRES

Wildfires caused by people are hitting the news more and more. The have devastated forests across the world. They have destroyed houses and farms. They have killed lots of people. The problem is becoming worse as our climate is becoming warmer. In many places, forests are becoming drier. Dead wood and leaves stay on the ground instead of rotting down.

Three weeks later, green shoots are sprouting from the seeds and from the blackened eucalyptus trees whose bark has protected them from the worst of the heat.

Aboriginal people have traditionally set fire to areas of eucalyptus forest because the fresh new shoots that grow after the fire attracts plant-eating animals like kangaroos, which they hunt.

In six years, the forest is green and thriving again.

TROPICAL FORESTS:

The Biggest Rainforest in the World

THE AMAZON RIVER BASIN IN SOUTH AMERICA contains the largest rainforest in the world. Covering an area of seven million square kilometres, which is about 28 times the size of the United Kingdom, it is the most biodiverse region on the planet, home to roughly a third of all the land animals and plants on Earth.

Close to the equator, the climate is hot and rainy all year round. The conditions are perfect for the trees to grow to great heights. Away from the rivers, where the forest can flood for several months every year, the canopy trees grow up to 40 metres tall with taller 'emergent' trees poking through in places to reach an enormous 70 metres – that's the same as a twenty-floor tower block.

Harpy eagles perch in the tallest trees, looking out for monkeys and sloths in the canopy to swoop down and catch.

The canopy is where most of the forest life is to be found. The six-metre-thick layer of leaves soaks up the sunshine for photosynthesis. It is up here that the trees send out their flowers. Later, fruit will form, producing the seeds that will grow to be the next generation of forest trees.

'Emergent' trees tower above

The canopy can block out 95 per cent of the sunlight from reaching the ground below. Underneath, conditions are dim and humid. The space between the canopy and the ground contains an 'understorey' of spindly trees which are waiting for one of the larger trees to fall, letting enough sunlight in so that they can grow up to the canopy.

The canopy is home to fruit-eating spider monkeys, seed-cracking macaws and countless types of insects, many still unknown to science.

Canopy – the 'roof' of the forest

Understory of thin, spindly trees

Epiphytes grow on the upper branches. The water they contain is often the home for tadpoles. Some tree frogs spend their whole life cycle there.

Buttress roots prevent enormous emergent trees blowing over in the wind.

Undergrowth or shrub layer

Forest floor

Below them on the forest floor grow dark-leaved undergrowth plants and sapling trees. This is where the nutrient recycling happens. The air reeks of rot. Fungi and termites quickly turn fallen tree trunks into mush. Leaf-cutter ants scurry along trails, taking leaf pieces to their underground homes where they feed other fungi which they then feed on.

AMAZON RAINFOREST

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