The amazing untold history of soil biodiversity and our welfare

BY FABIANO DE CARVALHO BALIEIRO

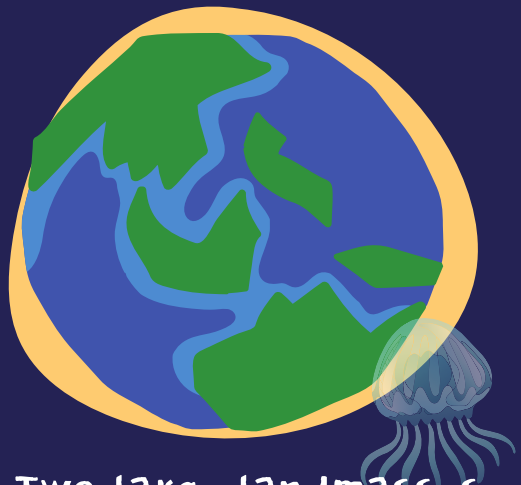

Hi, my name is Mary. I grew up hearing my father talks about soils, and the importance of keeping them healthy, that is, with life in abundance.
"Ok, sometimes he was so boring" using complicated words, but I understood that we depend a lot on the soil.
So, I will share with you a part of what I´ve learned, because I have no doubt that soil and its organisms allow life to exist!
I hope you enjoy our journey !!!!

Did you know that microrganisms and plants exist on earth since the continents were still glued !

+ 2 billion years ago

The first oceans and continents were formed. The tectonic plates (large landmasses) started to move away. The atmosphere had no oxygen to sustain life, but microbial life flourishes in the oceans and Cyanobacteria (able to do photosyntesis) start to enrich the oceans and atmosphere with oxygen

~500 million years ago



Two large landmasses move away in different direction (South and North). The warm climate and oxygen-enriched oceans make life thrive. Multicelular organisms, and early ancestors of terrestrial plants start to appear

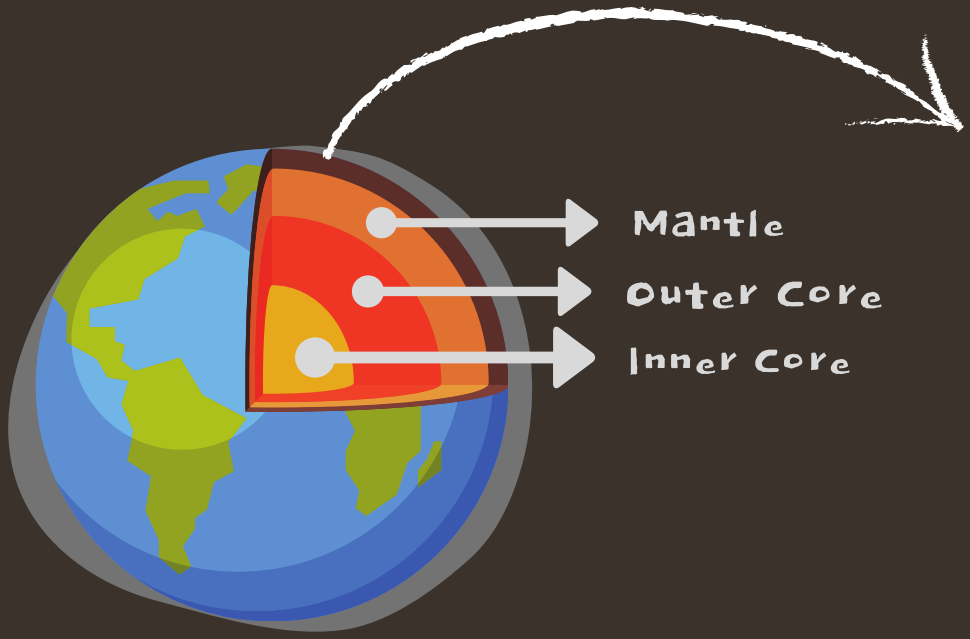
~170 million years ago

All major life groups were present on land and sea. Most of the important interaction between plants and organism had already been estabished

~6-7 million years ago

Some ape-like creatures began walking (habitually) on two legs. in Africa

During this long period, different soils were formed ...



Crust

The thinnest layer that covers the Earth´s surface is called CRUST. In this layer we find air, water and soils, which is capable to sustain most of earth biodiversity

Soils

The upper layer of Earth's surface made of broken down rock combined with a mixture of living and non-living organic materials

From the "marriage" of climate, organisms, relief, time and parent material (rocks), different soils were formed, presenting different colors, textures and composition. According these differences they are classified and named. See some examples, below.

