

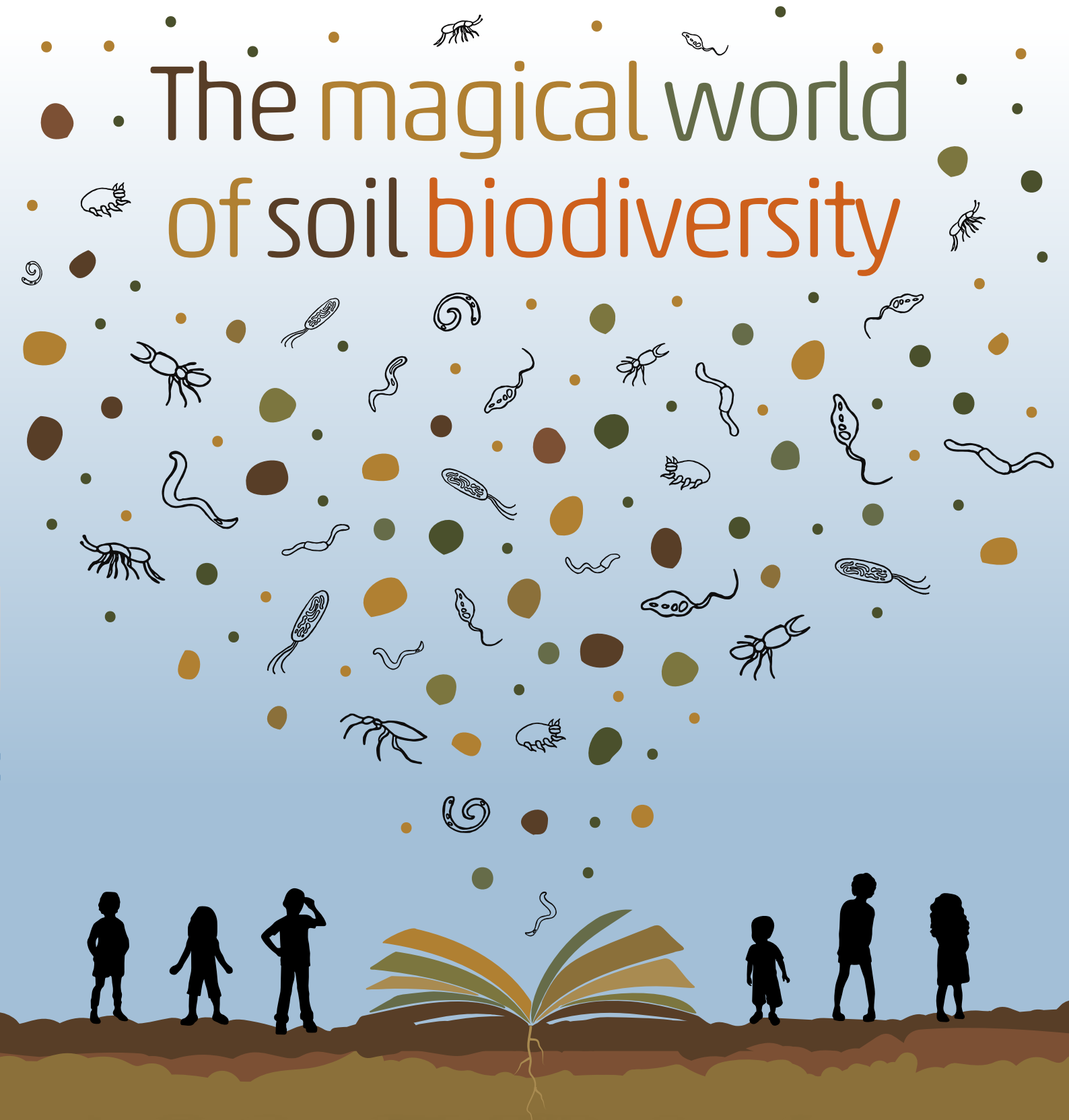


Food and Agriculture  
Organization of the  
United Nations



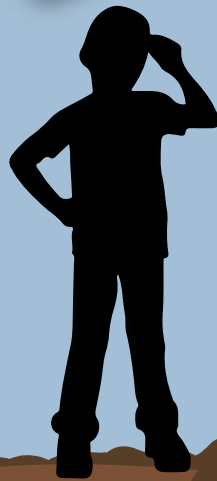
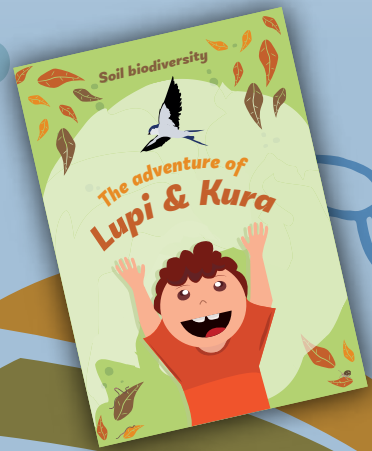
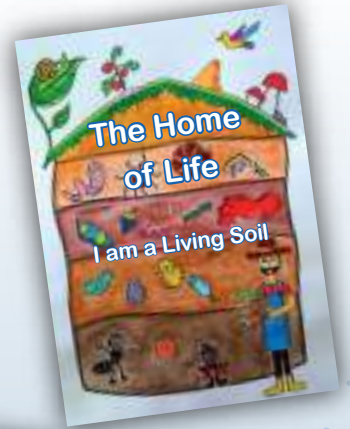
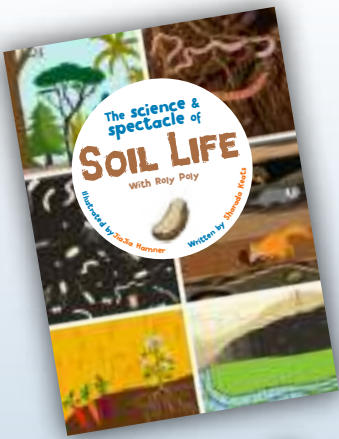
International Union of Soil Sciences

# The magical world of soil biodiversity



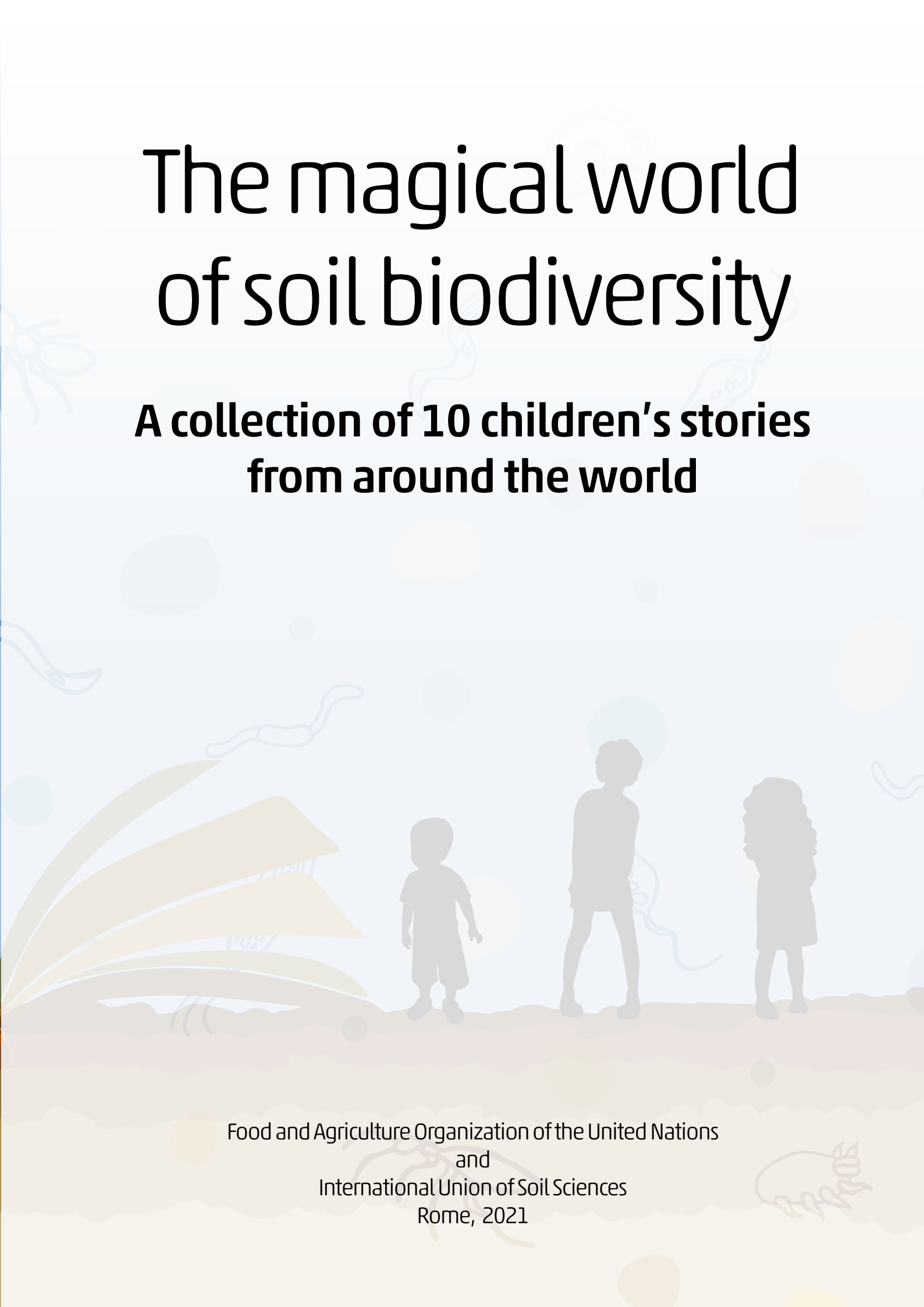
A collection of 10 children's stories  
from around the world





# The magical world of soil biodiversity

**A collection of 10 children's stories  
from around the world**

The background features a stylized illustration of three children standing on a patch of soil. To the left, there are large, layered, golden-brown shapes representing soil layers or plant roots. The sky is light blue with faint, abstract shapes and circles. The overall theme is soil biodiversity and children's stories.

Food and Agriculture Organization of the United Nations  
and  
International Union of Soil Sciences  
Rome, 2021

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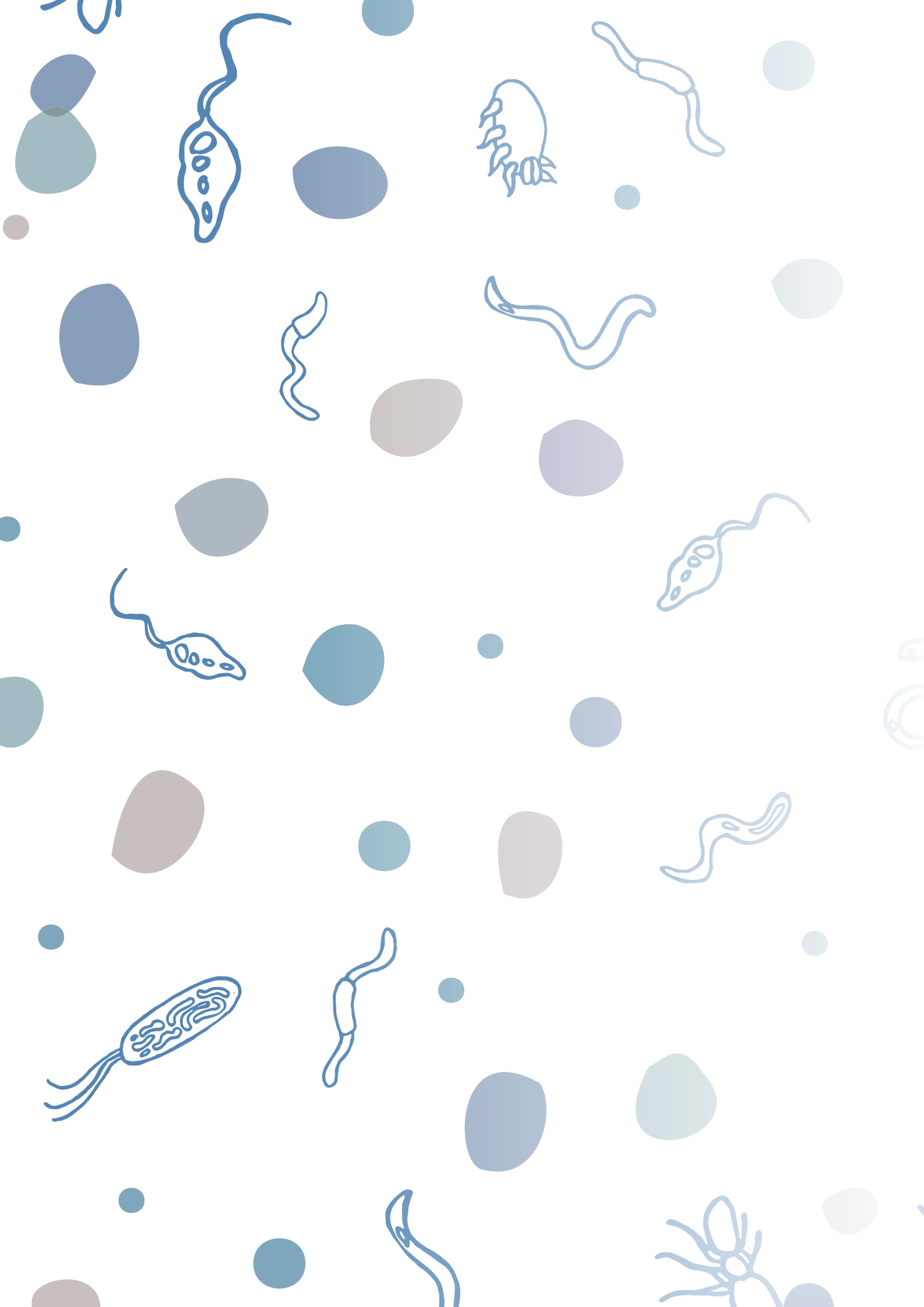
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# Foreword

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On the 5th December 2020, the seventh UN World Soil Day - celebrated under the motto "Keep soil alive, protect soil biodiversity", succeeded in reaching an estimated 800 million people worldwide through seven hundred and eighty coordinated events in over one hundred countries. Since its inception in 2014, this annual event has successfully promoted the importance of healthy soils and advocated for the sustainable management of soil resources to billions of people.

As soils are home to 25 percent of the world's biodiversity and are responsible for providing the ecosystem services essential to sustaining life on earth, they truly deserve to be protected and celebrated.

In August 2020, as part of the World Soil Day 2020 campaign activities, the Food and Agriculture Organization of the United Nations (FAO), the International Union of Soil Sciences (IUSS) and the Global Soil Partnership (GSP) launched a sixteen-page book-writing competition about soil biodiversity, for children aged six to eleven. This is the result.

The IUSS, FAO and GSP would like to express their deep appreciation for the quality of the work submitted and the commitment shown by all those who participated in this contest. A diverse, global mix of soil scientists, researchers, professors, teachers, classrooms, individual students, soil practitioners, designers, writers and photographers took part, and ultimately, submitted over eighty books from sixty countries. A truly remarkable achievement.

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We are very proud to present this collection of ten stories, including some of the best, regionally balanced entries from around the world. Each story is told in a fun, beautiful and unique way, to help children discover those remarkable and hidden soil animals and organisms that do so much hard work.

We hope that this special issue will be enjoyed by all, and serve as a useful and positive starting point for parents, schools and educators to talk to their young audience about the importance of soils and soil biodiversity, and why we should care. Together we can explore the challenges ahead in ensuring that our world survives and thrives while providing sustainable ways to continue feeding a hungry planet for future generations.

We also hope that some children will be further inspired to continue learning about this amazing subject and consider studying biology, soil science or natural resource economics/policy when they are older.

So, kids, discover the magic of soil, immerse yourself and meet those funny little animals that keep the soil healthy and fertile and are essential to the main biogeochemical processes that make life possible on Earth.

Happy reading!



Ronald Vargas

FAO GSP Secretary



Laura Bertha Reyes Sanchez

IUSS president



# Acknowledgements

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## Members of the jury

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Caridad Canales, UN Convention on Biological Diversity, Canada

Diana Wall, Global Soil Biodiversity Initiative, United States of America

Matteo Sala, FAO

Rainer Horn, Institute for Plant Nutrition and Soil Science, Germany

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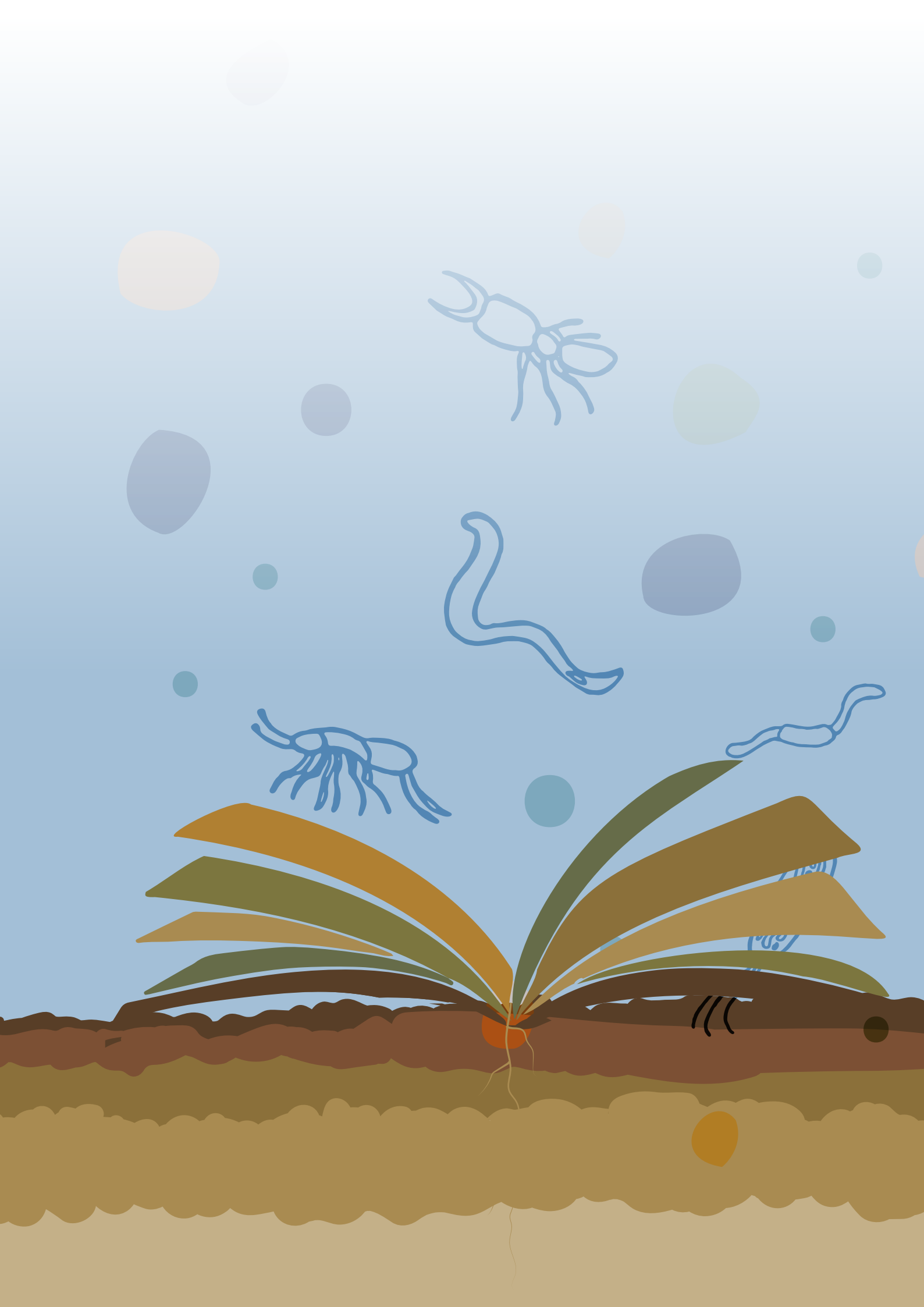
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# The science & spectacle of soil life with Roly Poly

## Authors

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**Sharada Keats** was born in Australia and is of mixed Guyanese and British heritage, growing up in Australia and Canada. She studied agricultural economics in Canada and the UK, and works in the food and nutrition sector - presently at the Global Alliance for Improved Nutrition. She enjoys writing both fiction and non-fiction for young people and has a special love for minibeasts like Roly Poly. She lives in the UK with her partner Mark, their son Jonah, and Molly the cat.



**JiaJia Hamner** was born in Beijing but grew up in the prairies of Canada. She attended university in the United States where she studied physics and graphic design. JiaJia enjoys painting, wandering in forests and observing nature wherever she can find it. She works as a freelance illustrator and lives in Seattle, Washington with her husband Chris and their cat Butters.

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Hiya! I'm Roly Poly!  
I'm a member of the  
Armadillidiidae family.  
Can you say that? ...  
Arm-ah-dilly-dee-dee.

# The Earth Beneath

Soil is alive and soil is life. Human life and life on Earth as we know it depends on soil.

Most land on Earth is covered by soil. Many ingredients make up soil, including nutrients that plants and people need to thrive. And soil is absolutely full of life. Scientists have only catalogued a fraction of these soil-dwelling lifeforms. Most are so small, we call them **microbes**.

## Soil ingredients

Different combinations of these ingredients make different types of soil.

Water



Organic matter



Living creatures



Sand, Silt & Clay



These are made of minerals. Sand particles are huge compared to clay particles!

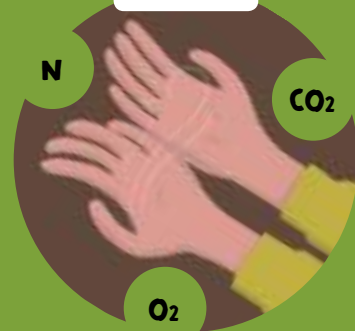


Sand

Silt

Clay (barely visible)

Gases



## It's ALIIIIIVE

You might think the largest living thing on Earth is a majestic tree like the giant sequoia, or perhaps a massive blue whale... but scientists believe the largest organism is a humongous honey fungus, whose root-like **rhizomorphs** and branching **mycelia** cover close to **nine square kilometres** of soil in an Oregon forest, in the United States of America. This fungus is thought to be about 2 400 years old!

That fungus is still a baby compared to the oldest living sequoia which put down roots in the soils of California's Sierra Nevada over 3 000 years ago!

Did you know?

Mushrooms are the fruits of the much larger fungus living underground.



# A WEB OF LIFE



Soil provides a rich habitat for a wide range of life – in fact it's the most **biologically diverse** part of our planet. Hundreds of thousands of plant species live in and around soil in all sorts of climates – from towering rainforest trees to desert cacti.

Underground, life ranges from tiny creatures invisible to the naked eye, like **bacteria**, **protists**, **nematodes**, and **tardigrades**, to slightly larger creatures like mites and springtails, to minibeasts like earthworms, ants, and termites. Larger animals all over the world, including mammals, reptiles, and birds also live in and around soil.



Nematodes



Tardigrades



Bacteria



Springtails

## little Burrowers

Earthworm

Trapdoor spider

Cricket

### HOW DO CRICKETS BURROW?

Some crickets dig holes in the ground as a place to hide, or to lay their eggs. They loosen soil with their heads and mandibles – the hard pincers on the front of their face – and they carry or kick it away with their legs.

Scorpion

Ant

Centipede

Beetle

## BIG burrowers



Puffin



Tortoise

### WHY BURROW?

Tortoises burrow for shelter, to **hibernate** and to nest!



Rabbit



Badger

Lizard



### DID YOU KNOW?

Yellow-spotted monitor lizards are the only reptiles known to dig burrows in a spiral shape! They can be over 3 metres deep – the deepest nests dug by any known **vertebrate**.



Do you know of any other animals, big or small, that burrow in the soil?

Fox



Vole



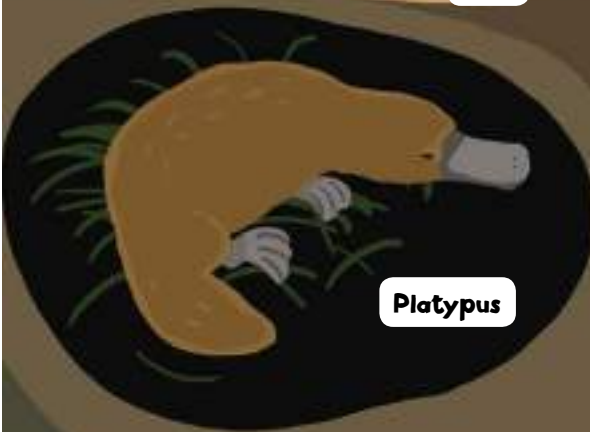
Burrowing frog



### DROUGHT DODGERS!

Some frogs wait out dry periods by 'sleeping' underground until rains arrive – some can wait for years!

Platypus



Burrowing owl



# THE UNDERWORLD

Soil is life... but death and decay are serious business for many of soil's little creatures, reliant on soil's organic matter.

**Organic matter** at its least decomposed, like newly-dead plants and animals, is called 'raw organic matter'.



Bacteria and fungi eat raw organic matter.

Worms and insects can also eat raw or partly decayed organic matter.



The partly decayed organic matter is called compost, and contains living **saprotrophs**.

When the nutrients from dead things return to the soil, plants absorb them, continuing the cycle of life.



Humus is the most decomposed state of organic matter. Humus can gradually decay over several years, or it can remain for thousands of years. It helps soils to hold water, making them more drought-resistant.

**Life depends on death, and death depends on life.**



Soil is full of dead and decaying matter. Most living things in soils, including plants, animals, fungi and bacteria depend on organic matter as a source of nutrients and energy. It also helps to make soils fluffier, allowing space for air and water. Darker coloured soils contain more organic matter than lighter coloured soils.

You might not find soil very delicious, but soil can be good for your human **microbiome** – the microbes in and on you!

**I ♥ humus as much as you ♥ hummus!**



**Do you think roots are super scrumptious?**



You're not alone! Plant roots provide nutrients that little creatures crave. More than a habitat, roots also ooze fluids full of acids, sugars and other things that **microorganisms** like bacteria and fungi find delicious!



**ROLY RECYCLES!**

Creatures like Roly are expert recyclers, helping to release nutrients back into the food chain.



# EARTH MOVERS and EARTH STABILIZERS

The longest individual earthworm ever recorded

was discovered in South Africa in 1967, measuring 6.7 metres long.

That's about 27 uncooked spaghetti noodles placed end to end!

Earthworms help aerate and release nutrients into the soil, while plant roots help keep soil, along with nutrients, from being blown or washed away.



## THE UNIQUE ENVIRONMENT OF ROOTS

The **rhizosphere** is the name given to the area around a plant's roots, where the chemical and physical properties of the soil are influenced by the roots, and all the life living there.

The largest species of earthworm lives in Australia. It's called the giant Gippsland earthworm. It measures about two centimetres in diameter, and can grow to three metres long.

## PUTTING DOWN ROOTS

One of the deepest root systems was found to belong to a shepherd tree growing in the central Kalahari, Botswana. These astonishing roots reached a depth of **68 metres**. They were discovered by people drilling wells to reach **groundwater** in 1974.



68 m is about the same as 12 giraffes standing on top of each other!

## AMAZING ANTS

Every landmass on Earth, except Antarctica and a few remote islands, is home to ants.

Earthworms get a lot of credit for keeping soil healthy – and they do – but ants also play a vital role. Their tunnelling helps to turn over soil, allowing water and oxygen to reach the rhizosphere, so they are especially important to people who farm in dryland areas where earthworms are less abundant. Ants also disperse seeds, contribute to the breakdown of organic matter, and protect crops and gardens from pest insects.

Out of an estimated 22 000 species of ants, more than 12 000 have been catalogued. They range in size from around two millimetres long, to as long as four centimetres.



# WHAT DOES SOIL DO?

What did dirt ever do for me?

Soil gives us food! As much as 95% of our food comes from soil, or feeds on plants that do. Farms, gardens, orchards, and pastures rely on soil. The biodiversity of that soil is vital for its health and ours.

It also gives us fibre and fuel! Crops like cotton for instance, used to make our clothes, are grown in the soil.

It purifies water and reduces contamination. When water trickles through soil, it is cleaned by physical, chemical, and biological processes.

It helps to regulate the climate. Our planet is warming, and well-managed soils can play an important role in mitigating this, by storing carbon and decreasing greenhouse gas emissions.

It's a home! More than a quarter of all species on earth are estimated to spend at least some of their life in soil.

## DID YOU KNOW?

Healthy populations of insectivorous animals can help soil capture more carbon. Leaf-eating insects, such as beetles, flies, and ants, release carbon dioxide into the atmosphere. In ecosystems where salamanders eat these insects, more leaves can turn into humus. This means the soil is able to store more carbon, which is good for the planet.

CO<sub>2</sub>

CO<sub>2</sub>

IOC

OC

CO<sub>2</sub>

OC

CO<sub>2</sub>

IOC

CO<sub>2</sub>

OC


Organic Carbons

Inorganic Carbons

IOC

CO<sub>2</sub>

Carbon dioxide



Soil is a place where nutrients are recycled. It stores and releases nutrients back into the food chain.


#### DID YOU KNOW?

Some kinds of animal manure – or poo – can be great for adding organic matter and nutrients to soil. Poo also attracts insects and the creatures who snack on them. Generations of farmers have used elephant dung, for instance, as a fantabulous fertilizer!



Soils soak up rainwater. They play an important role in helping to stop rivers from flooding.

We build on soil. We also build *with* soil. It provides a foundation for our houses, roads, railways and more. Soil isn't just a construction material for termites!



Soil can hold important pieces of our cultural history. It acts as a time capsule, preserving long-lost items that tell us about the lives of the people who lived a long time ago.

Soil can hold scientific treasures – bacteria for instance that might be used to make medicines, or for other scientific advancements.



**More biodiverse soils generally mean more fertile fields and farms, and a more secure food supply.**

**But soil, and the life it sustains, is under threat.**

# WHAT CAN WE DO FOR SOIL?

Many human activities, like certain farming and construction practices, as well as deforestation and pollution threaten our soils.

Nooooo!

Soils that take hundreds of years to form can be lost in a few years.

Soils that have been **degraded**, lost or polluted can be renewed and replenished, with time and effort. We can tackle runoff, **erosion**, **salinization**, and **desertification**, add nutrients back into soils and do other things to improve soil health.

It's much more difficult to revive degraded soil than to just look after it in the first place.

The plants we harvest take out nutrients from the soil. How good a soil is impacts how nutritious our food is – and how much of it we can produce. To ensure sustainable food systems, we must take care to protect and conserve our

precious soil. Agricultural terraces found around the world are an example of farming which can be better for our soils, though clearing native forests just to make farming terraces can be extremely damaging.

## Soil is precious!

The soil nourishes us, and so much more. It deserves protection and respect, not neglect, over-use, and poor treatment.

### VITAL VERTEBRATES

Vertebrates like hedgehogs, moles, lizards, and frogs enrich our environments and our lives. Their presence is an indicator of soil health because they feed on the worms and insects living in happy soils.



