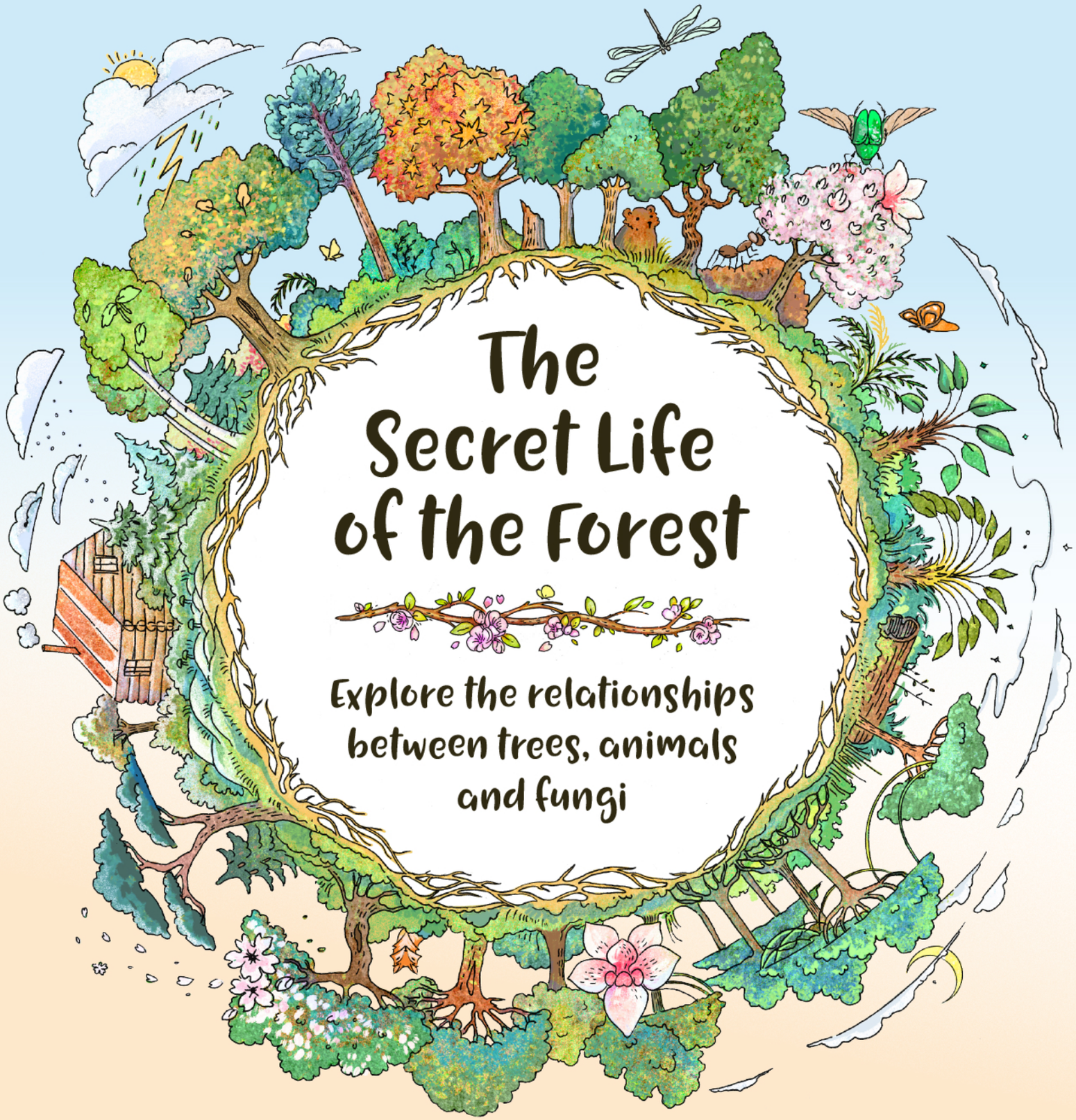
Written by Klára Holíková, Iveta Šedová, Jana Sedláčková, Štěpánka Sekaninová



