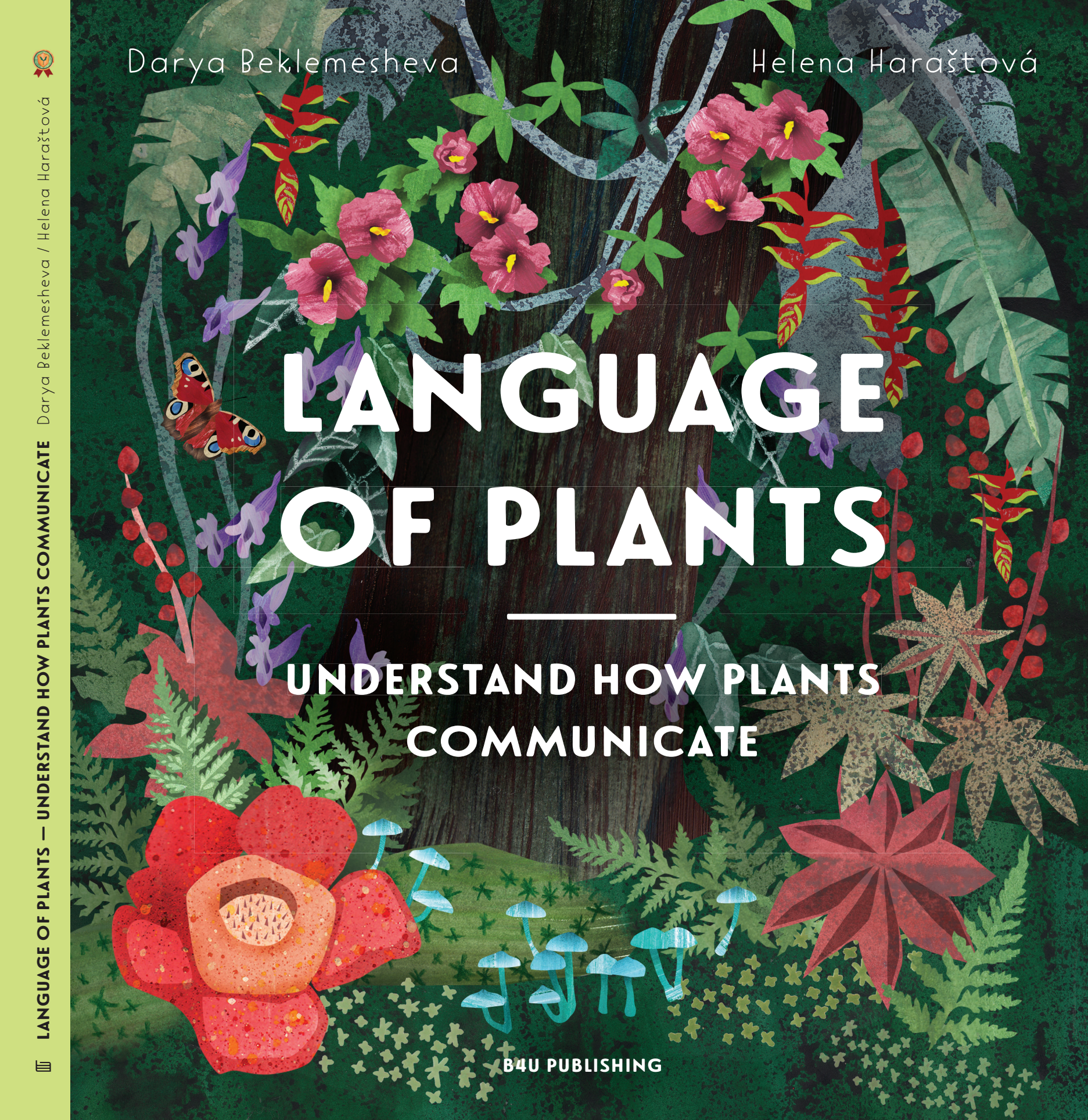
Darya Beklemesheva
Helena Haraštová

LANGUAGE OF PLANTS

UNDERSTAND HOW PLANTS COMMUNICATE



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LANGUAGE OF PLANTS — UNDERSTAND HOW PLANTS COMMUNICATE Darya Beklemesheva / Helena Haraštová

LANGUAGE OF PLANTS

UNDERSTAND HOW PLANTS COMMUNICATE

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PLANTS ARE LIVING ORGANISMS

The plant kingdom resembles our world in many ways

OUR VERY STRANGE RELATIVES

Imagine a creature that breathes, even though it has no lungs, digests food, even though it has no stomach or intestines, excretes harmful substances from its body, even though it has no liver, responds to light and sounds, even though it has no eyes or ears, and even behaves intelligently, even though it has no brain. You know them better than you think. They are plants! We have such a lot in common with plants. In fact, we have a common origin and ancestor. We are all living creatures.