Hedgehogs live in Africa, Asia, Europe and the Middle East. In some areas, their populations are in decline, owing to human activities. We can help by providing hedgehogs, and other vital vertebrates, with shelters, pesticide-free wild spaces and corridors.

Do you have a garden at home or at school? Perhaps there's a little patch of soil somewhere for you to experiment with growing vegetables or fruits?

Try using more **organic fertilizers, compost, and green manure** as a substitute for chemical fertilisers. This can be great for creatures living in soil, helping to build soil health and reducing reliance on chemical fertilizer.

Here's some things I recommend

**Rotate your crops!**

Don't grow the same thing in the same soil season after season. Different crops need different nutrients. Some crops – like **leguminous** plants such as peas and beans – even help to add nutrients back into soils.

**Don't over-water** your plants! If the soil's too wet, the roots and the creatures living in the rhizosphere won't get the oxygen they need to thrive.

To avoid damaging fungi and killing earthworms, **don't turn the soil over too often** once you've planted. You can also put compost on top of the soil, rather than digging it in.

**Mulching** can help suppress weeds. It also keeps water in the soil, preventing plants from drying out. **Mulch** can be a great habitat for soil creatures.

**Try not to squash** down or tread on your soil too much – this leads to compacted soils. Insects, fungi, and plant roots can't move through compacted soil very easily – and neither can water or oxygen.

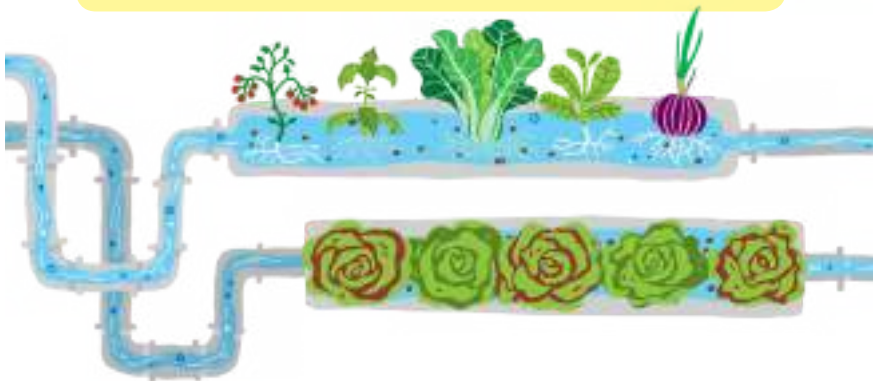
# THE FUTURE

Scientists are working on exciting advances to help soils, humans, and our shared planet – take a look at the three examples below.

## Attacking the plastic plague!

Under normal circumstances, plastics like PET (polyethylene terephthalate) take hundreds of years to decompose. But in 2016, in soil taken from near a bottle recycling facility, scientists discovered a species of bacteria that eats PET for breakfast! Before this, only a few organisms were known to degrade PET, and none so quickly. Now scientists have used these amazing bacteria to create a super-enzyme to help tackle plastic waste!

PET is the type of plastic used to make most soft drink and water bottles.



## Five-a-day... without soil?

**Hydroponics** – a way of growing plants in a nutrient soup instead of in soil – could help ease pressure on soil and water. Astronauts have used it to grow salad in space! On Earth, solar energy can power hydroponics. With the cost of solar power falling, there might be a hydroponic farm coming near you!

## Bringing soils back from the brink

Some highly polluted soils, such as lands where oil has been spilt, can be reclaimed by soil-dwelling life! **Bioremediation** – the use of microorganisms like oil-eating bacteria to break down pollutants – can help to clean polluted areas.



Threats to soil threaten our environment, food, and health. **You can help** by caring for the soil around you, telling people about the importance of soil, and protecting the creatures who live in and around soil.



Today I learned soil is alive and we should be nice to it!

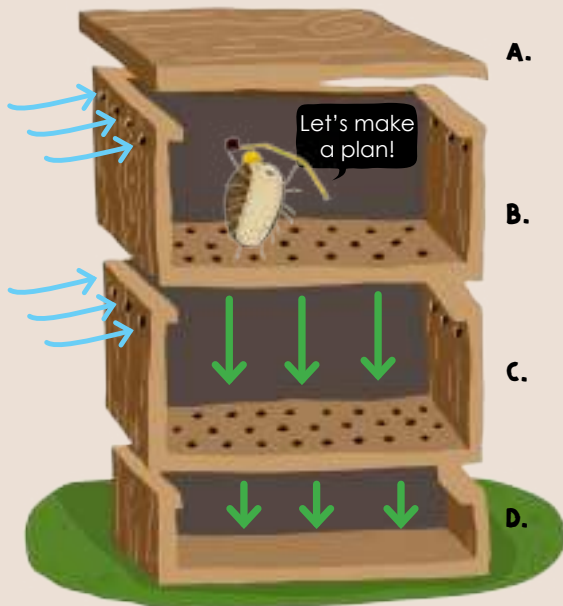
Really? Can you tell me more?

It says here the **tiger worm** thrives in rotting vegetation, compost, and manure!

Will you show us how to compost our food scraps so we can help our soils?

# CREATING WORM COMPOST

Waste worries worming away at you? Cast them away by putting the real worms to work. A worm farm is a natural way to reduce and recycle waste, while producing wonderful wormy compost! Try building one with your family, friends, school or community.



## Construct your worm farm

- A.** The lid keeps everything dark and moist and stops the worms from escaping!
- B.** This is where you can add small pieces of food waste. Holes in the sides keep the air flowing.
- C.** The worms will eat the food and produce worm **castings** which fall into this middle box through the holes.
- D.** A nutrient-rich liquid known as "worm tea" drains into the bottom box.

If making your farm from wood is too tricky, try reusing old stackable plastic containers with lids. Ask an adult to help you punch the holes.



If you'd prefer to avoid plastic, try finding a three-tier steamer pot from a thrift store for a small worm farm.



The tiger worm, *Eisenia fetida*, and its relative *Eisenia andrei* are tireless worm farm workers. In the wild, they live on the surface, and don't burrow into the soil like other earthworms.

Using worms to break down organic waste produces 'vermicompost'.



- 3 →
- 2 →
- 1 →

- 4 →
- 5 →



## Fill your worm farm

- 1 → Start by placing a layer of moistened, shredded newspapers in the top box.
- 2 → Add a few handfuls of compost, some damp soil and your chopped-up food scraps.
- 3 → Add your worms and cover with more moist, shredded newspapers.
- 4 → Vermicomposting doesn't smell bad. If your worm farm starts to smell stinky, it means something is wrong!
- 5 → Place a baking tray in this box to catch the worm tea. Then use it to water your plants.

There are many wonderful resources and designs for different types of worm farms. Keep researching to learn all the details of vermicomposting!

# GLOSSARY



**Bacteria** Single-celled organisms, invisible to the naked eye. Bacteria are sometimes called germs, but not all bacteria cause disease.

**Biodiversity** The variety and variability of life in any given area.

**Bioremediation** The use of microorganisms to clean pollution from contaminated areas, including soils.

**Castings** Worm castings, essentially worm poo, are a great organic fertilizer.

**Degraded soil** Soil that has a poor condition owing to improper use or poor management – for instance by agriculture, industry, or other actors.

**Desertification** A process through which fertile land becomes desert, often resulting from drought, deforestation, or inappropriate agriculture.

**Enzyme** A substance produced by a living organism which speeds up the rate of a biochemical reaction.

**Erosion** Soil erosion is the loss of the upper layer of soil – a form of soil degradation.

**Groundwater** Water present beneath the surface of the Earth.

**Hibernation** An extended period of minimal activity or dormancy, often through winter.

**Hydroponics** The process of growing plants without soil, but with added nutrients.

**Invertebrate** An animal without a backbone, including insects, spiders, and crustaceans. Invertebrates represent about 95% of animal species.

**Leguminous** Plants in the legume family, including some beans, peas, lentils, and peanuts.

**Microbe** or **Microorganism** Tiny creatures, too small to be seen by the naked eye. They include bacteria, viruses, fungi, and protozoa.

**Microbiome** The human microbiome is the collection of all the life living on or inside your body, like on your skin or inside your gut.

**Mulch** A layer of usually organic material applied to the surface of soil to conserve soil moisture, improve fertility, reduce weeds, and so forth. It is often made of decaying leaves, bark, compost, wood chippings, well-rotted manure, straw, or seaweed.

**Mycelia** The vegetative parts of a fungus, consisting of branching, threadlike structures.

**Nematode** Also called roundworms, nematodes are small and worm-shaped with smooth, unsegmented bodies. There are many thousands of nematode species, most about 5 to 100 micro-metres thick and 0.1 to 2.5 mm long. The smallest are microscopic. Some free-living species can reach 5cm long, while parasitic nematodes can reach over a metre long.

**Organic matter** Carbon-based compounds made from the remains of organisms like plants and animals, as well as their waste products.

**Protist** A group of organisms made up of protozoa, unicellular algae, and slime moulds, protists are single-celled organisms that are not an animal, a plant, or a fungus.

**Protozoa** A kind of protist, for example, an amoeba.

**Rhizomorph** Fungal root-like structures that help fungus spread and grow.

**Rhizosphere** The region of soil close to plant roots, influenced by plant root growth, respiration, and nutrient exchange.

**Salinization** The process by which water-soluble salts accumulate in soil. It can occur naturally or result from poor management. Too much salt is bad for soil life, including crops.

**Saprotroph** An organism that feeds on decaying organic matter.

**Tardigrade** Minute animals, known as water bears or moss piglets, tardigrades have eight legs and are segmented.

**Vertebrate** Animals with backbones or spinal columns – including mammals, birds, reptiles, amphibians, and fishes.







## Keep soil alive, protect soil biodiversity

**Biodiverse soils – those with a wide range of different plants and creatures – are essential.**



**“I believe soil is a living thing. That’s what soil health means, soil is life. Every living thing has rights. Therefore, soil also has rights.”**

**- Rattan Lal  
Soil scientist and winner of  
the 2020 World Food Prize**

This book was created for World Soil Day 2020, for the Food and Agriculture Organization (FAO) of the United Nations, the International Union of Soil Sciences (IUSS), and the Global Soil Partnership.

World Soil Day was first observed in 2014, and December 5th, 2020 marks the seventh World Soil Day.

# Soil biodiversity

## What's most important?

### Authors

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**Katelyn Lutes** is a soil research technician working in the biogeochemistry lab at the Agriculture & Agri-Food Canada Research & Development Centre in Lethbridge, Canada. She earned an M.Sc degree focused on soil science, and has considerable experience in field, greenhouse and laboratory research. She applies her expertise in analytical chemistry to soils and plant tissues as well as environmental gas and water samples. In her spare time, she enjoys drawing and hiking in the mountains with her dog Sprout.

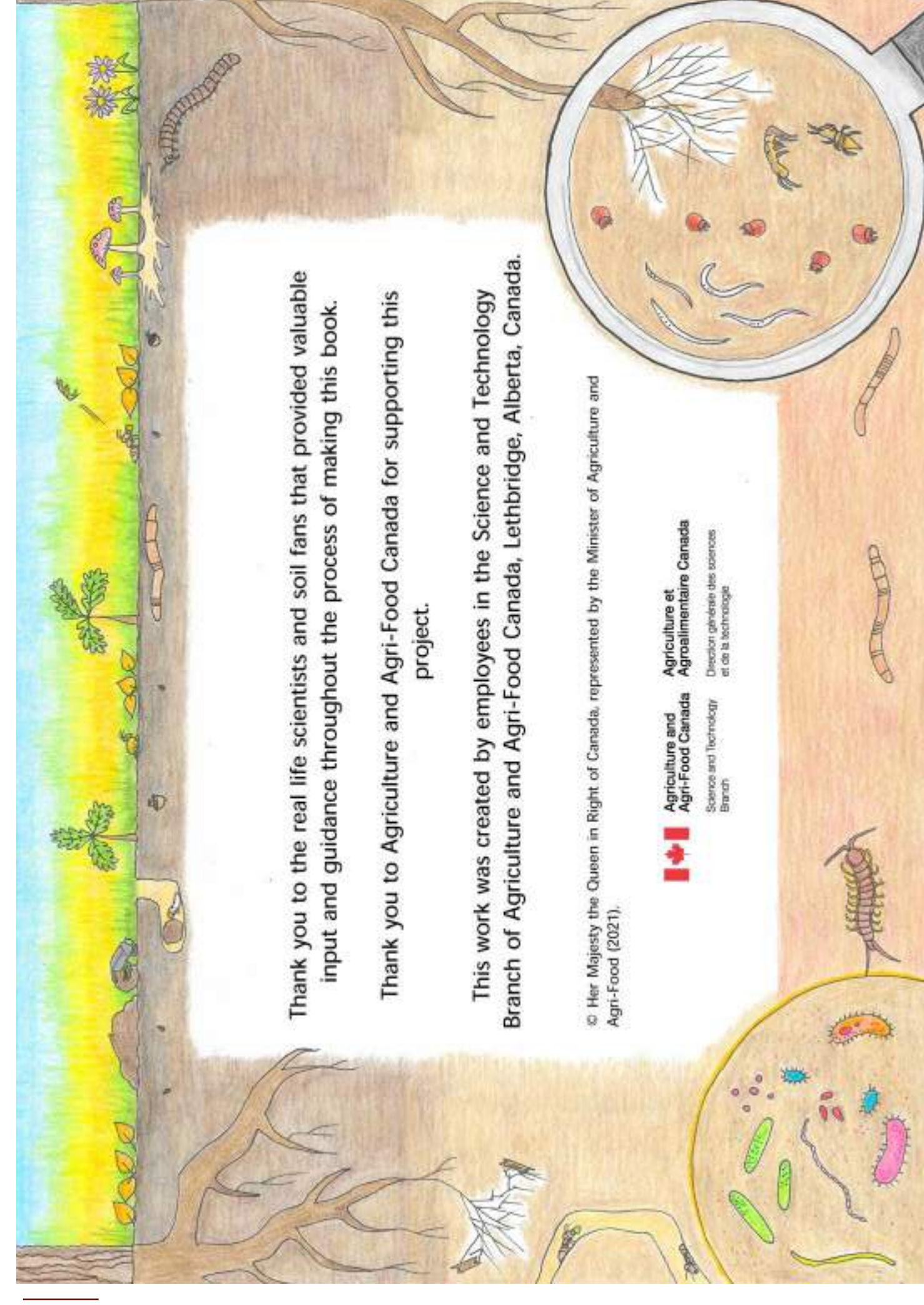


**Benjamin Ellert** has a PhD in soil science and works as a research scientist in biogeochemistry with the Agriculture & Agri-Food Canada Research & Development Centre at Lethbridge. Benjamin's interest in agriculture stems from his early years on a small mixed farm at Milk River in southern Alberta. He has considerable research experience around the biogeochemical cycling of agroecosystems and the land-atmosphere exchanges of greenhouse gases, applying isotopic techniques to trace element flows in the environment.

# BIODIVERSITY



Katelyn Lutes & Ben Ellert  
Illustrated by: Katelyn Lutes



Thank you to the real life scientists and soil fans that provided valuable input and guidance throughout the process of making this book.

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**Agriculture and  
Agri-Food Canada**  
Science and Technology  
Branch

**Agriculture et  
Agroalimentaire Canada**  
Direction générale des sciences  
et de la technologie

Welcome to the soil fan club! This is where scientists from different laboratories meet and discuss their research on soil science. This year, the theme of the club is:

## Soil Biodiversity

Soil is an ecosystem, with many living and non-living parts. In this club, we have many different scientists to help us understand soil biodiversity, and figure out what is the most important living part or group of organisms in the soil. Meet the scientists!



Billy the botanist studies plant life



Edward the entomologist is a zoologist that specializes in soil insects



Mo the microbiologist studies microscopic life in the soil



Zoey the soil zoologist studies soil animals



Melody the mycologist is a microbiologist that specializes in fungi



Emily the ecologist studies the interactions among soil organisms and their environment

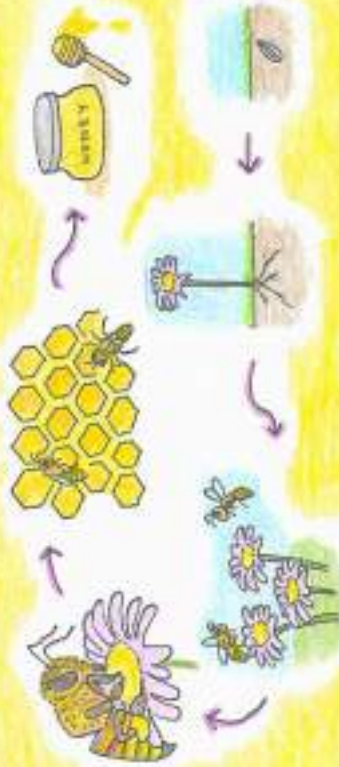




Billy the Botanist

"I am a botanist and I study plants. Nearly all of the plants I study would not be able to exist without soil, and one of the most important roles of soil is that it can support plant life. Planting seeds and growing food has been the objective of farmers and gardeners for a long time, and early civilizations thrived only when they were successful in protecting the soil and its biodiversity to grow food. Apart from seafood, most food comes from soil."

"Think about the cereal you eat for breakfast. The cereal came from wheat or oats, which grew from a seed in soil."

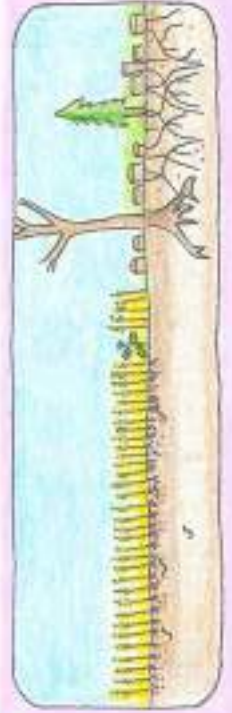


"Think about honey. The honey came from a bee hive. The bees collected pollen from many flowers to make the honey. The flowers were grown in soil."

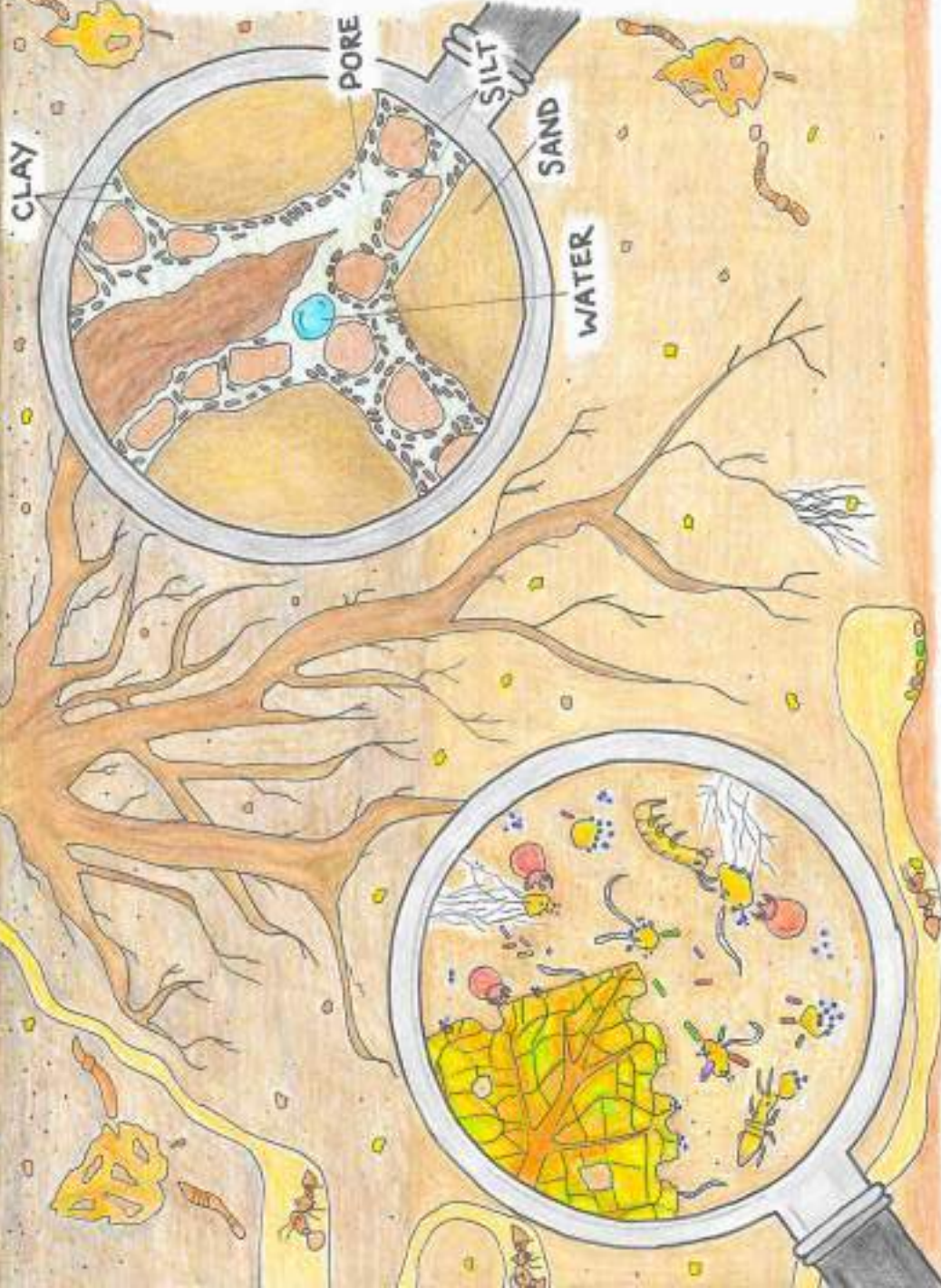
"Think about the slice of cheese on your sandwich. The cheese was made from cow's milk. The cow was fed grass in order to grow and birth calves. The field of grass was planted in soil."



"When we look at an ecosystem, we see so many different plants! Plants can also increase the biodiversity that we cannot see as easily, because plants provide food for more animals and microbes in the soil. When we plant only one crop in a farm field, or when we cut down forests for their wood, we completely change the biodiversity that we see. But, we also change the biodiversity we cannot see, in the soil. As humans, it is our responsibility to consider this biodiversity when we use the soil."



"When we think about plants, we usually think of the billions of plants we see on the surface. But half of the plant is hidden belowground in the soil as roots.



"The soil is not completely solid! Of course, there are solid soil particles, which exist as sand, silt, clay, or dead organic matter. But between these particles are open spaces, called pores. These pores can be filled with water or air, which plant roots use to grow.

Plant roots will take the easiest path in the soil, using available pore space or making new channels. In this way, they shape the structure of the soil. The roots also hold the soil down, like an anchor, so that it does not blow away in the wind or get washed away with rain.

"After plants die, they are broken down in the soil, or decomposed, which provides energy to the decomposers and releases nutrients to be used again by living plants, microbes and animals. This is essential to life on Earth, since most land-based life relies on food from plants for energy and nutrients.

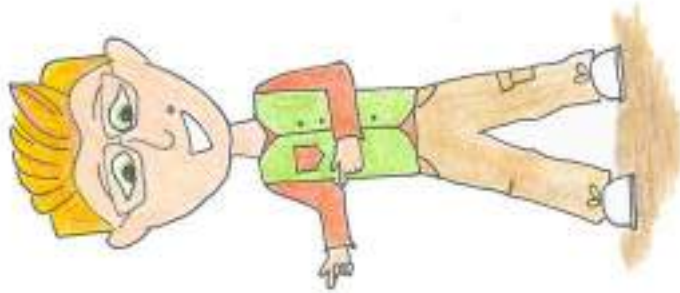
"Since there are so many plants in the world, which feed almost all life on the planet, and because plants provide the basic resources for soil organisms to exist, I think that the plants are the most important part of soil biodiversity!"





### Edward the Entomologist

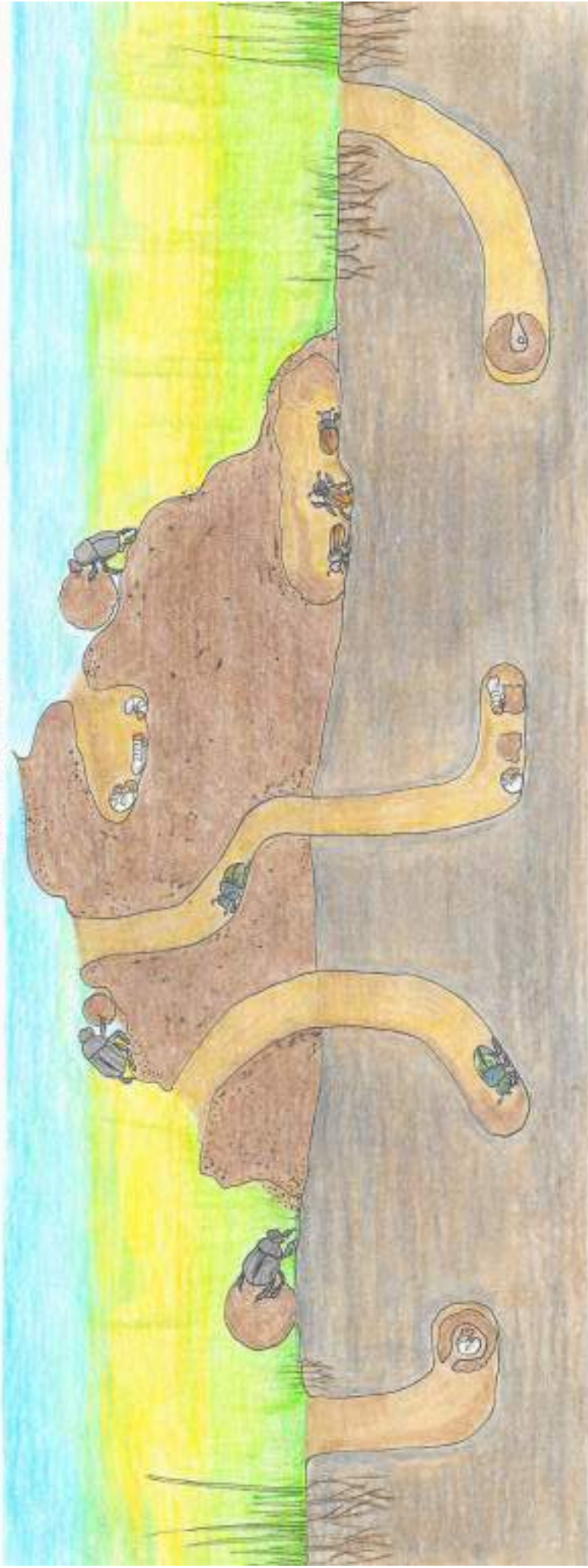
"I am a soil entomologist and I study insects. I think that the most important part about soil biodiversity is the diverse species of insects that we find in the soil. Soil is home to many insects so I will only discuss two of my favourites here, ants and dung beetles.



"Ants are ecosystem engineers, which means that they have a great effect on the soil when they build tunnels and nests. The ants in a colony work together to reshape the soil ecosystem, mixing and increasing pores in the soil, moving plant materials, and some species even farm fungi to get energy and nutrients. The activity of ant colonies may change the soil faster and much more than what we might expect for such small insects. Even though each ant is very small, because there are so many of them in the world, they actually make up more biomass, or weigh more, than the Earth's amphibians, birds, reptiles and wild mammals combined!

"Dung beetles are important for recycling dung from large herbivores, like grazing cows. To a dung beetle, fresh manure is a treasured source of food and building material. Some types simply live in the dung, while others move and reshape it, rolling it into balls and pushing it into tunnels in the soil. They feed on, reproduce in, and live in the dung. They even lay their eggs in it so that the larvae have a food source to eat.

"Can you imagine the world if animal dung was never decomposed?! Dung would quickly pile up, creating a mess that would smother the grassland so grass and the animals that depend on it could no longer grow. Dung beetles do a good job of quickly breaking down the dung, which otherwise would happen much more slowly. Dung beetles help to create healthy soils by returning nutrients to the soil and by spreading and breaking down the dung so that plants and other living things can thrive.



"Since so many insects live in and on the soil, and because they change and add nutrients to the soil, I think that soil insects are the most important part of soil biodiversity!"



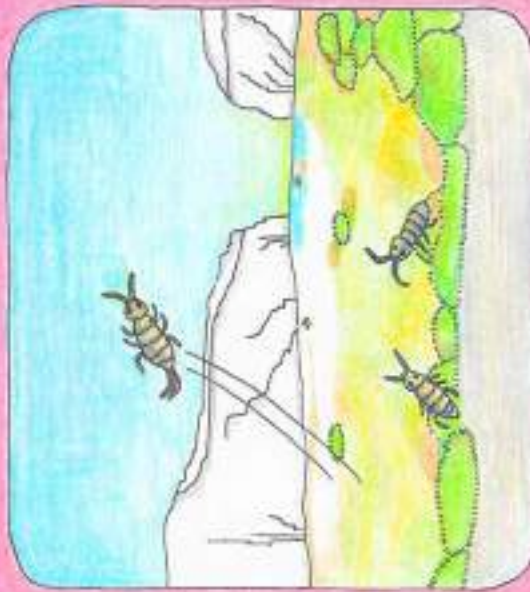
Zoey the Soil Zoologist

"I am a soil zoologist, which means that I study soil animals. I am interested in soil animals like springtails, mites, earthworms, millipedes, centipedes and nematodes. Soil animals are very common; there may be many millions of them in a square meter of soil. That's like having more than the population of your whole city within the span of your arms!"



"Springtails are very small insect-like organisms. Springtails can use a small appendage, or tail, below their body to spring themselves into the air when they feel in danger. They can jump up to 10 centimeters in the air, which is like you or me jumping over a skyscraper. Springtails live all over the world, in some of the most extreme soils, from the Antarctic, to deserts, to tropical jungles.

