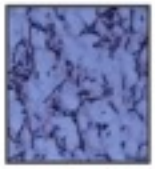
DECOMPOSER FIELD GUIDE

MICROORGANISMS

BACTERIA

Single-celled organisms responsible for the primary break down of materials. Bacteria are the most numerous organisms co-existing in the compost pile, and have highly diverse and adaptive diets. Every compost pile has a unique bacterial composition, and the makeup of the bacterial community changes as temperature and resource availability fluctuates.



PSYCHROPHILIC BACTERIA (*optimum growth between 59-68°F)*
Cold-loving bacteria that exist at temperatures below 68°F. Extremophile species can survive in temperatures close to absolute zero (-460°F). Psychrophiles are responsible for the first wave of microbial activity in the compost pile and produce a small amount of heat.

MESOPHILIC BACTERIA (*optimum growth between 89-99 °F)*
A mid-range bacteria found between 58-107°F. Mesophiles are highly efficient aerobes, as well as the primary source of bacterial decomposition in the compost pile. Mesophiles are responsible for building heat to support thermophilic populations, and experience a spike in population and diversity as the pile cools and cures.

THERMOPHILIC BACTERIA (*optimum growth between 120-140 °F)*
Heat-loving bacteria that exist between 105-140°F. Thermophiles perform the most intense decomposition work in the shortest period of time. The development of thermophilic conditions does not support the growth of other species, like fungi or macroorganisms. Thermophiles are responsible for the composting temperature spike that disables plant pathogens and kills undesirable seeds.

HYPERTHERMOPHILIC BACTERIA (*optimum growth around 176 °F)*
Extremophiles that thrive in especially hot environments, found primarily between temperatures of 140-220°F. Hyperthermophiles rapidly consume air and water resources, and if a community develops in the compost pile, it will likely persist less than 3-5 days.

ACTINOMYCETES

Higher-form bacteria similar to fungi, these primary decomposers give compost it's characteristically earthy smell. The majority of actinomycetes are aerobic and mesophilic and are highly-effective at breaking down resistant materials (i.e. woody stems, bark, paper) through the use of specialized enzymes. As actinomycete populations develop in the compost pile, they inhibit the growth of other bacteria through the production of antibiotics. Actinomycete filaments or colonies may be visible in later stages of decomposition.

FUNGI

Fungi are primitive, single or multiple-celled floras that include molds and yeasts. Some fungi create complex networks of hyphae chains (pictured) that connect to fruiting bodies (mushrooms). Most fungi are saprophytics (live on decaying matter), though there are parasitic forms that live off of other organisms in the pile. Compost fungi are predominately aerobic mesophiles and are effective at breaking down debris that is too dry, acidic, or low in nitrogen for bacteria to decompose. Fungal communities dominate in the final, cooler stages of the compost pile, when materials have been processed into a more easily digestible form.

PROTOZOA

Protozoa are single-celled microbes that feed on bacteria and fungi and are the simplest form of animal organism. Protozoa populations decrease dramatically with the introduction of thermophilic conditions. Protozoa process organic matter into food in a fashion almost identical to that of bacteria. Protozoa are less critical in the overall process of decomposition and comprise a relatively small proportion of compost biomass.

ROTIFERS

Rotifers are microscopic, multi-cellular organisms that are related to nematodes in both taxonomy and functionality in the compost pile. Rotifers dwell in water films attached to soil particles, plant material, and fungal bodies. Rotifers are an extremely diverse phylum that includes over 2,200 known species. Rotifers feed on organic detritus, protozoa, and bacteria, and have adapted to an impressive range of habitats and environmental conditions.

TARDIGRADES

Tardigrades are microscopic, water-dwelling organisms that are fully grown at 1mm. The eight-legged animals are nicknamed waterbears for their slow, clumsy movements that resemble the lumbering of a bear. Tardigrades subsist mainly on bacteria and plant matter, but some species predate on nematodes and rotifers. They are able to withstand incredible conditions including extreme heat and cold, extreme pressure, very high levels of radiation, and nearly a decade of dehydration. Tardigrades can enter a state of cryptobiosis (indefinite suspension of metabolic functioning) to outlast inhospitable environmental circumstances and are the first Earth animals known to survive in space.