IT ISN'T BORING BEING A PLANT

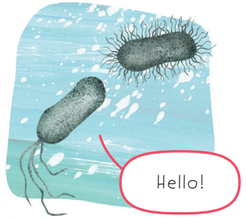
We now know of around 400,000 species. But of course, it's not that easy to find new species, because, as we all know, plants don't just turn up and announce themselves to the botanist, and they don't leave tracks. Plants are not able to move to a better place to escape pests or to avoid drought, the heat or the cold. And even though, they are capable of fascinating stuff, stuff that we have only recently begun to discover, thanks to modern technologies.

SOME PLANTS HAVE DISCOVERED A SPECIAL MEANS OF TRANSPORT, THOUGH—THEY KNOW HOW TO MAKE THEIR SEEDS TRAVEL LONG DISTANCES. ONE SUCH EXAMPLE IS CRAMBE TATARIA, A PLANT WHICH WAITS UNTIL ITS SEEDS ARE READY, THEN WITHERS COMPLETELY AND BREAKS OFF. THEN IT SIMPLY LETS WIND TAKE IT SOMEWHERE. AND WHILE FLYING IN THE AIR, IT DROPS ITS SEEDS TO THE GROUND.

LIFE-GIVING COOPERATION

ONCE UPON A TIME (2 TO 3 BILLION YEARS AGO)

Only unicellular organisms lived on Earth, similar to bacteria, protozoa or cyanobacteria.



LATER

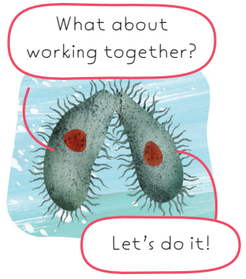
When you're successful, others imitate you. More and more complex organisms, composed of more and more cells, began to emerge and thrive.

FINALLY

Animals, plants, and fungi have become so different that you'd never guess that they had common origins.

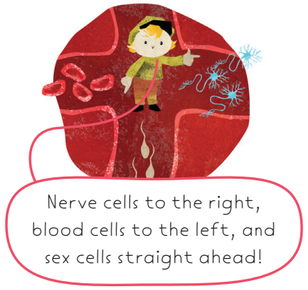
HALF A BILLION YEARS AGO

Two unicellular organisms discovered that when they combined, they were stronger and more resilient!



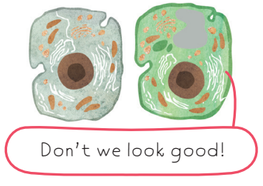
EVEN LATER

The cells of each particular organism gradually specialized, depending on where it lived and what it needed for its life. Various types of cells emerged.



AND INSIDE ...

If you look at a plant and an animal cell under a microscope, you'll see that they are a little different today.



Given that plants are stuck in one place their whole lives, they have had to develop some **sophisticated strategies** to:

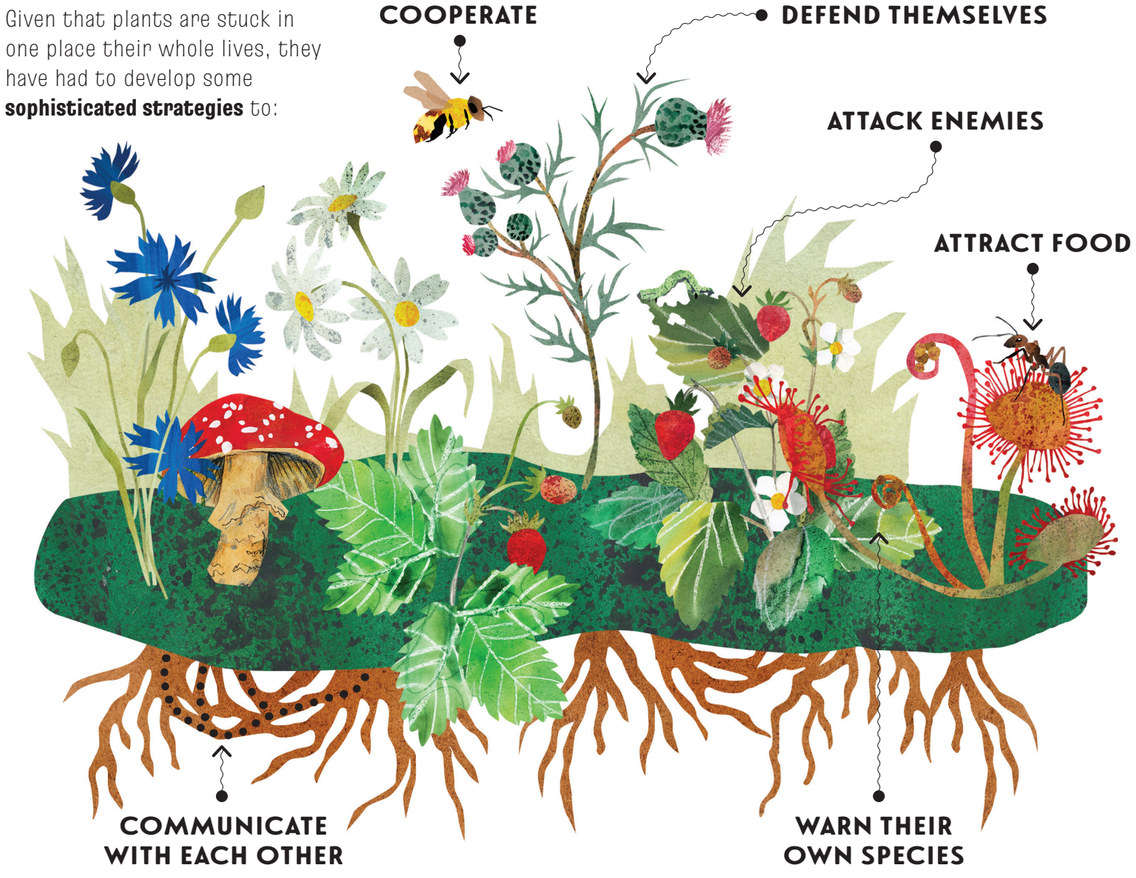


PHOTO-SYNTHESIS

SOLAR ENERGY

OXYGEN (O_2)

CARBOHYDRATES

CARBON DIOXIDE (CO_2)

CARBON DIOXIDE (CO_2)

OXYGEN (O_2)

WATER

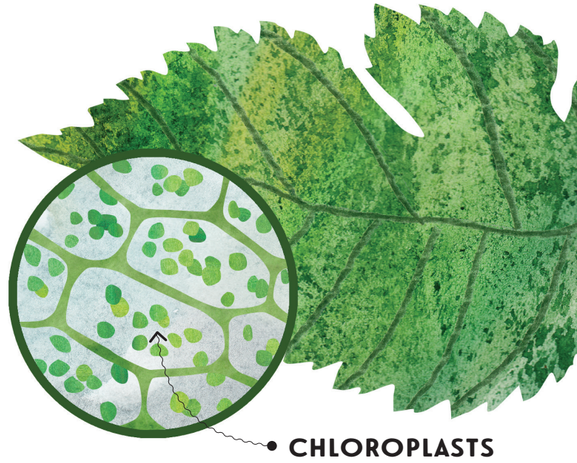
SOMETHING OUT OF NOTHING

Plants possess one incredible ability: they can make something out of nothing! Sounds like magic, doesn't it? The 'nothing' that they make 'something' from is, in fact, energy from the sun, air and water. And the 'something' they make is food. Plants make food not only for themselves, but for all of us. Whether we eat vegetables, meat or grains, all nutrients on Earth have their origins in plants. And remember, a by-product of this production is the oxygen we breathe. The process by which plant performs this miracle is called **photosynthesis**.