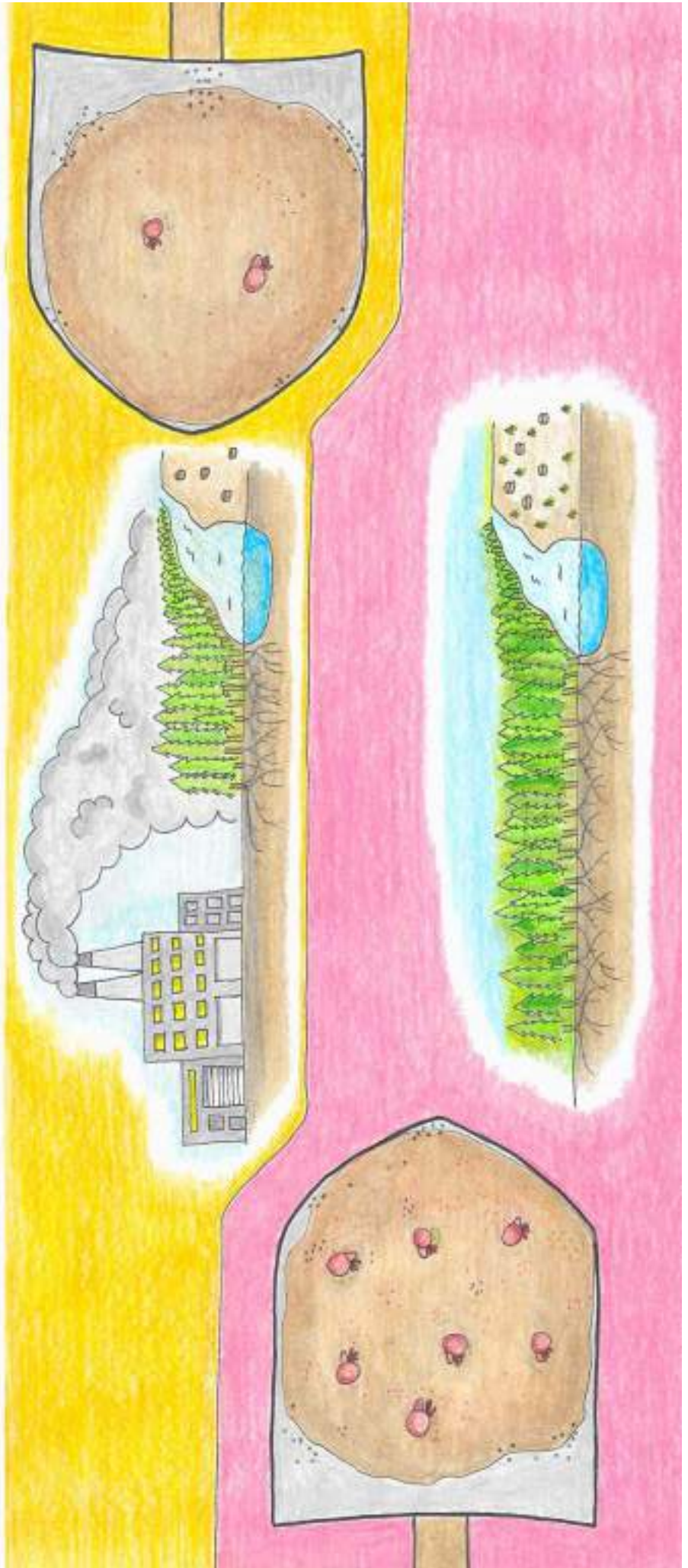
"In the soil, springtails shred, mix and eat dead plant material, returning nutrients to the soil as they dine. This helps to improve the environment for soil microbes and to increase soil biodiversity. But wait! Some springtails also like to eat bacteria and fungi, which changes the biodiversity of soil microbes too.



"Mites have similar roles to springtails in the soil; they also mix, shred and break down plant material, releasing nutrients and scattering soil microbes as they eat."



"One of the most common groups of mites, called *Oribatida*, has been used as a bioindicator. Bioindicators are living things that tell us about the health of their surrounding ecosystem. Imagine a forest growing next to a smokestack. Since trees grow so slowly, it could take years before they become sick and die because of the pollution from the smokestack. By then, it may be too late for us to help. Bioindicators respond faster to changes and are easier to measure, so by looking at the soil mites, we can quickly determine if the pollution is damaging the ecosystem and fix any problems. Studying the biodiversity of these mites can tell us if the ecosystem is healthy or if it is being stressed by disturbances such as mining, harvesting or climate change."



"Other long and skinny animals also live in the soil, including earthworms, centipedes, millipedes and tiny nematodes!"

"Earthworms can be ecosystem engineers, like ants. As earthworms tunnel through the soil they mix in plant materials. This helps decompose plants and provides food for other soil organisms."

"But earthworms can also lower biodiversity in soils where they do not belong. Sometimes their aggressive tunnelling changes forest soils so that other soil organisms have a difficult time finding familiar foods and habitats."



"As they eat, millipedes shred dead plant materials into smaller pieces, and mix it into the soil with smaller soil animals and microbes. Other soil animals would not be able to get as much food without the help of bigger animals like millipedes."

"Centipedes are predators, which means they hunt other soil animals because they like to eat them. In this way, they help to control populations living in the soil."



"Nematodes are tiny-worm-like soil animals that are invisible to the naked eye. They feed on plants and microbes, and larger soil animals feed on them. Like mites, nematodes have been used as bioindicators. But more nematodes does not always mean healthier soils since some nematodes become pests when they chew on the roots of crop plants."



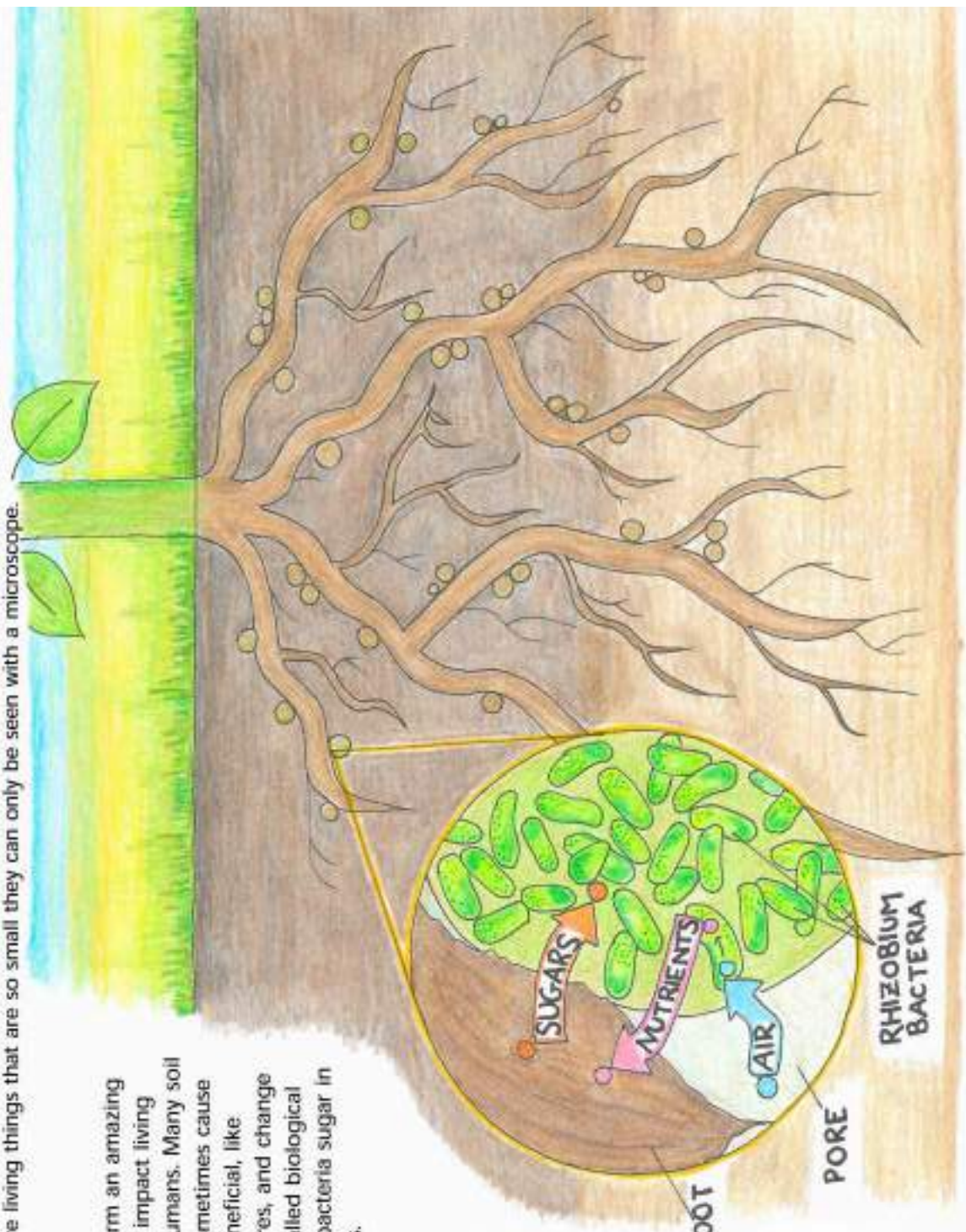
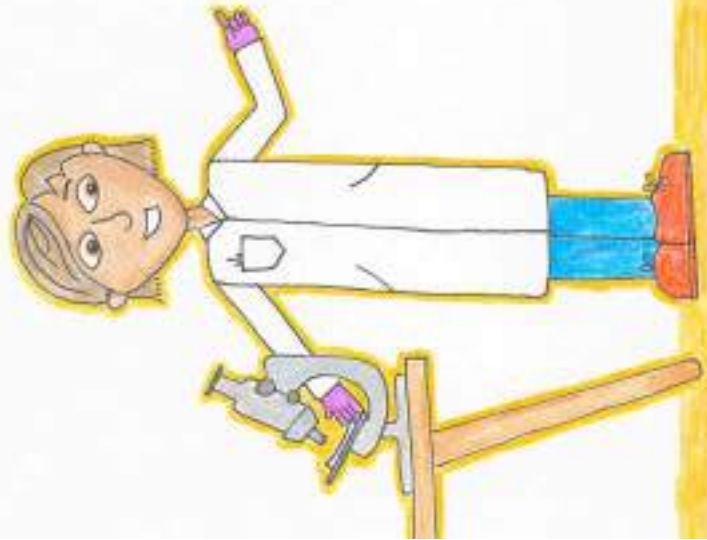
"Since there are so many soil animals that connect plants and microbes, I think they are most important part of soil biodiversity!"



Me the Microbiologist

"For me, the smallest organisms are most important in the soil! I am a soil microbiologist and I study soil microorganisms. Microorganisms, like soil bacteria, are living things that are so small they can only be seen with a microscope."

Despite their small size, microbes can perform an amazing number of nutrient transformations, which impact living things above and below ground, including humans. Many soil microbes help plant growth while others sometimes cause disease. Some bacterial infections are beneficial, like *Rhizobium* bacteria that take air from soil pores, and change it to nutrients that plants can use. This is called biological nitrogen fixation, where the plant gives the bacteria sugar in exchange for usable nutrients.

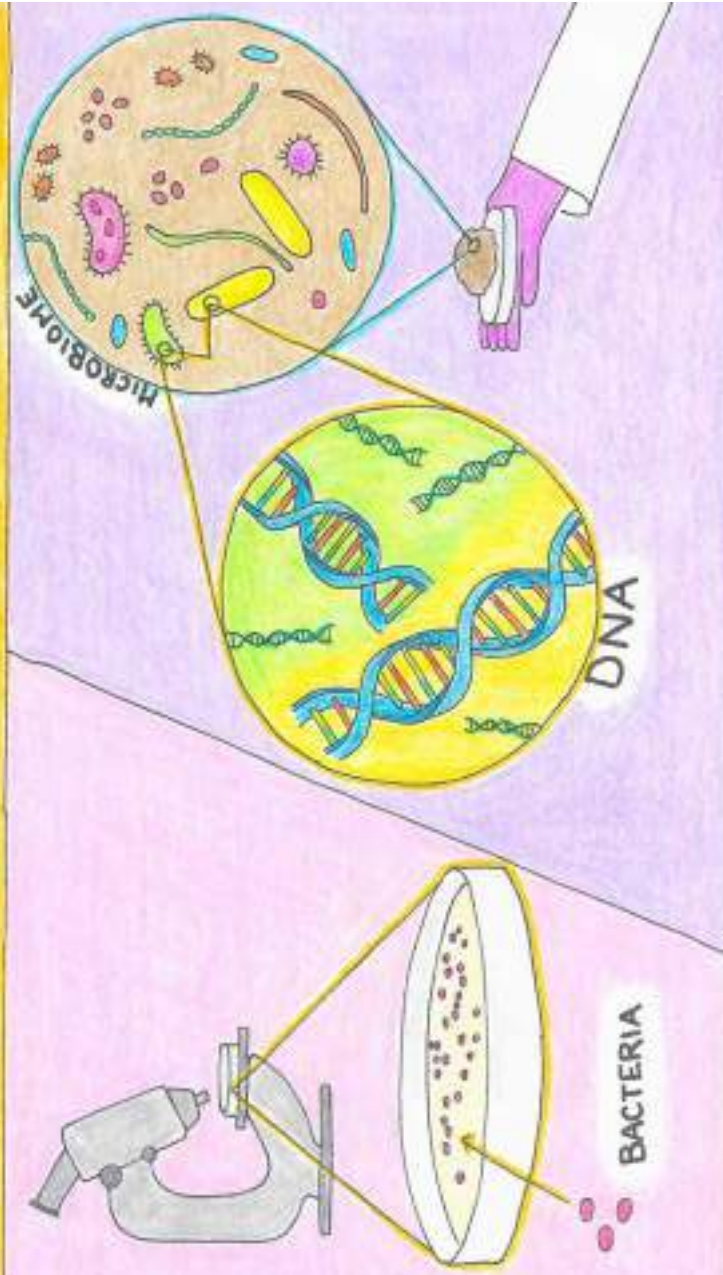


"Remember how ants have more biomass than most other animals on Earth? Well bacteria have a greater biomass than ants! Bacteria are second only to plants in global biomass. Even though bacteria exist only as a single cell, and animals are made up of many cells, the numbers of bacteria in a grassland are so huge that they often weigh more than the cows grazing above ground."



"Scientists can grow some types of soil bacteria on culture plates and study them using microscopes. But, there are too many types to study one at a time, and many cannot be grown in the lab. This means that we may not understand the full diversity of all the bacteria in the soil if we only use these methods."

"Today, soil microbiologists like me use a new type of science called metagenomics to identify each type of microbe in the soil. This way, scientists are learning about the soil microbiome, which is the entire variety of microbes found in the soil. It is important to improve our understanding of these microorganisms because they determine how ecosystems work, how our food is grown and even provide medicines."



"In just one teaspoon of soil, there can be hundreds of millions or billions of bacteria. We have not discovered most of the microorganisms in the soil, and we have very little idea of the roles in the soil. There is so much room for more discoveries! Since they are so diverse, I think that microorganisms are the most important to soil biodiversity."



Melody the Mycologist

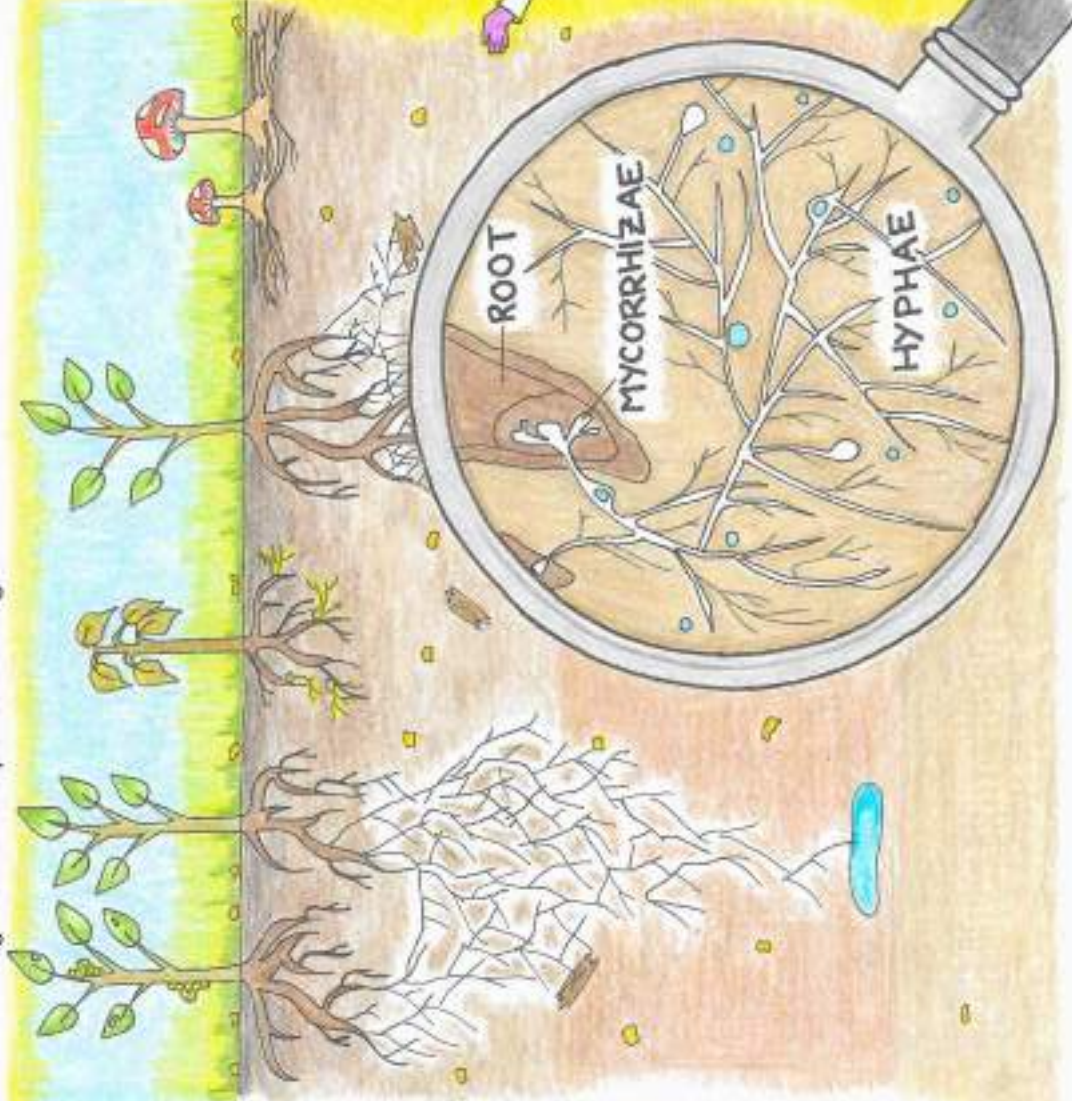
"As a soil mycologist, I study soil fungi and their relationship with plant life. Some fungi can grow bigger than elephants or blue whales. In fact, the largest organism on the planet is a fungus!"

"Soil fungi exist as long and thin interconnected strands called hyphae. Usually they are hidden belowground, but sometimes they form mushrooms, which we can easily see. Some soil fungi are powerful decomposers that can break down tough materials like wood. Other fungi can be pests that damage plant roots."

"Many soil fungi make a home in plant roots, and both the fungi and the plant depend on one another to live. We call them mycorrhizae, which means "fungus root". But why is it so successful?"

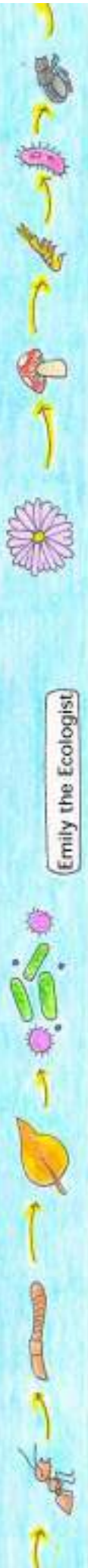
"Mycorrhizae do not have to get food by decomposing materials; instead they get sugars from the plant roots. In return, the fungi extend the root system and serve as tiny pipelines to move water and nutrients to the plant, accessing resources that may be out of reach."

"Mycorrhizae may even help plants to communicate with one another by using chemicals. The plant will release a chemical from the roots, which travels through the hyphae, to other connected plants. In this way, a plant can warn its neighbours about an insect attack."



"Since fungi recycle soil nutrients, help plants to grow and communicate, and have such a large biomass in the soil, I think that they are the most important to soil biodiversity!"

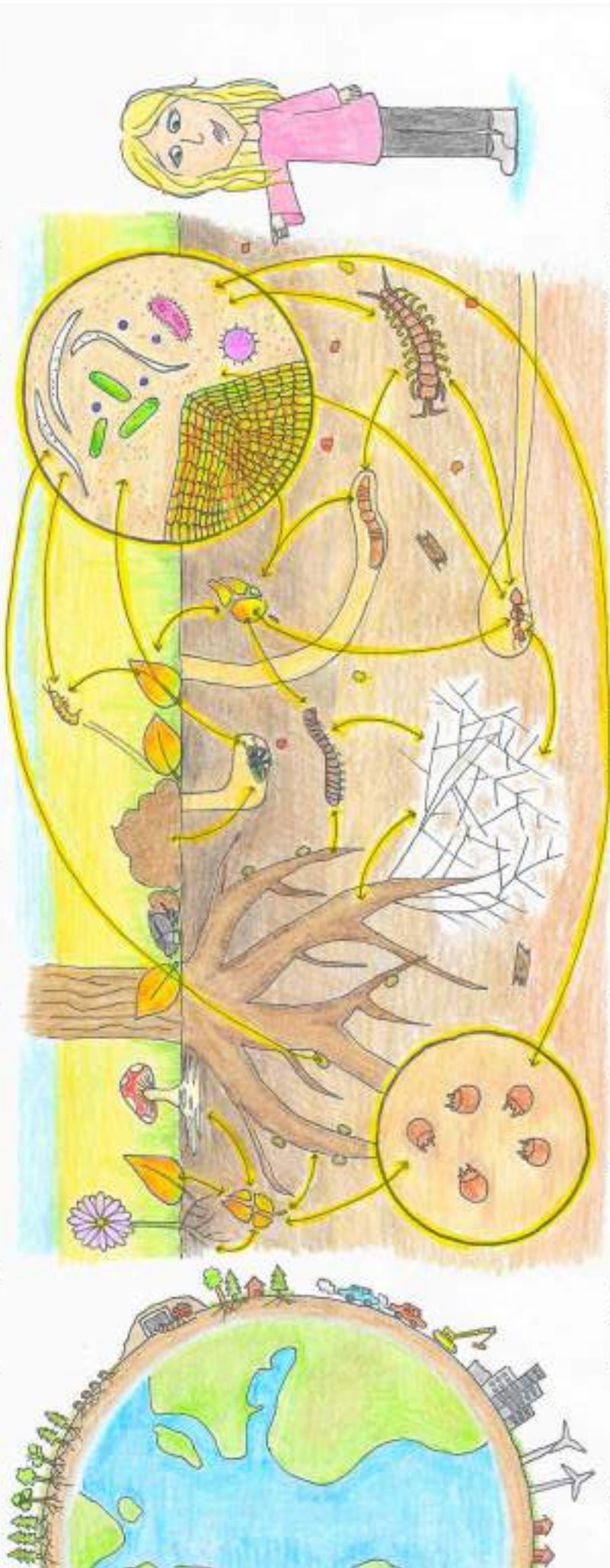




Emily the Ecologist

"I agree with all my fellow scientists; every organism is important, from microbes to plants and everything else contributing to soil biodiversity. I am a soil ecologist and I research the interactions among soil organisms and their surrounding environment.

"The soil ecosystem is a giant web, where everything is connected. Plants are connected to the soil microbes that transform nutrients for their roots to take up. Soil microbes are connected to the soil animals that spread and eat them. Soil insects are connected to plants that provide them with habitat and food. Soil animals are connected to soil insects that help to shred and mix materials into the soil for them to eat. There are so many connections that I could go on and on. Quite simply, we cannot have biodiversity without the soil, and we cannot have soil without the biodiversity of organisms living there.



"When we use the soil, it is not enough to consider only the resources, such as food and trees, that we can use right now; we must think about the future. When growing food, cutting forests, mining minerals, or building cities, we must always ask ourselves: 'will today's activities allow soil biodiversity to last so we will continue to benefit from the activities of soil organisms in the future?' because without proper care of our soils and the living organisms in them, we will not be able to keep life on our planet."

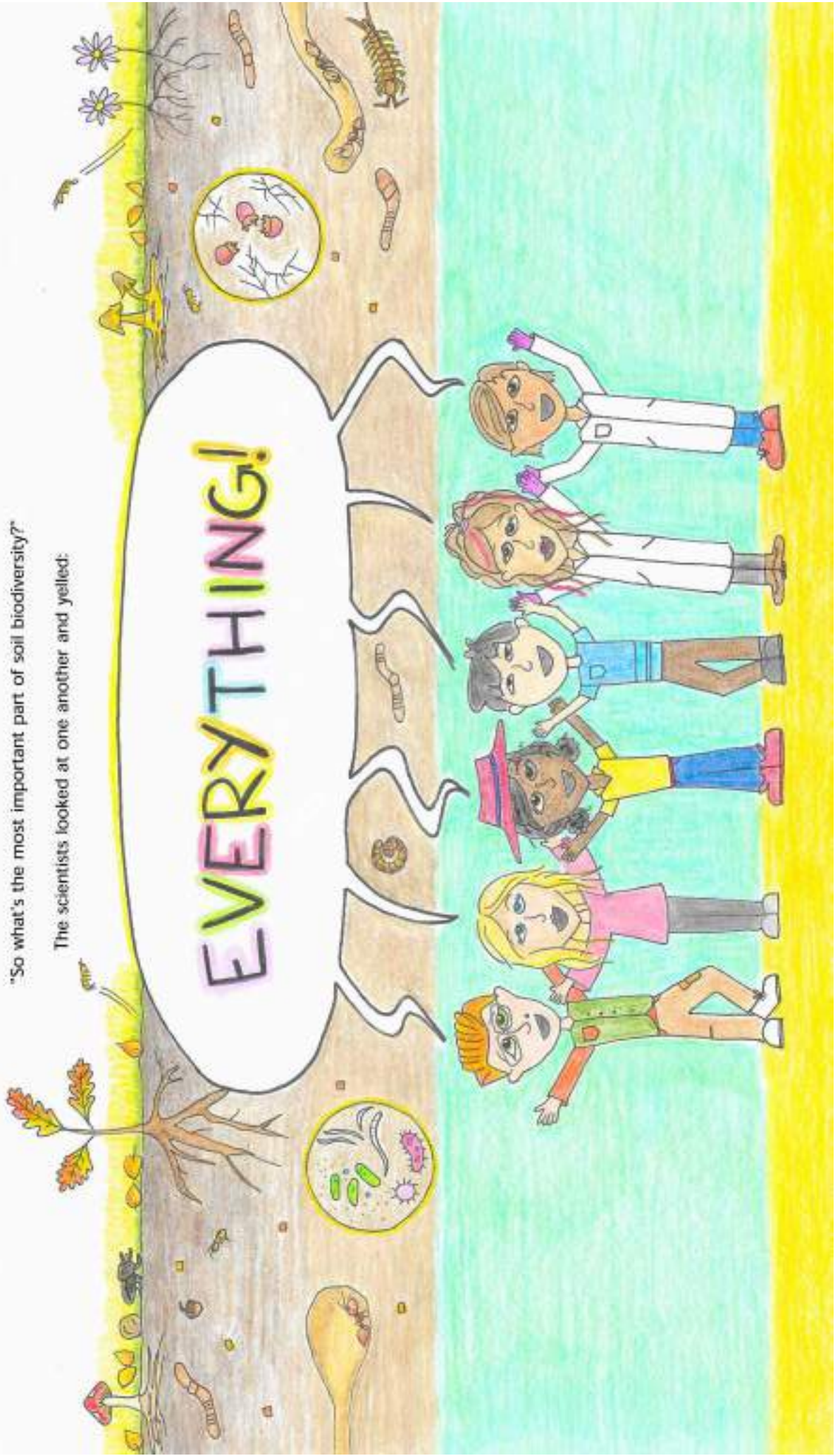
"Soil is so diverse, complicated, and packed with biodiversity, that all of us scientists must work together to better understand how soil biodiversity contributes to healthy ecosystems and the soil's ability to provide ecosystem services" Emily the ecologist finished.

The scientists smiled at one another. Finally they understood that they must work together to protect soil biodiversity, to keep soil alive, and to keep life on Earth.

"So what's the most important part of soil biodiversity?"

The scientists looked at one another and yelled:

**EVERYTHING!**



### Books for young readers:

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- Rajcak, H., Laverdunt, D. 2019. *Unseen World: Real-life Microscopic Creatures Hiding All Around Us*. Kent, UK: What on Earth Books ISBN 1999968018 36 p.
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### Web Resources:

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- English version: [www.globalsoilbiodiversity.org/s/Macrofauna-game-cards.pdf](http://www.globalsoilbiodiversity.org/s/Macrofauna-game-cards.pdf)
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### Resources for Educators and Students:

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# The home of life

## Authors

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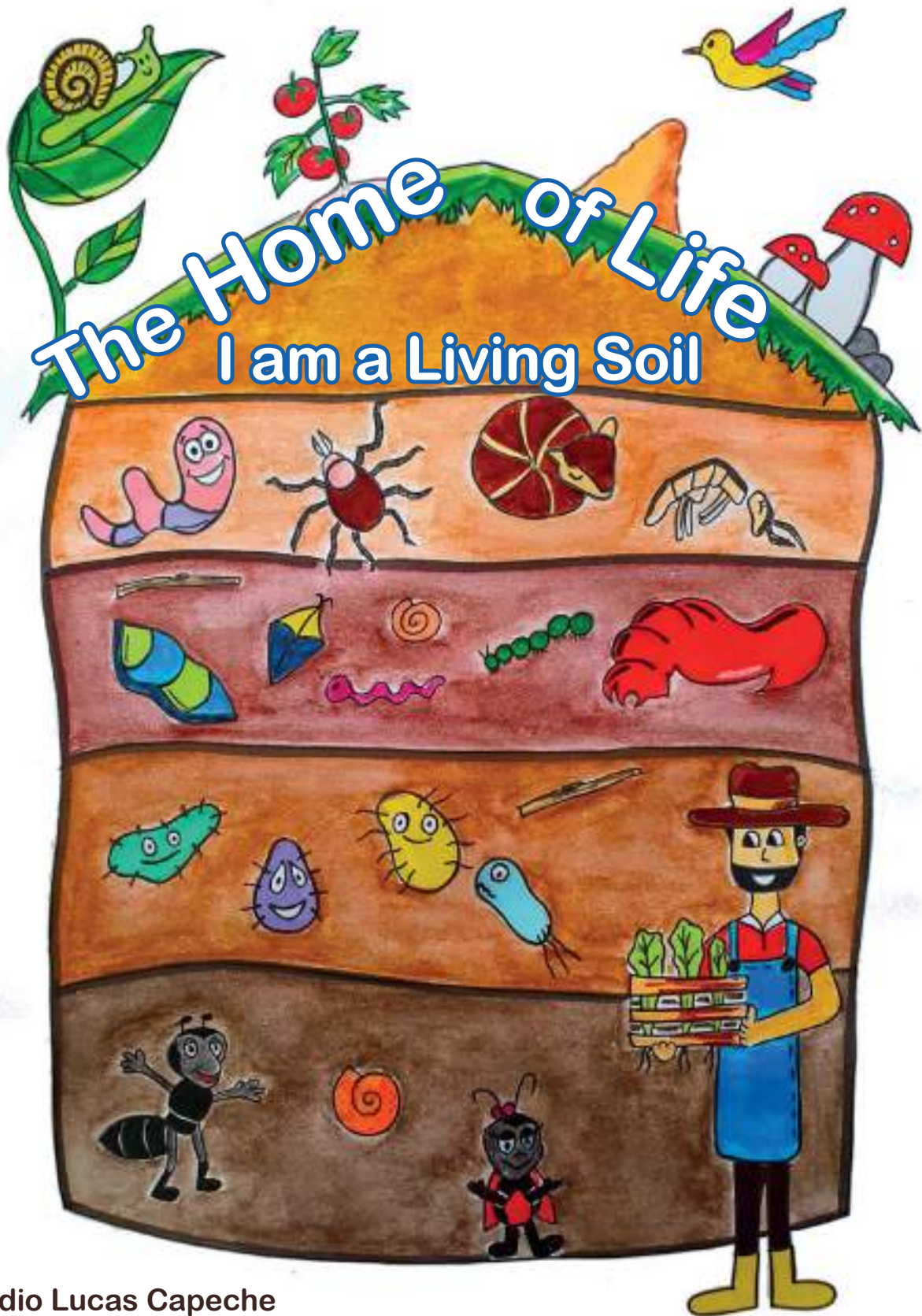
**Julia Stuchi** is a forest engineer, holding an M.Sc degree in Tropical Agroforestry as well as a doctorate in Biodiversity and Agroecology. Since 2011, she has worked at the Brazilian Public Agricultural Research Corporation (Embrapa providing knowledge exchange in environmental education, agroecology and public policies for the sustainable management of soil and water.