The Secret Life of the Forest

Explore the relationships between trees, animals and fungi

Illustrated by Katarina Kratochvilová

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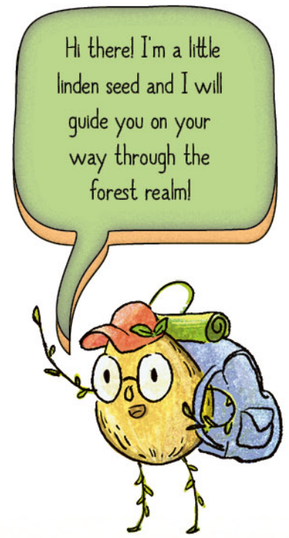
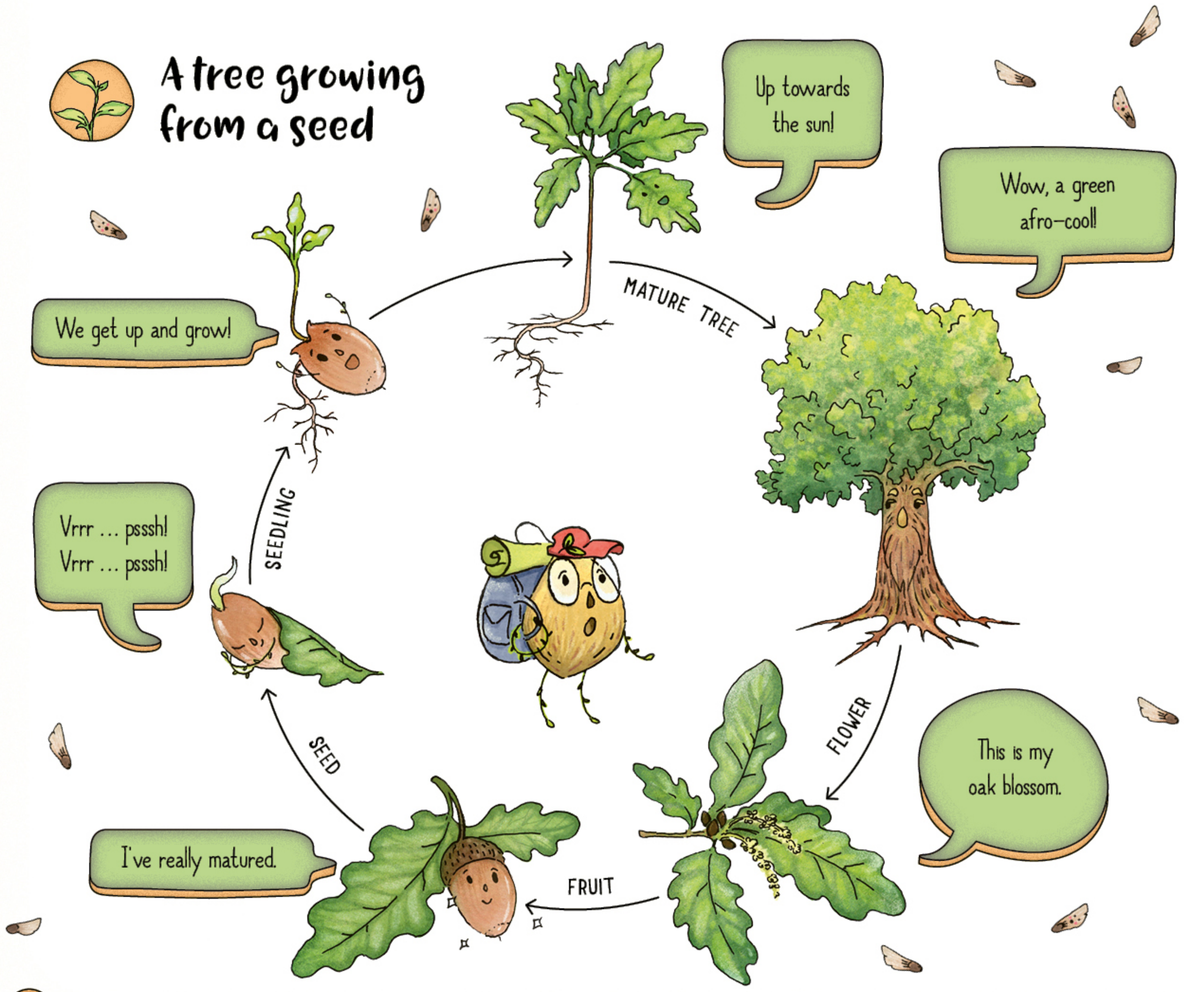
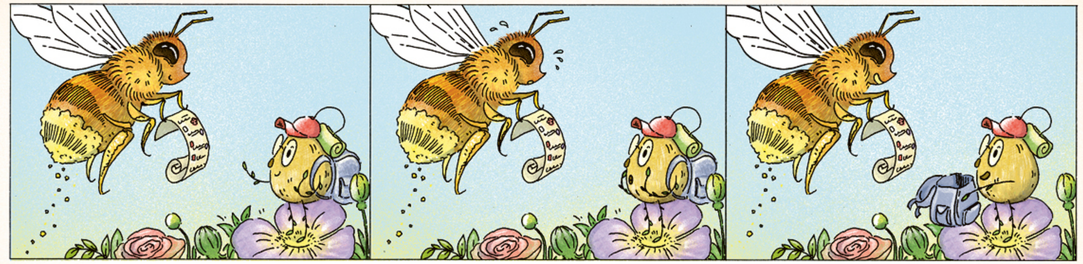


Where do seeds come from?

