Fact Sheet Series

Compost Ecology

#8

Composting is a biological process resulting in the rapid decomposition of organic matter. This process is carried out by the many organisms that exist within a compost pile. Bacteria are the primary decomposing organisms, but many other organisms, including actinomycetes, fungi, worms, and beetles all contribute to the process.

In a compost pile, our goal is to create optimum conditions for these organisms to thrive and do their work, enabling them to decompose organic material at a pace much quicker than in nature.

Compost Organisms

Three levels of decomposers work in a compost pile. Organisms at each level of the food web help keep populations of the other levels in balance.

First level decomposers eat only organic matter. These include:

- Bacteria, molds, fungi, earthworms, and sow bugs

Second level decomposers eat organic matter *and* first level decomposers. These include:

- Springtails, mold mites, roundworms, beetle mites, and protozoa

Third level decomposers are flesh eating predators that eat other organisms:

- Centipedes, rove beetles, ants, and predatory mites

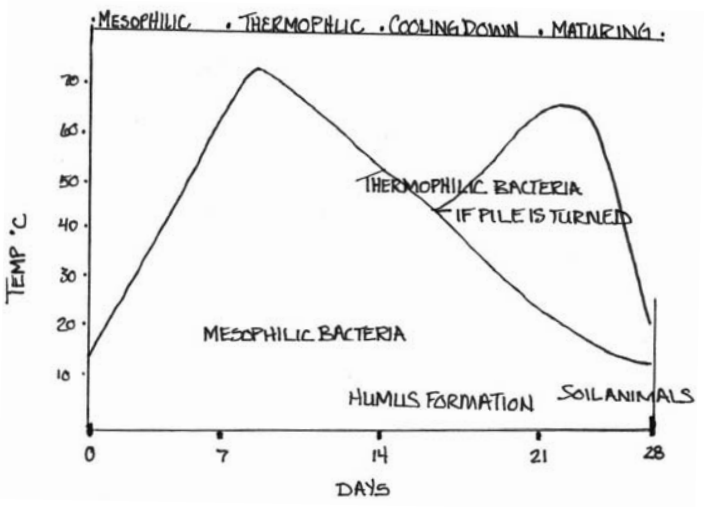
The process of decomposition is both chemical and physical. Microscopic organisms such as bacteria, fungi, and actinomycetes decompose organic material through a process of chemical decomposition. Macro-level organisms, those we can see with our naked eyes such as centipedes, worms, beetles, and springtails, decompose organic matter through physical processes.

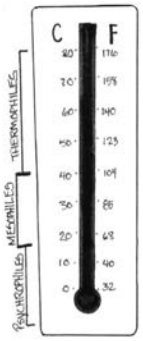
Micro-level Decomposers – Chemical Decomposition

Bacteria

Bacteria are the most important micro-organisms in your compost pile. They require both carbon and nitrogen, which come from organic materials, in order to flourish. They use carbon as a source of protein and nitrogen as their main source of energy. Bacteria can eat almost anything - living or dead. However, the greater the variety of materials you put in your compost, the greater the likelihood that bacteria will find an optimum blend of essential nutrients.

To eat, bacteria secrete an enzyme that softens materials, allowing them to engulf, ingest, and metabolize organic matter. This process not only softens and breaks down material in your compost, it also produces heat. Different bacteria work at different temperatures, and so as the temperature of your compost pile increases other bacteria become active.





- **Psychrophiles** go to work first, working at temperatures between 0°C and 18°C. They help generate heat to allow the next level of bacteria to go to work.
- **Mesophiles** work between 15°C and 40°C, but thrive between 21°C and 32°C. They raise the temperature of the compost pile for the thermophiles.
- **Thermophiles** work at temperatures from 40°C to 70°C. These are the most efficient decomposing bacteria in a hot composting pile.

Bacteria reproduce quickly in favorable conditions, by a process called binary fusion.

Some bacteria exist in aerobic conditions (with air), while others prefer anaerobic conditions (without air). Aerobic bacteria decompose materials much quicker than anaerobic bacteria, and do not produce an unattractive smell. The anaerobic process, called *fermentation*, results in the formation of ammonia-like substances (hydrogen sulfide and methane) which smell like rotting eggs. However, anaerobic composting retains more nutrients than aerobic composting.