**Claudio Capeche** is an agronomist and holds an M.Sc degree in Soil Science. He has been a researcher at the Brazilian Public Agricultural Research Corporation (Embrapa) since 1990, working with transferring technologies for management and conservation of soils, water and biodiversity, recovery of degraded areas and education in soils. He has also been the coordinator of the Embrapa & Escola program since 1997.

**Milena Pagliacci** is a Brazilian plastic artist, publicist and art therapist. She studied art in Florence, Italy and frequently participates in art exhibitions and competitions. She is also a visual facilitator in remote and face-to-face events, and teaches classes for adults and children in her atelier in São Paulo.

**Embrapa Soils** is an international reference for tropical soils and has a mission to enable research, development and innovation in sustainable agriculture, providing ongoing benefits to Brazilian society.




Claudio Lucas Capeche  
Julia Franco Stuchi  
Milena Pessoa Pagliacci

All living beings need a home to live in. The ground, also called SOIL, is our home.

There are very tiny animals that live at the top and in the soil. They have many different sizes, colors, and shapes.



We are going to show you what we do to make the soil full of life and our planet beautiful and healthy.



Did you know that we are the soil caretakers? And that the soil is the Home of Life of many living beings?

We eat everything that is above and inside the soil! Yummy!!! Our food is a mix of leaves, sticks, plants, fruits and other little pieces... We are the SOIL BIODIVERSITY!

Our food is called ORGANIC MATTER. After we eat, we turn it into very good food for plants called HUMUS. Humus has lots of vitamins for plants to grow strong and healthy.



Nice to meet you! I'm a WORM. My work is very important to make the soil fluffier. Thus, plants can grow better because roots become stronger. I dig many paths in the soil with my mouth!



Hello, I'm a little ARMADILLO BALL. I am a friend of plants because when I help to produce the humus, plants grow more beautiful.



Hey, we are the COLLEMBOLANS. We are a gang of little animals that eat a little piece of everything inside the soil. Then, we help to turn it stronger.



Hi! We are the MITES and we also help to transform organic matter into humus. We leave the soil with a lot of good food for the plants and other animals.





Hello! We are the MICROORGANISMS!

We are very, very, very small and you need the help of a microscope to see us.

We, the FUNGI, when we grow a lot, you can see us without the microscope, like mushrooms. We are the heroes of transformation.

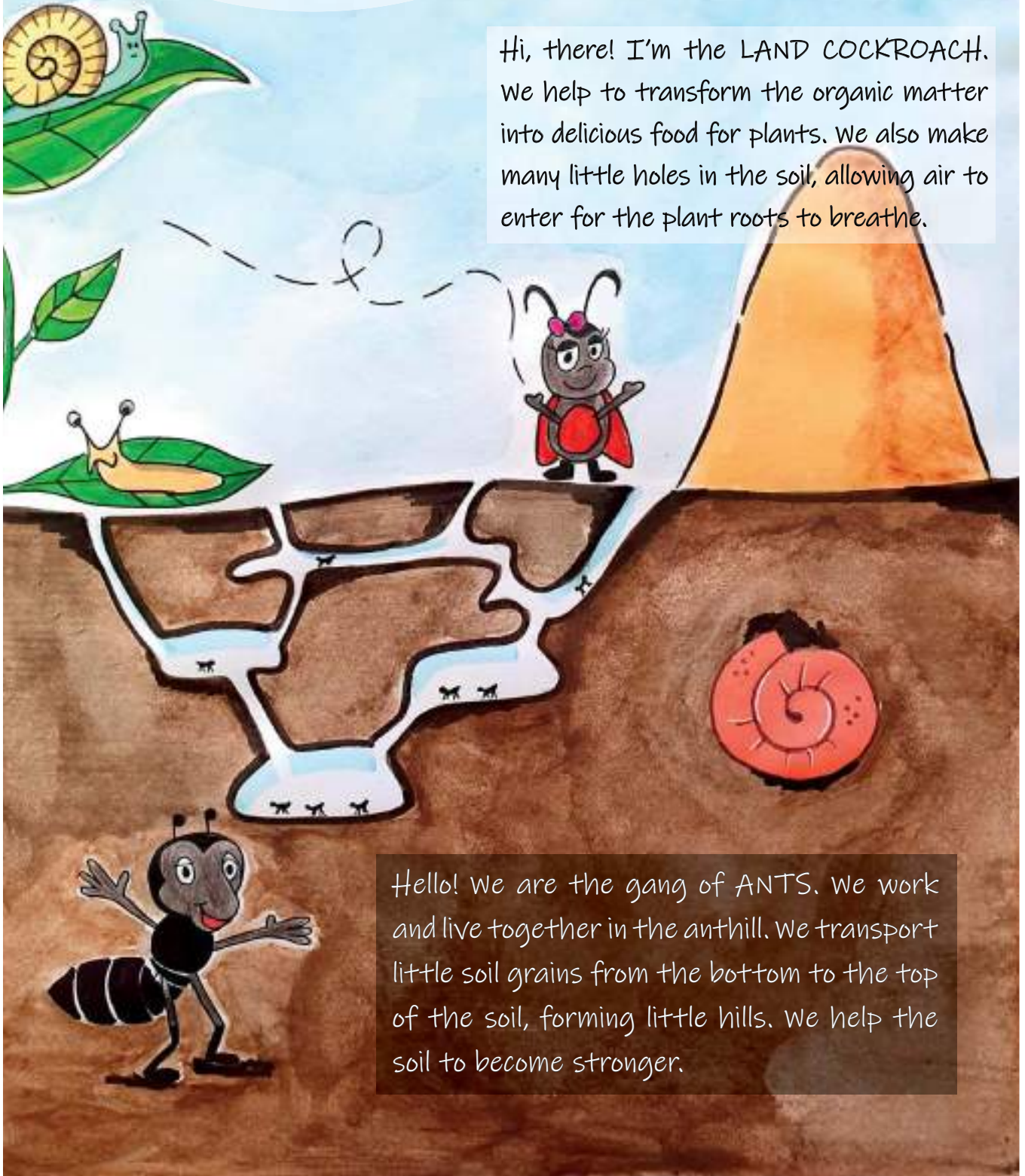
We, the ALGAE, live stuck together on rocks and on trees, forming a community called lichens. We are messengers that indicate when the air is very polluted.

BACTERIA! Some of us make our homes (the nodules) in the roots of the plants called legumes: beans, peas, peanuts... We help these plants by giving them food..



I'm the SNAIL and this is my little friend, the SLUG. We move very slowly from plant to plant. We give rides to fungi, bacteria, and our other tiny friends, so they can go everywhere on the soil!

Hi, there! I'm the LAND COCKROACH. We help to transform the organic matter into delicious food for plants. We also make many little holes in the soil, allowing air to enter for the plant roots to breathe.

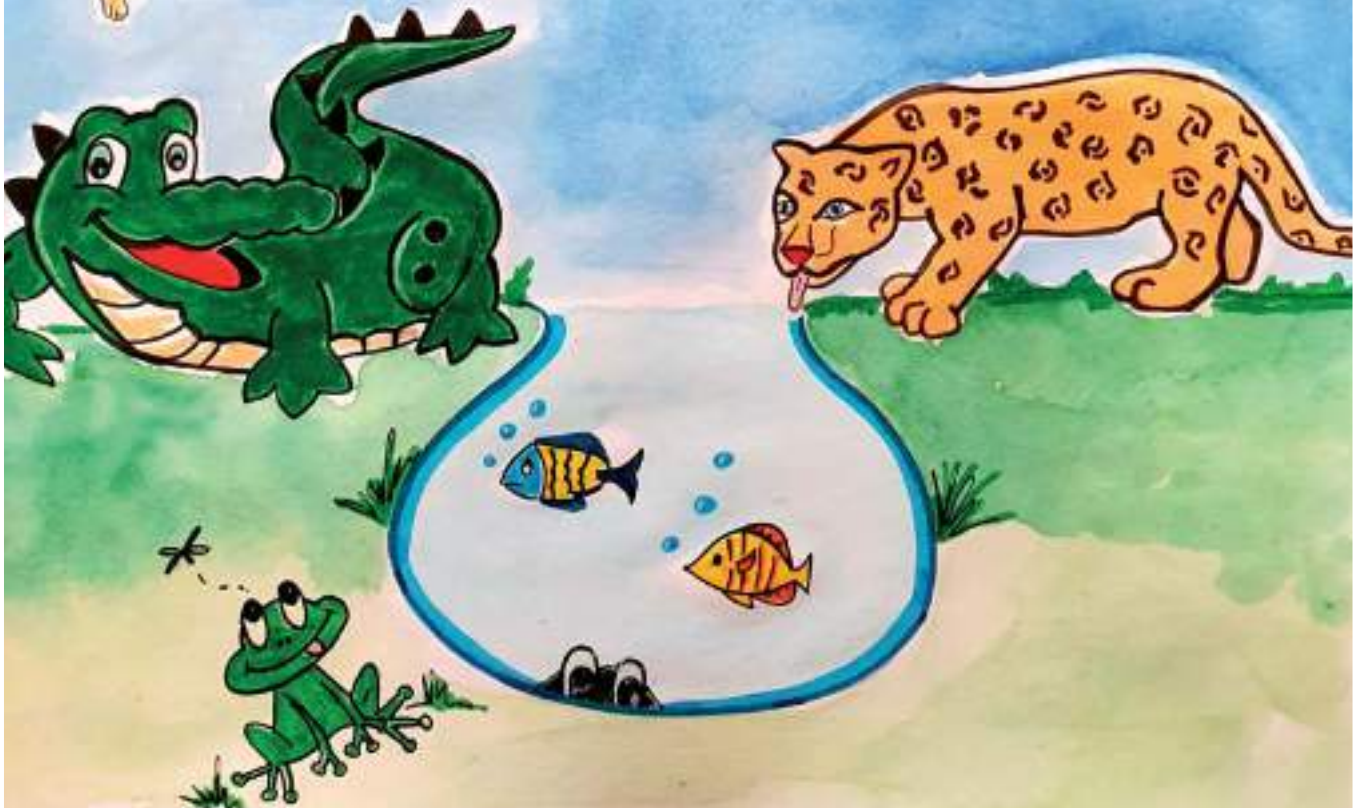


Hello! We are the gang of ANTS. We work and live together in the anthill. We transport little soil grains from the bottom to the top of the soil, forming little hills. We help the soil to become stronger.

As you could see, the job of our gang is very important because we make the soil softer, full of holes and with very small paths.

This job lets the plant roots breathe and grow better, looking for food and water. It also helps rainwater to enter the soil.

So, inside the soil, the water arrives where the rivers start! All the animals become very happy with all that fresh water that the soil produces in the springs.

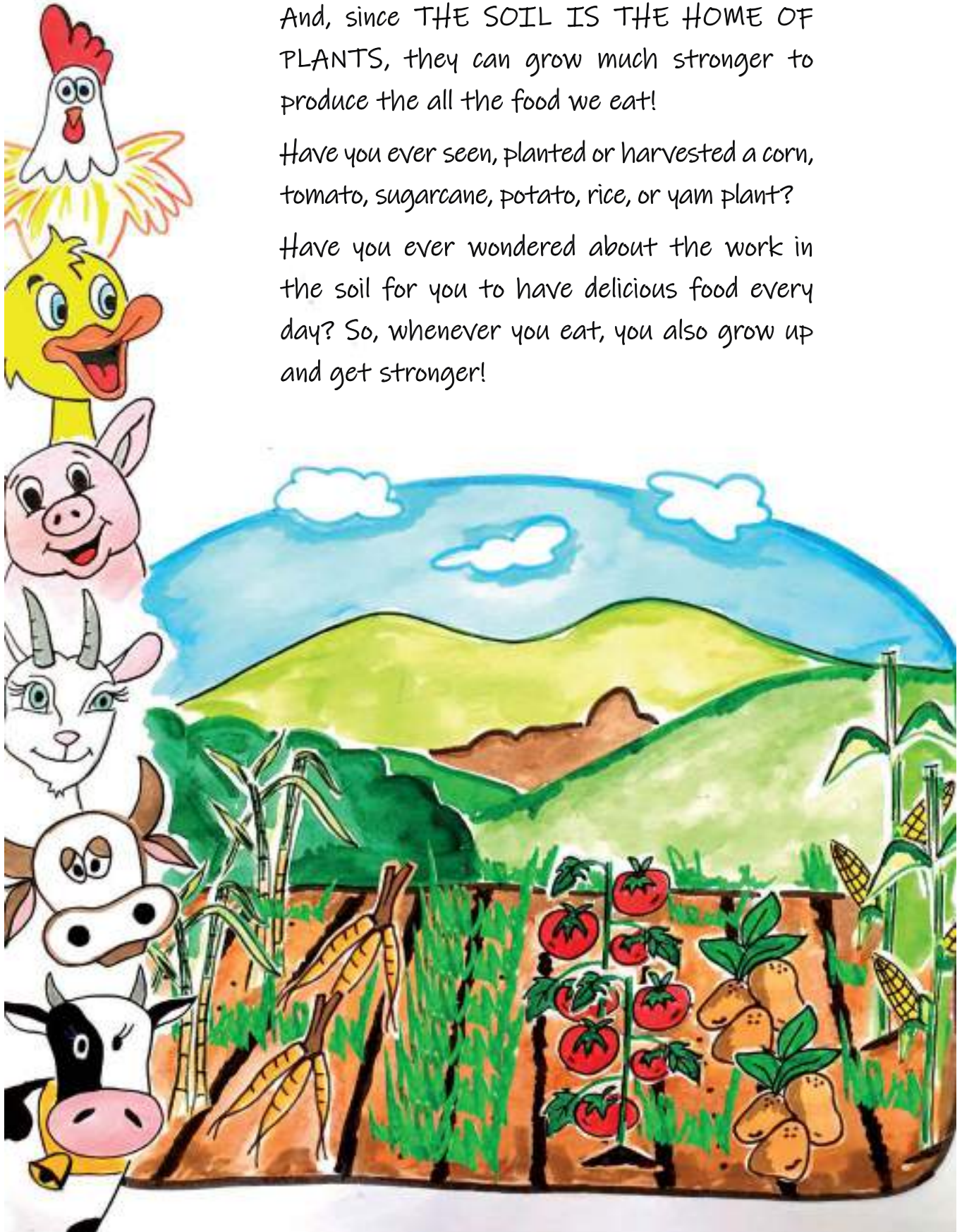


With the job and collaboration of all in our gang, the soil gets strong and healthy!

And, since THE SOIL IS THE HOME OF PLANTS, they can grow much stronger to produce the all the food we eat!

Have you ever seen, planted or harvested a corn, tomato, sugarcane, potato, rice, or yam plant?

Have you ever wondered about the work in the soil for you to have delicious food every day? So, whenever you eat, you also grow up and get stronger!



But for our gang to live in peace and take care of the soil, it needs to be protected.

Let's see how!

There are very, very, important people who work hard to take care of the soil, to plant and to harvest food: THE FARMERS!

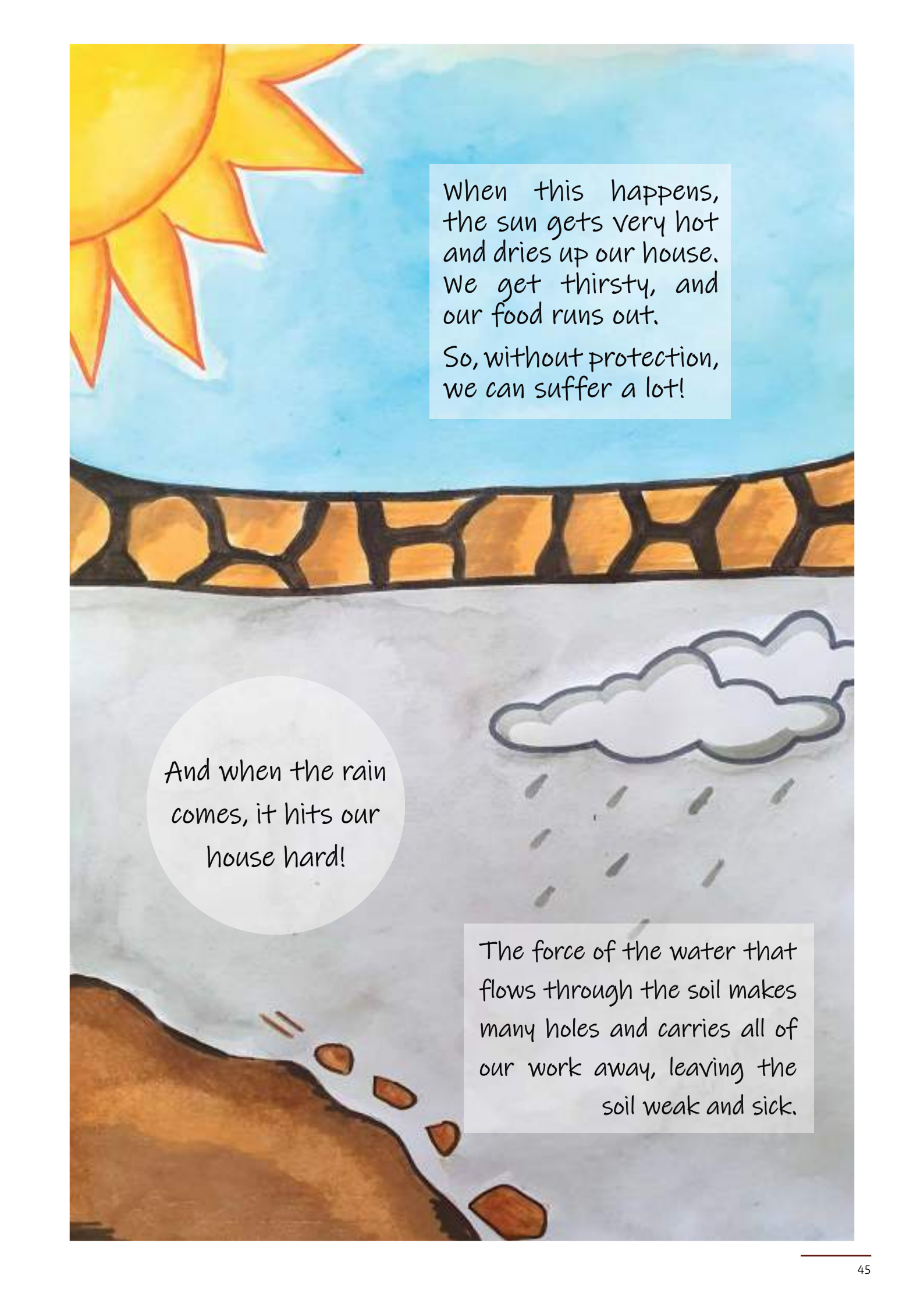
It is very important that farmers help take care of THE HOME OF LIFE, that we call SOIL.



So, whenever farmers plant something in the soil, it's not recommended to:

- Set fire to the top of the soil, because fires kill all our gangs and plants, and leave everything lifeless.
- Turn and make holes in the soil, because it messes with our house and our work.
- Leave the soil without plants, trees, or without our dear organic matter (dry leaves and sticks, remember?)





When this happens,  
the sun gets very hot  
and dries up our house.  
We get thirsty, and  
our food runs out.

So, without protection,  
we can suffer a lot!

And when the rain  
comes, it hits our  
house hard!

The force of the water that  
flows through the soil makes  
many holes and carries all of  
our work away, leaving the  
soil weak and sick.

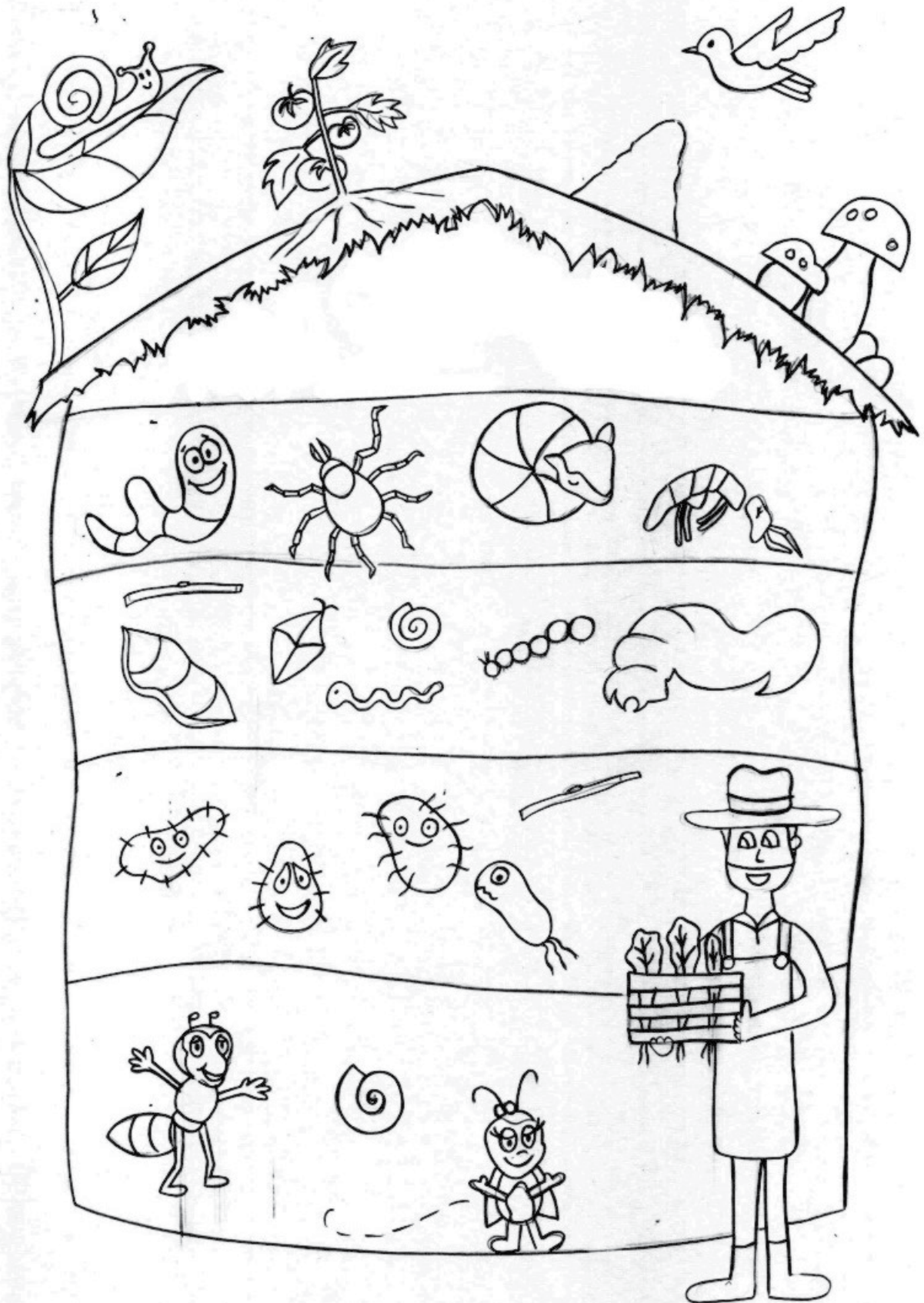
When farmers take care of the soil, our gang is protected.  
THE HOME OF LIFE is thankful and planet Earth is happy!  
So our gang, humans, and all other living beings will have  
food, water, clean air and much more to live healthier!!!



So, let's all take care of the  
Home of Life – the Soil!!



Let's paint!!



Hello little fellows! We have a surprise for you. Did you know that you can make paint for coloring using different types of soil? Have you seen that the soils can be yellow, pumpkin colored, red, brown, gray, black, white, pink and more? Cool, huh?

Let's learn how to make soil paint?



Preparing the soil:

- 1) Pick up the soil
- 2) Put to dry in the sun
- 3) After it is dried, break the clods
- 4) Sieve and store

Preparing the paint:

The paint is made by mixing two quantities of sieved soil, a quantity of white glue and a little water until it dissolves well. After painting, wait to dry.

This booklet is a simple way to approach, with this very special public, the importance of the beings that are part of the biodiversity of the HOUSE OF THE LIFE (the Soil) for our largest home, the planet Earth. Also, a way to celebrate with the children the World Soil Day (December 5).

**“KEEP SOIL ALIVE,  
PROTECT SOIL BIODIVERSITY”**



# Keep soil alive, protect soil biodiversity

## Author

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**Aldo Hernández** is a 22-year-old from Mexico currently pursuing a degree in visual communication and design at UNAM. He first came into contact with the IUSS through a competition to design a poster about soil care, which he subsequently won. He is convinced that creating diverse visual materials for spreading soil care information is essential in order to reach young and old alike, so everyone has the knowledge to look after the environment in which we live.



# KEEP SOIL ALIVE, PROTECT SOIL BIODIVERSITY



Soil is a very important resource for our planet, as indispensable as water or air, but we don't give it the importance it deserves.

Without the soil we wouldn't have where to grow our food, the plants that fill the planet with oxygen would have no place to grow and we wouldn't be able to live.

Inside the soil there is an immense habitat of living beings essential to maintain fertile soil, that is why these living beings are very important and it is necessary to be aware of them in order to take care of them. As these, there are thousands of species that we must take care of, so if you want more information about soil biodiversity and its importance, we invite you to consult the European Commission Joint Research Center's Global Soil Biodiversity Atlas.

Keep soil alive, protect soil biodiversity.



LILIANA WAS THINKING IN THE PARK ABOUT WHAT HER MOM SAID.



\*COUGH COUGH!\*  
WHAT WOULD YOU  
LIKE TO BE WHEN  
GROWN UP?

A SUPER HERO!!

WHY? DON'T YOU  
WANT TO BE A LAWYER  
OR A NURSE?  
\*COUGH COUGH\*



BECAUSE YOU ALWAYS FEEL  
STICK AND I WANT TO HELP YOU

YOU CAN DO IT ONE DAY, WHEN  
YOU KNOW WHAT DO YOU WANT  
TO BE WHEN YOUR GROW UP



I DON'T KNOW WHAT I  
WANT TO BE, GREAT SIMON.  
ALL MY FRIENDS WANT  
TO BE COPS, DANCERS OR  
ASTRONAUTS

WHY IS THERE NO  
SUPERHERO JOB TO  
SAVE THE WORLD?



AND WHO SAYS A  
SUPER HERO JOB  
DOESN'T EXIST?

?!  
WHO ARE YOU?



MY NAME IS RALPH  
AND I'M A SUPERHERO

REALLY?!









WHERE ARE WE?

WOOOOW I DIDN'T KNOW THERE WERE SO MANY ANIMALS ON THE SOIL!

THIS IS THE RHIZOSPHERE, A GROUND ENVIRONMENT!

ANIMALS, INSECTS, BACTERIA... IN THE SOIL THERE CAN BE MORE THAN 10 THOUSAND SPECIES PER SQUARE METER



WOW, BUT WHAT DOES THAT HAVE TO DO WITH SAVING THE WORLD?



WELL, THE SOIL IS A VERY IMPORTANT NATURAL RESOURCE FOR THE PLANET. FRUITS, VEGETABLES AND PLANTS THAT ANIMALS EAT, TREES AND FLOWERS THAT PRODUCE THE OXYGEN YOU BREATHE, ARE BORN FROM IT



WITHOUT IT THERE WOULD BE NO MEAT, FRUITS, VEGETABLES, PLANTS, ANIMALS, NOT EVEN AIR. IF YOU TAKE CARE OF THE SOIL YOU WILL SAVE THE WORLD



AND WHAT IS YOUR SUPER POWER?

PESTS?

SUPERPOWER? WELL, I HELP THE SOIL TO NOT HAVE ANY PESTS



THEY ARE SMALL ANIMALS SUCH AS LARVAE, ANTS AND EARTHWORMS THAT, ALTHOUGH THEY ARE VERY HELPFUL IN CARING FOR THE SOIL, IF THEY ARE TOO MANY, THEY WILL EAT MORE NUTRIENTS THAN THEY PRODUCE.

SO, IF I EAT THEM, THEY WON'T CAUSE ANY KIND OF PROBLEM



EMMA, HOW ARE YOU?





THANK YOU VERY MUCH LILIANA



HI RALPH, WE'RE HERE

LILIANA, THEY ARE WILLY AND DIANE. THEY WILL CONTINUE TO GUIDE YOU IN YOUR TRAINING

HI, NICE TO MEET YOU

NICE TO MEET YOU TOO



I'M HAPPY TO HELP



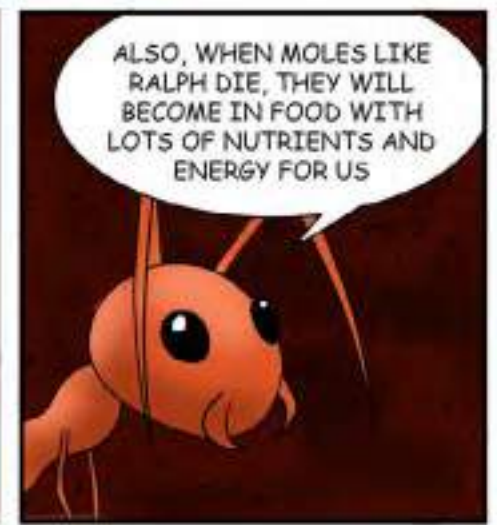
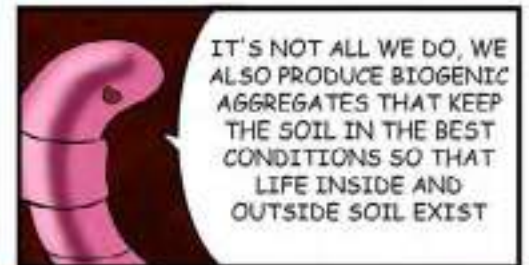
SEE YOU LATER EMMA

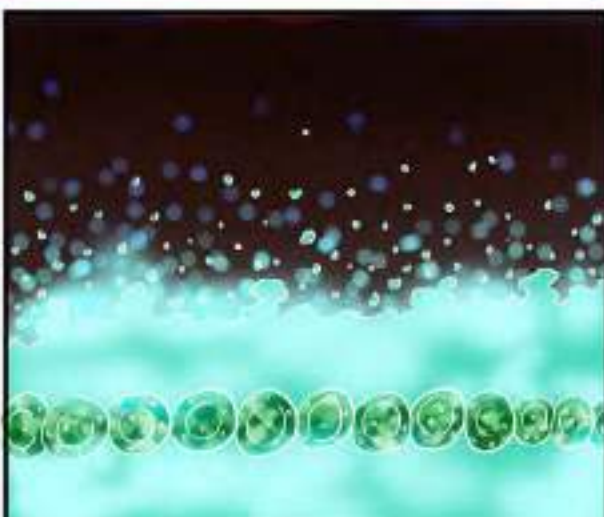
COME, WE MUST GET THROUGH THE TUNNEL

READY TO SHRINK MORE?