They are small but extremely important. Who? Bees, of course! Without these busy little creatures, no seeds—the embryos of new trees or plants—would ever see the light of day. It's just as well they are not alone in this vital work …

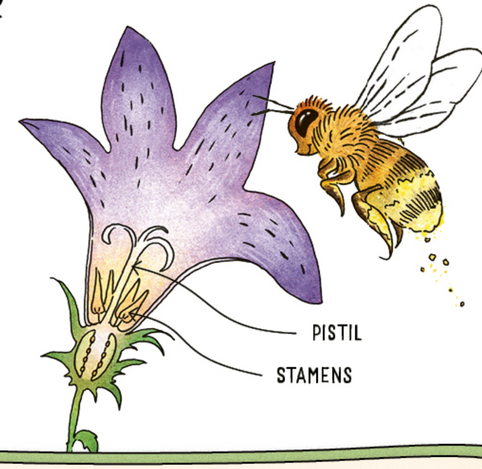
A tree growing from a seed





Do bees need a backpack for their pollen?

Of course not. Bees don't need a backpack or rucksack—they have grooves in their back legs where they store the pollen they collect. However, these grooves are tiny, so the bee has to make several flights to gather as much pollen as possible and **pollinate** as many plants as it can. This is very important work! Otherwise, unpollinated flowers wouldn't produce any structures like fruit, nuts or cones to protect the small **seeds**. The bees keep some of the pollen for … well, let's say for their own private purposes. They use it to make nutritious royal jelly for the offspring and the queen.



Guess who pollinates us!

Some plants can pollinate themselves with their own pollen—we call them **self-pollinating**. Others, including a lot of conifers as well as walnuts and hazelnuts, are pollinated by the **wind**. Others are helped by **water**. However, in order to pollinate, the rest need helpers from the animal kingdom: **pollinators**. Did you know that nearly all the lush green beauty of the tropical rainforests is pollinated by a **variety of animals** living in the treetops and the undergrowth?

1. Honeybee: We bees keep ourselves busy! In a single flight we can visit around a hundred flowers. Each of us makes several flights a day, so by the time the sun sets we might have pollinated a thousand flowers.

2. Bumblebee: I don't mind low temperatures, so I can start pollinating early in the spring. Mmm, this crab apple tree, for example, smells just divine!

3. Fruit fly: Can you smell that too? Something is fermenting here ... I definitely can't miss out on that! I love the scent of rotting fruit, especially figs, apples and pineapples.

4. Chafer beetle: We bugs like big open flowers with lots of pollen, like this magnolia. We help to transfer its pollen and as a reward we get to stuff ourselves!

5. Ruffed lemur: As the world's largest pollinator, I may seem slightly out of place among all these titchy little fellas, but believe it or not, I can pollinate every bit as well as them. After all, my whole life revolves around transferring pollen from the traveller's tree and drinking its nectar ...

6. Banana bat: I specialize in banana trees and cactuses. Each spring I lick the sweet nectar out of their long flowers, transferring pollen in the process. Then in the summer I have a regular banana feast!

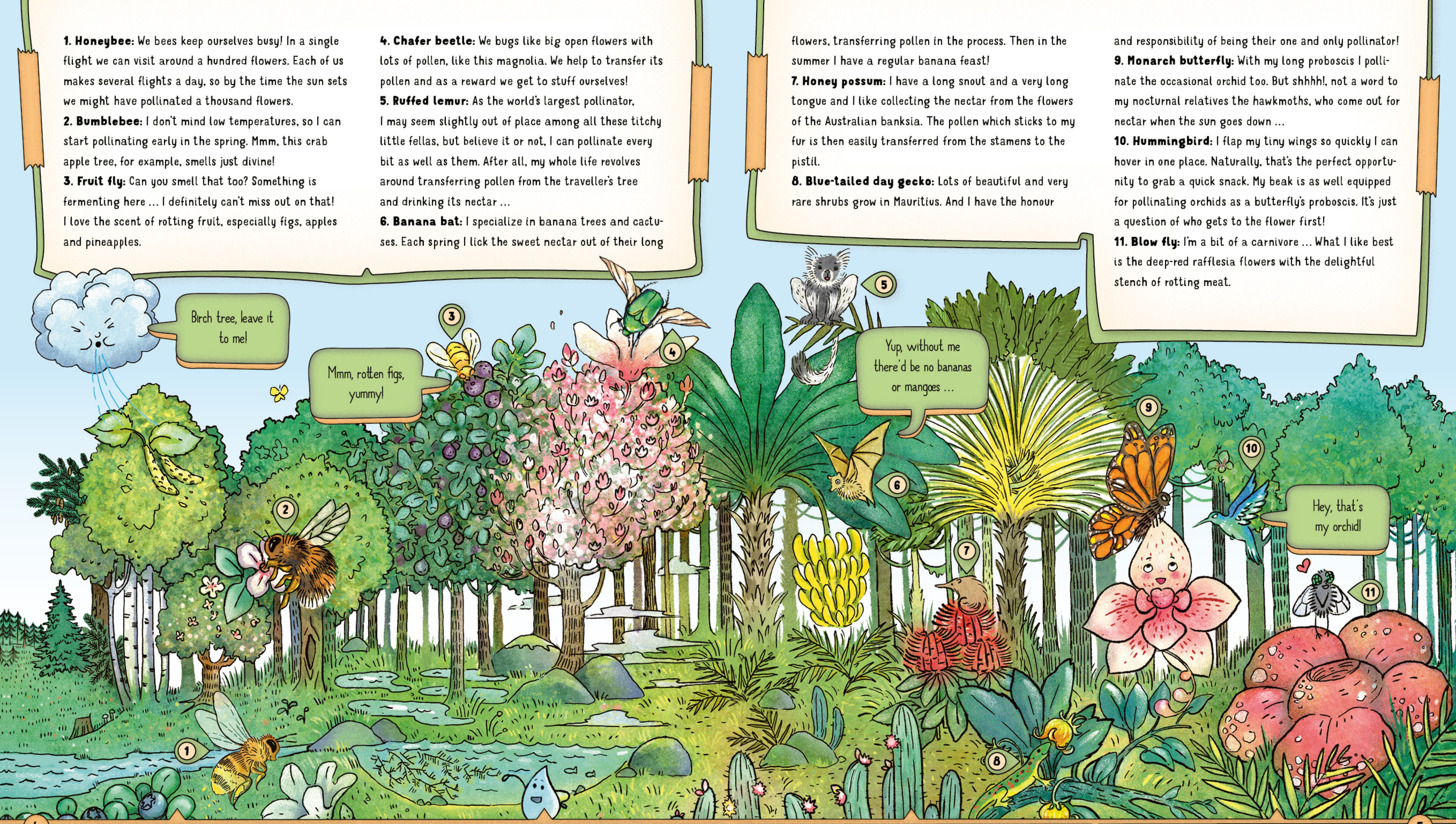
7. Honey possum: I have a long snout and a very long tongue and I like collecting the nectar from the flowers of the Australian banksia. The pollen which sticks to my fur is then easily transferred from the stamens to the pistil.

