Compost Education Centre

Factsheet Series

Compost Ecology

#8

Composting is a biochemical process, meaning that decomposition takes place as a result of biological life breaking chemical bonds. Microscopic organisms such as bacteria, actinomycetes and fungi chemically break down organic material via enzymes that they secrete. The decomposition process is finished by physical digestion through the digestive systems of larger macroorganisms.

Our goal when composting is to create optimum conditions for these organisms to thrive and do the work of recycling our organic waste into nutrient-rich humus for our gardens. These organisms are also beneficial when transferred to our garden soils, where they continue working to improve soil structure, make nutrients more available to plants, and fight pests and disease.

The Compost Food Web

Three levels of decomposers work in a compost pile to break down raw organic matter into the nutrient-rich, soil-like texture of finished compost. Organisms at each level of the food web help keep populations of the other levels in balance (take note of the numbers next to each group of organisms in the illustration below).

- **Primary Decomposers** (e.g. bacteria, fungi, earthworms, sow bugs, some mite species) eat only organic matter.
- **Secondary Decomposers** (e.g. springtails, some mite species, nematodes) eat organic matter and primary decomposers.
- **Tertiary Decomposers** (e.g. centipedes, ground beetles, ants) eat primary, secondary and tertiary decomposers.

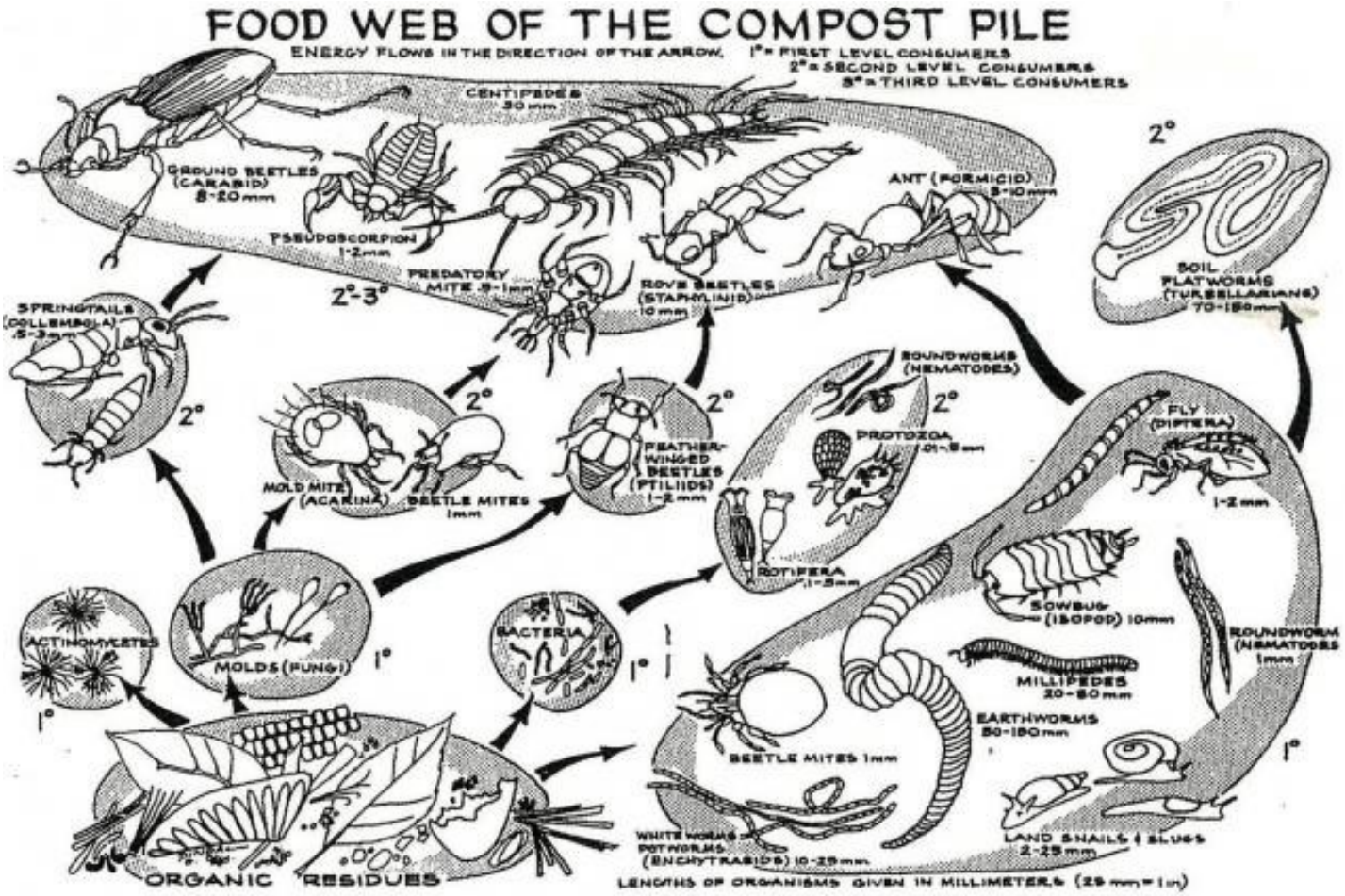


Image credit: Appelhof, M., Fenton M., Harris, N. 1993. Worms Eat Our Garbage: Classroom Activities for a Better Environment. Pg. 89 All uncredited mages from Wikipedia.

