Sound walk: Diverse Nature and its Evolutionary History

1. Fossils

How exciting it would be, if we could travel backwards in time to take a look on how life on earth was 100 million years ago!

Now turn around, so that you turn your back to your walking direction. Choose a safe spot, and take ten huge steps that will take you 100 million years back in time

You have now arrived at the prehistory of our planet, to the Cretaceous period! At this time, dinosaurs like Triceratops or Ankylosaurus were common animals on the earth.

What does the landscape around you look like? Does something look familiar?

With the help of fossils, researchers are able to investigate what kind of organisms have lived on the planet before. Fossils are remnants of the organisms that lived here a long time ago. For example, bones, teeth and shells of ancient animals and also parts of plants and fungi have been preserved as fossils. Sometimes the organism has also remained as a whole inside of the fossil.

With the help of fossils, we can get knowledge about the organisms that lived a long time ago. From the shape of the teeth, we are able to find out if the animal has been eating its food with teeth that look like the canine teeth of dogs, or whether it has been chewing plants with teeth that are shaped like the teeth in the back of our mouths.

Now feel your own teeth in the upper and lower jaw with your tongue. Are you able to notice their different shapes and forms? Which ones do you use to take the first bite and which ones do you use to chew your food?

Animal's footprints and their poo can also become a fossil. From the poop fossils, researchers can investigate what kind of food the animal has been eating. For example, there can be parts of insects, fish or plants in the fossils. From footprints it is possible to estimate the size of the animal or how it has moved.

Besides the fossils, researchers also use the information stored in organisms' genes and molecules to calculate when it is that different organisms have diverged from their common ancestors. This method is called the molecular clock.

Not so many fossils have been found in Finland. Our soil is very old and has gone through many changes, and we don't have much sedimentary rocks where fossils could have been preserved. On top of that, during the Ice age, the continental ice eroded away layers of soils where fossils could have been stored. Yet, dinosaurs have walked on this land too, and the nearest dinosaur fossils have been found from Southern Sweden.

Fossil fuels, like black coal, natural gas and oil are also fossils in a way – they were formed millions of years ago. The oil on earth originates from the plants and algae that lived on the ancient seas. They got mixed up with the other sediment layers, and because of the high pressure and heat, they formed into oil.

If we burn fossil fuels to produce energy, it releases carbon back into the atmosphere from soil where it was already safely stored in. Accumulation of carbon dioxide (CO_2) into the atmosphere will heat up the Earth and change the climate and living conditions in all parts of the world.

The fossils are remnants of real individuals and not made by anyone. But what if you could decide yourself what to store inside a fossil, what would organisms living here after us find? Or have you thought about what you don't want to leave behind?

If you are listening to the audio walk with your friends, you can tell each other what your imaginary fossils would contain.

Now you can continue your walk to the next stop.

2. Flowering plants and bees

Now turn backwards and take one giant step.
You have travelled deeper into the beginning of the Cretaceous period, 140 million years back in time!

The first flowering plants evolved during the Cretaceous period, at the same time as the Tyrannosaurus Rex was one of the top predators on Earth. The earliest bee fossils also originate from this same period.

Bees are among the most important pollinators of flowering plants. But there are other important pollinators too: for example bumblebees, butterflies, beetles, hoverflies, ants, and birds like hummingbirds.

Quite often, the pollinators evolve in close interaction with flowering plants. By carrying pollen from one flower to the next, pollinators help the flower to reproduce. The pollinators themselves benefit from visiting the flowers by getting nectar and food from them.

A big part of our food is also dependent on pollinators. Without them, we wouldn't have a lot of it. As humans, we benefit a lot from pollinators' work and are dependent on them.

3. Birds

Close your eyes for a moment. Do you hear any bird song around you? Now open your eyes and have a look around. Can you spot any birds?

You might have seen a great tit, that little yellow-chested bird, sitting on a tree branch or flitting within the forest nearby.

Now turn to face backwards again, and take a couple more steps deeper into the Cretaceous period.

