
APBI200
SOIL BIOLOGY & NUTRIENTS


Soil Biology -
SOIL ORGANISMS
Part 2

Lecture outline

- Soil fauna
- Abundance of soil organisms
- Soil food web
- Introduction to biochemical transformations

Classification of soil animals

Animals (fauna), all heterotrophs

Macrofauna: Largely herbivores and detritivores (>2 mm in width)

Vertebrates	Gophers, mice, squirrels
Arthropods	Ants, beetles and their larvae, maggots, termites, grubs, spiders, millipedes, woodlice
Annelida	Earthworms
Mollusca	Snails, slugs

Largely predators

Vertebrates	Moles, snakes
Arthropods	Beetles, ants, centipedes

Mesofauna: Largely detritivores (0.2 - 2 mm in width)

Arthropods	Mites, collembola (springtails)
Annelida	Enchytraeid (pot) worms

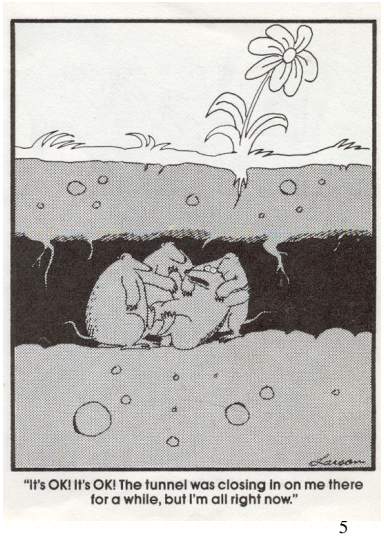
Largely predators

Arthropods	Mites, protura

Microfauna: Detritivores, predators, fungivores, bacterivores (< 0.2 mm in width)

Nematoda	Nematodes
Roterifera*	Rotifers, water bears
Protozoa*	Amoebae, ciliata

Vertebrates (mice, moles, ground squirrels, etc.) mix soil through their burrowing activity



Photos: Wikimedia

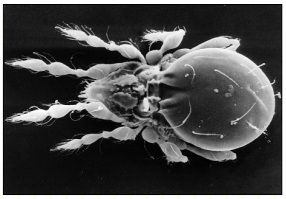
Annelids (segmented worms) most important representatives are earthworms

https://www.youtube.com/watch?v=n3wsUYg3XV0

Arthropods (spiders, mites, springtails, insects) shred plant residues, mix it with soil, and stimulate decomposition within their intestines. Some are predators

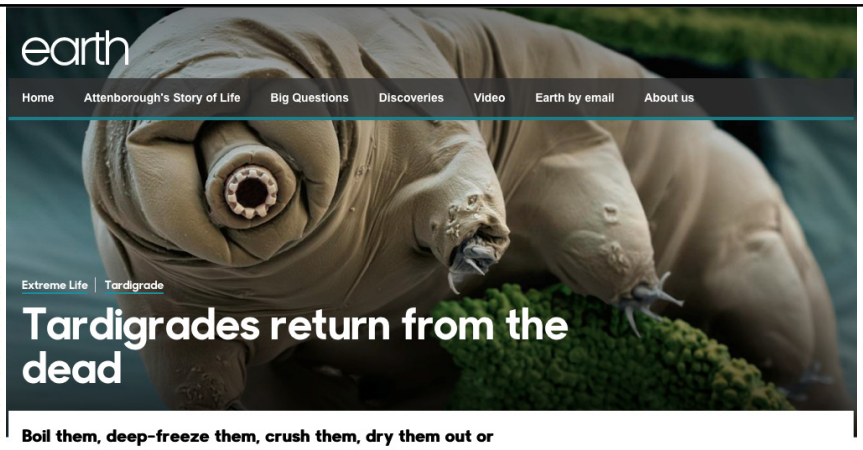
Springtail (collembola)

