SOIL BIOLOGY: LEARNING ABOUT WHAT LIES BENEATH

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Did you know that in one kilogram of surface soil there is between 5 and 100 km of fungal hyphae? Did you know that there can also be one thousand up to one million protozoa in that same sample of soil? If you didn't realise this, then you should have been part of our Soil Biology workshop, where you could have found out this and so much more about what lies beneath our feet!

The workshop, organised by Murrumbidgee Landcare's Cross Property Project and the Riverina Local Land Services (LLS), was held at Humula in October 2014. 14 land holders from around Humula, Tarcutta and Ladysmith attended the workshop, presented by Janelle Jenkins from the Riverina LLS.

The day was designed to be very hands on, giving participants the opportunity to better understand their own soil. Prior to the workshop, the participating land holders each collected soil from two different paddocks on their properties. These soil samples were sent away for chemical analysis. At the workshop, everyone received the results of their two soil tests, and there was a discussion of how to interpret the results.

Land holders also brought extra soil and clover plants from their sampled paddocks along to the workshop. This allowed participants to examine their own soil for macro and mesofauna, wash and detect root nodules on their clover plants, and spend time examining their soil for microfauna under a microscope.

Other topics covered on the day included learning about the influence of different groups of soil organisms on plants and soils, measuring soil biology, understanding the correlation between soil chemistry and soil biology, and discussing the influence of farm practices on soil health.

If you would be interested in attending a Soil Biology workshop in the future, please contact Jacinta Christie from Murrumbidgee Landcare: 0431 953 788 or jchristie@mli.org.au.

Land holders at the Soil Biology workshop at Humula examine their soils for signs of visible life

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Judy and Mike Slack-Smith of Humula examine their soil

Ty Hardy and Peter Sykes use microscopes to search for microfauna in their soil

Soil biology: Soil organisms

Soil organisms play a crucial role in decomposing organic matter, cycling nutrients and fertilizing our soils. Understanding the different soil organisms present, along with their functions and relationships, can allow us to better manage our soils, to encourage and maintain healthy soil biology and help generate more productive pastures and crops.

There are four levels of soil organisms, described below: microflora, microfauna, mesofauna and macrofauna.

Benefits of soil organisms

- Promote plant growth
- Enhance nutrient supply to plants
- Increase mineralisation and nutrient cycling
- Fix nitrogen
- Sequester carbon
- Stabilise soil structure
- Reduce impact of soil pollutants
- Reduce soil-borne pests and diseases

Microflora

The microflora are generally microscopic, and include bacteria, fungi and algae. Bacteria and fungi carry out 80-90% of all biological activity in the soil. They are the primary decomposers of organic matter, and are responsible for nutrient cycling and transforming nutrients into forms which plants can take up and use.

- *Bacteria*. Bacteria are some of the smallest and most abundant microbes in the soil. In a single gram of soil, there can be billions of bacteria. Most live in the top 10 cm of soil, where organic matter is present. They are generally found around the root tips of plants, and depend on flowing water to move through the soil.

  Bacteria are important in the decomposition of organic materials. In addition, Rhizobium bacteria, found on the roots of legumes (plants such as clover, beans, medic and wattles), are able to convert nitrogen gas from the air into forms that plants can use (a process known as nitrogen fixation).

- *Fungi*. Fungi consist of hyphae, which grow as ‘threads’ through the soil. Hyphae can be as small as a few cells, or can stretch as a network for metres or even kilometres throughout the soil.

  Fungi are important in the decomposition of hard, woody organic matter. They also help improve soil structure, as the fungal hyphae bind soil particles together to create water-stable aggregates which in turn create the pore spaces in the soil that enhance water retention and drainage. Mycorrhizal fungi colonise plant roots where they help the plant to obtain nutrients such as phosphorus from the soil, by providing a greater root area through which the plant can obtain nutrients.