Currently the most recent common ancestor of modern birds has been found in Belgium and it dates back to the end of the Cretaceous period. The researcher's interest was drawn to a small piece of rock, where a tiny little bone peeked out. Splitting the stone might have caused the bone to break, so instead the researchers used a computed tomography scan to have a look inside the stone. The scan revealed a 67-million-year-old bird skull! The researchers started to call the bird *The Wonderchicken*. This bird was rather small, and it had similar characteristics to the modern chicken-and duck-like birds. This Wonderchicken lived on Earth at the same time as the dinosaurs.

What do you think the Wonderchicken looked like? What sort of a beak did it have, and do you think it had feathers, like its modern relatives? What about the colour of the Wonderchicken, what sort of coloration it would have had? And, can you imagine what sorts of sounds it possibly made....?

Now, turn around again, choose a safe spot, and take 3 giant steps backwards in time. You have arrived at the Jurassic period!

The ancestors of modern birds diverged from dinosaurs during this time about 165-150 million years ago.

4. Squirrel

Choose a safe spot, turn around again, and take 2 small steps backwards. You have now arrived deeper into the Jurassic!

The first mammals developed during the Jurassic period. Mammals produce milk to nurse their young, and most of the modern mammal species give birth to living young.

Choose two interesting trees near you from which you would like to jump from one to the next. Find an even spot on the ground, from where you could push off like a long jumper. Now, get ready, and take a giant leap!

How many times do you need to jump to get from one tree to another?

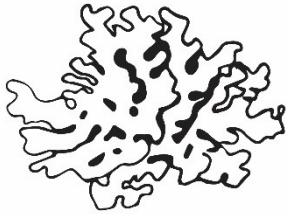
Jumping and climbing on trees is easy for the squirrel. It is very lightweight, and has sturdy legs, with which it can push off to jump. On top of that, it also has a fluffy tail that balances its movement. Scurrying from one tree to the next, the squirrel can jump even up to four meters in length! It is a huge leap, about 20 times the size of the squirrel's body.

The nails of the squirrel are long and crooked. With them it is able to firmly grab the tree trunk, so that it can go down the trunk head first. It can even stop in the middle of the descent as its nails, clinging to the trunk, will hold it in place.

The earliest fossil record of a squirrel was found in Hungary, and it was hundreds of thousands of years old. It is so young that the dinosaurs had already gone extinct on the earth by that time.

Imagine now what sort of a tail you could grow. Would it be fluffy and bushy like the squirrel's tail, or something completely different? Now you can attach your imaginary tail in its place, and try jumping again, agile like the squirrel.... How does it feel to jump with the tail on?

5. Lichen



For this track that tells about the lichen, we need to take on a form that is familiar to them. You can curl up to become like a rock, lay down like a fallen tree or root yourself to the ground like a tall pine. Or, where else have you seen the lichen growing? Once you have found a good shape that lichens would also approve of, you can continue listening.

Have you ever touched the thin, beard-like Usnea hanging on the tree branch? Or have you ever looked at the grey, flat and slightly rugged spots on tree trunk or rock surface? They are lichens. If you look around for a while, is it possible to find lichens in your nearby surroundings?

Lichens are a much younger group than Vascular plants, such as ferns or horsetails. Lichen is formed by fungi and algae that live together. The fungi part gives water to the algae, and algae produces sugar for itself and for the fungi. This sort of relationship, in which both parts benefit, is called symbiosis. In some of the lichens, the fungi are accompanied by cyanobacteria, which gives the fungi the sugar that it craves.

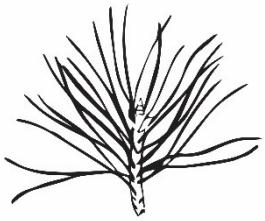
Throughout the planet's history, this kind of an alliance between fungi and algae has evolved several times.

In Northern Finland, lichens are an important source of nutrition for reindeer. The reindeer can smell the lichens growing on the ground even from under the snow cover. When the reindeer finds a good spot, it starts digging the lichens up from the snow.

Lichens can be found almost anywhere on Earth, from rainforests, fells or seashores. Lichen can grow even on top of a scrap car or on the rusty old street light. It has been estimated, that the lichens dominate 8 percent of planet's surface.