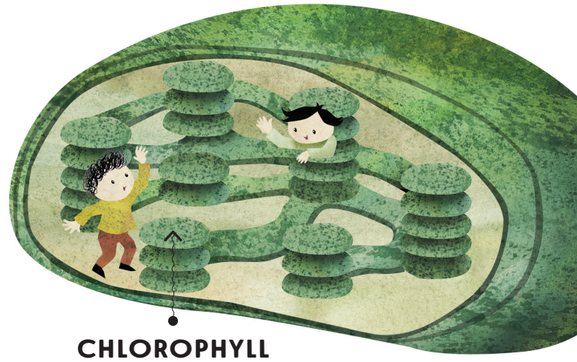
WHAT ABOUT NIGHT-TIME? PHOTOSYNTHESIS DOESN'T WORK AT NIGHT. INSTEAD, PLANTS BREATHE LIKE WE DO—THEY ABSORB OXYGEN AND RELEASE CARBON DIOXIDE. BUT THEY PRODUCE SUCH A TREMENDOUS AMOUNT OF OXYGEN DURING THE DAY THAT THERE'S ALWAYS ENOUGH LEFT OVER FOR US.

LEAVES ARE ESSENTIAL

The green leaves of plants are the secret of the whole process of photosynthesis. Their cells contain **chloroplasts**, in which there are chlorophyll pigments.



Chlorophyll gives plants their green colour. Nevertheless, it also absorbs energy from the Sun and turns it into carbohydrates. Without chlorophyll, photosynthesis would not be possible.



HOW A FOREST BREATHES

If you stared at a tree during the night, you would notice that it slightly stoops its branches. It relaxes in a way similar to human releasing their muscles or slowing down the beating of their heart during sleep.

BREATHING IN WINTER

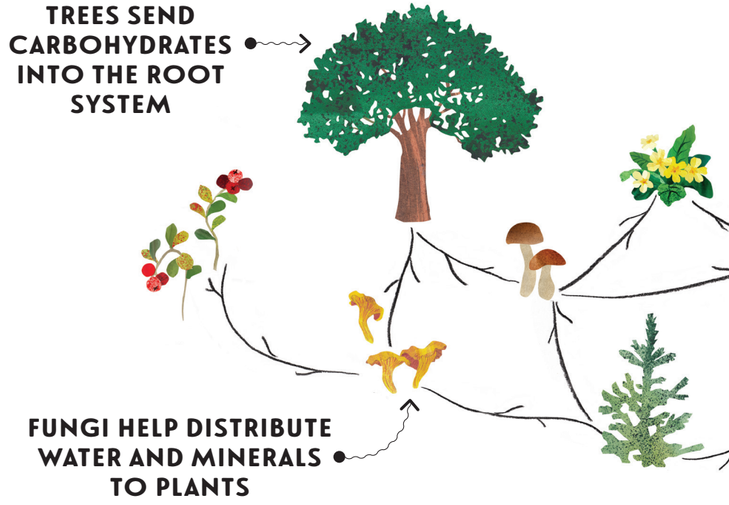
In winter, the plants go into hibernation, thereby reducing their need for oxygen to breathe. They don't die of asphyxiation, even though they only produce a minimal amount of oxygen. And why is it that we humans don't suffer from a lack of oxygen during the winter? Well, air circulates around the planet, so, for example, we're able to breathe oxygen produced by the coniferous forests of the taiga or by plants in the tropical rainforest!

A WORLD WITHOUT PLANTS?

We can't take it for granted that we live on a planet with enough oxygen and food, and with a safe environment for us to live in. We owe all of this to plants! However, plants become ill when people recklessly use harmful substances in agriculture and industry or they don't care of nature. Why not become a defender of plants? Why not look after the plants in your area?

WOOD WIDE WEB

Plants communicate with each other through their roots

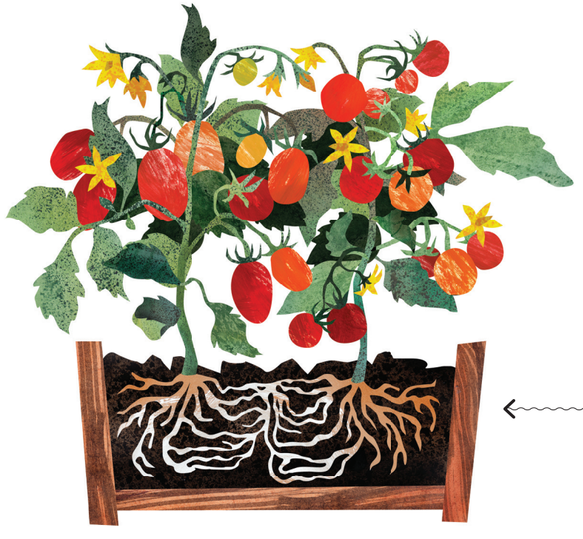


WHAT ARE ROOTS FOR?