Zoom!













Orgiazzi, A., Bardgett, R.D., Barrios, E., Behan-Pelletier, V., Briones, M.J.I., Chotte, J-L., De Deyn, G.B., Eggleton, P., Fierer, N., Fraser, T., Hedlund, K., Jeffery, S., Johnson, N.C., Jones, A., Kandeler, E., Kaneko, N., Lavelle, P., Lemanceau, P., Miko, L., Montanarella, L., Moreira, F.M.S., Ramirez, K.S., Scheu, S., Singh, B.K., Six, J., van der Putten, W.H., Wall, D.H. (Eds.), 2016, Global Soil Biodiversity Atlas. European Commission, Publications Office of the European Union, Luxembourg. 176 pp.



# Tommy and his earthy adventures

## Authors

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**Nivedita Deshmukh** is a design educator, independent design consultant and a happy mother from Mumbai, India. She found her true passion in teaching and is currently a visiting faculty for the Sir J.J. Institute of Applied Arts and School IntuitLab. The birth of her daughter inspired her to co-found Anek Chidiya, a children's library. She is well on her way to becoming a certified storyteller and library educator, while still pursuing her M.Sc degree in Design.



**Surabhi Deodhar** is a biologist by education, a French teacher by accident and a mom by default. She holds an M.Sc degree in Molecular Biology from the University of York but found her calling in teaching. She has a zeal for travelling and communication, coupled with an undying love for books, leading her to co-found Anek Chidiya in 2019.

**Anek Chidiya** is a library and storytelling initiative for children between 0 and 8 years old. The books range from international publications to regional content in a variety of languages. They conduct events and story-telling workshops designed to encourage children to explore their own imaginations. Their book clubs and informative sessions also give parents an opportunity to unlock their own creative thinking.

# TOMMY AND HIS FARTING ADVENTURE



Nivedita Deshmukh & Surabhi Deodhar

## References

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**Study of threats to Soil Biodiversity**

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7295018/>

**FAO Soils portal Publications- Soils and Biodiversity**

[http://www.fao.org/fileadmin/user\\_upload/soils-2015/images/EN/WSDPosters\\_Promotional\\_Material/En\\_IYS\\_Food\\_Print.pdf](http://www.fao.org/fileadmin/user_upload/soils-2015/images/EN/WSDPosters_Promotional_Material/En_IYS_Food_Print.pdf)

<http://www.fao.org/tempref/docrep/fao/010/i0112e/i0112e07.pdf>

**Art resources**

[Vecteezy.com](http://vecteezy.com) | [istockphoto.com](http://istockphoto.com) | [stock.adobe.com](http://stock.adobe.com)



By that time, Bleep's little receiver was beeping like it had gone nuts. The so-called Elixir locator had found its object of desire! The alien pushed a button on its case which opened up to let out a robot with one arm! To Tommy's astonishment, it collected a jar full of soil from right beneath their feet!! Bleep closed the lid once the robot had what it wanted and beamed from one pointy ear to the other.

A dumbstruck Tommy looked at the alien suspiciously. He was certain there was something crazy going on. How could this alien with its super advanced technology have come all the way to Earth looking for soil!!!? How could THAT be the Elixir of Life? Soil is just... well, dirt!! "You came all this way for dirt? And you think it is the saviour of your planet?" he said incredulously to the alien. The alien shook its head sadly. "Just like us, you don't even know that the secret to making life thrive is right here."

*"I have finally fulfilled my mission!*

*I have the Elixir of life!" Bleep exclaimed.*





Tommy was late to go home one evening from the park. He was paddling furiously downhill on his bicycle when his eye was caught by bright lights in the bushes on the side of the road. They were so bright he had to stop.

What was that?? Whoaaa!! It was a space alien emerging from a spacecraft!! He just could not believe what he was seeing. As he rubbed his eyes in disbelief with his sweaty palms, the alien approached him. It had three eyes, one sticking right up out of its head, and it had pointy ears! And to Tommy's great surprise, the alien spoke to him in English!

*"Greetings, earthling.  
I am Bleep from the planet Zobor.  
I come in peace."*

"Wha-wh-what do you want from me??" Tommy stammered, still in shock.

"I have come to your planet in search of the precious Elixir of Life to save life on my planet, which my Elixir locator has indicated is at these coordinates exactly," explained Bleep, pointing to a gadget in its hand.

Tommy was thoroughly confused. "You have definitely made a mistake Bleep. No such thing exists here at all!" said Tommy. He had never heard of anything called the Elixir of Life.



*"You will only find out when its gone and your planet is doomed!" it prophesied.*

The alien went on to explain, the planet Zobor had been just like Earth, full of beautiful and wonderful creatures thriving and living harmoniously. Until their species, like humans, slowly overused and abused the natural resources on their planet. They poisoned the air, the land, the water for their selfish needs and desires. But mostly they did not see that the crucible of life on any planet is the soil! The soil replenished and restored life

forces, and when this was destroyed, gradually the whole planet withered. Tommy was deep in thought. He saw this was very similar to what was happening around our own world as a result of human activity. "This is what our planet is also facing these days, we hear about it all the time! But what I don't understand is how does soil fit into this? What is special about it and how does it support life?"asked Tommy.

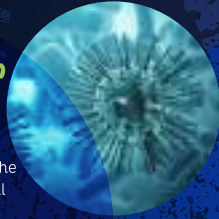


## Who are these earthy muddy heroes?

Bleep explained to Tommy that soil and all its inhabitants together help to circulate minerals and organic matter back into the food chain above ground. Their activities ensure that the living world above ground has all the necessary material to sustain and thrive. The variety of organisms living in the soil in balance and harmony is called **"Soil Biodiversity"**. These little critters sustain life on Earth! Tommy had no idea so many creatures lived right beneath his feet!

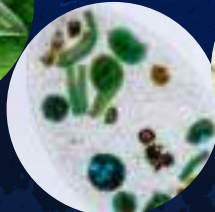
### Microscopic Microbes

Bacteria and fungi, that live in the spaces in between clumps of soil where water is available, are microscopic marvels of nature! They chomp up the dead matter that falls into the soil, and break it down into smaller particles so that plants can then use them as food. Without them, plants would not be able to get the nutrients they need through their roots.



### Powerful Protists And Natty Nematodes

Protists are teeny-tiny creatures that gobble up any nasty microbes that could cause disease. Nematodes are tiny worm-like creatures that do the same thing as protists, but their superpower is that they can live in any soil, even in the arctic! They ensure that the microbes that are helpful to plants keep growing in plenty and also break down plant food into bite size pieces! Now that sounds like a lot of work!



### Creepy-crawly Microarthropods

Ever wonder where all the leaves and branches and dead animals go when they are lying on the ground? Microarthropods, which are small insects like mites and springtails, munch on all these things in the top-soil and spread them into the lower soil layers. These are very important for soil fertility.



"That is amazing!" said Tommy. "But why is soil biodiversity important in the functioning of the planet?" Bleep went on to tell him about what soil biodiversity does for the planet. Here is what Tommy learnt.

**The planet's got to eat!**

**Catch that Carbon!**

These creatures together living in the soil are responsible for creating and replenishing the Earth's primary source of food - plants. Nutrients in the soil feed the plants, which feed the animals, which feed other animals, which die and which eventually feed the plants again! Phew!

Everything organic, that means everything in the living world, is made up of carbon. So anything new that must live in the world needs this building block. And soils trap this carbon with the help of the animals and microbes in it. When carbon is richly available in the soil, new life can come up in the world.



## Squirmy Worms And Their Friends

Have you heard anyone say earthworms are a farmer's best friend? Well they really are! They aerate the soil, which means they mix it up like a little spatula and make it nice and airy. It helps the water to trickle down into the lower earth and make the soil nutritious. Along with earthworms, centipedes, millipedes, ants, termites, wood lice and even scorpions help in this task and make the soil super rich. That is one dream team, right?



## Burrowing Animals

Did you know there are animals who make their homes not on the ground but below it? Animals like moles, badgers, gophers, voles and shrews find shelter in the soil by digging tunnels in it. They feed mainly on the other organisms that live there. And when they burrow in the soil, they enrich it with their droppings! Ewww, right? Not really! Animal poop is the best fertiliser for plants.



### The Earth's water bottle.

When the earth receives water from rain, the water trickles into the soil and is stored under the ground to a large extent. The creatures in soil create a maze in the soil structure and this maze acts like a sieve to clean the water, making it safe to drink! The more diverse the life in soil, the better the quality of water in it is.

### Erosion explosion

When the soil has no integrity, which means it is loose and does not hold its shape, all the rain water and even ice rush down it and wash away the layers, causing erosion. This stops water from getting trapped and leads to floods! Flooding causes devastation for human and animal life all across the world.

### Pests be gone!

Good soil is what makes farming and growing food possible. Healthy crops need to be free of pests, those pesky creatures that destroy the amount of food we can harvest. Various organisms in the soil eat up the nasty ones, so that our food crops can be saved from pests. That is why it's so important to keep soil biodiversity ship-shape.

### The Earth's medicine store

Just like there are good bacteria in the soil, there are many others which may be bad. By studying the interactions between different microbes, scientists get clues as to which ones can help us make medicine to fight disease causing ones! It is a gigantic laboratory where nature is always doing its experiments, and we can learn so much from it. These medicines can help save lives.

# Threats to soil: Threats to our planet!

Tommy had now realised how important the soil was for Bleep. Without soil, its planet, Zobor, was doomed! He began to see why Bleep was calling it the Elixir of life. But this was also worrisome! His own world was headed the same way... it wouldn't be long before they were faced with the same future. So what were the threats, the villains of this story? What dangers do soils and their residents face? Bleep told Tommy about a few of them, though there are several more.

## Climate Change

Changes in the climate mean trouble for the living creatures in soil as the soil too changes because of it.

## Soil erosion

The surface of the soil is scraped off by wind, water, deforestation, construction etc. and the living things beneath it are destroyed.

## Soil sealing

An impermeable layer is formed beneath the soil that suffocates it because of all the things we humans build on it.

## Soil salinisation

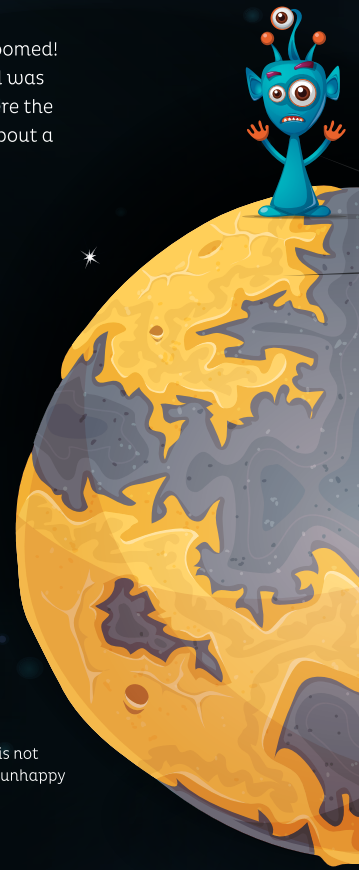
As a result of improper irrigation and overusing groundwater, soils become salty, slowly making the land there a desert.

## Land use change

When the soil is forced to grow things it is not suitable for, it becomes unstable and an unhappy home for its residents!

## Nuclear pollution

Nuclear wastes are super poisonous to the soil, killing off the creatures living in it.



Tommy was still in shock from all that he had heard and seen. He had so many questions he wanted to ask the alien!

*Did they have similar animals and plants on Zobor?  
Why did the alien have 3 eyes?  
Did the alien kids have to go to school everyday like human kids?  
They had the same soil after all!*

But Bleep had already stepped onto the spacecraft and was ready to leave. "I must hurry back to Zobor so I can save it! No time to lose! But heed my warning Earthling! Do not destroy your planet like we did.. It is not too late for you yet! Your soil, water and air make this planet habitable. Take good care of them!" With that the spacecraft took to the sky with a WHOOOOSH!

Tommy returned home and told his anxious mother all that happened. He wondered, how could one kid make a difference? She explained "Just like the tiny creatures in the soil that make the planet survive, each one of us can play some part and together save our beautiful planet!" Tommy is now a **Soil Crusader**!! He does everything he can to help replenish the soils and convince as many people as possible to do the same. You can be one too!





# Conservation Efforts Save Our Soils!

Just like Bleep's planet Zobor, Earth too is headed towards the same fate. Tommy thought long and hard, what could we humans do to protect this precious resource? Here are a few things we humans could think about.

## Research the resources

We need to know more about these heroes under our feet to be able to find a way to save the world! Only 1% of bacteria and fungi on our planet are known and researched as of now. That must increase!

## Laws for life!

We need to introduce laws and rules made by governments all over the world to stop human greed from permanently damaging our planet.

## Down With pollutants!

Soils have a close relationship with water and air, so we need to stop air and water pollution in its tracks! The nasty chemicals that seep into the soil because of human activities can impact the whole planet!

## Embrace our forests!

Our forests are our biggest treasure! Deforestation leads to large scale soil erosion as do forest fires caused by over harvesting of forest resources. Just protecting nature's treasure trove can help protect our soils and in turn, our whole world!

Here is a poster for all you budding Soil Crusaders to put up at home! Cut along the dotted line.





Tommy is looking for buried treasure!  
 Select a path such that he meets the most number of insect friends on his way.



Concept and design by  
**Anek Chidiya**

On the occasion of **World Soil Day (WSD) 2020**,  
 For the Food and Agriculture Organization of the  
 United Nations (FAO), the International Union of Soil  
 Sciences (IUSS) and the Global Soil Partnership (GSP)

**"Keep soil alive,  
 protect soil biodiversity"**

## ....and ACTION!!

What can each kid do to save our tiny superheroes?  
Here are some things to get you in action!

### Green thumbs up!

You can help in the garden whenever you can and make friends under the soil too!  
Find out what kind of fertilizer, compost and seeds are used and tell your adult gardeners to use the good organic stuff!

### Plant more trees

Help out in your community or school every time there is a tree planting drive.  
If there isn't one, start one!

### Heal the world!

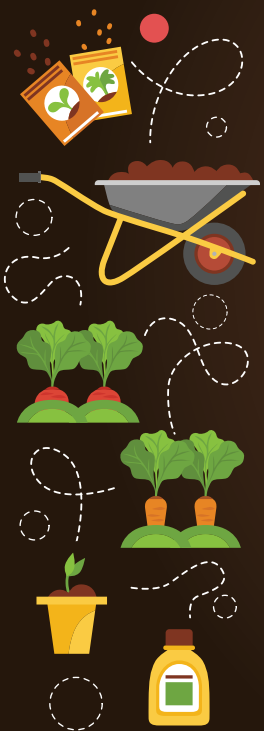
Our families and us can take an oath to cycle more, carpool more, walk more!  
Each one of us can make the air, water and soil cleaner by doing this.

### Spread the word

Talk to your teachers, parents, friends and even local farmers to spread the message about the importance of soil biodiversity and how we can conserve it. The more we spread awareness, the more we can do to stop the destruction of our precious planet!

### Buy organic and sustainable produce

We can choose to buy fruits and vegetables labeled organic. Over time, this will mean less use of pesticides, artificial fertilizers and over farming for high yield crops that harm soil biodiversity.



# TOMMY AND HIS EARTHY ADVENTURE



Nivedita Deshmukh & Surabhi Deodhar

# It's time for action!

## Authors

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**Magaly Ruiz** has a degree in Chemistry from the Simón Bolívar University, as well as an MSc and a PhD in Soil Science from the Central University of Venezuela. She has worked on several research projects on soil organic matter, microbial activity, enzymatic activity, and the evaluation of organic fertilizers. She taught engineering and agronomy for twenty five years. She continues to support research activities and classes in the postgraduate courses of Soil Science in the Central University of Venezuela, and Education, Environment and Development in the Libertador Pedagogical University.



**Alejandra Ramirez** has a degree in Strategic Communication and Graphic Design from Javeriana University. She specialized in Food Innovation, exploring the ecosystem inside the food industry, and became a co-author of the publication 'The Future of Food Service'. As an instructional designer at the Future Food Institute, she designed and developed educational programs for the expansion of their global hubs. Alejandra lives in Barcelona, where she works as a Researcher and a community manager, while doing an M.Sc degree in Digital Marketing.

# IT'S TIME FOR ACTION



**JOIN US!**

BECOME A MEMBER  
OF THE SOIL LEAGUE  
TO KEEP SOIL ALIVE  
**PROTECT SOIL  
BIODIVERSITY**

By

Magaly Ruiz  
Alejandra Ramírez

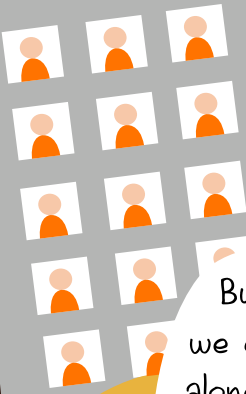


Soils produce less food every day. People are getting sick because food has fewer nutrients. Someone has to do something!!!

Our soils are getting worse every day! Life on Earth is being threatened!!!

Did you know that around **95% of our food** is directly or indirectly produced **on and from our soil?**

# FUTURE MEMBER



Soil League, we called this emergency meeting to help the soil. We need to work together and recover the life in it.



But... but, we can't do it alone, we need to make contact with them!

Bacteria sitting here

The humans? They won't listen...

They will... they also need the soil.

# SL

## Did you know that bacteria and fungi live in the soil?

They are so small that we can only see them through a microscope! There are also mites, worms, insects, and large animals such as moles. All of them together form the BIODIVERSITY of the soil.

We will invite all the children around the world to join us in this mission.

**Our future is in their hands.**



Hello Alice!  
We have seen your love for nature and how much you care. We are here because you are super important in our mission to save the world.

The soil is more than just dirt, as it hosts one of the largest ecosystems around the globe. But it's dying, and we need your help to recover its biodiversity.

**Did you know that when leaves, twigs, flowers, and fruits fall from plants and reach the ground, insects, mites, and worms cut them into tiny pieces?**

Then, bacteria and fungi break down these pieces, producing nutrients that feed plants.



# [invisible heroes]



bacteria



fungi & algae



mites



earth worms



insects



mole

But the soil is more than a house for many of us. It's also needed by all beautiful plants and trees to grow. Farmers need healthy soil to grow the crops that feed the world, and without it, neither humans nor animals would be able to enjoy their favorite foods.

## What if we grow a garden together?

Gardening is a healthy, easy, and fun activity to enjoy with friends and family. You will learn while growing plants, setting up a worm farm, and even cooking what you harvest.



Hi Robin! I saw you didn't finish your snack. Let's avoid wasting food. Every day more soil is needed to produce food. Also, forests are being cut down to have more land to plant. And by removing these trees, the soil loses its biodiversity.

**Did you know that some bacteria and fungi attach to the roots of plants and help them get nutrients?**

Plants also help these bacteria and fungi to nourish themselves. Everyone helps each other.


It's key to always eat all your food  
to grow healthy and strong.

Also, it's crucial to avoid letting food get wasted. Try to pack  
your snack in small portions. This way, you will be able to decide  
how much you want to eat, and if you don't want to eat anymore,  
you can always save the food for later.



### **What if we grow a seed in a cup?**


It's easy! Fill a transparent cup with some soil  
and put in some beans or corn grains (they have  
to be raw). Water them carefully every day. After  
a few days, the seed will germinate, and you will  
see how first the roots begin to grow. These roots  
are also part of the biodiversity of the soil.



Hi Peter! I come from a nearby field where they grow tomatoes, which you like to have with your pizza. Now, we don't have much food there because of chemicals. They used to make an organic compost by mixing the dried leaves and the skins of the fruits and vegetables. Oh! that was good food.


**Did you know many farmers use large amounts of chemical fertilizers and pesticides to make their plants grow taller?**

This works for a short time. But it contaminates the waters under the ground, the rivers and lakes, and the soil.



We are small, but we can make large quantities of compost. What we need is a bed filled with soil, fruit and vegetable peels, dry leaves, and we like manure too. Crumble all that, and then let us worms do the rest. We will eat it and transform it inside our bodies, and what we excrete is the compost that plants love.

**YES!**



### What if you had an earthworm farm in your school?

Talk to your teacher about it. Making a worm compost is very fun and useful. You can use it in your school garden or bring it back home to give your plants some extra nutrients.



**Did you know that many insects are CRUSHERS?**

They cut leaves, flowers, and fruits into tiny pieces. Then they take those pieces to their home, which is in the ground. Many smaller friends, like mites and springtails, continue to cut these pieces and also feed on them.

Hello Mary! We need your help to save the soil! Yes, our soil is losing the nutrients that plants need. And plants nourish humans and animals on Earth. We have to do something!

Would you like to see what insects do in the ground and learn more about them?

You can do it in a garden or a park. Watch the insects that move over the ground. If you can, remove the top of the soil a little bit with a shovel, but not too much!. You will find some hidden insects if you are lucky. Take a photo of them and then search in a book or online for the insect's name and what it does in the ground.

### **What if you talk to your teacher about collecting insects as a class project?**

Every student could catch a few earth-dwelling insects in a small transparent container. Remember to make some pinholes in the lid, so our six-legged friends can breathe. Then make an exposition of live insects in the class, and share with your classmates what those insects do to help the soil.





It's a mole. Moles live in the ground. I don't understand what's doing in the city.


What kind of animal is it?

Hi guys, I can explain.

**Did you know that underground, all beings, even the roots of the plants, need to breathe air and drink water?**

Moles, worms, ants, and insects, dig and move the soil, creating holes and tunnels through which the water and air can pass more easily.





The mole and many other animals had to flee from the forest in which they live. Some people are cutting down trees and leaving animals without food and their home.

The trees they cut down are used to make paper, toilet paper, cardboard, and many other things.

**What if we help reduce deforestation by using less paper?**

Try to use a less amount of paper when writing or drawing. Write or draw on both sides before disposing of the paper. Also, do not let the paper get dirty, and don't put it in the trash, so you can properly recycle it after using it. Want to help even more? What about planting a tree near your house or school?

Friend, you can join us and save the soil biodiversity.  
Share with your friends and family what you know about  
the soil.

Also, let them know it is in danger. Deforestation,  
chemical fertilizers and pesticides, and tractors that till  
the soil are some of the threats.

Only together we can do something  
to save the planet.  
We need you!



## MOLE'S GLOSSARY

**Biodiversity:** Variety of plants, animals, insects, and other living creatures on Earth.

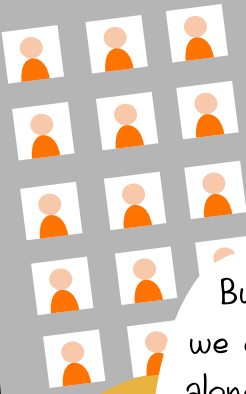
**Nutrients:** Substances in food that help plants, animals, and humans live and grow healthy.

**Bacteria:** Microscopic living thing, made of one cell each, that lives in all parts of the Earth.

**Fertilizers:** Natural or chemical substances that help the plant to grow.

**Pesticide:** Natural or chemical substances that kill some insects and fungi that harm plants.

# FUTURE MEMBER



Soil League, we called this emergency meeting to help the soil. We need to work together and recover the life in it.



But... but, we can't do it alone, we need to make contact with them!

Bacteria sitting here

The humans? They won't listen...

They will... they also need the soil.

# SL

## Did you know that bacteria and fungi live in the soil?

They are so small that we can only see them through a microscope! There are also mites, worms, insects, and large animals such as moles. All of them together form the BIODIVERSITY of the soil.

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**Our future is in their hands.**

# IT'S TIME FOR ACTION

By: Magaly Ruiz & Alejandra Ramírez



We are looking for brave children who want to become part of the Soil League and keep soil alive protecting its biodiversity.

JOIN US!



## Let's get hands on:

- Learning about the environment
- Preserving natural resources
- Protecting forests
- Promoting good farming
- Saving earth dwelling animals
- Creating a better future



# The adventure of Lupi & Kura

## Authors

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**Pedro Mondaca** is a young soil scientist from Chile, and the father of Jacinta and Salvador, who are the inspiration for this booklet. He is an agronomist, holding an MSc in Agronomic and Food Sciences, and is a PhD candidate in AgriFood Sciences at the Pontifical Catholic University of Valparaíso. He is interested in soil ecology, soil metagenomics, and remediation of contaminated soils by trace elements. Being passionate about nature and science, Pedro founded Agro Conciencia, as an effort to bring them together.



**Agro Conciencia** is an emerging organization in Chile that promotes sustainable development based on science and conscience (ciencia and conciencia, in Spanish). They research ecological intensification in agriculture, urban agriculture, forest conservation and ecological restoration, and the remediation of contaminated soils. Agro Conciencia considers that the protection of natural ecosystems and the enhancement of ecological interactions in man-made systems through scientific development are crucial to facing the main challenges of our time. The organization also seeks to strengthen environmental education to support a new relationship between nature and humanity.

**Soil biodiversity**

**The adventure of  
Lupi & Kura**

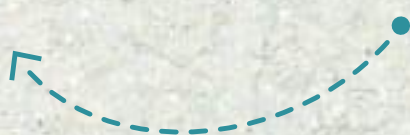


**Do you know swallows?**

**Swallows are birds that enjoy warm weather, that is why they travel to different parts of the world following the sun.**



**This is Lupi a female swallow.**



**And this is Kura.  
A boy dreaming with  
a better world...**



**They did not know each other, until...**

Lupi and Kura mean feather and stone respectively in Mapudungun ("language of the earth"), the language of the indigenous Mapuche people in South America.



Dedicated to Jacinta, Salvador and all the children of the world.

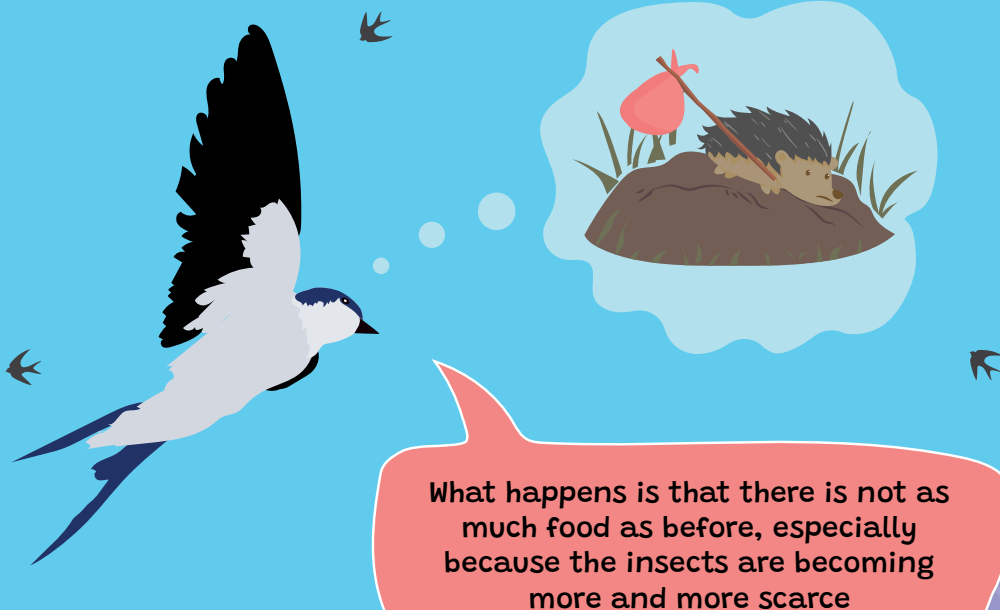
Authors: Pedro Mondaca, Maite Berasaluce and Catalina Bórquez  
Artwork: María Fernanda Silva and Karen Carrera  
Affiliation: AGROCONCIENCIA, Chile (agroconciencia@outlook.com)



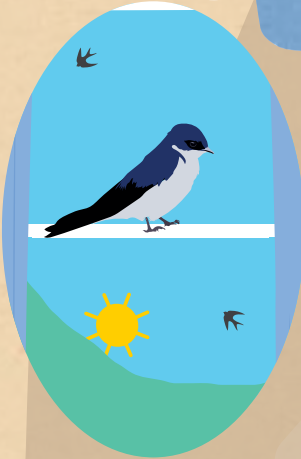
**Lupi the swallow, lands on Kura's window. She seems restless and worried. Suddenly, something unexpected happens... she starts talking to him!**



**Lupi tells him that she comes from far away and that on her long journey she encountered many animals that were hungry and homeless.**



A lot has happened lately, for example, the weather is changing so rapidly! maybe you've heard about climate change...



Yes, I heard it is affecting the bees

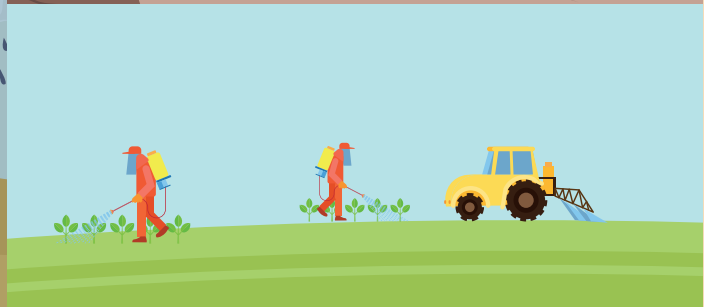


Right, but not just bees. There are many other important living beings that are being affected and you have not paid enough attention to them. In fact, did you know that most insects need soil to live?

Unfortunately, many soils in the world are losing their health due to climate change and activities that do not respect nature...