Just like mosses, lichens do not rush, as it takes a looong time for them to grow. How long should a stone, or you, stay in one place before the first lichens would start to grow on top

of it, or you...? You can now get up from your lichen-like shape, and continue the journey backwards in the planet's history.



6. Vascular plants and pine

Turn to face backwards, and take four big steps.
Now you have stepped 400 million years backward in time!

Find a comfortable place and settle down to stand firmly on the ground, like a pine tree. To aid rooting deeper, you can first jump into the air – one – two – three – NOW, and now let your feet root firmly on the ground, right where they landed. Imagine that you start growing deep roots from the soles of your feet, and gravity starts pulling them deeper into the soil.

Stand on the ground, and let the wind move your tree trunk for a while.
When the wind stops, imagine, that long roots start growing underneath the earth's surface, just about where your feet are. They are growing longer and longer, until they are many metres long. Soon they have grown and spread around so long that they meet the roots growing from the other pine trees.

The first Vascular plants evolved around 430 – 360 million years ago. Pine trees belong to the Vascular plants, and also their history dates far far back. The first pine tree species evolved around 150 million years ago, and they radiated across the northern continents during the Cretaceous period.

The tree roots form a mycorrhiza with the fungi. With the help of mycorrhizae, the plant receives nutrients from the fungi such as nitrogen and phosphorus. In return, fungi get sugars from the trees which benefits their growth.

For a long time, trees were thought to live alone. Today however, research has shown that in fact trees are often connected to each other and can even communicate or collaborate.

For example, with the help of their mycorrhizal-networks, trees can send each other nutrients and water. They can also signal to each other, if they suffer from drought or if their foliage is eaten by insects. Some tree species can even recognize their own kin or help

their own offspring by pumping more sugars to their collective mycorrhizae network. One could say that this underground mycorrhiza root network creates a sort of tree-wide-web.

Now you can step out of your own mycorrhizae, and continue the journey.

7. Dragonflies and other insects

Now pause and imagine small wings that start to grow from your scapulae. They glimmer multicoloured in the sunlight. You can now take a little flitting flight with your newly grown wings.

Now we will stay hovering in the air, in around the same time period where vascular plants were born.

The oldest insects date back to around 479 million years ago and the first insect societies evolved millions of years before humans started to form their own communities. Insects were among the first animals that moved to live on dry land and in fresh waters. They were also the first organisms on Earth that evolved the ability to fly.

Dragonflies diverged from other insects around 350 million years ago. They are older organisms than for example butterflies. From the fossil records we know that the wingspan of an ancient dragonfly could have been over half a metre! In turn the biggest dragonfly that lives in Finland is called the Siberian hawker (*Aeshna crenata)* and its wingspan is around 12 cm.

Try to measure with your own fingers how big the 12 centimetre wings would be? What about the half a meter wings of the ancient dragonfly? How big would they be...?

Many insects go through a complete metamorphosis, where larvae first hatch from the eggs. Larvae often go through several instars and moults before they are big enough to form a pupa or cocoon. However, some insects such as dragonflies have an incomplete metamorphosis where adults emerge from the nymph and do not have a pupal stage at all.

Insects are one of the biggest group of organisms on Earth. They are an important part of ecosystems and animal communities on earth. For example, many insect-feeding bird species time their migration and nesting periods based on the availability of insect food. They are ready to travel very long distances in order to nest in areas with high abundance of

tasty insects. Insects are also important pollinators and decomposers as well as parasites and predators.

Think how amazing it would it be if you could live partly underwater and partly flying in the air, within the same lifetime! Now spread your dragonfly wings, and glide deeper into life's history.

8. Fungi

What sort of mushrooms have you seen? What sort of shapes and forms have they been? Choose a nice spot around you. Now try to take different mushroom forms with your body. You can imitate how they are shaped and how they stand on the ground. How does for example chantarelle pop out of the ground?

What about boletus, what kind of a shape does it have? And what about the bumpy false morel, how could you take on its shape with your body? What other kinds of mushrooms do you know ….? How do you think they are able to stand upright, do they have roots…?

Now you can return back into human form, and turn around to take 3 big steps back in time!