Millipede



Arachnids mite

Spider

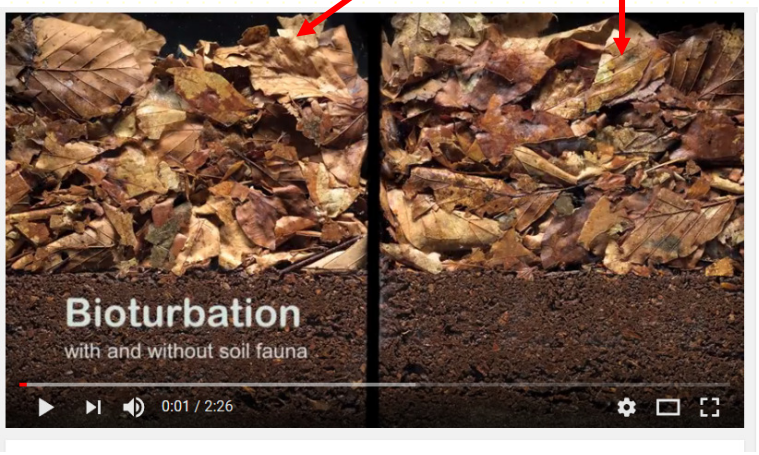


Functions:

- Predators of other animals and grazers of bacteria/fungi/algae → helps in nutrient cycling
- work as pioneer species by inhabiting new developing environments

https://ed.ted.com/lessons/meet-the-tardigrade-the-toughest-animal-on-earth-thomas-boothby

Bioturbation (mixing) without & with soil fauna



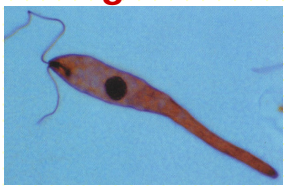
https://www.youtube.com/watch?v=Mxp1nnrUG0Q

Protozoa - "primitive animals"

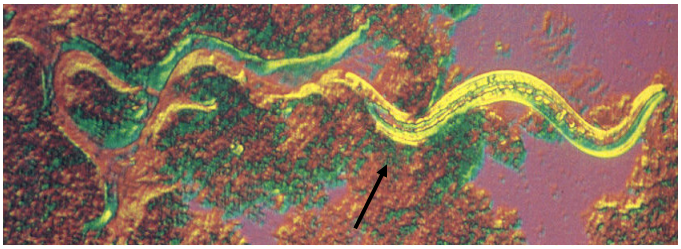
- feed on fungi & bacteria (release excess NH_4^+ near root system), or fragments of organic matter
- help suppress disease by competing with or feeding on pathogens
- are food source for other soil organisms

Ciliate

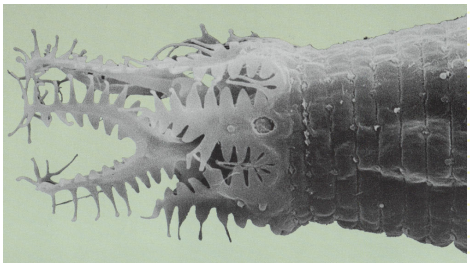
Flagellate



Nematodes (threadworms) - after consuming bacteria, nematodes excrete much of the excess N as inorganic N (ammonia), hence increasing mineralization



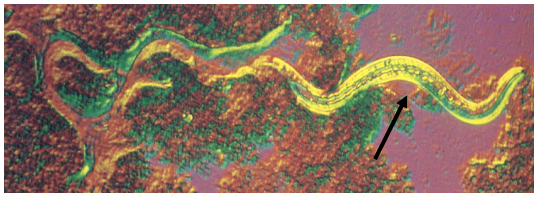
Mouth parts of a plant parasitic nematode



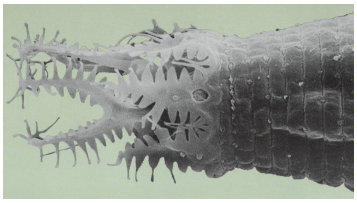
Mouth parts of a bacterial-feeding nematode

Nematodes (threadworms):

- bacterial-feeders - after consuming bacteria, nematodes excrete much of the excess N as inorganic N (ammonia) → increases nutrient cycling
- predators (used for biocontrol of insect pests)
- plant parasites (root feeders)



Mouth parts of a bacterial-feeding nematode



Mouth parts of a plant parasitic nematode

Numbers and biomass of soil organisms in the surface soils

Organism	Estimated number per g	Estimated biomass of species (kg/ha)
Bacteria	$10^8 - 10^9$	400-5000
Actinomycetes	$10^7 - 10^8$	400-5000
Fungi	$10^5 - 10^6$	1,000-15,000
Algae	$10^4 - 10^5$	10-500
Protozoa	$10^4 - 10^5$	20-200
Nematodes	$10 - 10^2$	10-150
Mites	1-10	5-150
Collembola	1-10	5-150
Earthworms	$10 - 10^3$ per m^2	3,000 (in BC)