8. Blue-tailed day gecko: Lots of beautiful and very rare shrubs grow in Mauritius. And I have the honour and responsibility of being their one and only pollinator!

9. Monarch butterfly: With my long proboscis I pollinate the occasional orchid too. But shhhh!, not a word to my nocturnal relatives the hawkmoths, who come out for nectar when the sun goes down ...

10. Hummingbird: I flap my tiny wings so quickly I can hover in one place. Naturally, that's the perfect opportunity to grab a quick snack. My beak is as well equipped for pollinating orchids as a butterfly's proboscis. It's just a question of who gets to the flower first!

11. Blow fly: I'm a bit of a carnivore ... What I like best is the deep-red rafflesia flowers with the delightful stench of rotting meat.



Trees—the lungs of the planet

What do trees actually need in order to grow from tiny seeds into majestic giants? The answer lies in a magic trick with a mysterious name: photosynthesis.

What do trees eat?

Trees don't need all that much to eat. They make do with a bit of **light and water**. Naturally, like all living beings, they also breathe. However, unlike people, most of the time they breathe in **carbon dioxide** rather than oxygen. They use this gas along with water to make **sugar** (yum!), an important source of energy for their growth. And in return they breathe out **oxygen** into the air, which is then breathed in by people and animals. A one-hundred-year-old beech tree can breathe out 1,000 litres of oxygen, which is enough for three people. This mysterious process has an even more mysterious-sounding name: **photosynthesis**!

... And how do they breathe?

Trees breathe quite ever so quietly and only through their **green parts**—i.e. the **leaves**. None of this mysterious photosynthesis goes on in the wooden trunk or in the roots.

Breathing at night and in winter

Photosynthesis needs light to work. So, can it happen at night, in the dark, when it's pitch black and the only light comes from the moon and the stars? And what about in winter when the leaves have fallen from the trees—how do trees breathe then? Don't worry, the trees have got it all figured out. In winter, they go to sleep—this means they use much less oxygen than in the spring or summer. At night, trees breathe the way people do: they breathe in a little oxygen and breathe out a little carbon dioxide. Overall, though, they still breathe out more oxygen than they use up—which is why people are right in calling them the "**lungs of the planet**".

How do trees make friends with each other?

Just imagine, those small, helpless seeds—without which no dense forest would ever see the light of day—have whole tree families of their own. So it's not just adult trees we find in the forest, but also their children and their ancient ancestors.

Trees help their children

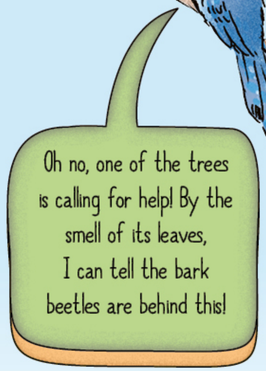
A tree community takes good care of its babies. As soon as a new seed falls to the ground, the parent tree connects to it through a network of fine roots. That's so it can **send nourishment** to it in the form of **water** and **sugar**. It knows very well that a lone seed with just one little root and a sprouting shoot isn't able to get nutrients for itself—to do that, it'll need leaves, which are able to capture sunlight. Seeds that are carried to another forest by the wind will get help from older trees in the vicinity.