We have now arrived at the time when the first fungi evolved. The oldest fungi fossils date back to the Ordovician period 460 million years ago. Researchers still need more information on how and when the first fungi evolved because there are only very few fungi fossils that have been found so far.

According to current understanding, it was living side by side with fungi via, mycorrhiza, that enabled plants to transition from water to land. Mycorrhiza is a long, underground structure, that is formed from plant and fungi cells. With the help of mycorrhiza, the plant and the fungi are able to get nutrients and water more efficiently. For example, chantarelle and boletus form mycorrhiza together with tree species.

Fungi are not able to produce their nutrients themselves, but they gain them from their surroundings. Therefore, fungi are called heterotrophic. They can act as decomposers or parasites. In a parasitic relationship fungi benefit from their host species but cause harm to their host. Fungi can also live as mutualists in close relation with other species that benefits them both. Like fungi, we humans depend on other species.

Now you can continue your journey to meet fungi's age peers, bryophytes.

9. Bryophytes

Look around you, can you see any bryophytes in your surrounding? If you spot any kind of moss near you, try to touch its surface gently. How does it feel? How do you think it would be to sleep on a bed made of moss? Like many other animals, also humans have used moss for sleeping, for example as the material for mattresses.

Now you can take two steps sideways, as it is estimated that evolution of bryophytes such as mosses, liverworts and hornworts dates back to around the same time as fungi.

It is easy to find bryophytes from the ground or on top of stones. They spread to new areas with their spores. The earliest known spores are 470 million years old – they resemble our modern Liverworts. Bryophytes appeared on the planet before the dinosaurs, when plants colonized the earth.

Why haven't the bryophytes grown as tall as the trees? Well, they don't have roots, so they are not able to transport water and nutrients for long distances within the plant. The structure of the bryophyte is very thin. If they would be tall, they could not stand upright. Bryophytes are important for many animals. For example, the great tit and blue tit use it as material for building their nests. Little spiders attach their nets on the surface of the moss, hoping to catch something to eat. Bryophytes are also eaten: some of the tiny little tardigrades suck liquids from inside of them.

Now imagine that you shrink to a tiny, 1 mm tall Tardigrade on top of the moss. You can squat down, making yourself as small as possible. What kind of moss do you live on? What does it look like, now that you are looking at it from its fluffy surface level? Tardigrades are one of the most durable organisms on Earth. They can handle even 300 degrees celsius below zero! Now you can start moving around on the moss, tardigrade-style, observing its surface with your tiny feet.

In the moss world, one does not get hasty. Bryophytes grow very, very slowly and if they do not get destroyed, they can live thousands of years.

Humans have used mosses for many purposes: it has been good insulation for keeping the house warm, and we have even made diapers out of them. Many delicate berries like

cranberries and cloudberries grow on top of the mosses too. Can you come up with any other ways in which we would benefit from moss?

10. Present time

During this walk, we have travelled 500 million years back in time. Yet, it is only a tiny fraction of the age of our planet.

Now, take 10 giant steps forwards, walking back to the present time. Look around you for a moment, how does the world look today?

Perhaps after this journey you understand better, how long it has taken for this diverse nature to evolve.

You are surrounded by bryophytes, which evolved around 500 million years ago, and trees, whose evolutionary history dates back to 400 million years ago.

The ancestors of the modern dragonfly that flies by you, started to colonize the land at the same time as the first plants and their fungi partners. Organisms evolve constantly in interaction with each other, also today.

As a human, you are among the youngest in this group. Early-human fossil records date back to around 5 million years ago, and modern humans, us, *Homo sapiens*, evolved only around 200 000 years ago.

Even though we are such a young species, we have managed to shape the Earth intensively throughout our short history. At present we use fossil fuels and release carbon that was stored into the soil hundreds of millions of years ago. This causes our climates to change very rapidly. Unfortunately, many organisms do not have time or can't adapt to these rapid changes.

We take over space for our own purposes, for example by building cities, roads or for other types of land usage. At the same time, we leave even less space for fungi, other animals or plants. We seem to have forgotten that just like fungi and trees, flowers, pollinators, and the algae and fungus in lichen, us humans also need other organisms to survive.

Take a moment to think about how we are allied with other species and organisms? How would you like to cultivate this kind of alliance?