Estimated number of species in BC

- **Vascular plants** 2,500 species
- **Birds** 450 species
- **Mammals** 100 species
- **Reptiles** 20 species
- **Amphibians** 20 species

  Most species in the groups listed above have been identified

- **Arthropods** 35,000 species (~50% are not yet identified)

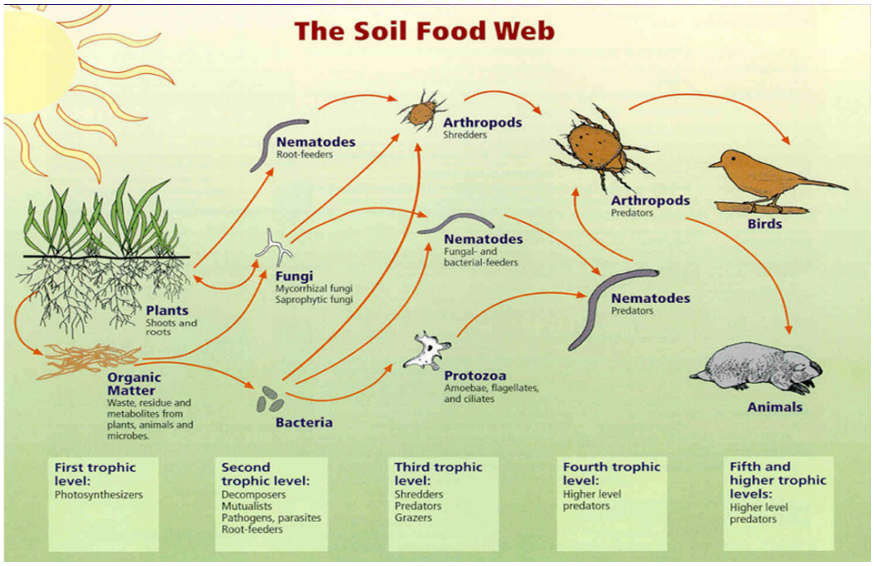
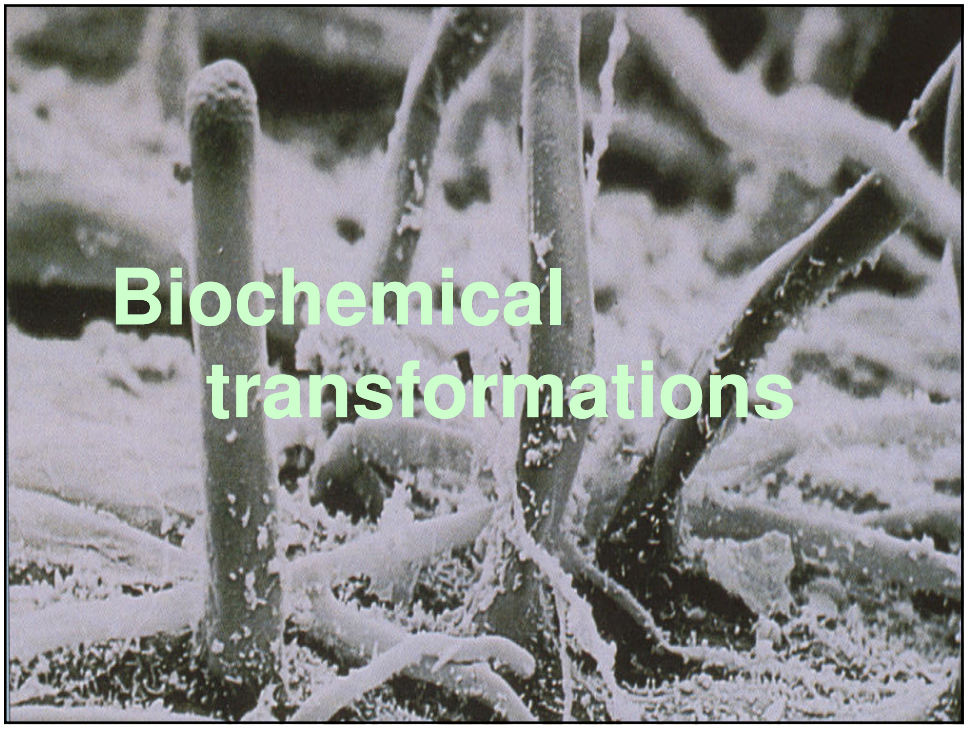
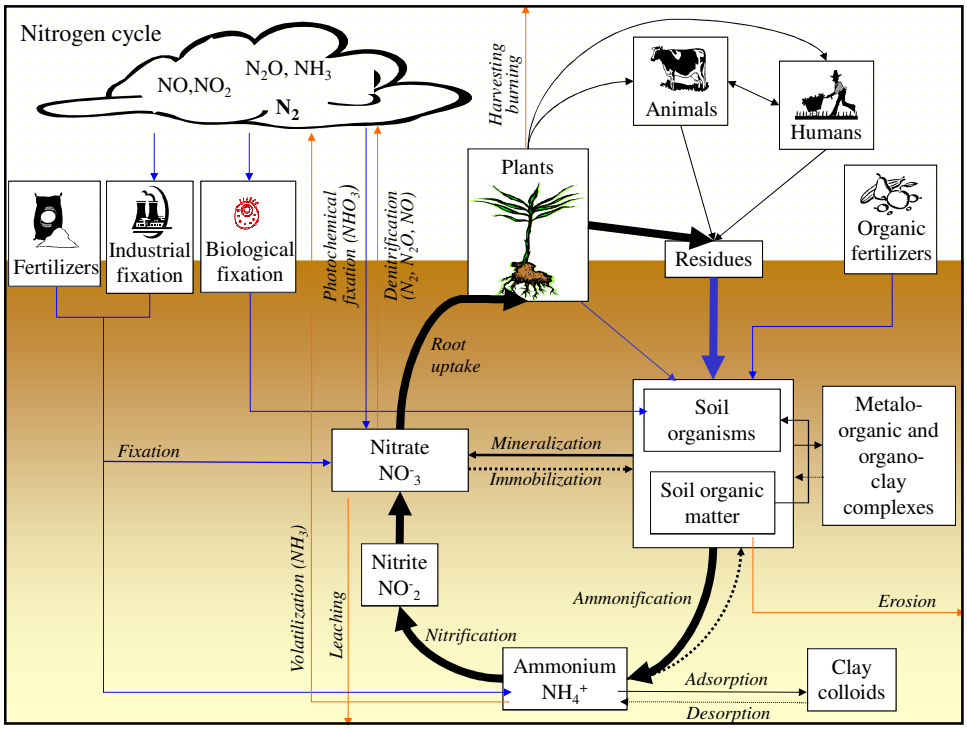