For a long time, people thought that plants needed roots just for stability and drawing water and nutrients from the soil. But in the 1980s, scientists took a look underground and noticed that the roots of plants and fungi were interconnected. Why? It turned out that these connections were ingeniously formed and dense networks. Scientists began to call them **mycorrhiza**.

HOW DOES IT WORK?

The mycelium extends its fungal threads in different directions until it encounters roots of plants. As soon as this happens, the two root systems connect and the fungi and plants literally become inseparable friends. The fungi send water and minerals to their allies, which makes the plants grow faster. The plants supply the fungi with carbohydrates that they cannot make themselves but which they cannot live without. It is no wonder that 70 to 90 percent of all plants and practically all fungi are hooked up to mycorrhiza. This system works in temperate woods, tropical rainforests and even in the Arctic.



YOU CAN MAKE YOUR OWN MYCORRHIZA ON THE BALCONY. ALL YOU HAVE TO DO IS GET SOME SOIL WHICH HAS MYCORRHIZAL FUNGI IN IT (YOU WILL FIND IT AT ANY GOOD GARDEN CENTRE).

WOOD-WIDE WEB

Scientists have found that a dense network of roots in which fungi are present also connects individual plants to each other. Through mycorrhiza, they can also help each other. Imagine the whole network as the branched out brain of a forest with many centres. Here important information is stored in and sent from. You might think this is like the internet, a worldwide network of interconnected computers which is called the 'world-wide web.' This natural network has thus been given a similar nickname – the '**wood-wide web**.'

1. Fungi. We are the messengers. We pass on nutrients, water and information.

2. Old plants. We are the founding fathers of the network. Together with fungi, we form its information nodes.

3. Young plants. We're keen to join you, as soon as our roots are more developed.

4. Mother plant. I send nutrients to my seedlings so that they grow well and prosper.

5. Seedling. Thanks to the nutrients from my mother plant, I grow stronger and thrive.

6. Auxin. You will find me in the roots of plants, and I decide the direction in which they grow.

7. Mycelium. We thin fungal threads form a dense and tremendously long network. You will find many kilometres of us in a teaspoon of soil!

8. Root. I am able to perceive the Earth's gravity and so I always grow towards the centre of the earth. I look for water and nutrients for the plant and fix it firmly in the soil.

A MYSTERY LIKE A DETECTIVE STORY

What about cooperation between different species of plant? Scientists had long suspected that, through mycorrhiza, the birch tree and the fir tree had a mysterious alliance: that the birch sent nutrients to the fir in summer and the fir did the same for the birch in winter. So, they made an experiment. In a group of birch trees, fir trees and thuja trees, they randomly covered some of the plants with black bags, and therefore such trees were unable to perform photosynthesis. They also added extra radioactive carbon to some of the uncovered trees (plants can produce carbon through photosynthesis). When they later examined which trees contained radioactive carbon, surprisingly enough, they found out that it was present in some of the covered trees. But these trees could not produce any carbon, so it was clear that they received a gift of carbon from plants that had more of it than they needed.

WHEN THE WOOD-WIDE WEB IS BENEFICIAL

A NETWORK OF MUTUAL ASSISTANCE

Solidarity is common among plants. They most often share with each other carbon, nitrogen, phosphorus, and various hormones.

EARLY WARNING NETWORK

Pests, drought, or fire? Plants give timely warnings to their neighbours in danger.

DONATE AND DIE

With the last of their strength, very old and dying trees pass on their nutrients to the young plants around them.

... AND THE OTHER SIDE OF THE 'WEB'

THUJA

Remember the experiment with birch, fir and thuja trees? It turned out that the thuja trees didn't get involved in helping their neighbours. They behaved as if they were not part of the experiment.

ORCHID

It willingly engages in mycorrhiza, but while others donate, the orchid only takes.

WALNUT TREE

The substances it sends to its plant neighbours weaken and kill them. It won't tolerate any competition.