Ferralsols

Histosols

Nitisols

Chernozems

Cambisols

... and at the same time microganisms and plants "holding hands"

Yes, it was in soils where many types of interactions between plants and microbes have emerged.

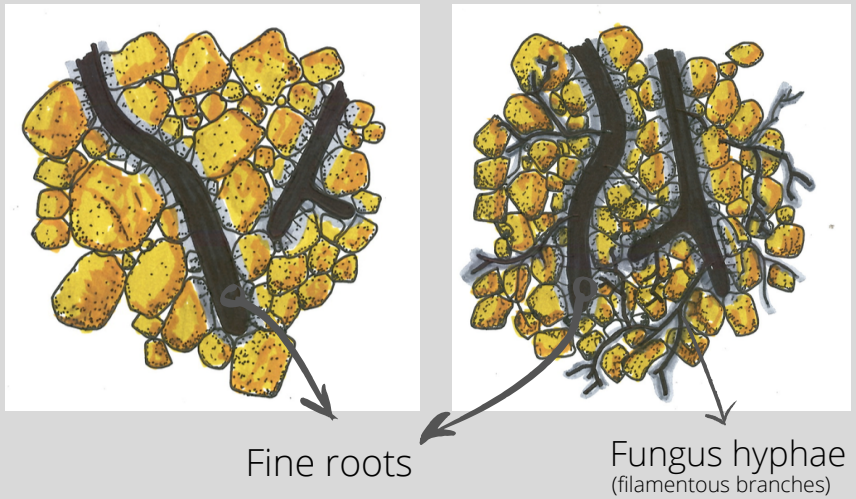
The roots of most plants, for example, are colonized by symbiotic fungi to form mycorrhiza.

Besides these associations, many others benefit nature and thus our well-being.

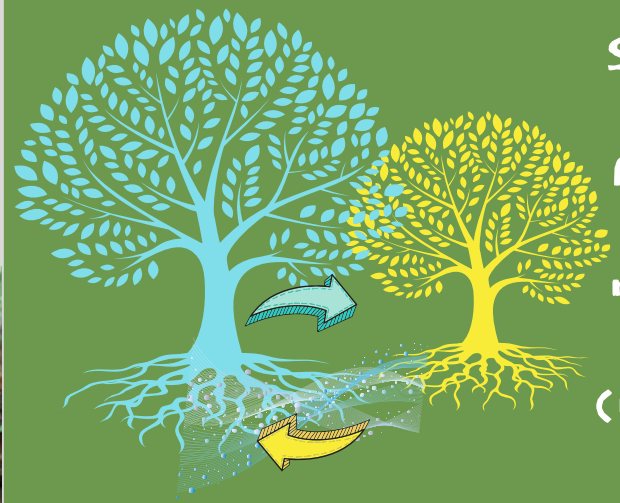
Some examples of soil fungi ....

Mycorrhiza (plant + fungus)

Mycorrhiza (-) Mycorrhiza (+)



Some fungi increase the efficiency of nutrient uptake in poor soils, allowing the host plants to grow and persist in low nutrient environment



Some plant species share mycorrhizal fungi, allowing the transfer of nutrients from one plant to another (networking plant-microbes)

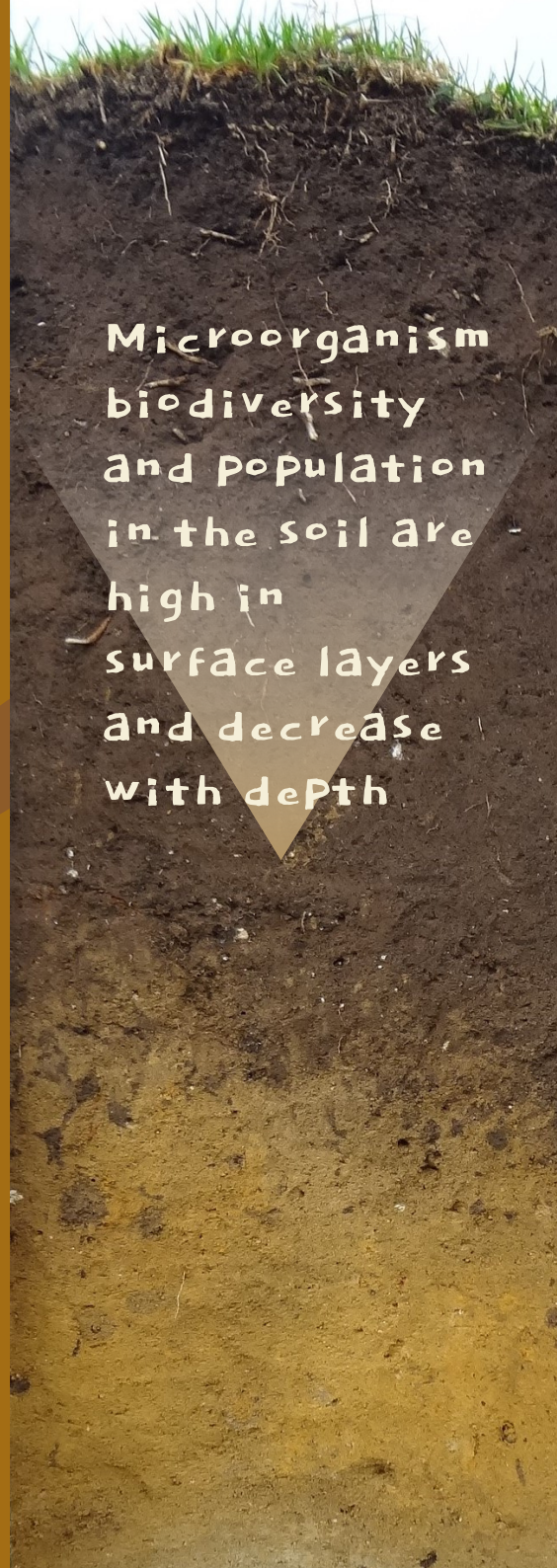
But what are the microbes that live in the Soil