Image courtesy USDA Natural Resources Conservation Service

What are the reasons for greater biological diversity in soils relative to aboveground ecosystems?


Biochemical
transformations


Nitrogen cycle
NO,NO2
N2O, NH3
N2
Harvesting
burning
Animals
Humans
Plants
Fertilizers
Industrial
fixation
Biological
fixation
Photochemical
fixation (NHO3)
Denitrification
(N2, N2O, NO)
Residues
Organic
fertilizers
Root
uptake
Soil
organisms
Metalo-
organic and
organo-
clay
complexes
Fixation
Nitrate
NO-3
Mineralization
Immobilization
Soil organic
matter
Nitrite
NO-2
Volatilization (NH3)
Leaching
Ammonification
Erosion
Nitrification
Ammonium
NH4+
Adsorption
Clay
colloids
Desorption

The sources of soil N are:

- Biological fixation of N_2
- Deposition of N (NO_3^- and NH_4^+) compounds from the atmosphere by precipitation
- Fertilizers
- Plant residues
- Manure

Addition of organic matter

Processes that are mediated by soil organisms

The losses of soil N occur through:

- Plant removal
- Leaching
- Gaseous losses (denitrification and NH_3 volatilization)
- Erosion (wind and water)
- Ammonium fixation (clay complexes)

Processes that are mediated by soil organisms