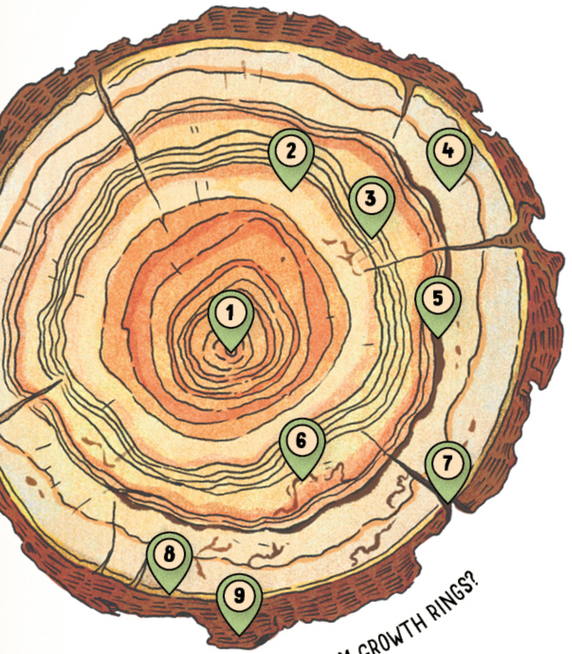
Super-fast root mail

It's not just life-giving fluids that trees send to each other through their roots. Thanks to their vast and extremely tangled network of roots, they also **communicate with each other** and are able to warn each other of imminent danger. For example, when a huge group of greedy bark beetles is about to descend on them or one very hungry deer has set its sights (and its teeth) on them. This vast root network links the whole forest together!

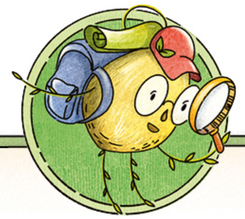
A mysterious scent

While trees talk to each other by means of a network of roots, they communicate with friends and foes from the animal kingdom using a different language: a special scent. As soon as they start to feel threatened, they release this special scent into the air and the wind carries it right under the noses of all the animals nearby. Beetles and other insects can't stand the smell of it because it's horribly bitter. Birds, on the other hand, can't get enough of it, so they immediately follow it and the scent leads them to a place that is teeming with delicious food.





WHAT CAN WE TELL FROM GROWTH RINGS?



Experiment in the forest!

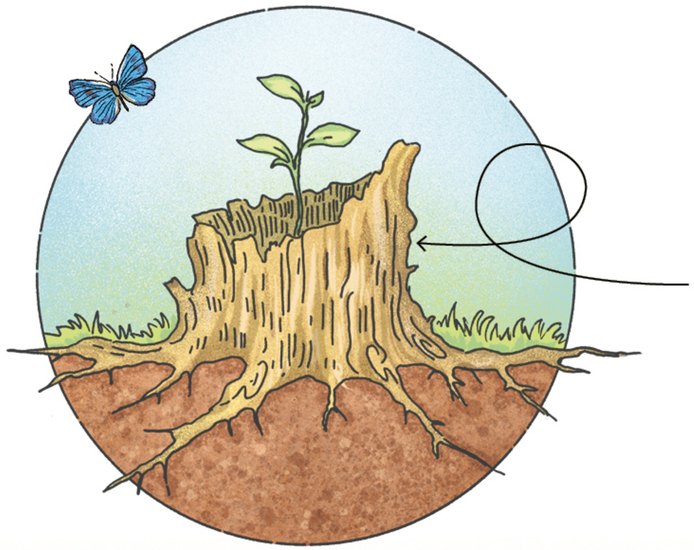
Try to calculate the age of a tree by counting its growth rings—each ring represents one year. Tree experts can even tell from the colour and shape of the individual rings in which year the tree suffered from a harsh winter or insects and when, on the contrary, it had a good year.

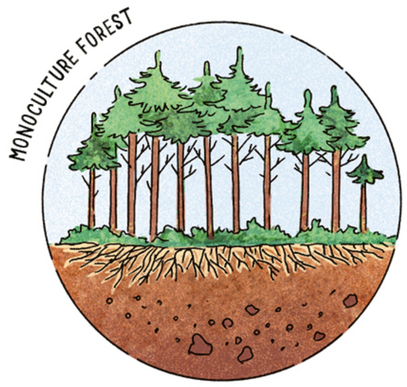
How old is that tree?

We can recognize old trees by their broad trunk covered with wrinkles of a rough material called **bark**—the thicker and bulkier the trunk, the older the tree is likely to be.

On a cross section of a tree we can see the lines of its **rings**. They resemble big human fingerprints. We can learn a lot from them! People even developed a special scientific discipline which deals with their mysterious reading—it is called dendrochronology.

1. YEAR 1
2. WARMER YEARS
3. COOLER YEARS
4. YEAR WITH A LOT OF PRECIPITATION
5. SCAR FROM A FOREST FIRE
6. INSECT ATTACK
7. EARTHQUAKE
8. INNER BARK
9. OUTER BARK





One tree to rule them all ...

