

# *The Science of Composting*

**Composting** is the biological decomposition or breakdown of organic material by bacteria and other organisms. Bacteria are the primary decomposing organism, but there are many others, including fungi, actinomycetes, worms and beetles. These organisms bring about decomposition by feeding on organic material. The result is compost or humus, a dark, nutrient-rich soil conditioner.

While our ancestors recognized that composting was useful in building soil and growing healthy plants, they didn't know how or why it worked. Much of the how and why of composting has arisen out of the explosion of interest and research into composting over the last 50 years. This research has produced a body of information that we call the "science of composting".

Any organic material in the natural environment will decompose over time. Composting, as a science, looks at the factors that enable decomposition to proceed more quickly and efficiently by managing or controlling these factors.

## **Organic Material**

Any organic material can be added to the compost. For our purposes organic material is everything growing in the backyard and most food waste, especially fruit and vegetable scraps. Weeds, leaves, plant trimmings, apple cores, tea bags and potato peels are organic. Wood and large twigs are organic, but may take too long to decompose to be of practical use in composting.

## **Decomposing Organisms**

Decomposing organisms are all the micro-organisms and larger organisms involved in breaking down organic material. Bacteria are the primary decomposing micro-organism. They arrive with the organic material, and start the process by breaking down the organic material for their own food. Bacteria grow and

multiply while conditions are right for them, and die off as they create conditions more favourable for others. Bacteria, actinomycetes and fungi all consume waste directly and are known as first-level decomposers (see Food Web of the Compost Pile diagram). They are assisted by larger organisms, such as earthworms, beetle mites, sowbugs, whiteworms, and flies - which also consume waste directly.

First level decomposing micro-organisms are eaten by second-level decomposers such as springtails, mould mites, feather-winged beetles, protozoa and rotifers. Third-level decomposers eat both first and second-level decomposers and include centipedes, rove beetles, ants and predatory mites. Organisms at each level of the food web help keep populations of the lower levels in check.

## **Micro-Organisms - Chemical Decomposers**

### *Bacteria*

Bacteria are abundant. There may be millions in a gram of soil; you would need 25,000 laid end to end on a ruler to make 2.54 cm (an inch). They exist on every piece of organic matter even though you can't see them. When exposed to organic tissue, bacteria "invade"- eating and digesting the tissue, breaking it down into simpler forms for other bacteria and organisms to consume. As a group, bacteria are considered to be nutritionally diverse, which means that they can eat almost anything, living or dead.

### *Actinomycetes*

Actinomycetes are a higher form of bacteria, similar to fungi, and second in number to bacteria. They don't respond well to acidic conditions (below pH5) or high moisture conditions, but operate best at medium temperature areas of the compost. Actinomycetes take over during the final stages of decomposition, often producing antibiotics that inhibit bacterial growth. They are likely to work on tough organic material and give compost its pleasant, earthy smell. They are especially important in the formation of humus. They liberate carbon (C), nitrate nitrogen (NO<sub>3</sub>) and ammonium nitrate (NH<sub>4</sub>) making 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. The individual cells have a nucleus surrounded by a membrane and they may be linked together in long filaments. Fungi live on dead or dying material and obtain energy by breaking down organic material. Like actinomycetes, fungi are present during the early and final stages of composting, when the organic material has been changed to a more digestible form. Of the major micro-organisms, fungi function best under acidic conditions.

## *Macro-Organisms - Physical Decomposers*

Macro-organisms are the visible organisms involved in transforming organic material into compost. They are more active in the later, mature stages of composting, when temperatures are dropping but decomposition isn't complete. Micro-organisms decompose chemically, while macro-organisms are higher up in the food chain and decompose physically - by digging, grinding, chewing, digesting, sucking and churning.

### *Ants*

Ants are insects with six legs, a head, thorax and abdomen. Ants feed on a variety of materials in the compost. They may bring fungi and minerals such as potassium and phosphorous into the compost.

### *Millipedes*

A millipede is thick-skinned with dark red segments. There are many segments, each with two pairs of legs, but not the thousand that "milli" implies. They eat soft decaying vegetation. They will roll up in a ball when they are in danger.

### *Snails and Slugs*

Snails and slugs are mollusks that travel in a creeping movement. Snails have a spiral shell with a distinct head and a foot that is retractable. Slugs are without a shell and somewhat bullet shaped with antennae on their front section. Both feed on living plant material but you find them in the compost attacking plant debris.

### *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, protozoa and fungal spores. There are also pest forms of nematodes that attack plant roots.

### *Fermentation mites*

Fermentation mites, also called mould mites, are transparent-bodied creatures that feed on yeasts in fermenting masses of organic matter. These mites are able to withstand anaerobic conditions for moderate periods of time, and may be a good indicator of these conditions in the compost. They eat plant material, such as the soft tissue of leaves.

### *Springtails*

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

### *Spiders*

Spiders are eight-legged creatures and third-level consumers that feed on insects and small invertebrates.

### *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, feeding on soil invertebrates their size or larger. This means they are unwelcome in a worm bin as they may attack and kill the worms.

### *Sow bugs*

Sow bugs have a flat and oval body with distinct segments and ten pairs of legs. They are first level consumers that feed on rotting woody materials and other durable tissues like leaf veins. Pill bugs look similar to sow bugs but roll up in a ball when disturbed.

### *Flies*

Flies are two-winged insects that feed on almost any kind of organic material. They also act as airborne carriers of bacteria. Wherever they land, they deposit bacteria. Aerate your compost once a week to control.

### *Whiteworms*

Whiteworms (potworms) or enchytraeids (en kee *tray'* id) are about an inch long. They help finish off compost by breaking particles of material down into smaller pieces.

### *Earthworms*

Earthworms are the most important of all the larger decomposers in the compost pile. There are over 60 species of earthworms in North America. The one we most often find in compost or manure piles is the red wiggler (*Eisenia foetida*). They are about five cm long with alternating segments of buff and maroon. *Lumbricus rubellus* is another earthworm that lives in compost. They consume bacteria, fungi, protozoa and organic matter. As they digest organic material, they leave nutrient-rich castings in their path. Unlike other large decomposers, they break down material both physically and chemically. The dew worm (*Lumbricus terrestris*) and other species of earthworms will also visit your compost.