MIGHTY SCENTS

Plants call for help and warn each other

HOW THE UNASSUMING ACACIA CAN KILL AN ANTELOPE

In the 1990s, conservationists in South African wildlife reserves were taken aback by the extraordinarily large numbers of dead kudu antelopes. The cause of the deaths of so many animals left them scratching their heads.

However, the veterinarians gradually ruled out all these possibilities and eventually identified the least likely perpetrator as the killer – **acacia trees**! How did this actually happen?

A prime source of food for kudu antelopes has always been acacia leaves. The acacia defends itself against its herbivore aggressor by increasing the concentration of tannins in its leaves. Consequently, the leaves soon become bitter. So after a few mouthfuls, the antelopes move on to places where the leaves are still beautifully sweet. But that just isn't an option when the reserve is enclosed by a high fence. The antelopes' food sources were limited, and the acacia trees became in danger of being wiped out. That's why they began to warn each other. The trees under attack released a strong-smelling ethylene into the air, which other acacias in the area detected. As a precaution, they also increased the concentration of tannins in their leaves. When the kudu antelopes eventually arrived, they were greeted with a hefty dose of poison.

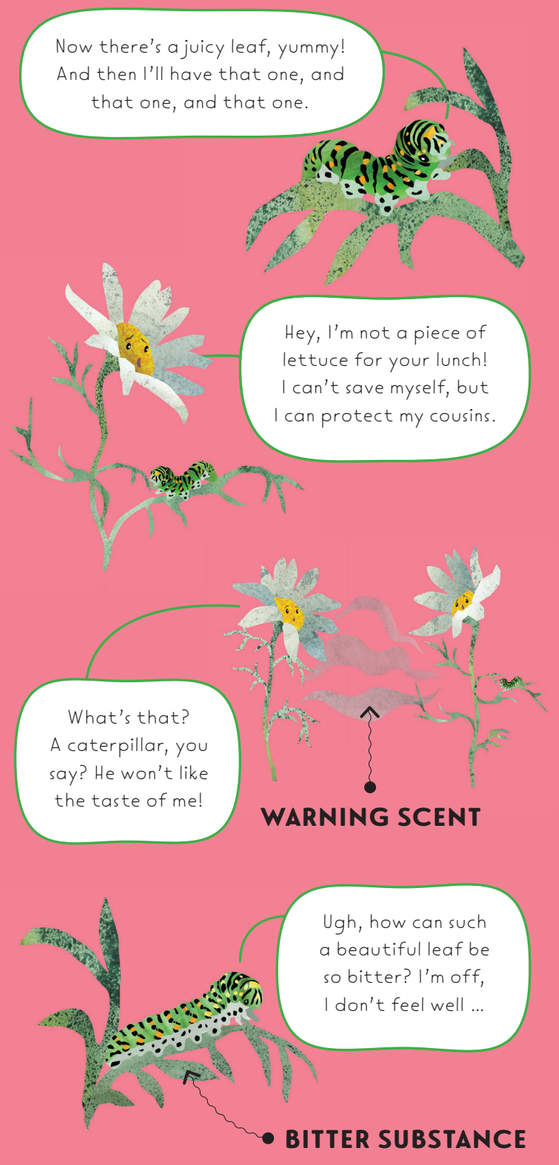
SCENTS AS A WARNING

The story of the unfortunate antelopes—and the clever plant communication—had an interesting outcome. Over time, the animals came to understand that, on their expeditions to their beloved acacias, they would be safe if they approached them upwind. The ethylene warning only travels where the wind blows, so the plants on the other side do not have prior warning of the approach of the hungry animals. At the same time, antelopes no longer eat too many leaves from a single tree, but just nibble a few, so that the acacia does not have to defend itself with its full armoury of tannins. Nature managed to restore its lost balance.

It might come as a surprise that trees which have not been attacked also pass on warnings by means of scent. Researchers verified this in an experiment in which they slightly damaged the leaves of a number of poplar and maple trees. The damaged trees began to emit phenolic compounds as a warning, and the scientists also detected the same compounds on trees in the area that were intact and undamaged! Now you can easily desipher the meaning of the pleasant scent of freshly cut grass—in fact, it is a call for help.