NEMATODES

Nematodes, or roundworms, are cylindrical, transparent animals related to rotifers in taxonomy and functionality. They are the most abundant of invertebrate decomposers in the pile (a handful of soil contains several million individuals) and are one of the most diverse of all animals, with an estimated 1 million species. Nematodes are found at all levels of the food chain, with diets that include bacteria, protozoa, fungal spores, and other nematodes. While many nematodes are less than 1 mm in length, some species are visible to the naked eye.

MACROORGANISMS

While microogransims are responsible for the majority of decomposition activity in the compost pile, macroorganisms proliferate in cooler phases of compost development. These organisms exit, become dormant, or migrate to the periphery of the pile during thermophilic conditions.

SPRINGTAILS

Springtails, also known as collembola, are small, wingless insects. Some species use a tiny, spring-like lever, called a furcula, at the base of the abdomen that allows them to leap 50-100 times their body length. Along with mites and nematodes, springtails are some of the densest invertebrate populations in both the soil and the compost pile. While some species feast on decaying matter and prey on nematodes, most springtails feed on fungi and are an important limiting factor for fungal populations.

MITES

Mites are a highly diverse group of arachnids (over 30,000 species) that have great population density in the compost pile. Mites operate at all levels of the food chain, and some species are so highly specialized they feed on only one organism. Compost piles are often home to fermentation mites (also known as mold mites), transparent-bodied creatures that feed on yeasts of fermenting organic materials.

PSEUDOSCRORPIONS

Pseudoscorpions are arachnids that look like miniature scorpions but have no tails or stingers. They usually reach a size between 2-8mm. Pseudoscorpions locate prey using odors and vibrations and hunt larvae and small invertebrates with the poison glands at the front of their claws. They are phoretic creatures, meaning they hitch rides on other animals to get around. There are 3,300 known species of pseudoscorpions, and their habitats range from the soil litter layer to caves, intertidal zones, tree hollows, human homes, and, of course, compost piles!

POTWORMS

Potworms, also known as enchytraeids, are annelids that resemble small earthworms. These segmented, white worms grow between 10-25mm and feed primarily on mycelia (fungi strands), decomposing vegetation, and the bacterial populations found on detritus. Potworms are often found congregating near food scraps in vermicompost bins but co-exist comfortably with the resident red worms. Like earthworms, potworms partially digest decaying matter, helping to create more available food material for other decomposers.

ANTS

Familiar insects that eat fungi, food scraps, seeds, and other insects, ant colonies may form in compost piles during the cool, curing stage. Ants have complex social organization and, at an estimated 22,000 species, may comprise up to 25% of terrestrial animal biomass. Ants thrive in low-moisture environments and may be considered pests in piles that do not receive regular watering.

FLIES

Another well-known insect, flies dine on organic detritus, plant saps and nectars, blood, and other insects. While flies can only ingest liquids, they are able to convert solid materials to liquid form by vomiting an acidic, dissolving agent. The most common flies in compost piles are fruit flies, which can become pests in a pile with unburied food scraps. Cool or curing compost piles are a hospitable environment for fly larvae.

EARWIGS

Earwigs are nocturnal scavenger insects that can be found in small, dark, moist environments during the daytime. The compost pile is an ideal habitat, as earwigs feed on decaying organic matter as well as a diverse array of fresh vegetation and small insects. Earwigs grow to a length of 2-3cm, and are distinguished by jaw-like pinchers (cerci) on the abdomen, used for both hunting and copulation. There are over 2,000 known species of earwigs, which have adapted to a variety of habitats from caves and woodlands to human homes and gardens.

WOODLICE

Woodlice, including sow bugs and pill bugs (pictured) are terrestrial crustaceans that make up the order Isopoda. Isopods are the only crustaceans that have adapted to living their entire lives on land. Woodlice breathe with gill-like structures and, thus, require moist environments (like the compost pile) to survive. Woodlice feed on decaying wood and are especially useful for breaking down resistant matter like leaf veins and fibrous plant tissues. Pill bugs can roll into a sphere but lack the tail-like appendages of larger sow bugs.

CENTIPEDES

Centipedes are arthropods with flattened, segmented bodies. Unlike millipedes, centipedes have a single pair of legs per segment and are a faster-moving, predatory creature. Centipedes are nocturnal hunters that possess paralyzing poison glands on their claws and prey on invertebrates close to or larger than their size. With an estimated 8,000 species, centipedes have adapted to a wide range of terrestrial environments. Unlike vertically mobile millipedes, centipedes dwell in the surface level of the compost pile. Red centipedes can be a threat to vermicompost bins, as they will predate on the resident red worm population.