Microorganisms

Microorganisms are organisms that cannot be seen with the naked eye. They are the primary decomposers responsible for the breakdown of organic material at the microscopic level.

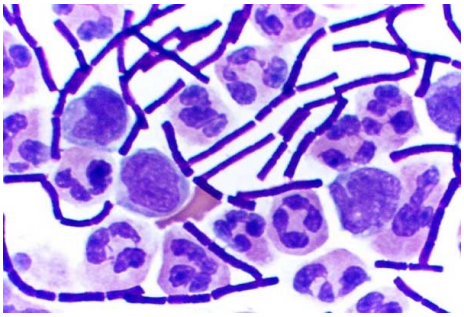
The Microorganism/Temperature Relationship

Your compost pile microorganisms (see the illustration on page 1) change with time and differing temperatures :

- Mesophillic (thriving in temperatures of 10^{o}C to 45^{o}C) bacteria and fungi are the first to go to work. The temperature of the compost pile gradually increases due to these microorganisms breaking complex molecules into simpler forms - a process which releases heat as a byproduct.
- As the temperature of the pile increases, thermophillic (thriving in 45^{o}C to 70^{o}C) bacteria take over, further breaking down organic material.
- As the majority of material gets broken down and thermophillic bacteria begin to run out of food, the pile starts to cool down. Actinomycetes and fungi enter in at this point to begin finishing the decomposition process.

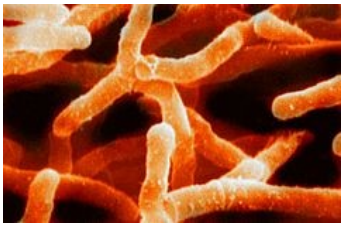
Bacteria

Bacteria are the most prevalent microorganisms in your compost pile. The ones we want to concentrate on are aerobic (require oxygen in order to live) and can endure the higher temperatures of the compost pile. The two main nutrients they require to do their work are carbon and nitrogen. They break down complex molecules of carbon into simple sugars which they use as an energy source. Nitrogen molecules are broken down into simple amino acids which the bacteria use as building blocks for growth and reproduction. Phosphorous, potassium and other micronutrients play a role here as well, providing the elements necessary for the bacteria to produce their digestive enzymes.



Actinomycetes

Actinomycetes are a higher-level bacteria that are the second most abundant microorganisms in your compost pile. They take over during the final stages of decomposition, conducting the finishing steps to make nutrients available for uptake by plants. The most notable byproduct of their digestive processes is the sweet, earthy smell that both finished compost and healthy soil have.



Fungi

Fungi are simple plant forms that can often be recognized in the compost pile as long, white, filamentous strands. They are one of the organisms responsible for breaking down lignin, the fibrous substance in woody materials. This why you will often see these white filaments under the bark of decaying trees in the forest. If there is lots of woody material in your compost, then it is likely that your finished product will be fungally dominated rather than bacterially dominated.

Macroorganisms

Macroorganisms are organisms we can see without the aid of a microscope. They are more active in the later stages of the composting process, when temperatures have dropped but decomposition is not complete. Macrodecomposers digest food physically by chewing, grinding and excreting.

A few macroorganisms you are most likely to see in and around your compost pile are (see the diagram on page 1):

Worms

Worms are the most talked-about macroorganism in the compost pile (and in the garden!). They consume bacteria, fungi, protozoa and organic matter. As they digest organic materials they leave nutrient-rich, refined castings in their path. Unlike other large decomposers, they break down material both physically and chemically.

Worms also slowly and continuously aerate and mix the compost pile by moving vertically up and down through its layers.

You can find two types of worms in the compost: earthworms (Lumbricus terrestris) and red wrigglers (Eisenia foetida). If your compost pile conditions are favourable, worms will find their way to it. We don't recommend purchasing worms to put in your compost pile, as they tend to migrate away quickly. But if you build it right, they will come!

Sow Bugs

Sow bugs are easy to identify by their grey, flat, segmented bodies. They eat bacteria and are often abundant in the compost pile. They act like "taxi cabs", shuttling the nutrients that attach to their bodies throughout the compost pile.