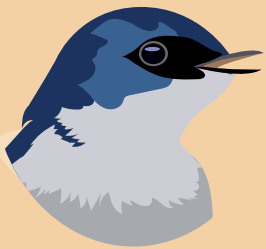
**As a consequence, we can see for example: Acid rains, soil erosion, desertification, invasion of exotic species, soil contamination, etc..**



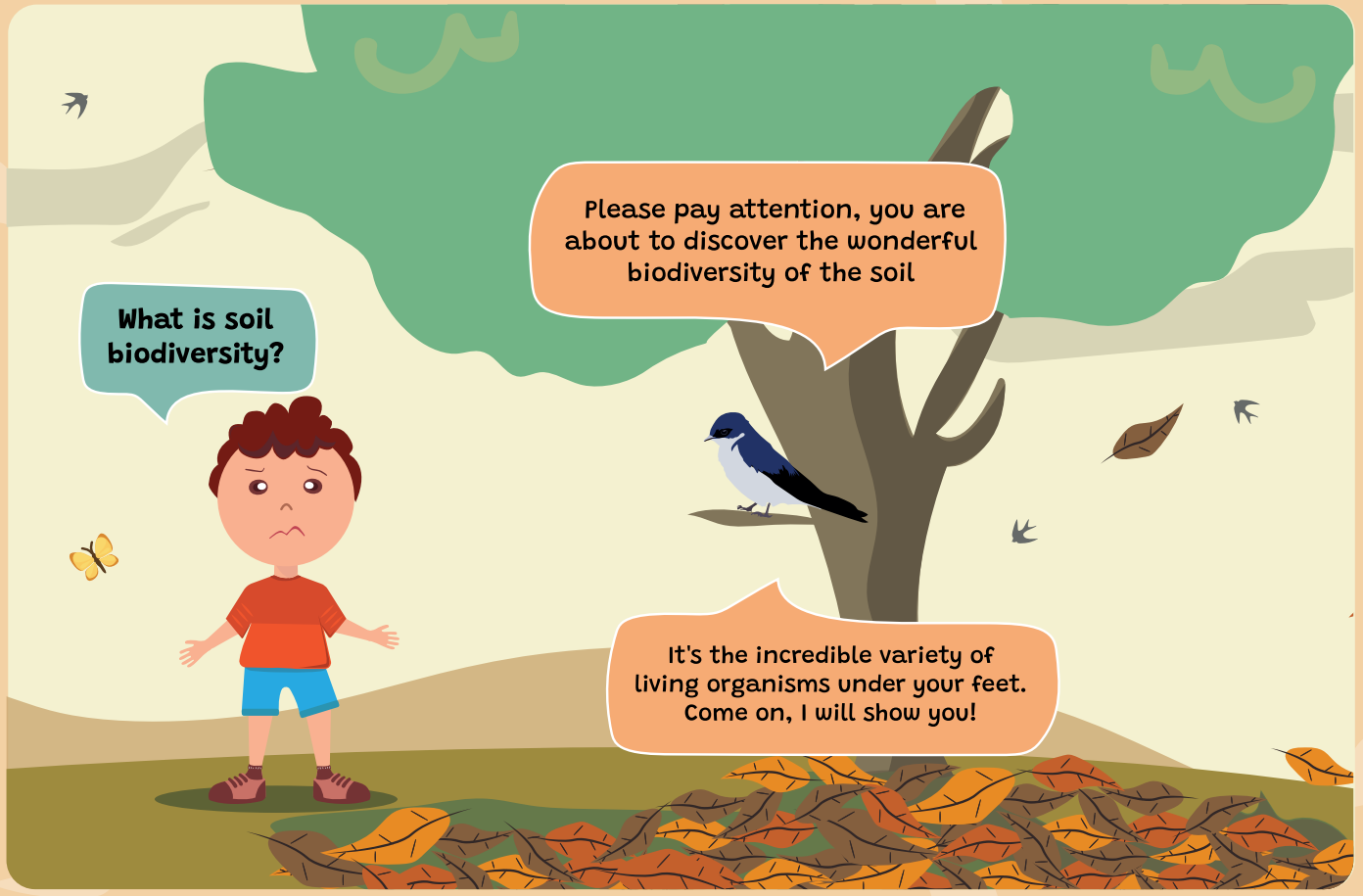


Soil health?

Yes, the soil allows an infinite number of organisms to live, organisms that are necessary for ALL of us to survive. We say that a soil is healthy when it can shelter many and diverse organisms



If you go to the nearest tree, I assure you that you will find at least one soil organism. Let's see!



What is soil biodiversity?

Please pay attention, you are about to discover the wonderful biodiversity of the soil

It's the incredible variety of living organisms under your feet. Come on, I will show you!

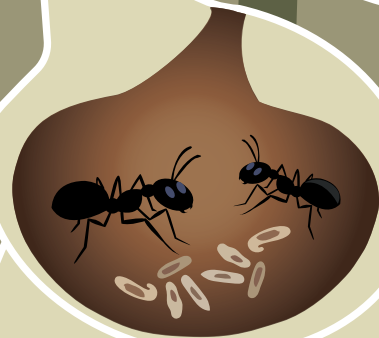
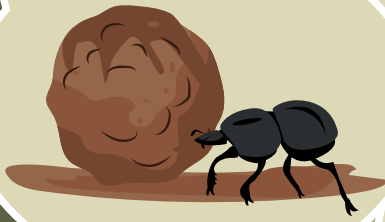
If you remove the leaves that are on the surface, you will see that there are living organisms on the ground, some you can see with the naked eye and others with the help of a magnifying glass.

Let me introduce you to some of them



### Dung beetle, the strongest animal

These beetles love dung! To the point that they shape dung into balls that can weigh hundreds of times more than their own weight. Even so, this shape allows them to roll it easier! This is why the dung beetle is known as the strongest animal in the world.

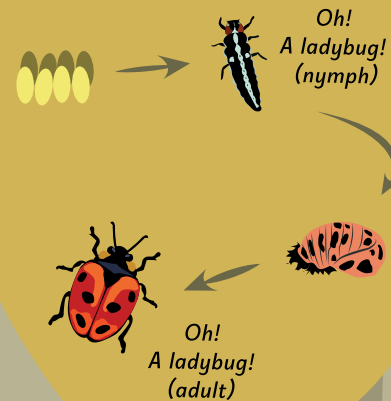


### Ants, social insects

Ants are among the most abundant in the world, they live in large complex colonies with a division of tasks and cooperative care of the young generations. In general, a colony of ants has only one queen ant, which stands out for being the only reproductive ant, since the others are sterile and fulfill other tasks within the colony.

### Did you know?

Most insects undergo metamorphosis. That is, they change in shape or structure, which is usually associated with the development of wings.



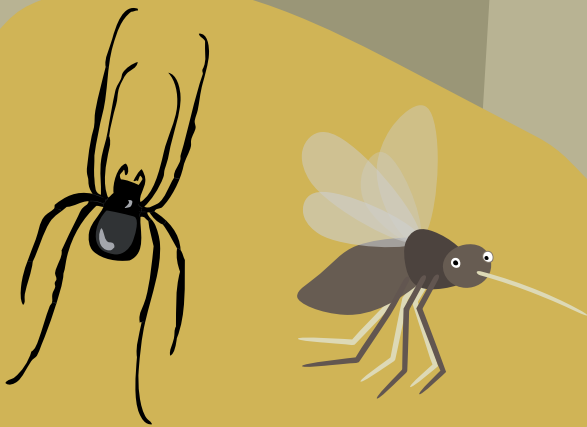
## Spiders and scorpions, great hunters

Soil is often used as their hunting ground, where they use different methods to capture their prey.



One of the most impressive strategies is adopted by the ambush “trapdoor spiders”. They make holes in the ground, often closed by traps and surrounded by spider webs that serve to alert when prey has been caught.

Scorpions are nocturnal hunters, they stay hidden under rocks or underground during the day. They can survive long periods without food, even up to 12 months.



### Don't mistake insects with arachnids!

Insects have 6 legs unlike arachnids which have 8 legs. Also, if you look closely, insects have

3 segments: head, thorax, and abdomen, while arachnids also have an abdomen, but their head and thorax are joined into a single segment called the cephalothorax.

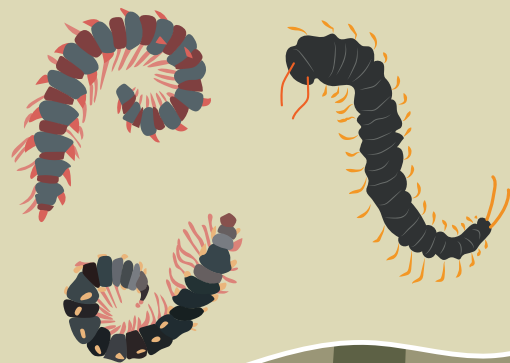
Ask an adult for help, get a magnifying glass and check it out!

## Centipedes and millipedes, soil dwellers

You can easily tell them apart without having to count their legs. While both species have segments, centipedes have only one pair of legs per segment, while millipedes have two pairs of legs per body segment.

### More about the Millipedes:

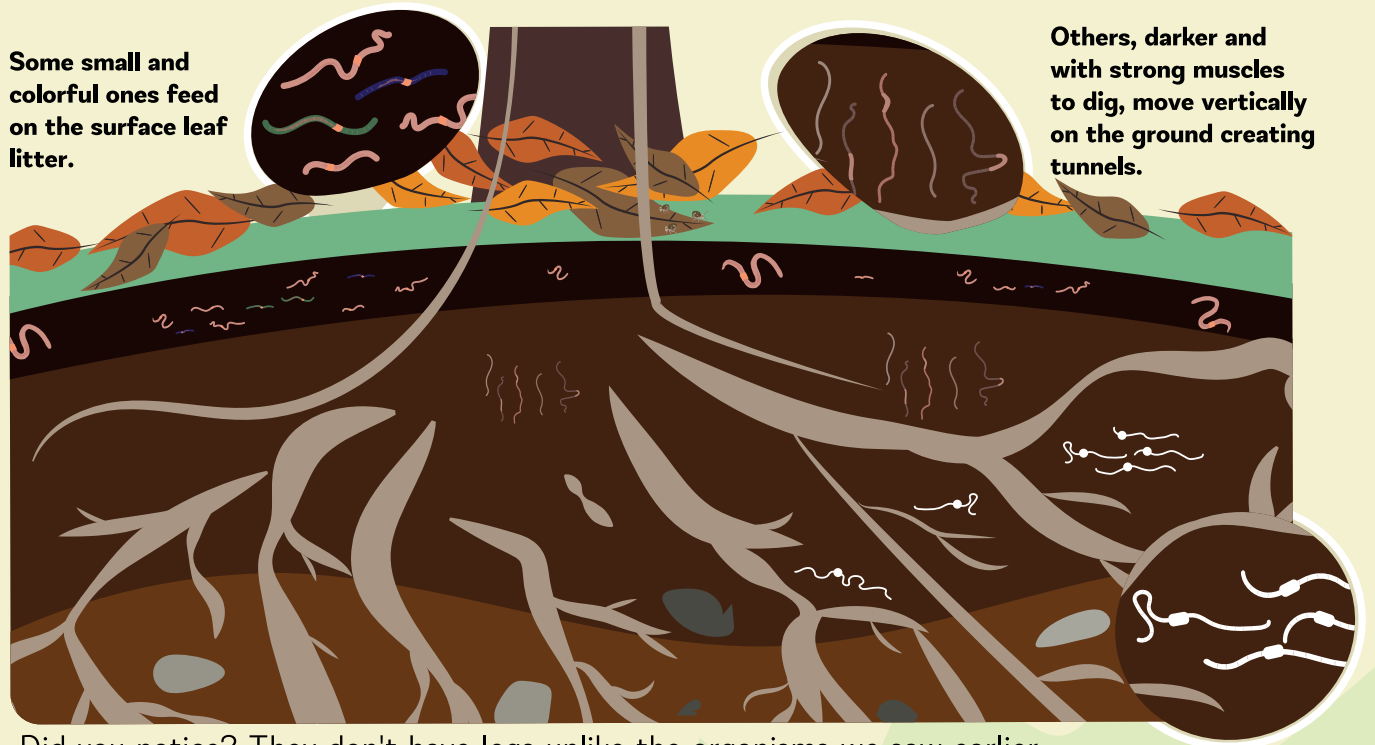
- Some millipedes roll into a ball as a defense mechanism.
- Some millipedes are bioluminescent, so they can glow in the dark.



## Earthworms, soil engineers

Earthworms range from a few cm to over 2 m long. They move through the soil creating tunnels that allow the soil oxygenation, which helps many organisms to breathe.

They have different functions and inhabit different parts of the soil.

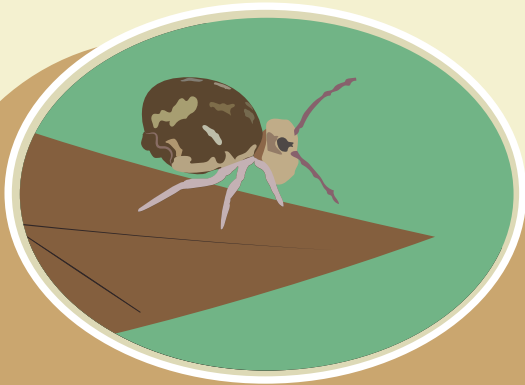


Some small and colorful ones feed on the surface leaf litter.

Others, darker and with strong muscles to dig, move vertically on the ground creating tunnels.

Did you notice? They don't have legs unlike the organisms we saw earlier, that's a good way to recognize them.

While other white ones, live entirely within the soil.



### Springtails, an unnoticed but very special organism

They are small (0.12 – 17 mm) but generally very numerous when there are tree leaves to eat. They have earned the title of being the fastest spinning animals on earth, because when they jump they spin, reaching three hundred and seventy-four flips per second.

Very interesting, isn't it? For these and many other soil organisms to live, there must also be smaller ones that you can't see with the naked eye, but that you can see with a microscope.

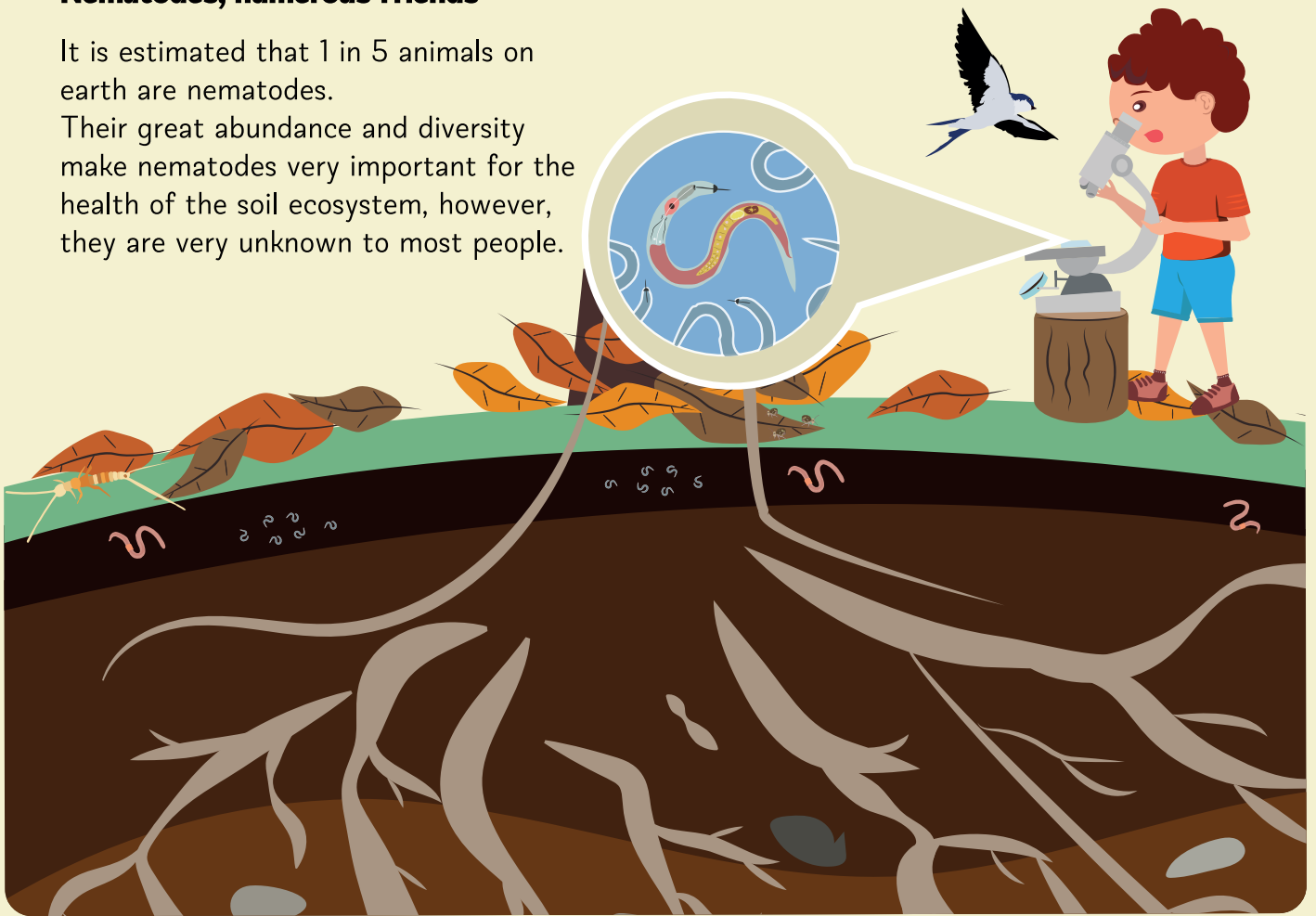
Let's go get one!



## Nematodes, numerous friends

It is estimated that 1 in 5 animals on earth are nematodes.

Their great abundance and diversity make nematodes very important for the health of the soil ecosystem, however, they are very unknown to most people.



**Nematodes are so cool that they can survive in space, but they are not the only ones. There is also an interesting soil organism called "water bear".**

**Water bears not only can live in space but they are able to withstand a strong gamma radiation, extreme temperatures, and can live for 200 years. Thus, they are the toughest animals on the planet.**



Look! These tiny nematodes serve as food for insects and spiders, but they can also feed on the roots of plants, other nematodes, and ...

Let me guess, these little nematodes also feed on something smaller?

That's right!



## Bacteria and fungi

They can be food for nematodes, and can also help the plant obtain water and nutrients. For these and other reasons, bacteria and fungi are considered beneficial in maintaining a healthy soil.



Rhizobium

Mycorrhiza

Having healthy soils that support the biodiversity of various organisms can also help people.


For example:

- Farming on healthy soils is the basis for healthy food.
- Playing in healthy soils improves children's immune systems, and therefore you will become more resistant to diseases.

"These are the smallest organisms..."

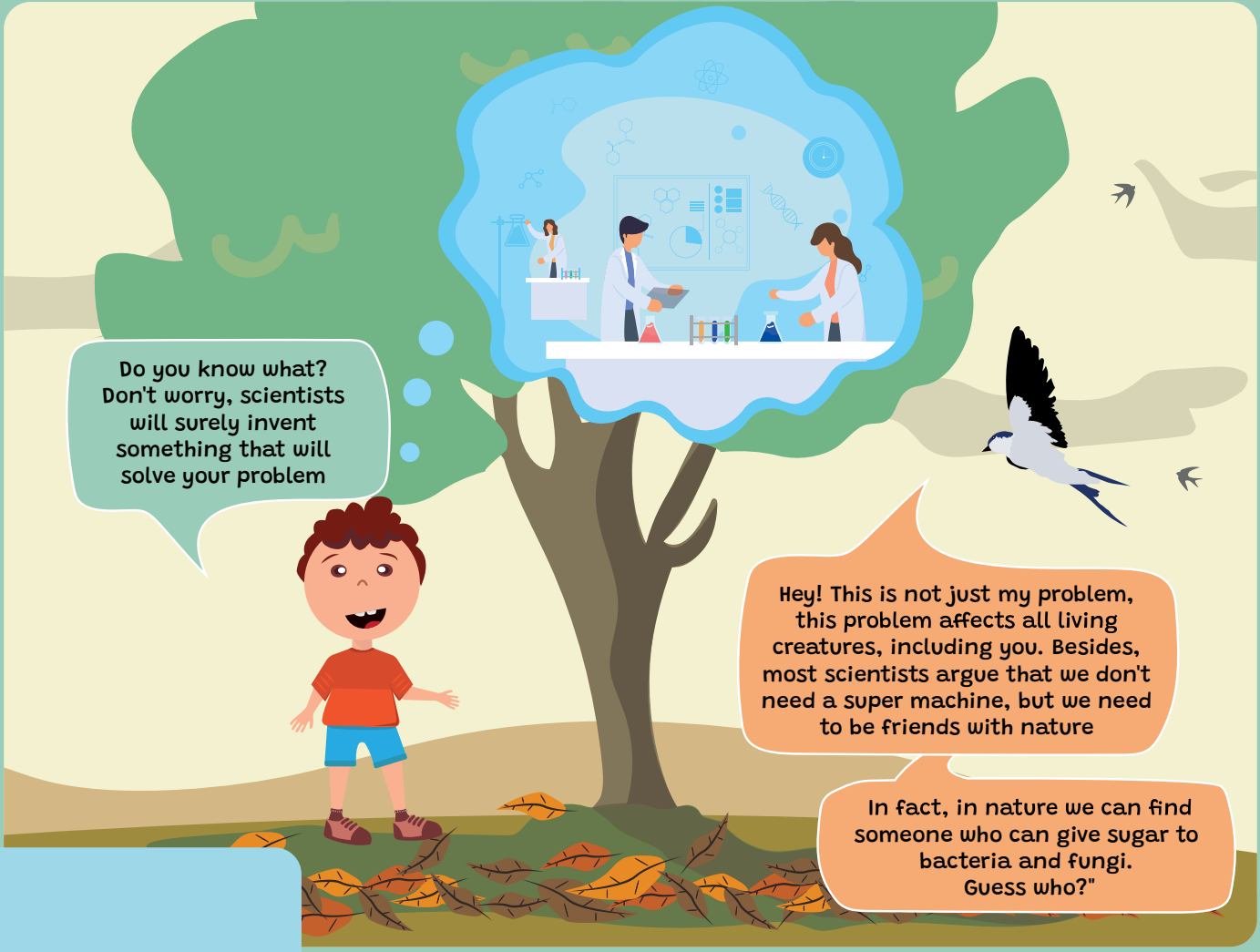
"Wait! If they are the little ones, then what do bacteria and fungi feed on?"





Easy, I will explain it to you. Most bacteria and fungi feed on organic matter, such as leaves and branches that fall to the ground, also on sugars

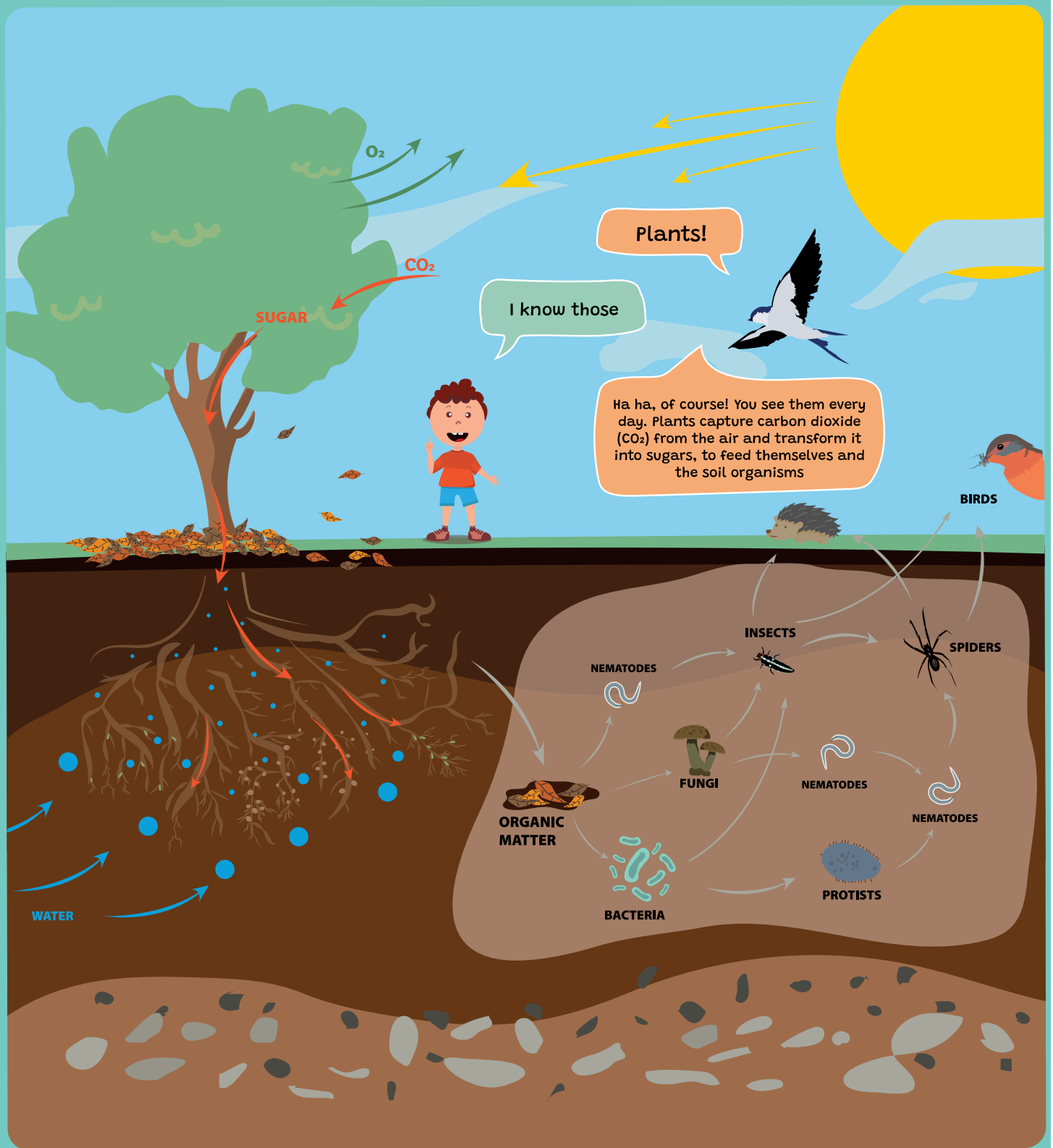
But... wait, wait! How are we going to give sugar to these tiny organisms!?



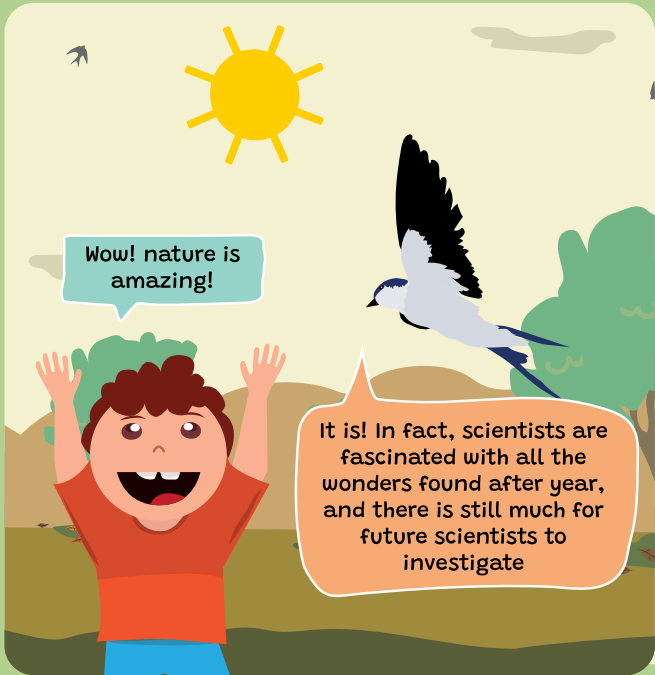
Do you know what? Don't worry, scientists will surely invent something that will solve your problem

Hey! This is not just my problem, this problem affects all living creatures, including you. Besides, most scientists argue that we don't need a super machine, but we need to be friends with nature

In fact, in nature we can find someone who can give sugar to bacteria and fungi. Guess who?"



**Remember that thing about the weather changing so rapidly? Well, excess CO<sub>2</sub> in the air is one of the causes. By making their food (photosynthesis), plants contribute to reducing this excess CO<sub>2</sub> in the air, that is, they save the planet.**



Wow! nature is amazing!

It is! In fact, scientists are fascinated with all the wonders found after year, and there is still much for future scientists to investigate



I understand, you're telling me this because you want me to be a scientist when I grow up?

You can be whoever you want. However, I do want to encourage you to protect soil organisms in one way or another

**For example;**

**Plant, care, and maintain a tree**



**Recycle or compost your vegetable scraps**



**Care for animals, big and small ones**



Do you understand? There is less and less soil available for plants and soil organisms. But you can help from now on!

I can do it!



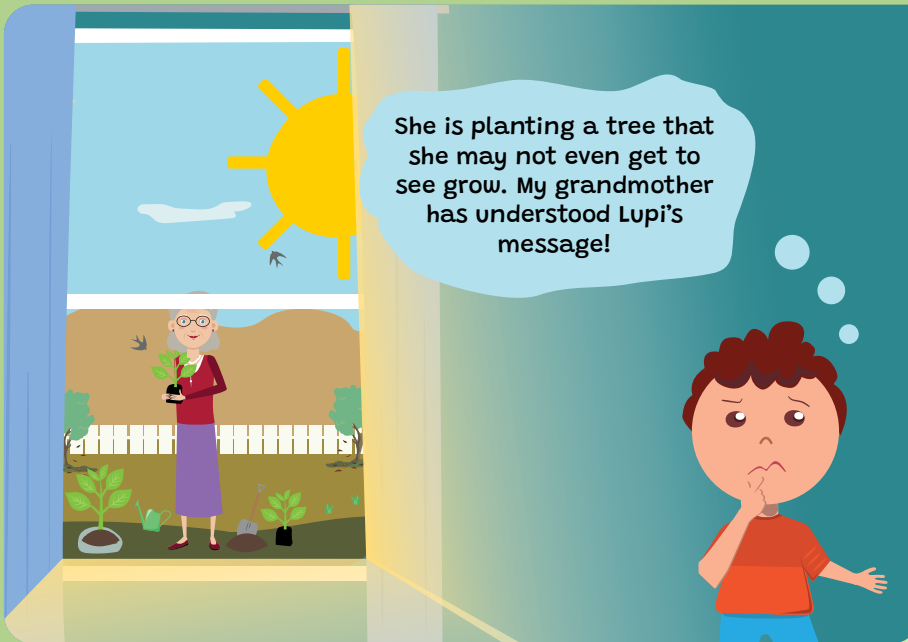
But... why don't people do anything about it?

Not all people know what is happening or the importance of the soil, but change can start in your home with your family



**WAKE UP  
WE WILL MAKE  
A BIG CHANGE!**

Wake up?



Planting a tree is an act of love towards me and all living beings

Let's do it!



**Keep soil alive, protect soil biodiversity!**

Mycena



Did you find these organisms?  
Look them up in the book!

Pill bugs



Diplura



### Recommended activities

Start a nature journal! You can register whatever you want: animals, plants, insects, fungi, etc. If you can, accompany your notes with drawings or photos. Many outstanding scientists started doing this at your age!



Try looking at soil from different locations, what do you see? Pay special attention to the colors and textures when rubbing it between your fingers.

Share your love for soil biodiversity and the environment! Start an environmental youth brigade to take care of the soil and the environment.

### No microscope, no problem.

Create a microorganism trap so you can see bacteria and fungi without one.



1. Ask an adult to boil a cup of rice with one cup of water and two tablespoons of sugar (optional), until the rice is cooked but hard.
2. Put the rice in a container and cover it with a mesh or porous cloth.
3. Bury it so that the surface is 5 cm deep and leave it there for 3 to 7 days.
4. Remove the container and observe the shapes and colors that have covered the rice. Do this in different places and write down your observations.

### More information?

Did you like any particular type of organism? Much of the information in this booklet comes from the Global Soil Biodiversity Atlas. There, you and your family can find detailed information about the different organisms and see photos of them!