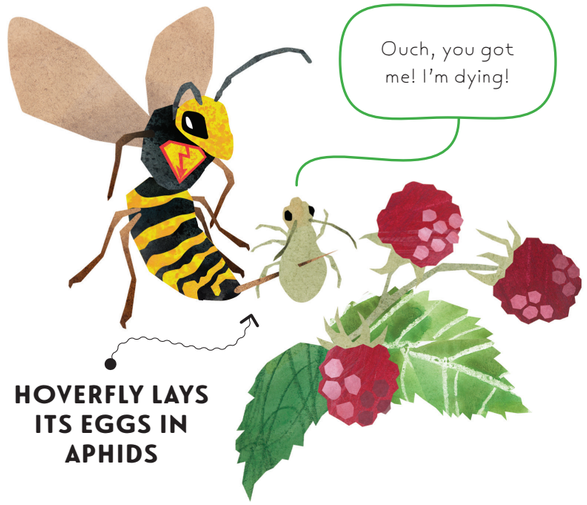
UGH, A CATERPILLAR!

Some plants can give a timely warning of the approach of caterpillars, too.



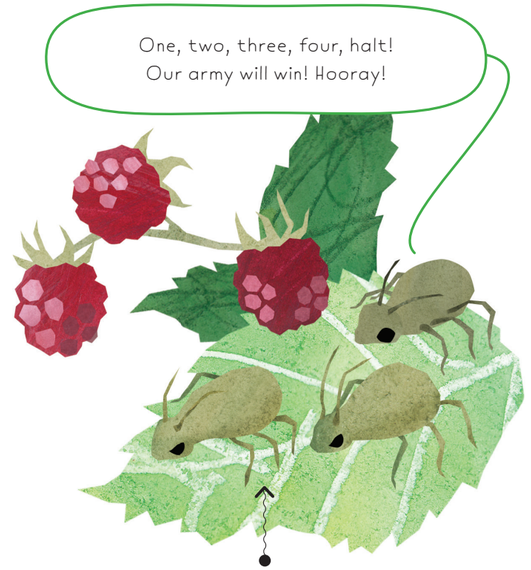
SCENTS AS A CALL FOR HELP

'SOS! Raise the alarm! There are plants infested with aphids, voracious beasts which are not affected by plants' poisonous substances!' Sometimes plants are not able to get rid of the enemy by themselves, so they need someone's help. Over the course of time, plants have learned another clever trick with scents: by means of a special enticing scent, they are able to attract insects that have their own way of dealing with aphids, namely hoverflies.



IT'S ALL ABOUT ESSENTIAL OILS

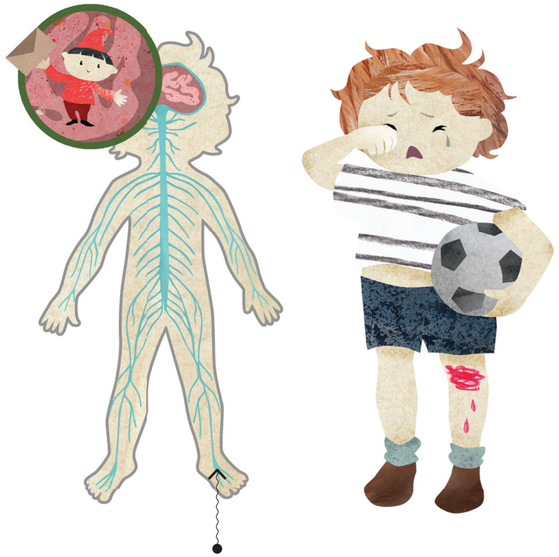
Essential oils are various fragrant substances that plants make themselves. It is the oils that plants smell of. Some plants, such as pine, spruce, mint and chamomile, produce large amounts of essential oils and, for humans, their scent is a defining characteristic. Some oils have healing properties or help a person overcome stress or fatigue, while others are an irritant or even harmful for humans.



A HOVERFLY IS A SMALL INSECT THAT HAS A STRIPED COAT SIMILAR TO THAT OF A WASP. INSTEAD OF A STING, IT HAS AN OVIPOSITOR, WHICH IS A LONG SPIKED TUBE USED FOR LAYING EGGS DIRECTLY INTO THE APHIDS, THEREBY KILLING THEM.