Mites

These extremely tiny macroorganisms can be spotted as light brown, white or red specks traveling around the compost pile. They feed on organic matter, and some of them prey on fly larvae and other mites.

Centipedes

The brown, shiny, many-legged bodies of centipedes are often seen in the compost pile. They are third level decomposers, meaning that they feed on higher-level organisms like spiders and worms. A few are nothing to worry about, but if too many centipedes occur in the compost pile, they can overpredate more beneficial organisms like worms.

Optimum Microbe Conditions

Remember the key factors for successful composting (see Factsheet #1)? Those are actually the key conditions needed by microbial life in order to thrive!

- **Moisture** - Many microorganisms breathe through their skin and require a moist environment in order to carry out this process (like our lungs are kept in a moist environment inside our bodies). However, if the pile is too wet, the microorganisms are susceptible to drowning. Therefore, you need to make sure your pile is as **moist as a wrung out sponge** so these little guys can do their work!
- **Air** - Backyard composting is an aerobic decomposition process, meaning that the microorganisms responsible for breaking down your waste require oxygen in order to live. **Aerate your pile weekly** by disturbing it regularly with a garden fork or Wingdigger (available for sale at the Compost Education Centre).
- **Surface Area** - Chopping your materials up as small as your time and energy allows increases the availability of soft surfaces for microorganisms to digest, resulting in a faster composting process.
- **Diversity of materials** - The greater the diversity of materials you create your compost with, the greater the diversity of beneficial microorganisms you will have in your pile.

It is important to remember that without these microorganisms there would be no decomposition of our food waste. So look at and touch your compost pile regularly to get a feel for its moisture and air levels!

Compost Organisms in Your Soil

It is important to remember that the reason we are trying to create such microbially-diverse compost is that it will ultimately benefit our soil. Just as we carefully maintain compost conditions to breed beneficial microorganisms, we also need to support microbial life in our garden soils.

What do soil organisms do for us?

1. Make nutrients available to plants

Some fungi and bacteria form symbiotic relationships with plants. These organisms attach themselves to the surface, or in some cases the inside, of plant roots. Nutrients that were once inaccessible to the plant are broken down into available forms via the enzymatic activity of the microorganisms. The nutrients can then be easily accessed by the plant due to the close connection of the fungi or bacteria with the plant's roots. In return for this service, the plant provides carbohydrates (energy in the form of sugars) that allow these microorganisms to live and reproduce.

Nitrogen-fixing bacteria root nodules

Even without forming a symbiotic relationship, soil organisms liberate nutrients from organic matter through their digestive processes, contributing to the overall nutrient content of your soil.

2. Build soil structure

As organisms move through the soil ingesting plant matter, they improve soil structure. Earthworms move vertically up and down through the soil (they come to the surface to mate), mixing the soil layers, creating air pockets for plant roots to expand into and depositing their nutrient-rich castings behind them. Fungi help bind soil aggregates through their network of hyphae (root-like strands that extend from the fungi to permit feeding and vegetative propagation). Aggregation of soil increases its water-holding capacity and also creates air spaces within the soil profile.

3. Fight pests and disease

The greater the diversity of soil organisms you have, the healthier your garden will be. Just like in the compost pile, your soil has a food web with primary, secondary and tertiary levels that consume each other. Beneficial macroorganisms consume the larvae of many common garden pests such as aphids and cabbage moths, while microorganisms can help to fight fungal diseases such as powdery mildew.

Soil Stewardship

Microorganisms in the soil still need water, air and food. They also thrive in a relatively undisturbed environment.

Here are a few steps you can take to help the microbial populations in your garden:

- **Add compost**

As this factsheet has explained, a properly managed compost is home to billions of beneficial microorganisms, many of which are transferred to your garden soil when you amend it in the spring and fall.

- **Mulch**

Protecting the soil with a layer of leaves or straw helps to prevent it from becoming waterlogged or too dry for the organisms living in it. Keep those moisture conditions you were working on in your compost pile going in your garden soil!

- **Dig less**

Fungal hyphae can extend for kilometers in undisturbed soil. Because these filaments provide important services in your garden, avoiding chopping them up through tilling or lots of digging is advised. No-dig gardening is practiced in many gardens as a way of preserving the soil structure and the life in it. It involves planting into the hole left when you pull out a plant that has come to the end of its life.

- **Compost Tea**

Compost tea is a wonderful way to inoculate your garden with billions of beneficial microorganisms. It is a liquid amendment you can make yourself and apply to your garden as a foliar spray or soil drench. The Compost Education Centre's free workshop on Advanced Composting contains valuable information on this essential organic gardening tool.

Compost Education Centre

1216 North Park St.
Victoria, BC V8T 1C9
250-386-9676
info@compost.bc.ca
www.compost.bc.ca
Wednesday - Saturday
10am-4pm

Base funding provided by the Capital Regional District and City of Victoria.