Microfauna

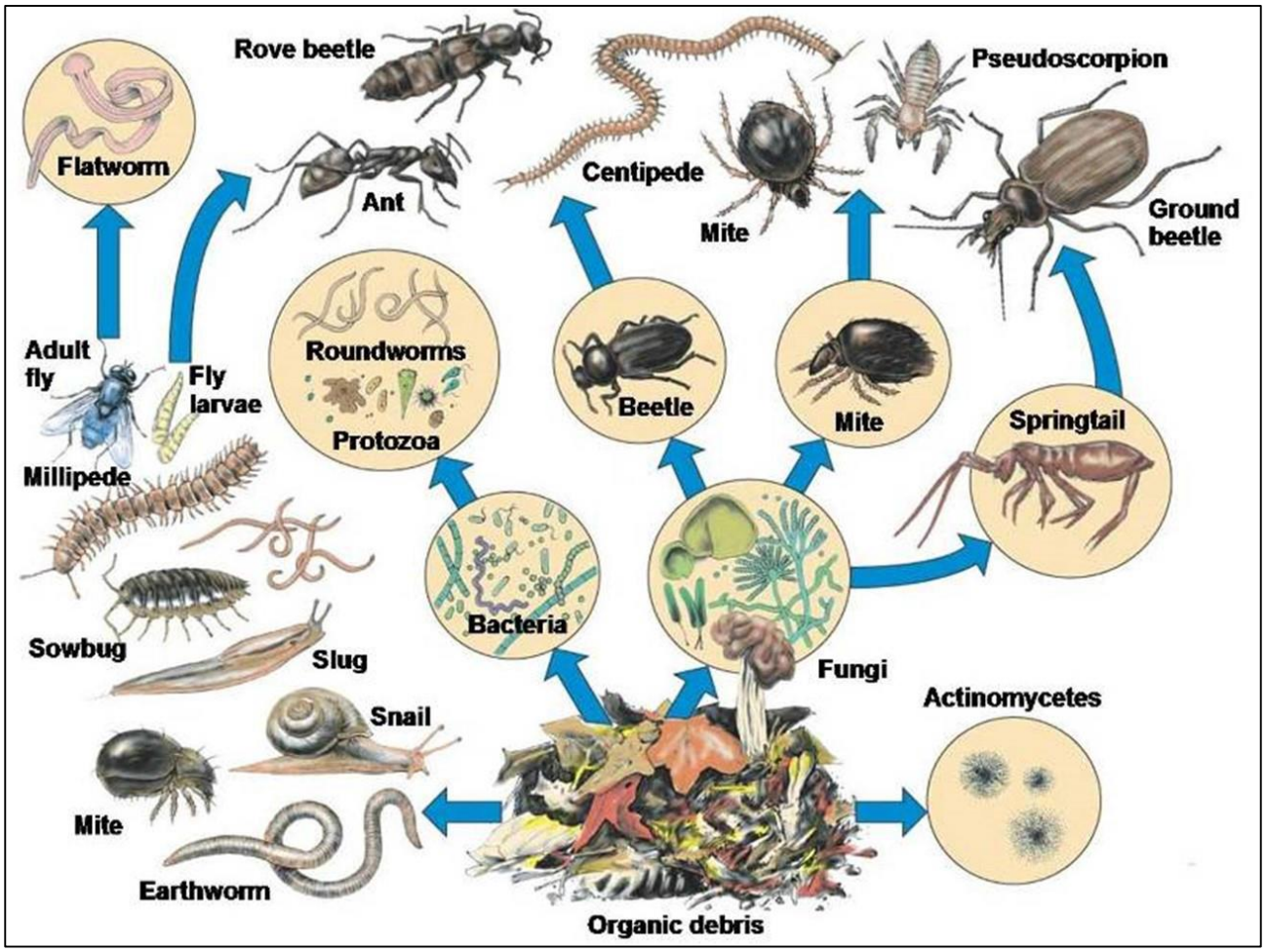
The microfauna are small soil animals, including protozoa and nematodes. They range in size from microscopic to those that can just be seen with a magnifying glass. Most depend on flowing water to move. They graze on the microflora, and are able to ingest small particles of soil organic matter, which are then decomposed by enzymes within the organisms.

- *Protozoa.* Protozoa need bacteria to feed on. They are particularly active in the rhizosphere (the area around plant roots). They help release plant available nutrients to

the soil.

- *Nematodes*. Nematodes are small, non-segmented 'worms' less than 1 mm long. They live in the thin films of water surrounding soil particles, and are generally found in well-structured soils with large pore spaces, or coarser soils, where food is easily available.

  Nematodes help break down organic matter, and release nutrients into the soil when they eat bacteria and fungi. They also help by dispersing bacteria and fungi, which cannot move around in the soil without 'hitching a ride' inside or on the back of nematodes. Nematodes can also attack and kill a range of pests such as borers, grubs, thrips and beetles. The digested pests are then added to the soil organic matter reserves.



An example of the soil food web (courtesy of Janelle Jenkins)

Mesofauna

The mesofauna are organisms that you can see with the naked eye, and include spiders, mites and springtails. They need moist soil to avoid drying out, and generally remain on or near the soil surface, within larger soil pores, channels and other sheltered sites such as litter.

Mesofauna graze on fungi, algae and lichens in the soil, and play an important role in mixing the soil.

Macrofauna

The macrofauna are generally easily seen with the naked eye, and include earthworms, beetles, termites, ants and slaters. They can be described as shredders, predators and soil engineers. Some need moist soil, while others have protective skins.

Macrofauna are responsible for recycling dead and decaying matter. Their burrowing activity aerates the soil, which allows water penetration, provides channels for root growth and increases soil aggregation. Their bioturbation (disurbance of the soil) also performs an important role in mixing organic matter and top soil with soil from lower down the profile.

Encouraging beneficial soil organisms

- Provide a hospitable environment: There must be enough food (organic matter), water and suitable hosts (if necessary).
- Address soil health problems: Soil issues such as acidity and compaction depress bacteria populations.
- Reduce soil disturbance: Tillage has a disastrous effect on fungi as it physically severs the hyphae and breaks up the mycelium.
- Build organic matter: Use practices such as green manure crops and strategic grazing, and ensure that there is a good ground cover of grass or mulch.
- Reduce fungicide use: Broad-spectrum fungicides are toxic to a range of fungi. Their use will result in a decline in the numbers of beneficial types.
- Reduce use of pesticides: The use of pesticides that enter the soil can affect nematode numbers in the soil. Some have a direct detrimental effect, while other agricultural chemicals produce non-target effects that damage nematode populations.
- Grow plants that encourage mycorrhizal fungi: Arbuscular mycorrhizal numbers reduce under wheat, canola and lupin, and also under a bare fallow. When these plants are included in a rotation, fungi numbers drop due to the lack of host plants and this reduces fungi colonisation in the following crop. Mycorrhizal numbers increase under highly mycorrhizal plants such as pasture grasses and legumes.

Acknowledgement

The information in this article was taken from Murrumbidgee Landcare's Soil Biology Workshop, run by Janelle Jenkins (Riverina Local Land Services), and the NSW DPI's Soil Biology Basics information series, available at: www.dpi.nsw.gov.au/agriculture/resources/soils/biology/soil-biology-basics.