Microorganisms form a very small fraction of soil mass;

However, in a simple teaspoon of soil (about one gram) we can find:

- One billion bacterial cells (corresponding to about ten thousand different bacterial genomes or type of bacteria);
- Up to one million individual fungi,
- About one million cells of protists, and several hundred nematodes.

Beside microorganisms and microfauna, the soil is home to many species of arthropods, earthworms and mammals.



Soil Macrofauna ("soil bugs")

Bugs are invertebrates – small animals that have body > 1cm and width > 2 mm; visible to the naked eye (See some of them in this page)

Earthworms

By their digestive system, earthworms feed on plants debris and soil, increasing availability of nutrients for plants.

The extensive channelling and burrowing by earthworms loosen and aerates the soil, improving the drainage.

Earthworm casts cement soil particles together, making "soil aggregates" more stables.

Soils rich in earthworm are more productive, than without them.

Better soil, better fruits and vegetables

Healthy soils, healthy foods !

There are an amazing number of organisms that keep our lives healthier!!

The food we consume plays an important role in our immune system.

Farmers who manage their soils ecologically are able to produce healthier and delicious food

More flavoured

More taste

More vitamins

More antioxidants

Many other benefits are provided by soil biodiversity ...

Support to plant growth and food supply

MICROBIAL PRODUCTS ARE CRITICAL TO SOIL AGGREGATION, IMPROVING SOIL STRUCTURE, AND MAKING THE SOIL MORE HABITABLE FOR PLANTS

SOIL MICROBES CONTRIBUTE TO SOIL FORMATION THROUGH NUTRIENT CYCLING

SOIL MICRORGANISMS MOBILZE NUTRIENTS FROM INSOLUBLE MINERALS (NOT AVAILABLE) TO SUPPORT PLANT GROWTH

Improves the climate

BY THEIR GROWTH AND ACTIVITIES MICROBES INCREASE CARBON SEQUESTRATION THROUGH THE STIMULATION OF ROOT GROWTH AND CARBON STABILIZATION IN SOIL

THEY ALSO REGULATES THE GREENHOUSE GAS EMISSION FROM SOILS

WATER QUALITY AND FLOOD MITIGATION

WITH THE HELP OF MICROORGANISMS, SOILS ARE ABLE TO ABSORB TOXINS, AGROCHEMICALS, FUELS, RECYCLE ORGANIC WASTE, REDUCING POTENTIAL HARM TO OUR HEALTH.

SOIL MACROPORES FORMED BY ROOTS, EARTHWORM AND OTHER ORGANISMS ARE ESSENTIAL FOR WATER INFILTRATION, AND THUS FOR SUPERFICIAL RUNOFF

INDUSTRIAL AND PHARMACEUTICAL USES

SOIL MICROBES ARE ABLE TO PRODUCE CHEMICAL SUBSTANCES AND ENZYMES EXTREMELY USEFUL FOR CHEMICAL INDUSTRY, PHARMACEUTICS, AND FOOD PROCESSING, TO BE EMPLOYED AS ADDITIVES, CONSERVANTS, DYES AND FLAVORS.