In **multi-species forests**, the different species of trees support each other, because they complement one another—sometimes a little and sometimes a lot. However, in other forests there are only trees of the same species and the same age growing. These are called **monoculture forests** (mono as in one species of tree.) The most common type is a spruce forest, because this tree is a real sprinter—it grows very quickly—and it also has beautiful straight wood, which is why in the past people thought it was a great idea to grow it on a big scale ... But later they found out that there is a problem, or rather several problems, with growing trees this way:

1) Many trees of the same species growing too close together compete with each other for light. In a small space, they will only grow thin trunks ...
2) ... and they are more easily attacked by pests or eaten by deer.
3) There are always the same flowers growing and the same animals living under the same trees. That's why many organisms won't find conditions suitable for life in monoculture forests.
4) The root network of a single species of tree is not as strong as a network made up of different types of trees ...
5) ... and that's why single-species forests are worse at retaining water. The soil beneath them is more easily depleted, which disturbs the already fragile root system even more.
6) These trees are often planted in an environment which is unnatural for them and a lot of them will perish very soon.

Experiment in the forest!

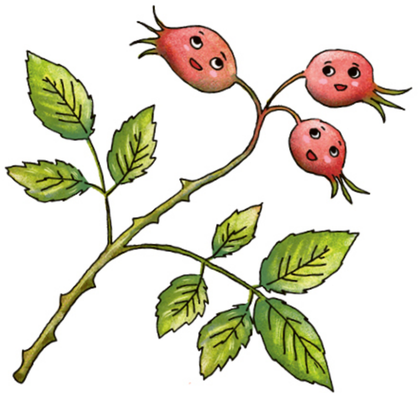
Find tree stumps in the forest and try to work out which ones are living and which ones aren't. How can you tell? If the bark is peeling off and there is rotten wood inside the stump, it's already dead. But if its bark is firm and the inside is solid, the stump is still alive! How is that possible? The trees growing around it are still helping their chopped-down pal and sending it all the nutrients it needs through their roots. However, don't think that dead wood is useless for the forest! On the contrary, many types of fungi and insects will use it for a long time to come.

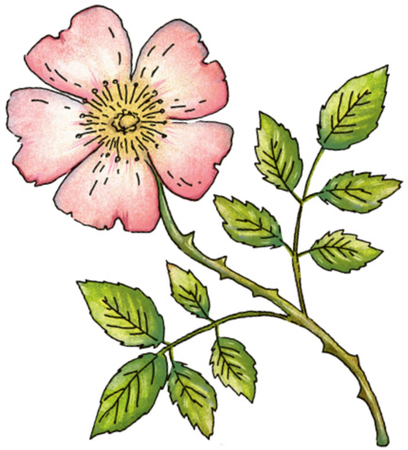
Protection against the wind

The wind is useful as it can carry small seeds hundreds of kilometres across the country. Sometimes, though, it goes crazy and blows up a storm. Then everything in its path goes flying. Are slender forest trees able to hold their ground? And how do they do it?

Can trees stop the wind?

Fortunately, all trees have **branches** that can come through the wind (coniferous trees in particular are excellent at protecting the forest from the wind all year round). And when tall trees and low shrubs join forces, they stand a much better chance against the wind. **Shrubs** (such as rose, euonymus, blackberry, privet and elderberry bushes) are excellent at protecting the forest against ground-level winds.





When a strong wind blows …

When the wind really picks up, it's not a good idea to linger in the forest. You're much better off avoiding the falling trees and branches. But the truth is that a forest which is made up of different kinds of trees is the best type of landscape for withstanding strong gusts of wind. It's usually only the old and very dry trees that succumb to a gale …

The layers of the forest

As well as trees and shrubs, the forest has a few other layers which provide a cosy retreat for large animals as well as small insects.

1. **Tree layer** – plants over 5 metres high
2. **Shrub layer** – plants reaching heights of between 1 and 5 metres
3. **Herb layer** – all woody and herbaceous plants under 1 metre
4. **Moss layer** – mosses and lichen
5. **Root layer** – plant roots and fungi mycelium

A small glossary of the forest

Chlorophyll — A green pigment in plants or the green colour in leaves; it plays a very important part in photosynthesis (p. 36).

Decomposers — Tiny or microscopic animals, fungi and bacteria that do invisible but vital work: they gradually break down leaves and dead animals into a fertile mixture called humus which enriches the soil (p. 27, 32, 33, 36).

Forest — A mysterious community of trees and other woodland plants, animals and fungi which live together in close-knit relationships. They can help but sometimes also harm each other. There are many types of forest: boreal forest or taiga, mixed forest, tropical rainforest and watery mangroves (p. 42, 43, 44, 45).

Fungus — A strange organism, neither animal nor plant. Fungi have their own separate kingdom and multiply through their spores or a network of fine roots (p. 17, 18, 19, 20, 21, 24, 26, 32, 33).

Growth rings — Each year a tree gains one more growth ring. You might notice them on a sliced-through tree stump. An experienced woodsman can tell a lot from these rings (p. 10).

Harvester — A heavy machine designed to quickly cut down trees, lop off branches, saw and stack wood from the forest (p. 57, 58).