# Ane, the ant

## Authors

---

**Luciana Santos** holds an M.Sc degree in Quality, Safety and Environment from the University Clermont-Auvergne and a graduate degree in Production Engineering from the Federal University of Uberlandia. She always saw illustration as a hobby, but recently, the opportunity of illustrating this booklet has transformed her horizons.



**Marcela Lázaro** is a PhD student in Environmental Geochemistry at the Fluminense Federal University, developing a project about the pedology and geochemistry of replanted mangrove soils. She holds an M.Sc degree in Soil Science from the Rural Federal University of Rio de Janeiro.

**Gabriel Nóbrega** holds an M.Sc degree and PhD in Soils and Plant Nutrition from the Federal University of Ceará and the University of São Paulo, respectively. He is a professor in the Department of Geochemistry at the Fluminense Federal University, with interests in soil genesis, carbon dynamics and soil contamination.

**Glauca Guimarães** holds a PhD in Education from the State University of Rio de Janeiro and has graduated in Pedagogy from the same institution, where she is currently an Associate Professor.

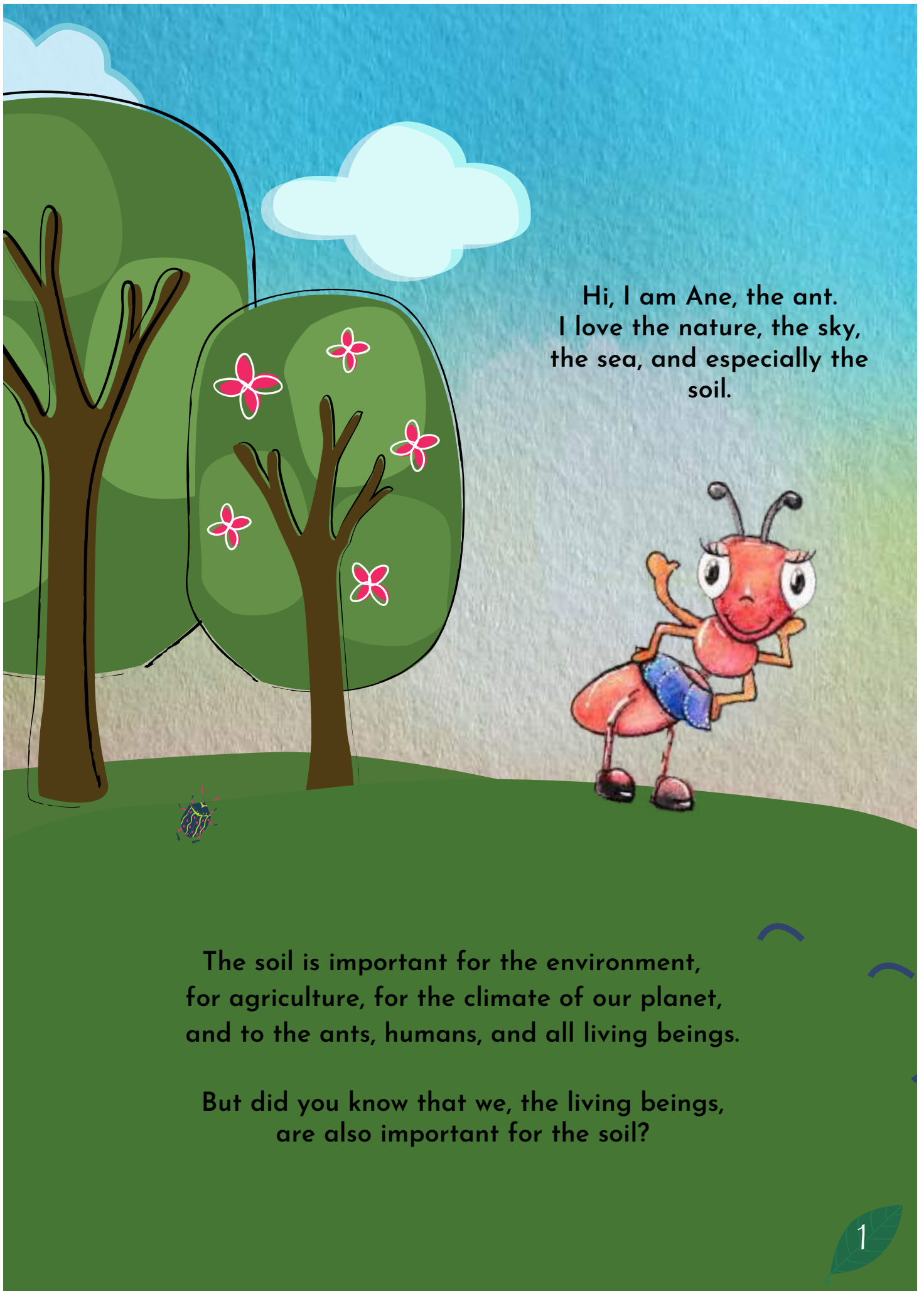
**Rodolfo Ferreira** holds a PhD in Education from the University of São Paulo, an M.Sc degree in Education from the Federal University of Rio de Janeiro and has graduated in Pedagogy from the State University of Rio de Janeiro, where he is currently an Associate Professor.

# Ane, the ant

Keep soil alive, protect soil  
biodiversity



• Marcela Lázaro • Luciana Santos • Gabriel Nóbrega •  
• Glauca Guimarães • Rodolfo Ferreira •



Hi, I am Ane, the ant.  
I love the nature, the sky,  
the sea, and especially the  
soil.

The soil is important for the environment,  
for agriculture, for the climate of our planet,  
and to the ants, humans, and all living beings.

But did you know that we, the living beings,  
are also important for the soil?



To know the answer, let's understand a little bit about it.



- ✓ Soil is the outermost layer of our planet's crust as if it were a shell.
- ✓ It occupies all continents.
- ✓ It is formed by parts of rocks, waste of plants and animals, air, water, and organisms.



The soil offers us a lot of good things:

- Plant food;
- Water purification;
- Control of the planet's climate and more!

However, for these services to occur, the soil must be healthy.



One way to check if the soil is healthy is by identifying the presence of organisms, such as myself, earthworms, armadillos, microorganisms, plants.

All of these organisms are my little friends and constitute the soil biodiversity.

What do you think about knowing a little bit about life inside the soil?

Many organisms live there, but I will present just a few to you.



Plants are very important for soil biodiversity.

They protect the soil from rain and strong winds.

They provide food for all organisms.

Their roots make the soil more steady.

The **Microphones** are microorganisms (fungi and bacteria) that form a rock band in the soil.

They turn greenery and animal waste into food for plants.

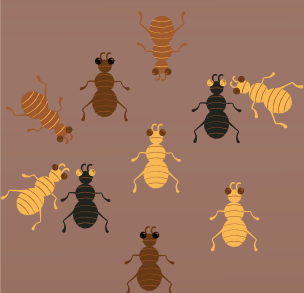
In this process, they can exchange some gases with the atmosphere, letting them circulate throughout our planet.

We, the ants, dig and turn the soil to build our house, the anthill.



This allows atmospheric air and water to reach the deepest layers of land and can be used by other organisms and also by plant roots.

Speaking of plants, in our wanderings, we spread pieces of plants around, like seeds and pollen, allowing them to grow in a lot more places.





This is Tutu, the armadillo.

It is known as the bigger soil engineer, because it alters the entire soil space by creating its dens, which are very large and deep.

This change in the soil's environment allows the life of other organisms and the passage of water.





This is Ninoca, the worm.

It feeds with soil and the waste of vegetables and animals, creating a powerful fertilizer for plants.

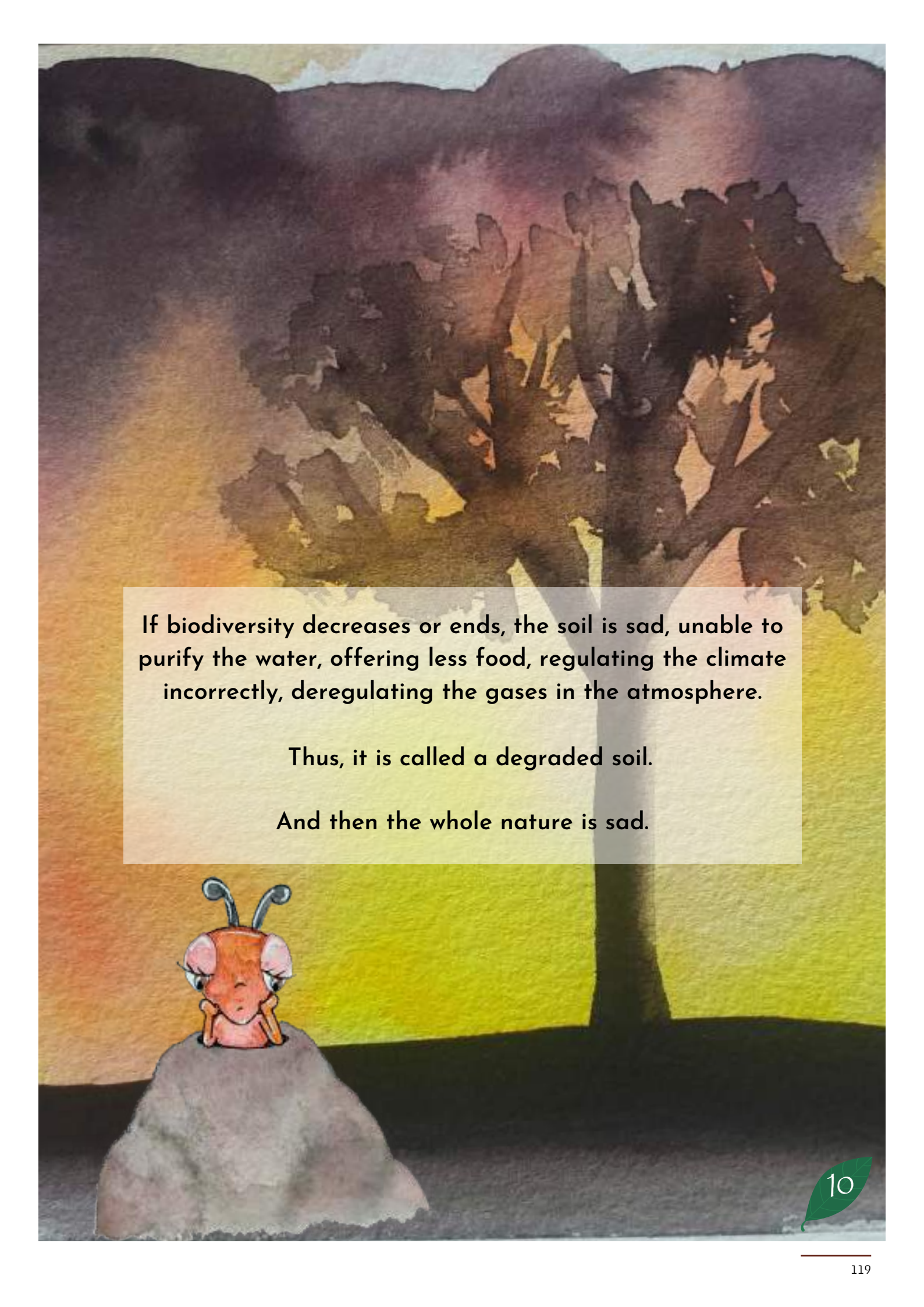
In addition, when they are in the soil, it becomes very porous, ready to receive the production of many vegetables and flowers, for example.



The greater is the biodiversity, the better is the soil!





A watercolor illustration of a landscape. In the foreground, a small, sad-looking ant with two antennae sits on a mound of grey soil. The background features a large, dark tree with a thick trunk and dense foliage, set against a backdrop of rolling hills in shades of purple and brown. The sky is a mix of yellow and green, suggesting a hazy or overcast day. The overall mood is somber and melancholic.

If biodiversity decreases or ends, the soil is sad, unable to purify the water, offering less food, regulating the climate incorrectly, deregulating the gases in the atmosphere.

Thus, it is called a degraded soil.

And then the whole nature is sad.

The degradation of the soil occurs mainly because the human being has caused fires, deforestation, and incorrect planting.

All of this decreases soil biodiversity.

As a result, other processes are beginning to appear, such as erosion, desertification, the increase in the planet's temperature, and the lack of food.



It is necessary to spread the importance of soil biodiversity to many people, so that we can preserve and recover it.

Some actions can be taken:



- Preserve nature
- Do not deforest
- Do not occupy preserved areas
- Produce food in a sustainable way
- Recover degraded areas

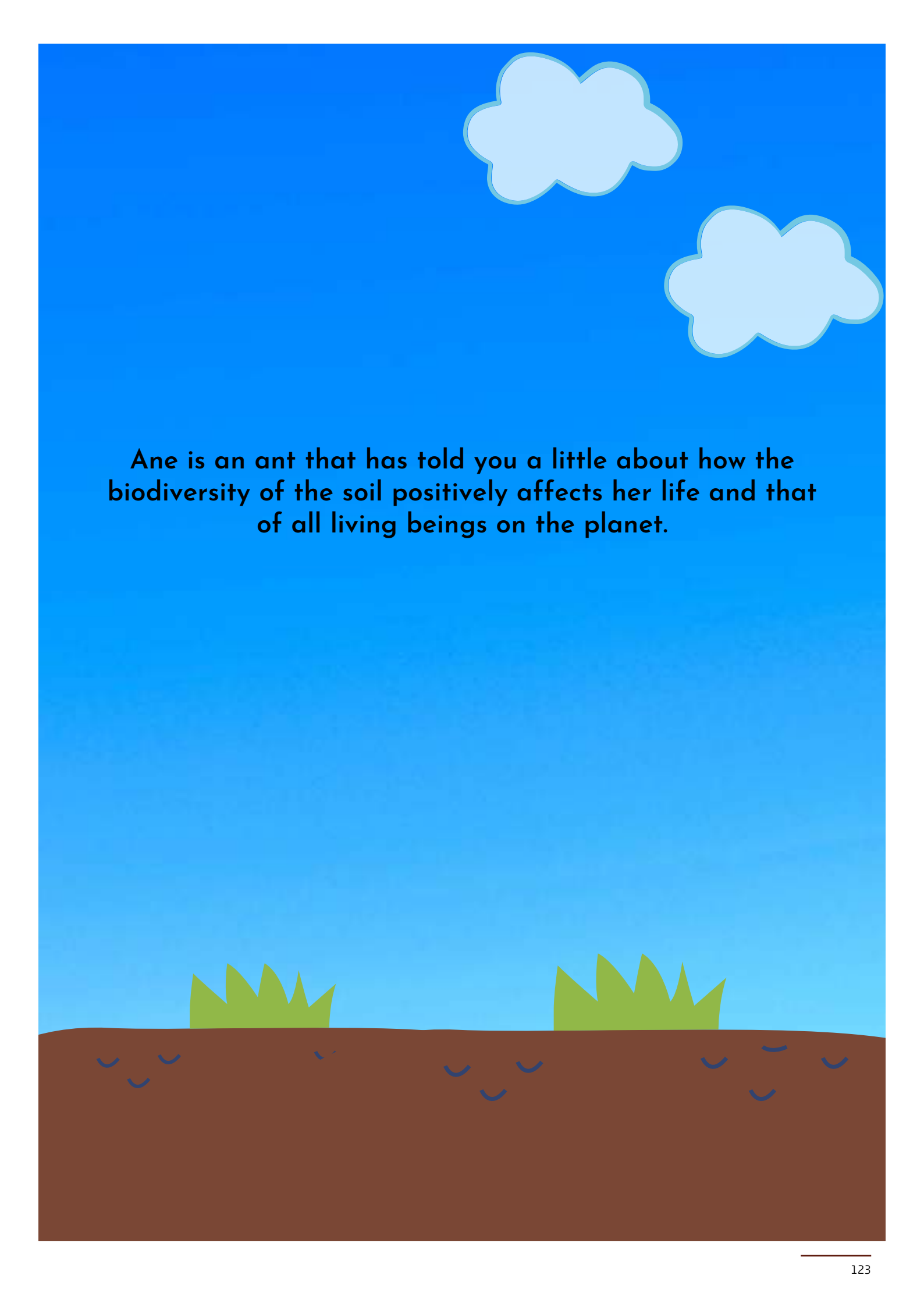




If everyone does their part

We will all be happy!





**Ane is an ant that has told you a little about how the biodiversity of the soil positively affects her life and that of all living beings on the planet.**

# The life under your feet

## Authors

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**Stephanie Jurburg** is a researcher at the German Centre for Integrative Biodiversity Synthesis Halle-Jena-Leipzig, studying bacteria, and especially soil bacteria. She makes the point that bacteria are crucial, because they make sure that everything that dies is turned into something living again.



**Roel van Klink** studies insects from around the world in order to understand the gains and losses in their biodiversity due to human activities and climate change. He is also a researcher at the German Centre for Integrative Biodiversity Synthesis Halle-Jena-Leipzig.

THE LIFE  
UNDER  
YOUR FEET

S.D. JURBURG AND R. VAN KLINK



HAVE YOU LOOKED  
DOWN LATELY?





THE SOIL IS FULL  
OF CRITTERS OF  
ALL SHAPES AND  
SIZES

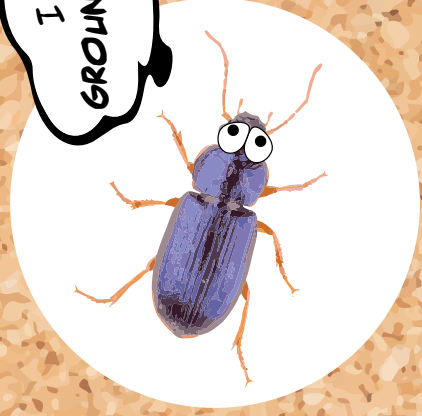


I AM AN  
EARTHWORM

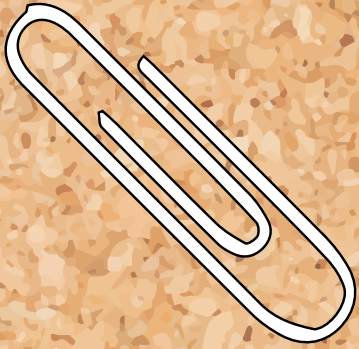


- EARTHWORMS DON'T HAVE EYES
- THE LONGEST EARTHWORMS ARE OVER TWO METERS LONG!

I AM A  
GROUND BEETLE



- THERE ARE MORE THAN 40 000 SPECIES OF GROUND BEETLES
- MOST GROUND BEETLES HAVE SHINY BODIES



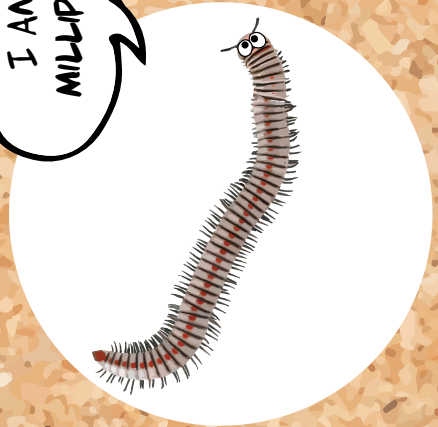
# STANDING UP, YOU CAN SEE CRITTERS AS LARGE AS A PAPER CLIP

I AM A  
WOLF SPIDER

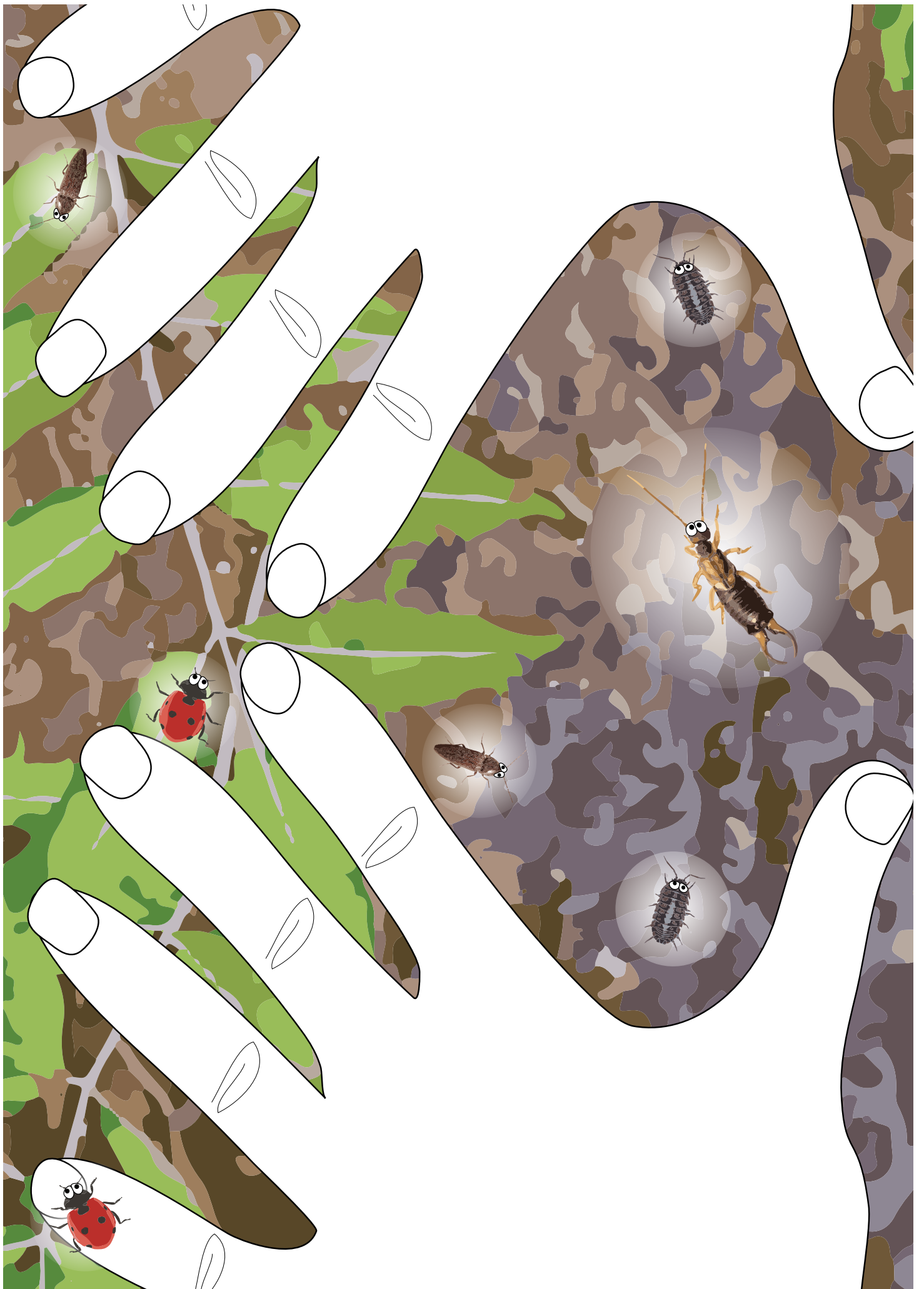


- WOLF SPIDERS LIVE ON THE GROUND AND DON'T SPIN WEBS
- AFTER HATCHING, BABY WOLF SPIDERS RIDE ON THEIR MOTHER'S BACK

I AM A  
MILLIPEDE



- THERE ARE MORE THAN 12 000 SPECIES OF MILLIPEDES
- THE LONGEST MILLIPEDE HAS 750 LEGS

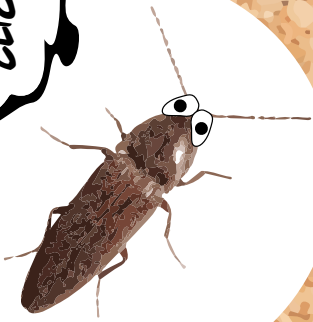


I AM A  
LADYBUG



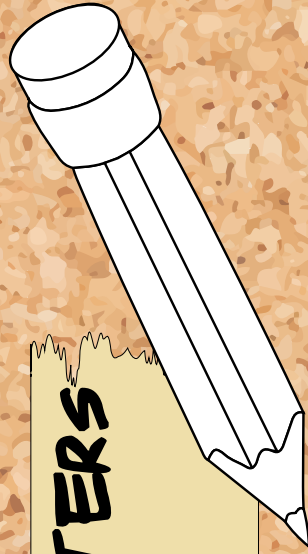
- LADYBUGS ARE ALSO CALLED LADYBIRDS
- LADYBUGS ARE BEETLES, NOT TRUE BUGS

I AM A  
CLICK BEETLE



- IF A CLICK BEETLE FALLS ON ITS BACK, IT WILL JUMP AND MAKE A CLICKING SOUND
- CLICK BEETLES ARE COMMON IN GARDENS

# KNEELING DOWN YOU CAN SEE CRITTERS AS LARGE AS AN ERASER



I AM AN  
EARWIG

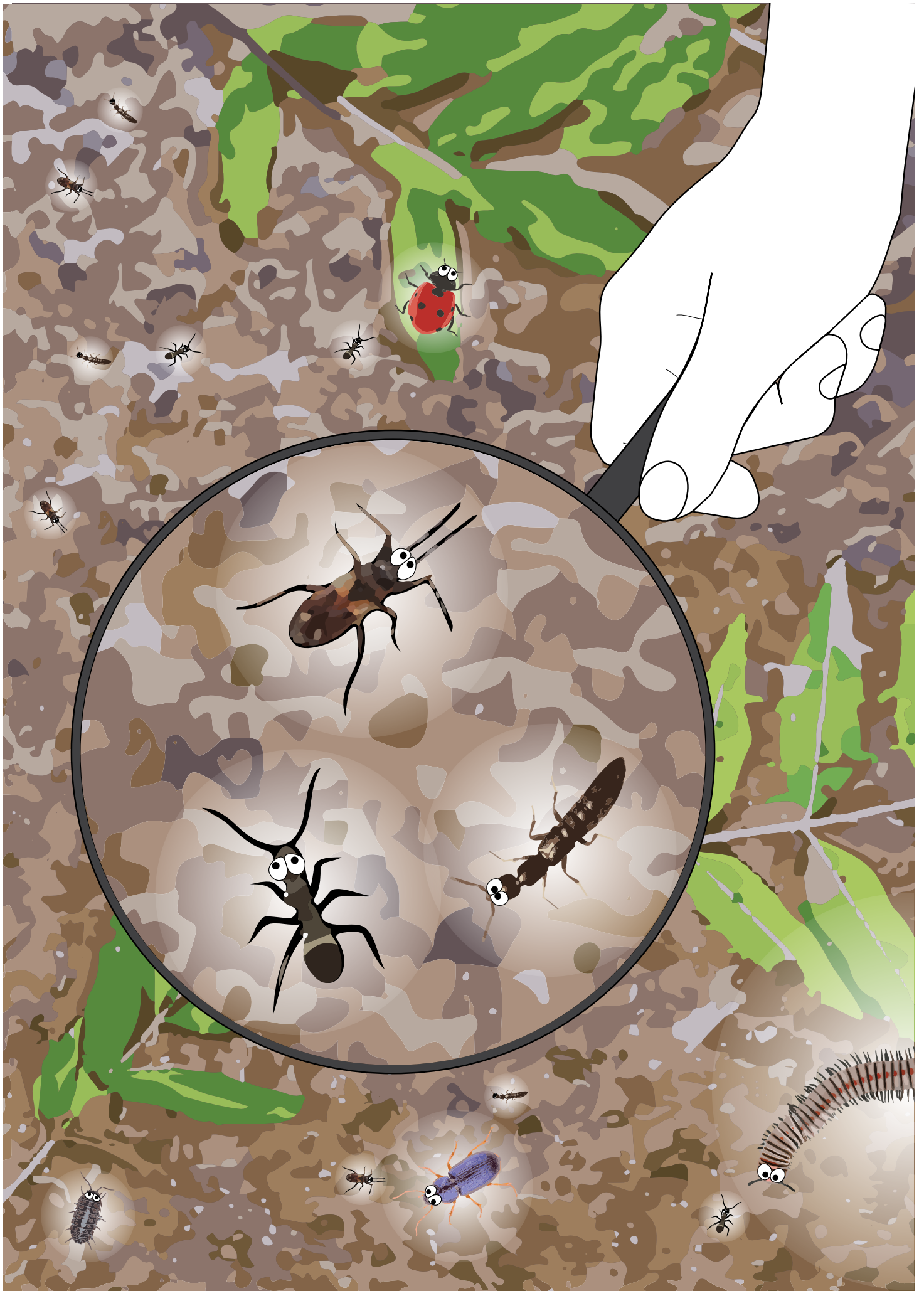


- EARWIGS GET THEIR NAMES FROM THEIR WINGS, WHICH LOOK LIKE HUMAN EARS.
- THEY DON'T LIKE TO FLY

I AM A  
ROLY POLY



- ROLY POLIES ARE NOT INSECTS! THEIR CLOSEST RELATIVES ARE CRABS AND LOBSTERS.
- ROLY POLIES HAVE 14 LEGS

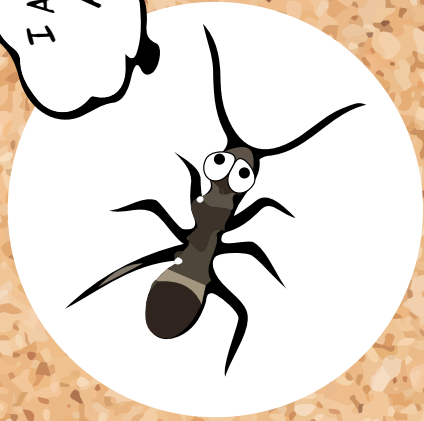


I AM A  
ROVE BEETLE



- WHEN THEY'RE NOT FLYING, ROVE BEETLES TUCK AWAY THEIR WINGS BY FOLDING THEM 7 TIMES!
- THERE ARE MORE THAN 63 000 SPECIES OF ROVE BEETLES

I AM AN  
ANT



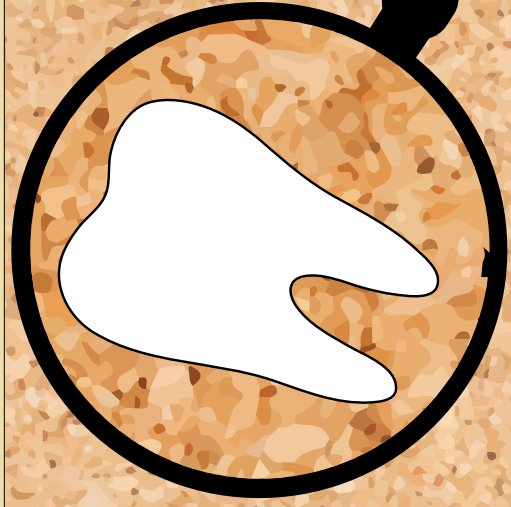
- ANTS LIVE IN COLONIES THAT CAN HAVE MILLIONS OF MEMBERS
- AN ANT COLONY ALWAYS HAS A QUEEN, WORKER ANTS, AND SOLDIER ANTS