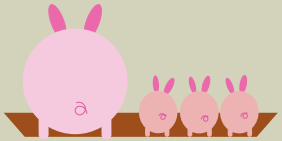
Environmentally-friendly crop production

Biological Nitrogen Fixation

Some soil bacteria transform N2 from atmosphere in available nitrogen for plants. Species like soybean, chickpea, peanuts, beans, lentils are especially benefited by this process and are the bases of human and animal diets

Soybean is main source of protein in the world

Is the main source to livestock production



Pig (29%)

Poultry (53%)

Aquacutlture (8%)

Around 80% of the soy consumed by humans consists of soy oil

This simbiosis between soybean and a soil N2-fixing bacteria (called rizhobium) saving billions of dollars with the replacement of N-fertilizers around the world and with its lower pollution potential

Others examples of nitrogen fixing species used on human diet, around the around:

chickpea

Pea

Tamarind

Peanuts

Lentils

Beans

But soil biodiversity is under threat !!

See the 5 main harmful factors below

Overexploitation of forest resource and conversion of forest to agriculture

The vast majority of terrestrial biodiversity is found in the world's forests. Together, they contain more than 60 000 different tree species and provide habitats for 80 percent of amphibian species, 75 percent of bird species and 68 percent of mammal species. The loss of aboveground biodiversity implies losses below it.

Soil contamination with waste and chemical disposals

The use of some chemical in soils, such as mineral fertilisers can make some plant-microbes relationships redundant, and their breakdown can lead to the loss of other benefits such as nutrient cycling and disease protection.

... others soil microbial threats

Climate change

Soil biota can control the fluxes of CO_2 and others green house gases (GHGs), such as methane (CH_4) and nitrous oxide (N_2O).
Through their capacity to stock carbon, soils can act as a buffer compartment in a context of climate change. But the warm climate increase the soil organic matter decomposition, which makes soil poor and aggravate the climate change.

Unsustainable soil managment practices

Erosion, acidification, excessive fertilizer use, compaction caused by over grazing and some (wrong) farming practices as soil ploughing are harmful to maintenance soil organic matter and to microbial activity

What we can do to save soil biodiversity and human heath?

Traditional and scientific knowlegde bring simple solutions !

Crop rotation and intercropping

Alive roots and organic inputs maintain microbial activities. Defines habitat to soil fauna and can act as natural fertilizer (biological nitrogen fixation). It´s always interesting diversify the production system!

No-tillage

Mulching protects soil against erosion and helps to maintain moisture and temperatures favourable to soil organisms

Apropriate waste disposal

Some industrial and agro-indstrial residues have heavy metals or substances called xenobiontics, in other words environmental pollutants. Knowing their characteristics is possible to disposal them correctly or recycling them.

Others environmentally-friendly practices that keep soil biodiversity alive

Use nutrient wisely

When applied in high quantity inorganic fertilizer could pollute soils, strems and aquifers. In addition they could increase the decomposition of soil organic matter, which harm the soil aggregation and its capacity to allow water infiltration. Soil analysis is recommended for a safe and efficient fertilizer recommendation

Avoid acgrochemicals

As well as fertilizer, agrochemicals affect negatively the soil biodiversity and functioning. Nutrient cycling and pest control are among the most affect services.
Agriculture systems with less inputs are more resilient, more diverse and produce better foods and water

"We need to think global, but act local"

TOGETHER WE CAN PROTECT SOIL BIODIVERSITY !!

Some important actions:

1. Implement land use planning. We must use soil according to its capacity and fitness !
2. Increasing investments in land use sustainable soil management are essencial !
3. Soil monitoring system based in soil bioindicators could help us to produce healthy foods!
4. Environmental education: society needs to understand that in addition to production, the soil provides a lot of valuable goods and services for us ...

You can learn more. Visit these sites :

Soil formation
http://www.fao.org/resources/infographics/infographics-details/en/c/284480/
About soil threats
http://www.fao.org/resources/infographics/infographics-details/en/c/326257/
Soil biodiversity
http://www.fao.org/resources/infographics/infographics-details/en/c/285727/

Make memorable the World Soil Day (5th December)
http://www.fao.org/world-soil-day/en/

Don´t forget ...

Keep soil alive, protect soil biodiversity!!

Bye, Bye!!

Consulted Literature and sites

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Photos

Ademir Fontana (soil profiles, p.: 4 and 6)); Gabriel Faria (No-tillage, p.: 13); Cláudio Lucas Capeche (Crop-rotation, p.: 13); Pricila Vetrano Rizzo (Composting, p.: 13); Felipe Santos da Rosa (Soil sampling, p: 14); CanvaPro (p.: 12 and 14); Alexander-Schimmeck, Cláudio-Capo and Kulli-Kittus (fungus, from unsplash free image plataform, p.: 5) and John-Cameron (waste, p.11) and Fabiano C Balieiro (fire in forest ecosystem, p.11); Other photos from Canva (Pro)

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Wrote by Fabiano de C. Balieiro, using Canva ®