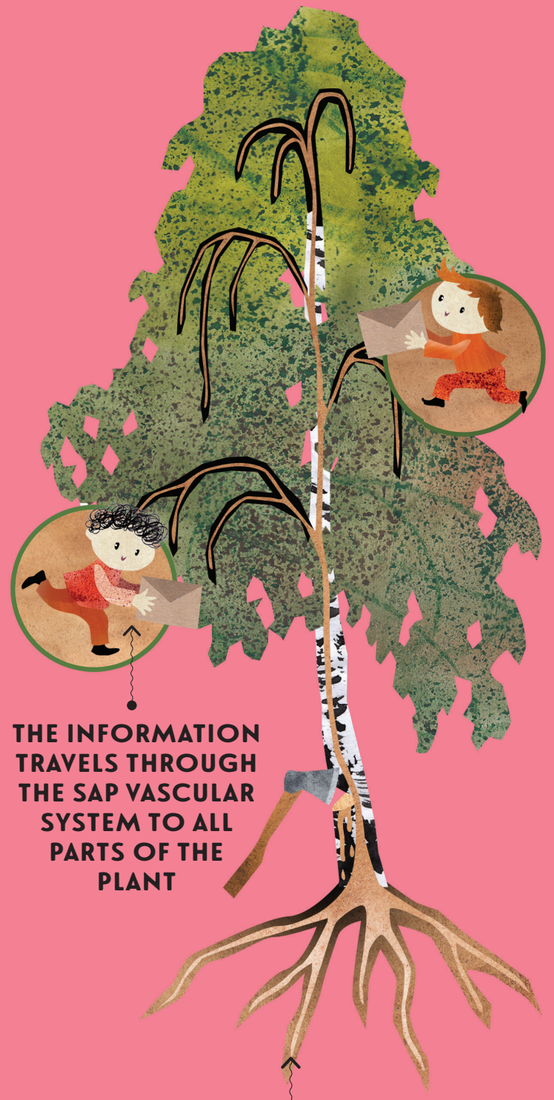
HOW DOES A PLANT KNOW THAT IT IS UNDER ATTACK?

For humans and animals, it's easy: we have a brain and an interconnected nervous system, so when something injures us, the cells of our nervous system begin transmitting information about the threat at lightning speed. The information thus travels from the site of injury to the central decision-making organ, which is the brain.



THE INFORMATION TRAVELS THROUGH THE NERVOUS SYSTEM FROM THE HURT SPOT TO THE BRAIN

However, plants have neither brains nor nerve cells, which presents a bit of a problem. It's still somewhat of a mystery how a plant as a whole realizes that it has been attacked on a certain part of its body. Plants probably use their sap vascular system, which can transmit electrical signals, to spread this information.



THE INFORMATION TRAVELS THROUGH THE SAP VASCULAR SYSTEM TO ALL PARTS OF THE PLANT

WHAT IS SAP?

It is a clear fluid that flows in the vascular bundles of plants. It flows through the entire plant, from the roots to the tips of the leaves. It is a bit like blood in humans.

LIFE OR DEATH STRUGGLE

Plants compete with one another

Not only children, but also adults sometimes quarrel and haggle. And it's the same with animals, which compete with each other for the most desirable female, or for crumbs of bread left lying on the pavement … So, what about plants? Are they unselfish, altruistic, always willing to lend a hand…? Don't you believe it! Even plants compete with each other.

A NON-EXISTENT IDYLL

Imagine soil where individual plants are growing side by side in peace and harmony. They have enough:

1. SUNLIGHT
2. SPACE
3. NUTRIENTS
4. WATER

You'd never find that kind of situation in nature. All plants need light, water, nutrients, and space to live, and, of course, they all strive for the biggest possible share of them! And when the amount of resources is limited, so begins a merciless struggle for the survival of the fittest…

LANGUAGE OF PLANTS

Understand how plants communicate

Written by Helena Haraštová
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LANGUAGE OF PLANTS

UNDERSTAND HOW PLANTS COMMUNICATE

What if plants have superpowers we have overlooked? Could it be that plants rule the world? When you look at plants, you probably say to yourself: Very nice, but a bit boring. Plants don't walk or talk, and they let themselves be pulled up and cut down. But is that all there is to them? Recent scientific findings have shaken our traditional view of plants. Now we know that plants not only take an interest in the world around them, but they react to it too. Plus, they communicate in ways we humans can only dream of ...

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