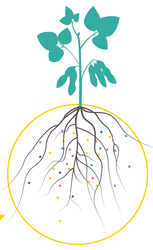
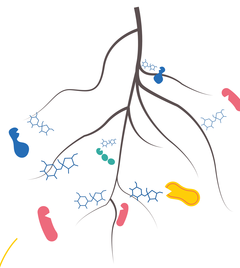
plant-soil interactions



the **rhizosphere** is a bustling metropolis where biological turnover provides available nutrients right where plants need them most!



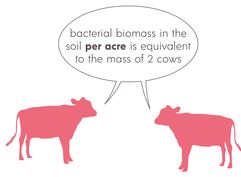
roots release carbon-rich sugars that attract **bacteria** and **fungi**...

...high concentrations of bacteria and fungi attract **protozoa** and **nematodes**...

...and high concentrations of protozoa and nematodes attract **arthropods** and **earthworms**.

the decomposers: **bacteria**

bacteria are the ultimate recyclers. they get their food and energy from decomposing plant and animal residues, which they convert to biomass, preserving the nutrients against losses until predation or turnover releases them in plant-available form.



the connectors: **fungi**

fungi are also important decomposers in the soil food web, but form a unique relationship with plants. fungi connect to and extend plant roots, increasing the uptake of water, phosphorus and other nutrients, providing resilience against pests/disease, and allowing for communication between plants.

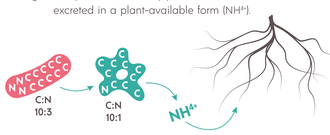
the largest organism in the world is a fungus that is **2.4 miles long** in blue mountains, oregon

$1.5 trillion

the annual value of the services provided by soil microbes

the grazers: **protozoa**

protozoa are on a much stricter diet, grazing mostly on bacteria alone. for every 10 units of carbon, bacteria contain 3 units of nitrogen, but protozoa can only put 1 unit to use. the rest is excreted in a plant-available form (NH^{4+}).



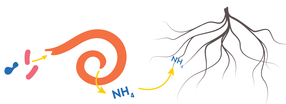
protozoa consume up to **10,000 bacteria/day:**

one protozoan eats 10x this many bacteria every day!

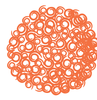
diameter: 1/500 in.
length: 1/20 in.

nematodes

these microscopic worms tend to pass on soil organic matter, preferring to feed on living things! while some attack roots and cause disease, a vast majority feed on bacteria, fungi, and other nematodes, releasing mineral nitrogen (NH^4) in the process.

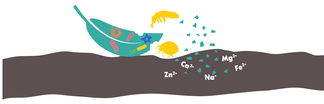


"if all the matter in the universe except the nematodes were swept away, our world would still be dimly recognizable... **by a film of nematodes.**"
- nathan cobb

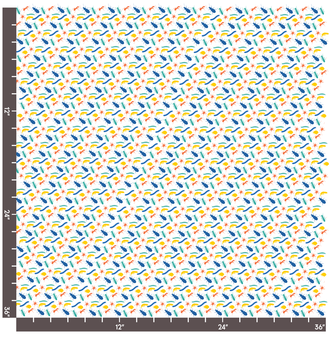


the shredders: collembola & mites

on the prowl for bacteria and fungi to eat, arthropods inadvertently ingest and shred up plant matter. microbes hitching a ride in their guts break it down. like a bioreactor they convert organic residues into plant-available nutrients.



a single square yard of soil will contain **500 to 200,000** individual arthropods, **2-800x** as many this:



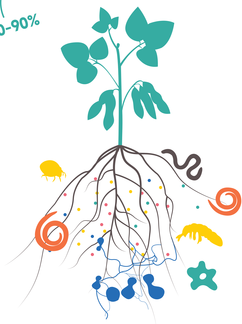
the blenders: earthworms

as earthworms push through the soil creating channels, they combine mineral & organic materials in their guts, excreting well-aggregated casts that help build structure, boost microbial activity, and increase nutrient availability for plants.

earthworms can apply up to **200kPa, or 30psi of pressure** in order to move through a heavily compacted soil, about the amount of pressure that keeps your bike tire intact

the soil food web is responsible for most of the processes that take place in the soil

80-90%



not only are they inhabitants of the soil, **they are the architects of it.**

as they eat and excrete, interact with one another, and navigate the soil ecosystem, they **decompose** waste, **recycle** nutrients, **detoxify** contaminants, **store** carbon, and **build** the kind of structure that resists flooding and drought.

they are a silent army, hidden beneath our feet that supports and sustains life on earth.