Hollow tree — Usually an old tree with lots of cavities and holes where birds and other forest animals often reside (p. 30, 31).

Humus — A fertile layer of soil made up of the dead and decomposed remains of plants, animals and fungi (p. 32, 33, 35, 53).

Inner bark — A nutrient network that trees have directly below their outer bark. Like our veins, the veins of inner bark act as a pipeline for a life-giving fluid known as sap, made up of water, sugars, proteins, minerals and other substances (p. 10, 28, 29).

Lichen — Another curious forest dweller—neither algae nor fungus but something in between. Lichens are among the oldest organisms on Earth (p. 13, 25, 26, 27, 35, 42).

Mangroves — Communities of trees growing directly in water (even salt water). Mangroves have thick roots, and swimming freely among them are small fish hunted by various water birds (p. 42, 44, 45).

Mixed forest — A forest in which there are both deciduous and coniferous trees. They are mostly found in the temperate zone (p. 42, 43, 44).

Monoculture — A forest which people plant with only one species of tree (such as spruce) so that they can harvest wood from it quickly and easy. However, this dense planting of trees with thin branches and shallow roots has a lot of disadvantages (p. 11, 29).

Moss — A tiny plant that forms a soft carpet wherever it's at least a bit damp and shady, so especially in the forest! (p. 13, 25, 26, 27, 35, 42, 43, 46, 47)

Palm oil — A seemingly cheap oil that comes from the fruits of the oil palm tree. However, we pay dearly for its low price with more carbon dioxide in the atmosphere, because oil-palm plantations are mainly grown on fertile land created by cutting down tropical rainforests … (p. 49).

Paper — The paper in this book was also produced from a mixture of wood pulp (cellulose), recycled old paper and a few other substances (p. 58, 59).

Parasite — An animal, fungus or plant which feeds by taking nutrients from other inhabitants of the forest (p. 11, 25, 26, 27, 28, 29, 30).

Photosynthesis — A mysterious process inside the green leaves of a plant where water and carbon dioxide breathed in by the plant are turned into sugar through the effect of sunlight and warmth. Photosynthesis is hugely important for life on Earth because it's the reason why we have enough oxygen and can breathe freely … (p. 6, 7, 26, 29, 36).

Pioneer species — Adventurous trees or shrubs which may set off far from their parent tree as tiny airborne seeds and eventually sprout in places where there are no other woody plants growing (p. 15, 27).

Pollinators — Animals that help plants to transfer pollen from their stamens to their pistils and thus to reproduce. As well as the busy bees and other insects, they also include butterflies, geckos and even some small mammals (p. 2, 3, 4, 5, 48, 50, 51).

Recycling — A process in which we reuse material we would otherwise throw in the trash (for example, we can make beautifully clean and new paper from old, scribbled paper thrown into a special container). This means that the original paper doesn't go to waste (p. 57).

Resin — A sticky fluid mainly excreted by coniferous trees when something or someone injures them (the resin helps to seal over the wound) or so that they can get rid of bothersome bark beetles or other parasites that want to hold a banquet in their wood (p. 29, 53).

Seed — The embryo of a new life concealed within the fruit of each tree. Some seeds have a fluffy coating or wings so that the wind can easily carry them or they can gently float down to the ground by themselves; others might be hidden, for example, within a nut (p. 2, 3, 8, 14, 15, 16, 45, 50, 52, 53, 54, 60, 61).

Seedling — A sprouted seed with its first new leaves (p. 3, 35).

Self-pollinating plants — Not all plants need help from pollinators or wind in order to pollinate. Some of them just pollinate themselves by transferring their own pollen (p. 3).

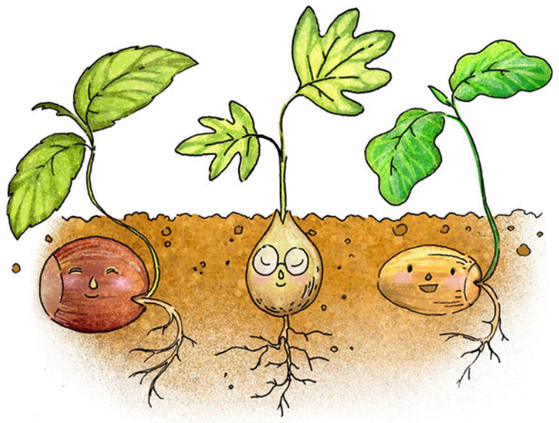
Soil erosion — An unwelcome process in which the forest soil gradually breaks down and is carried away by water or wind. This can be caused by logging machines called harvesters or by growing trees of only one species with shallow roots (p. 46, 58).

Symbiosis — A mutually beneficial relationship between two or more forest organisms which help one another (one example might be ants which feed aphids and get drops of honeydew from them in return) (p. 2, 3, 4, 5, 8, 9, 19, 24, 26, 27, 33, 34, 39, 40, 41).

Taiga — A coniferous forest that chiefly grows in the north (for example, in Canada or Siberia) (p. 42, 43).