Actinomycetes

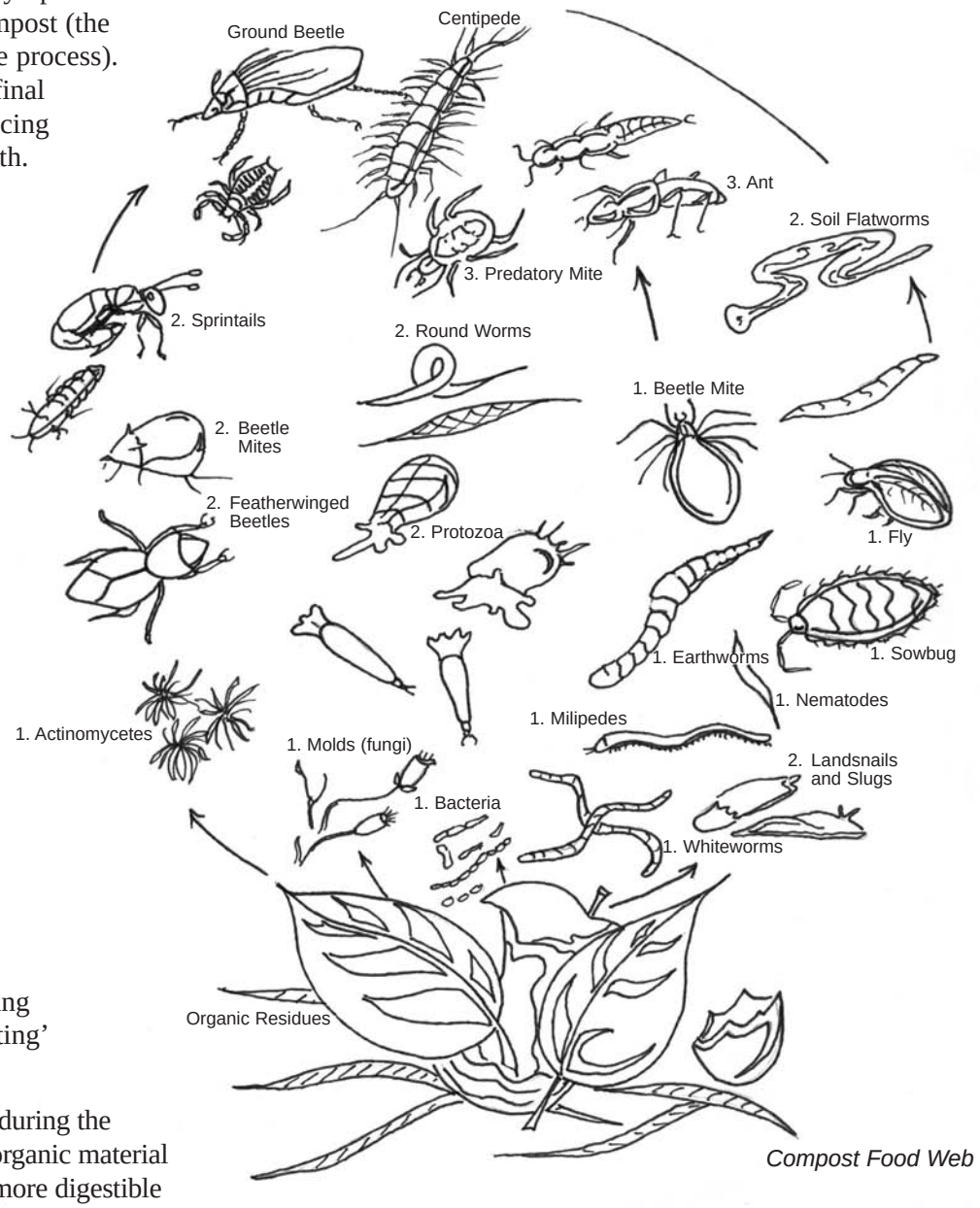
After bacteria, actinomycetes are the second most abundant micro-organism in your compost pile. They do not respond well to acidic conditions (below pH 5.5) or high moisture conditions. They operate best at medium temperature areas of the compost (the edges of the pile and at the end of the process). Actinomycetes take over during the final stages of decomposition, often producing antibiotics that inhibit bacterial growth. They work on tough-to-break-down organic material (avocado shells, seeds, glossy leaves) and they give compost its pleasant earthy smell. They are especially important in the formation of humus - organic matter that has reached the final state of decomposition. As well, actinomycetes liberate carbon and nitrogen, making these important nutrients available to plants.

Fungi

Fungi are smaller in number than bacteria or actinomycetes, but larger in body mass. Fungi are simple organisms that lack a photosynthetic pigment. Their simple individual cells may be linked together in long filaments. In natural forest ecosystems, single fungi organisms have been found to spread over several square kilometers. Fungi live on dead or dying material and obtain energy by 'ingesting' organic material.