## WITH A MAGNIFYING GLASS, YOU CAN SEE CRITTERS AS SMALL AS YOUR TOOTH

I AM A  
TRUE BUG



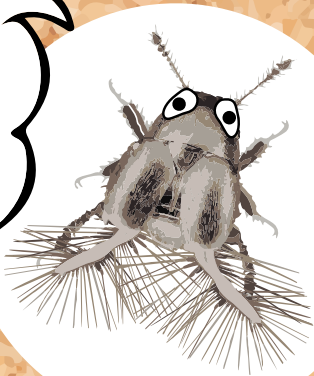
- TRUE BUGS ARE NEVER LARVAE, THEY HATCH AS MINIATURE ADULTS AND GROW
- TRUE BUGS HAVE SPECIAL MOUTHS FOR SUCKING JUICES OUT OF LEAVES OR PREY





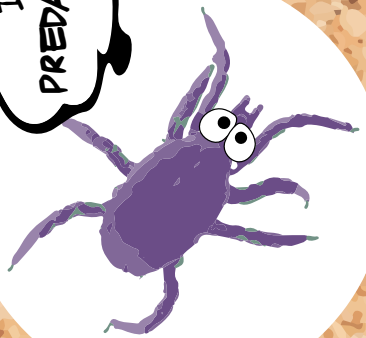


I AM A  
FEATHERWING  
BEETLE



- THESE BEETLES GET THEIR NAME FROM THEIR TINY FEATHERY WINGS
- MANY FEATHERWING BEETLES ARE SO SMALL THAT THEY DON'T HAVE A HEART

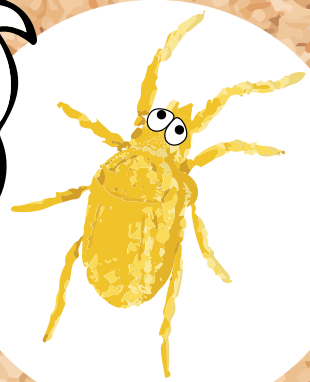
I AM A  
PREDATORY MITE



- PREDATORY MITES ARE A FARMER'S BEST FRIEND: THEY EAT GARDEN PESTS!
- MITES ARE RELATED TO SPIDERS AND SCORPIONS, LIKE THEIR COUSINS, THEY HAVE 8 LEGS

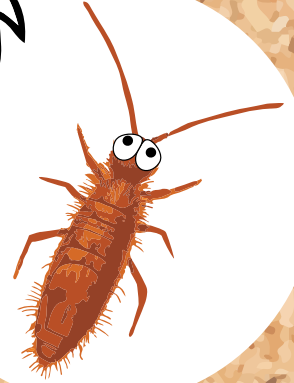
## WITH A MICROSCOPE, YOU CAN SEE CRITTERS SMALLER THAN THE TIP OF A NEEDLE

I AM A  
MOSS MITE



- MOSS MITES EAT DEAD PLANT LEAVES AND HELP RETURN THE NUTRIENTS TO THE SOIL
- YOU WILL FIND THEM IN EVERY SOIL

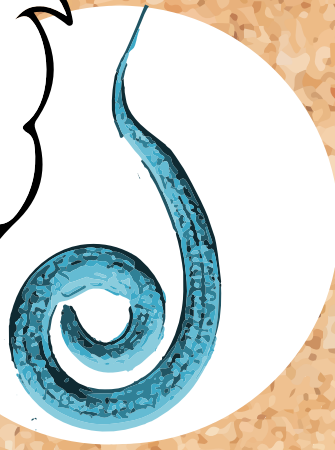
I AM A  
SPRINGTAIL



- SPRINGTAILS ARE ALSO CALLED COLLEMBOLA
- ON THEIR UNDERSIDES, SPRINGTAILS HAVE A FORK-LIKE SPIKE, WHICH THEY USE TO JUMP AWAY FROM PREDATORS

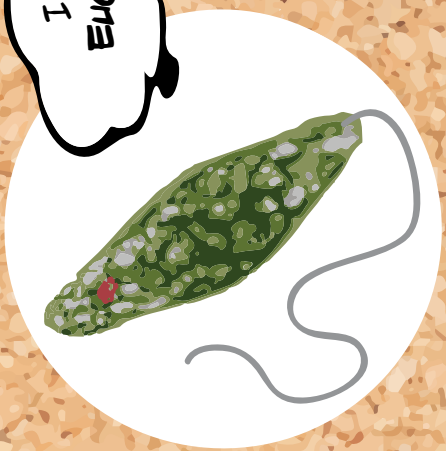


I AM A NEMATODE



- NEMATODES ARE VERY SIMPLE ANIMALS, BUT THEY ARE THE MOST ABUNDANT.
- 4 OUT OF 5 ANIMALS ON THE PLANET ARE NEMATODES

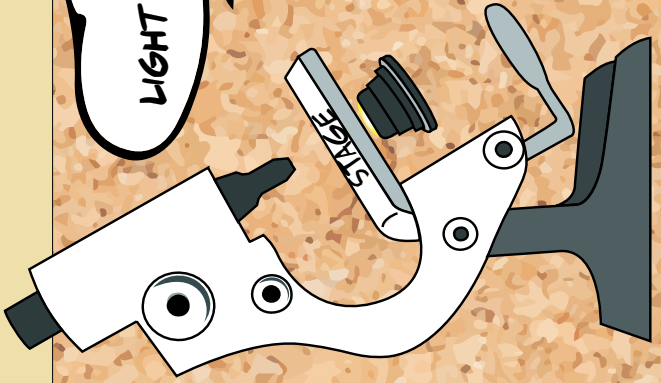
I AM EUGLENA



- EUGLENA ARE SINGLE-CELLER THEY ARE PROTISTS, NOT ANIMALS!
- EUGLENA MOVE WITH THEIR TAIL-LIKE FLAGELLUM

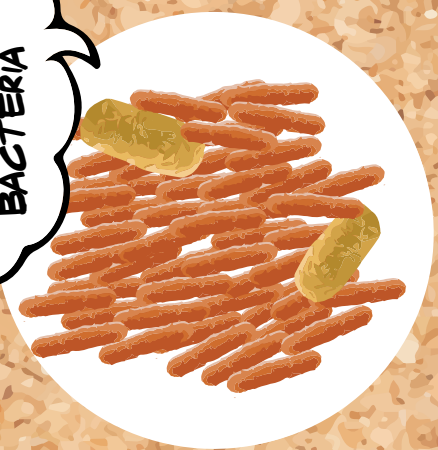
# WITH ANOTHER LENS ON THE MICROSCOPE, YOU CAN SEE CRITTERS SMALLER THAN A HAIR

I AM A LIGHT MICROSCOPE



- A TEASPOON OF SOIL CAN HAVE A BILLION BACTERIA!
- SOIL BACTERIA GIVE SOIL ITS EARTHY SMELL

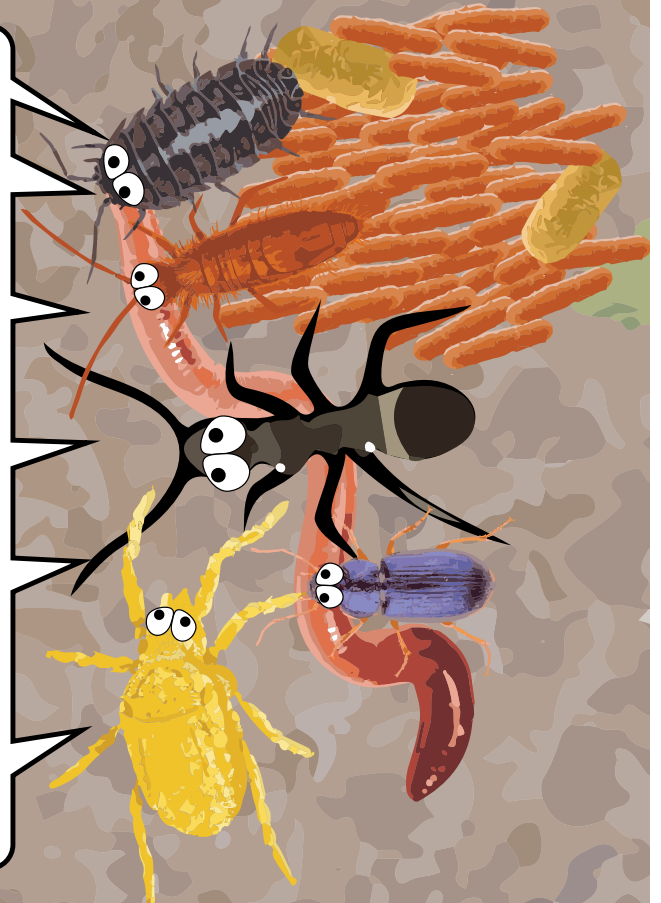
WE ARE BACTERIA



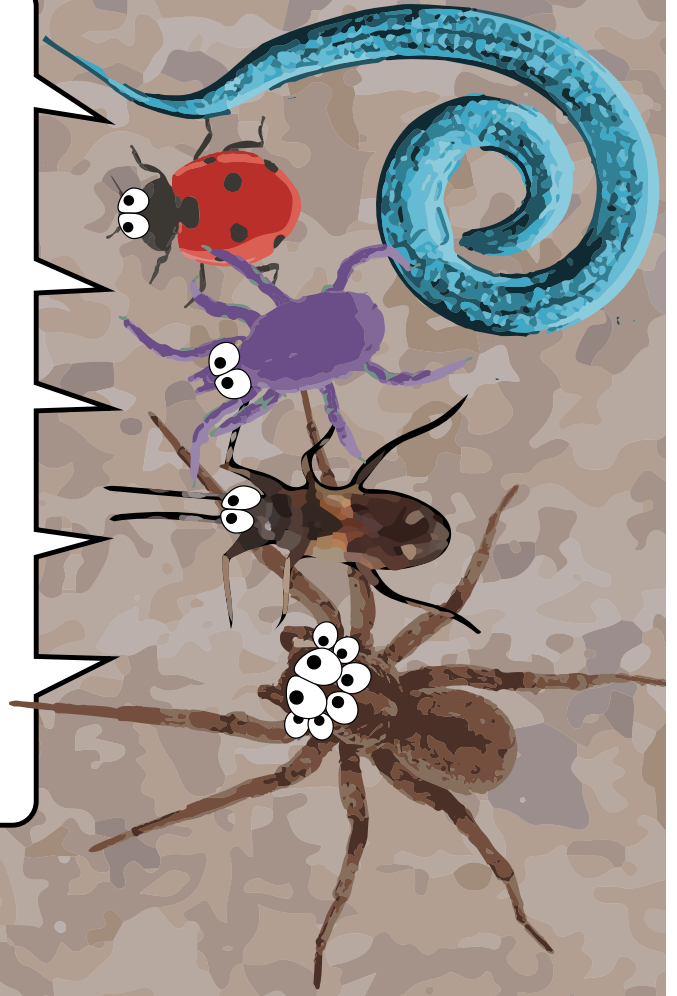
- LIGHT MICROSCOPES WERE USED TO SEE BACTERIA FOR THE FIRST TIME
- TO SEE CRITTERS, PLACE THEM ON THE STAGE. A LIGHT IS SHONE FROM BELOW, AND LENSES IN THE NECK ARE USED TO MAGNIFY THE SAMPLE


# THESE CRITTERS KEEP OUR SOILS HEALTHY

WE BREAK DOWN DEAD PLANTS,  
DEAD ANIMALS, AND POOP SO THAT  
LIVING PLANTS CAN USE THEM TO  
GROW



WE PROTECT PLANTS FROM  
PESTS



A vibrant, colorful illustration of various soil organisms, including worms, beetles, ants, spiders, and other insects, arranged around a central text block. The organisms are depicted in various colors and poses, some with large, expressive eyes. The background is a dark, textured grey, suggesting soil. The text is written in a bold, white, sans-serif font, oriented vertically in the center of the image.

SO KEEP SOIL  
ALIVE, AND PROTECT  
BIODIVERSITY!





# Coco loves soil

## Authors

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**Frederick Dadzie** is a PhD student at the University of New South Wales, Sydney, working on the restoration of degraded drylands combining both soil biogeochemical processes and soil microbiology to improve soil health and support plant re-establishment. He studied Tropical and International Forestry at the University of Goettingen, Germany, and majored in soil biogeochemical processes and plant growth.



**Giancarlo Chiarenza** is a PhD student at UNSW Sydney. He has a BSc in Natural Sciences from the University of Genova) and an M.Sc degree in Environmental Sciences at the University of Bologna, majoring in Environmental Botany. He is interested in large-scale plant-soil relationships and how soil can shape ecosystems. His love for soil started during his M.Sc degree, studying the extent that soil affects natural ecosystems.

**Chen Han** is an international student from China, studying for her PhD in Chemical Engineering at UNSW Sydney, Australia. She works on projects to reduce the greenhouse effect and help solve the energy crisis. Her art is nature based and full of warmth and a love for life.



5 DECEMBER 2020  
World Soil Day  
Keep soil alive,  
protect soil biodiversity

# COCO LOVES SOIL

realising the importance of soil biodiversity

*Written by Frederick Dadzie, Giancarlo Chiarenza and Chen Han*

*Illustrated by Chen Han*



Coco is a pig, and he really wants to play in the mud. However, he feels a little scared of the soil, and always wears gloves and boots when he plays in the mud.

*Mommy, can you take me outside to play in the mud?*

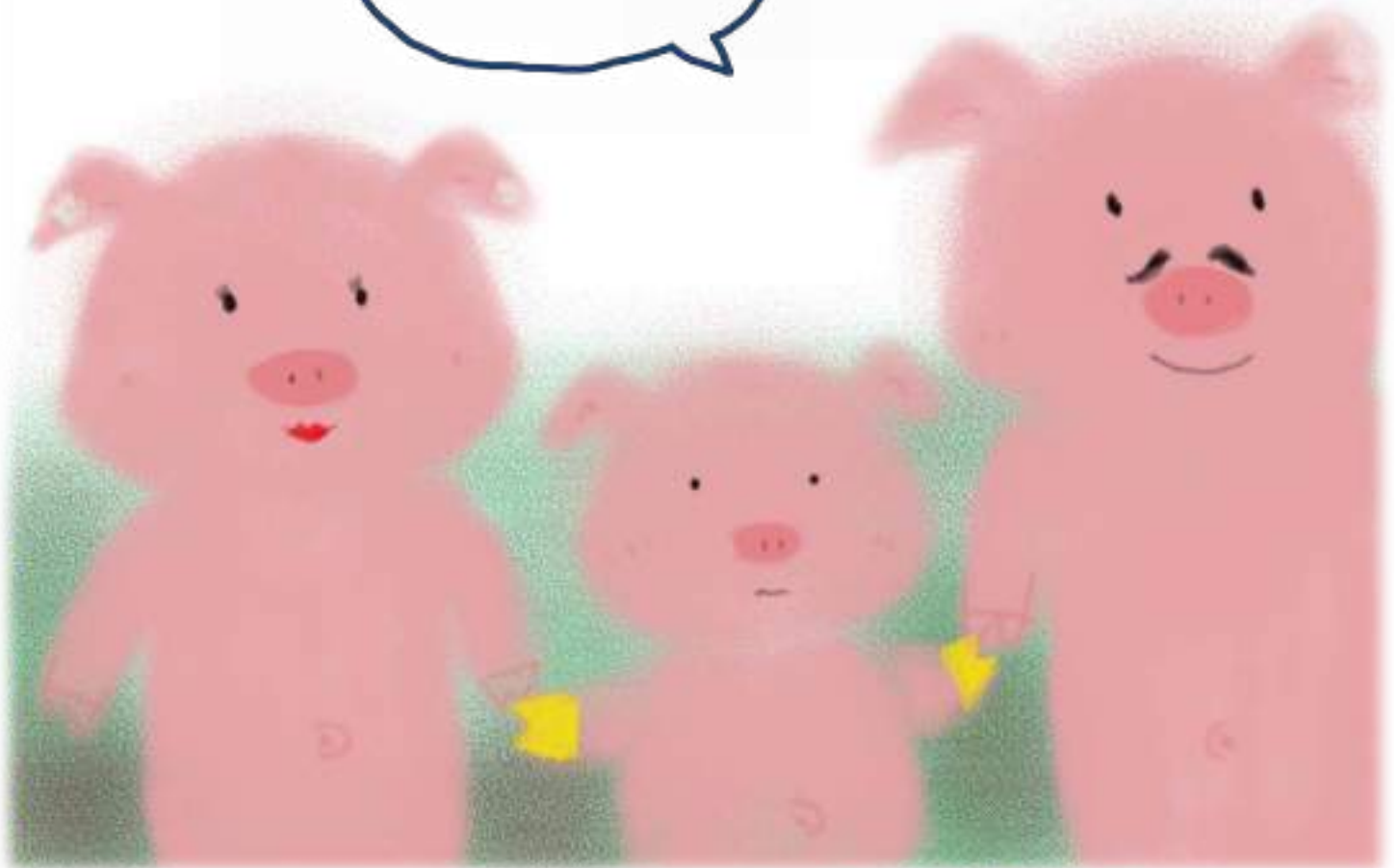
*Yes, Coco! And Daddy can tell you the wonderful things about the soil.*



Pig Daddy and Mommy take Coco to find the secret of the soil, and hope they can get rid of Coco's fears.

*Daddy, what is so great about the soil?*

*Wow! Coco, that is a good question. I will show you how important the soil is. The soil is the home of many living things.*



Daddy tells Coco stories about the soil.

**Daddy:** Do you see how beautiful the water is?

The soil helped clean it for the fish. The soil gives nutrients to the plants for them to grow well. The soil also gives all humans a place to live on.

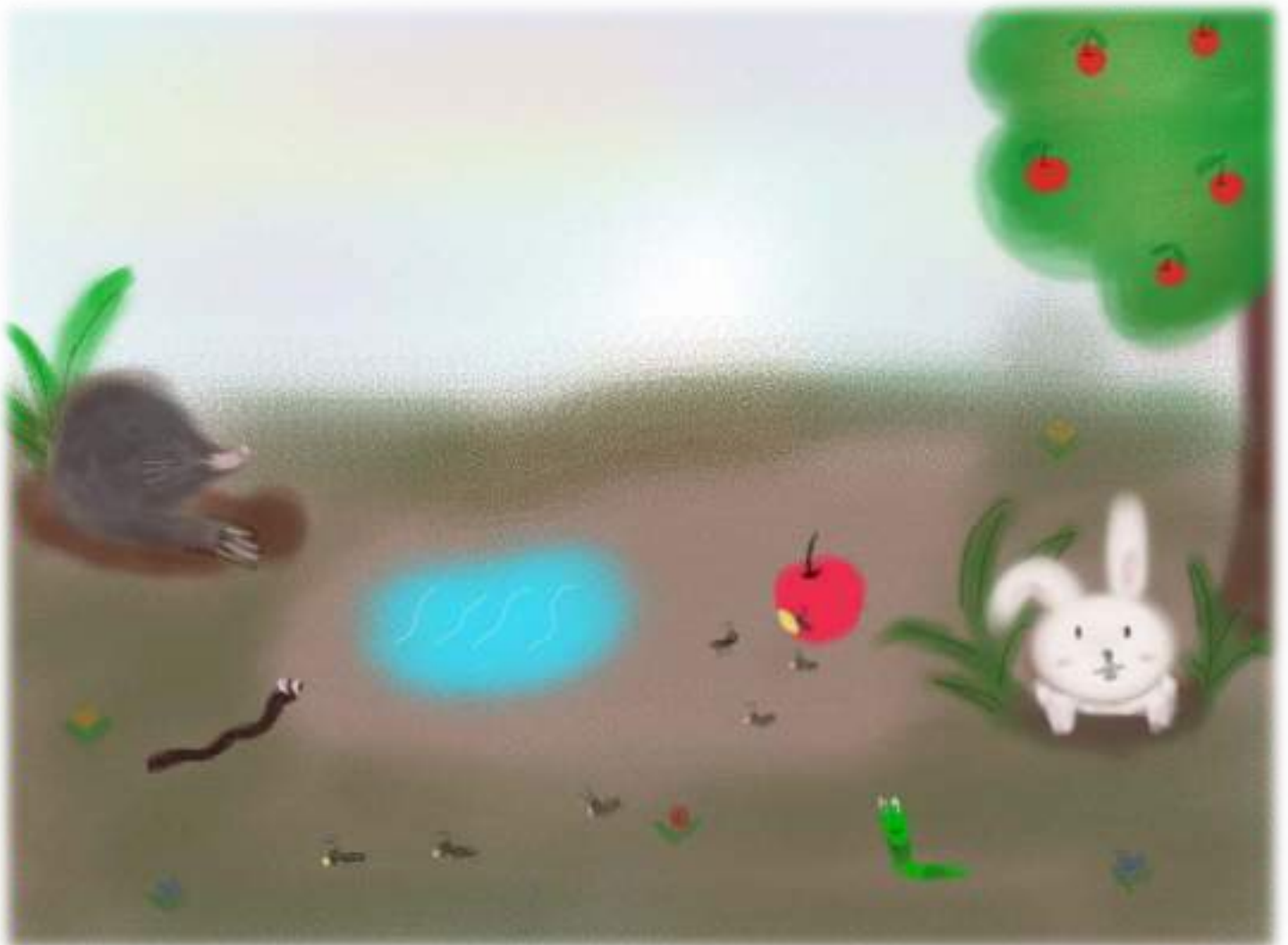


Pig Mommy introduces some friends to Coco. These friends live in the soil.

**Mommy:** Do you remember Daddy said that many things live in the soil?

**Coco:** Yes!

**Mommy:** Well, all of them work in different ways to make the soil do all the great things that it does.



Daddy comes in to tell more about the animals living in the soil.

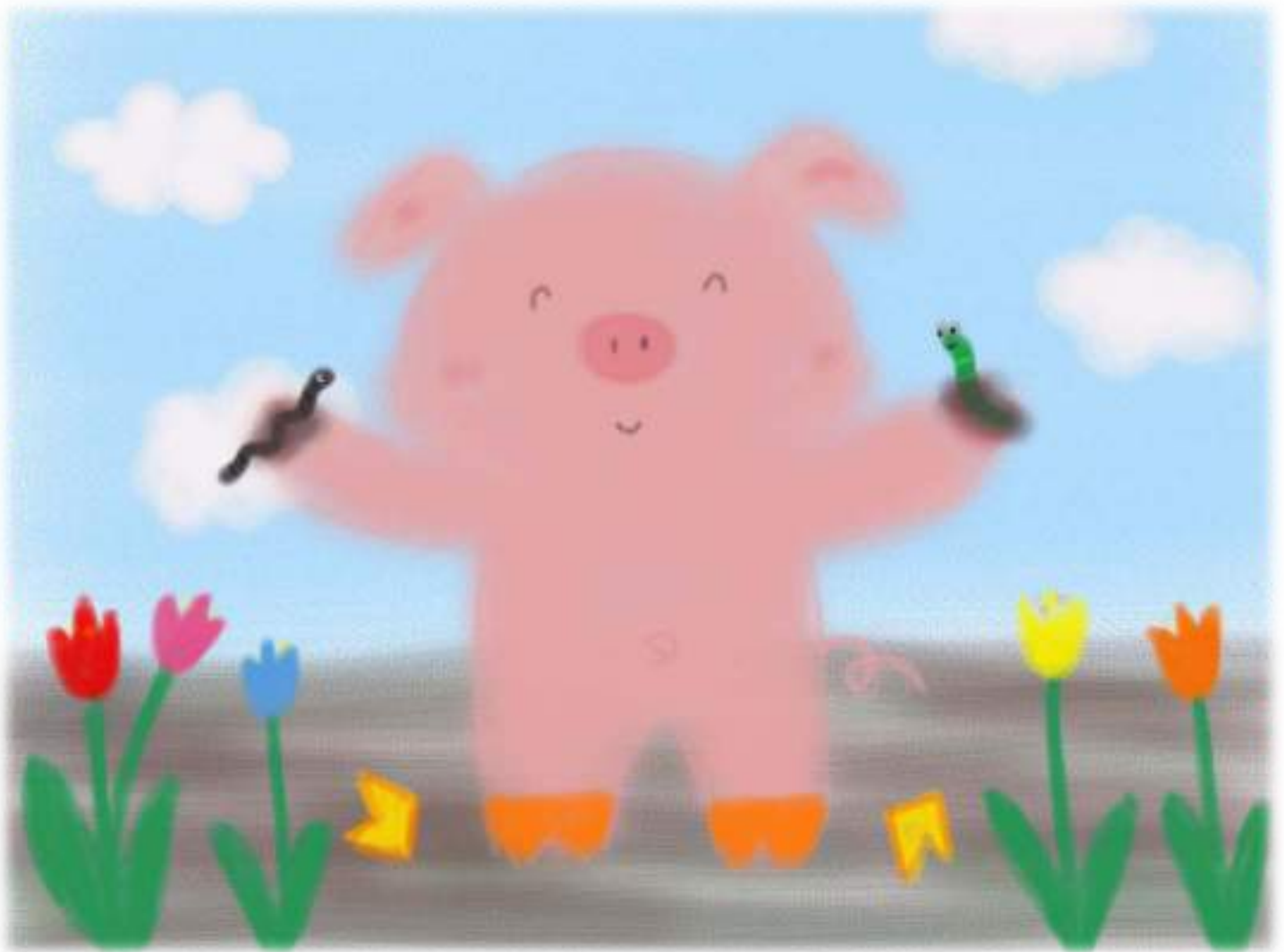
**Daddy:** Big animals like moles and rabbits dig tunnels in the soil, and bring soil nutrients that are buried deep in the soil to the soil surface<sup>1</sup>. This is important for plants because they can get nutrients that will make them grow well<sup>2</sup>.

**Coco:** Wow, I want to give them a hug!



**Daddy:** Earthworms also create holes that allow water and air to go into the soil<sup>3,4</sup>, so that there is water for other living things in the soil as well.

**Coco:** They are so great! I want to take off my gloves and shake hands with them!



**Mommy:** Look Coco! There are some other small organisms like springtails and mites that break down big chunks of organic substances in the soil<sup>5</sup>. They make the nutrients in the organic substances available for plants to use.





Pig Mommy is a scientist and does soil biodiversity research. She is very happy to show bacteria to Coco.

**Mommy:** Do you want to hear another cool thing about the small living things in the soil?

**Coco:** Yes!

**Mommy:** When the soil gets sick from putting in bad things like rubbish, petrol and excess salts, the plant is not able to grow well. Sometimes the plants die. To heal the soil, we need small living things like bacteria that we cannot see with our eyes (microorganisms) to eat (degrade) the bad things in the soil to make it clean and healthy again<sup>6,7</sup>. We can use a microscope to see the small organisms. So you see, every living thing in the soil is important.



Coco is very happy. He takes off his boots and gets closer with these small friends.

**Coco:** Daddy and Mommy, I love soils and I want to be friends with all the things that live in it!

**Mommy:** Why do you want to be friends with them?

**Coco:** So that I can help make the soil do greater things. I also want to play in the mud together with my friends!

**Mommy:** Ok Coco, remember to protect your friends. When we protect every living thing in the soil, the soil functions properly!



In 2020 world soil day, let us protect the soil biodiversity with Coco's family!



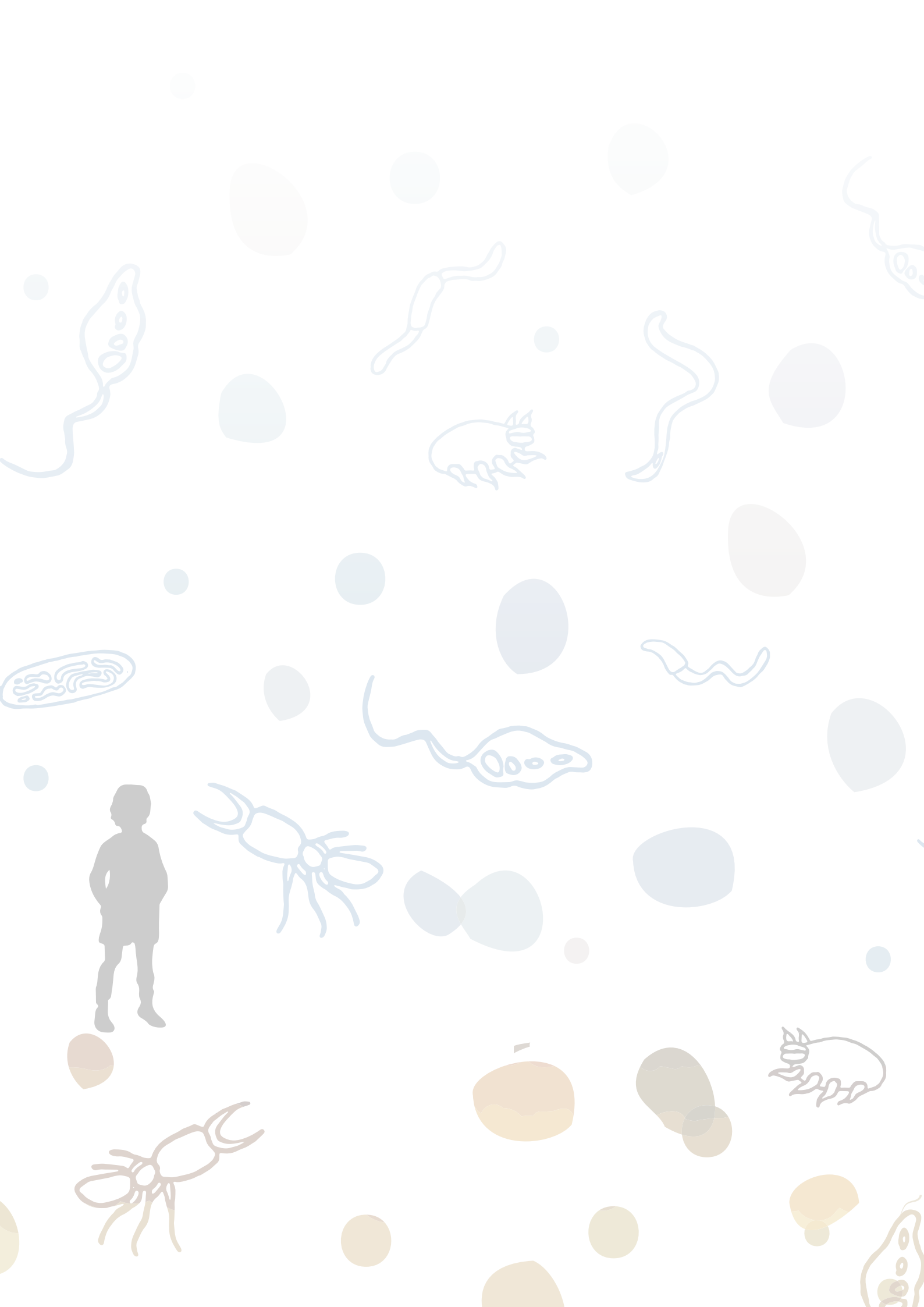
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Keep soil alive,  
protect soil biodiversity



***Coco loves soil!***  
***Keep soil alive***  
***Protect soil biodiversity***







The Global Soil Partnership (GSP) is a globally recognized mechanism established in 2012. Our mission is to position soils in the Global Agenda through collective action. Our key objectives are to promote Sustainable Soil Management (SSM) and improve soil governance to guarantee healthy and productive soils, and support the provision of essential ecosystem services towards food security and improved nutrition, climate change adaptation and mitigation, and sustainable development.

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# World Soil Day

Keep soil alive,  
protect soil biodiversity



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