Tree — A perennial plant with a wooden stem (trunk) whose surface is often protected with bark. It can have leaves (deciduous trees) or fine needles (coniferous trees) growing from the branches of its crown.

Tropical rainforest — A type of forest mostly found in warm, wet regions. This lush tree cover is home to many rare species of plants and animals, and some parts of it are so inaccessible that there are even species we still don't know about … (p. 5, 27, 42, 43, 45, 48, 49, 50, 51).



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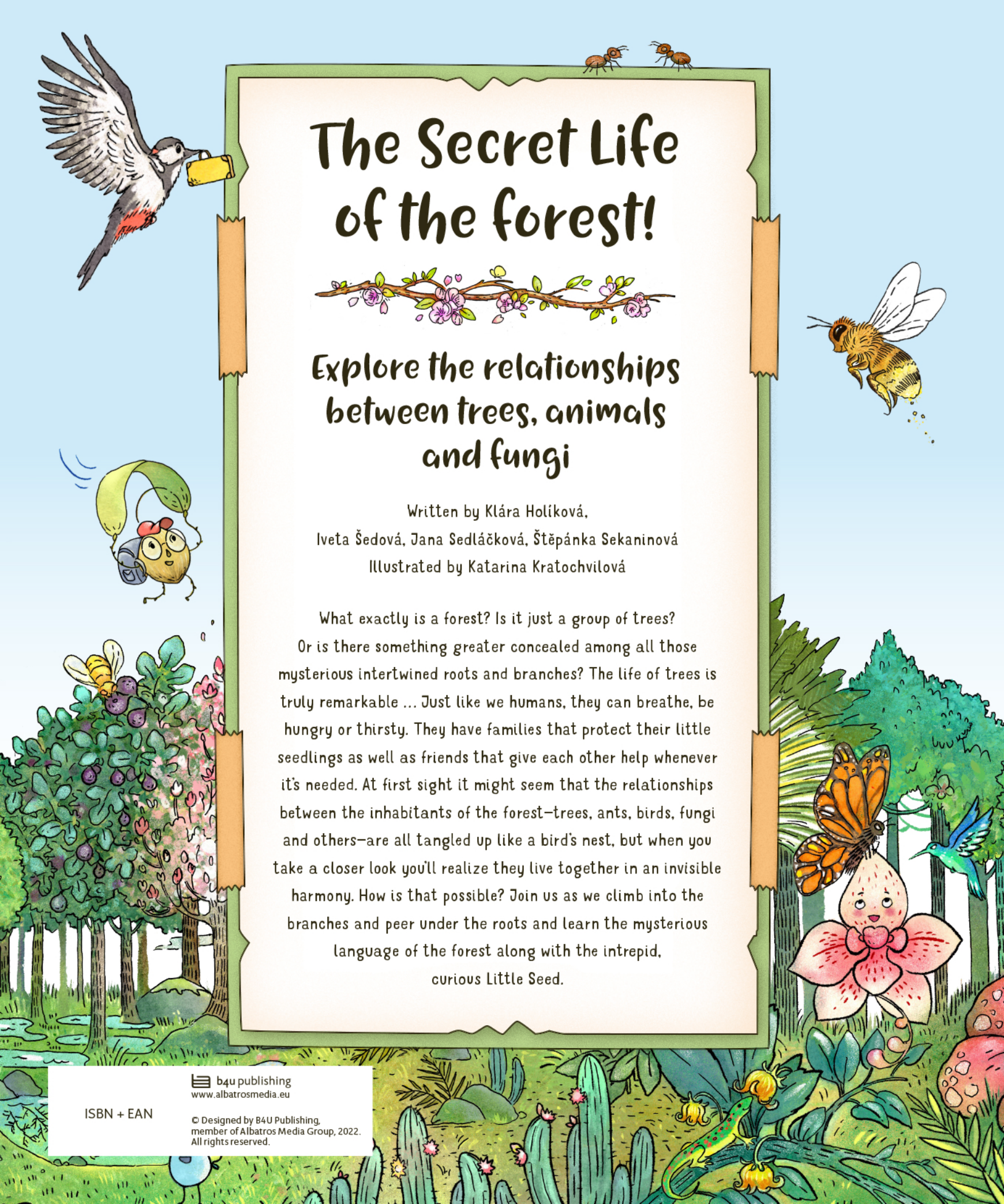

The Secret Life of the forest!

Explore the relationships between trees, animals and fungi

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What exactly is a forest? Is it just a group of trees? Or is there something greater concealed among all those mysterious intertwined roots and branches? The life of trees is truly remarkable ... Just like we humans, they can breathe, be hungry or thirsty. They have families that protect their little seedlings as well as friends that give each other help whenever it's needed. At first sight it might seem that the relationships between the inhabitants of the forest—trees, ants, birds, fungi and others—are all tangled up like a bird's nest, but when you take a closer look you'll realize they live together in an invisible harmony. How is that possible? Join us as we climb into the branches and peer under the roots and learn the mysterious language of the forest along with the intrepid, curious Little Seed.

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