Like actinomycetes, fungi are present during the final stages of composting, when the organic material has been converted (by bacteria) to a more digestible form. Fungi are also the only organisms that can break down lignin, the gluey substance found in woody materials. Therefore, in a compost pile with lots of woody twigs, the fungal component will be higher than one with just green garden and food waste. Of the three mentioned major micro-organisms, fungi function the best under acidic conditions.

Fungi reproduce by releasing spores from a fruiting body. The fruit, called a mushroom, releases spores into the air, and the wind carries the spores off to start the next generation.



Compost Food Web

Macro-level Decomposers

Macro-organisms are the visible organisms involved in transforming organic material into compost. They are more active in the later, mature stages of the composting process, when temperatures are dropping but decomposition is not yet complete. Macro-decomposers ingest food physically, by grinding, chewing, sucking, digesting, and churning.

Worms

Worms are the most easily recognizable and most important macro-organisms in a compost pile. You can find two types of worms in the compost: earthworms (Lumbricus terrestris) and red wigglers (Eisenia foetida). Earthworms prefer to move through the open soil, while red wigglers prefer enclosed spaces. Worms consume bacteria, fungi, protozoa, and organic matter. As they digest organic materials they leave nutrient-rich castings in their path. Unlike other large decomposers, they break down material both physically and chemically. See our Fact Sheet #2 for more information on using worms for indoor composting.

Red wriggler worms

Springtails

Springtails are small insects distinguished by their ability to jump when disturbed. They principally feed on fungi, though they also eat molds and nematodes and chew on decomposing plants. They vary in colour from white to blue to black.

Springtail (Image from www.nyccompost.org)

Nematodes

Nematodes (round worms) are the most abundant invertebrates in the soil. Some nematodes live on decaying organic matter, while others are predators on other nematodes, bacteria, algae, and fungal spores. There are also pest forms of nematodes that attack plant roots.

Whiteworms

Whiteworms (or potworms) are about an inch long. They help finish compost by breaking particles of material down into smaller pieces.

Centipedes

Centipedes are flattened and segmented with one pair of legs in each segment. They have 15 or more pairs of legs. They are third level consumers that feed on soil invertebrates their size or larger. This means that they are unwelcome in a worm bin as they may attack and kill the worms.

Keeping Organisms Alive

The conditions required to keep all these compost organisms alive are essentially the conditions that are needed to create good compost:

- **Adequate moisture.** Keep the compost about as wet as a damp sponge. Too much moisture can drown organisms, while too little causes dormancy.
- **Air.** Without air organisms die quickly. Aerating your compost pile ensures they will remain populous. When constructing your compost pile, use woody and fibrous branches to create air pockets throughout the pile.
- **Diversity.** Diversifying the types of materials added to the compost will improve the diet for compost organisms.
- **Surface area of materials.** Smaller materials are easier for compost organisms to ingest.

It is important to remember that without these compost organisms there would be no compost. So take a good look inside your compost pile the next time you visit it and see how many of these organisms you can find. You'll be surprised how many there are when you look closely!

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, we also need to support microbial life in our soil. Soil organisms still need water, air and food. A good soil structure will provide air, so be careful not to over-till or over-dig your soil. And continually adding organic matter to your soil will feed the organisms.

What is the Role of Organisms in the Soil?

Organisms play many roles in our soil, and are a major factor in ensuring plant health. Here are just a few of their many important roles:

1. Create symbiotic relationships with plants

Fungi and bacteria form important relationships with plants. The organisms attach themselves to plant roots and help the plant take up water and nutrients. Some fungi help to extract valuable nitrogen from the air to feed to plants through their roots. In return, the plants provide carbohydrates (energy) to the fungi, allowing them to thrive.

Compost is essential for maintaining healthy microbial life in the soil. (Images of mite, worm and sowbug from www.nyccompost.org)

2. Decompose organic matter

Soil organisms continually consume plant material and other organic matter. As these materials are broken down their stored nutrients are released and made available to plants.

3. Build soil structure

As organisms move through the soil, ingesting plant and organic matter, they help improve soil structure. As earthworms move up and down through the soil (they come to the surface to mate), they help mix and aerate the soil, aiding plants in their growth. When organisms ingest, metabolize and then excrete matter, they are adding nutrients, especially nitrogen, to the soil. Fungi help bind soil aggregates through their networks of hyphae (root-like strands that extend from fungi to permit feeding and vegetative propagation), that improve soil structure by promoting better water and nutrient retention.

4. Fight disease

The greater the diversity of organisms that exist in your soil, the more difficult it is for pathogens to get out of control. Microbe-rich compost tea can be used for disease suppression and prevention.

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