MILLIPEDES

Millipedes are arthropods with elongated (often cylindrical), segmented bodies. Millipedes possess two pairs of legs per segment and usually have a total of 40 to 400 legs. Many species coil into a tight spiral as a protective mechanism. Pill millipedes are an exception; with short bodies that can roll into a sphere, they are sometimes mistaken for pill bugs. Millipedes are slow-moving creatures that primarily feed on decaying vegetation, but will eat the carcasses and excrement of other insects. Millipedes thrive in warm, damp environments, and are valuable for compost mixing, aeration, and nutrient conversion.

SPIDERS

Spiders are the largest order of arachnid, with over 40,000 classified species. Almost every known spider species is predatory, and the compost pile serves as a buffet of insects and other small invertebrates. Web-building spiders are often found in the corners of the bin or inside the lid. Wolf spiders (pictured) are commonly found in and around the compost pile, though they are free-traveling predators with no web and no permanent home. These agile wanderers live and hunt in solitude, and have excellent eyesight that allows them to prey upon arthropods of all sizes.

BEETLES

Beetles form the order Coleoptera, which constitutes almost 25% of all known biota. Beetles are a highly diverse group of creatures with 400,000 classified species (about 40% of all known insect species). Some species regularly found living in compost are feather-winged beetles, rove beetles and ground beetles (*Scaphinotus petersi* pictured). Feather-winged beetles feed on fungal spores. Rove beetles and ground beetles are larger, and predate on small insects and animals, including snails and slugs. Ground beetles have been known to diversify their diet with seeds and vegetation.

SNAILS/SLUGS

Snails are terrestrial mollusks that have the capacity to retract into a shell; slugs are terrestrial mollusks with a reduced internal, small, or no shell. Both snails and slugs thrive in damp environments, with slugs requiring this moisture in order to prevent desiccation. Snails and slugs feed on living or decaying plant matter, but unlike other detritivores, do not require bacteria to pre-digest food materials; instead, snails and slugs secrete a cellulose-digesting enzyme that breaks down vegetation on contact.

EARTHWORMS

Perhaps some of the most recognized and most valuable assistants in the compost pile, earthworms are annelids that have been classified into over 7,000 species. Earthworms are incredibly important for the maintenance of soil health and perform critical functions including: mixing and moving soil between layers and increasing soil porosity and permeability (increases infiltration, improves water retention and provides space for root growth). Earthworms are efficient decomposers of organic materials, feeding both the rotting materials and on the fungal, bacterial, and protozoa populations that grow upon this matter. Worms have intestinal mucus that helps to make nutrients more readily available to plants by protecting them from being leached out of the soil by water (this mucus is also a beneficial substrate for microbial communities). Worms breathe through their skin and require a moist environment for survival. Different types of worm inhabit different areas of the soil and serve different functions in relation to composting.

NIGHTCRAWLERS are representative of *anecic*, or deep-burrowing species. Nightcrawlers are long, typically reaching between 20-25cm, but have been recorded at lengths of 50 cm. Anecic species inhabit relatively permanent burrow networks that extend several meters into the soil and help mix soil nutrients by pulling surface matter into burrows for feeding and by excreting castings throughout burrow systems. Nightcrawlers enter a backyard compost bin in the later, cooler stages of the pile.

GREEN WORMS are a common *endogeic*, or upper-soil, species of earthworm. Green worms have adapted to a wide variety of habitats but are rarely seen emerging from the soil. Endogeic worm species spend their lives in the upper soil strata, feeding primarily on the soil and the organic matter within. Unlike anecic species, they do not have permanent burrow channels and fill their temporary burrowing systems with castings as they move. The channels created by endogeic species are largely horizontal, while anecic species produce more vertical burrows. Because endogeic species spend most of their lives within the soil, they are unlikely to dwell inside the compost pile, but will live underneath it!

RED WORMS (pictured) are classic examples of *epigeic*, or surface-dwelling worm species. Red worms are much smaller than nightcrawlers and are the species traditionally used for vermicomposting, as they rapidly process large amounts of organic matter and reproduce fruitfully. Red worms may establish in a backyard compost bin, but will have a lower population density relative to a vermicompost bin. Red worms thrive in shallow environments with a variety of easily accessible organic scraps (and a variety of resident microbial populations). Epigeic species are poor burrowers and prefer to live and feed in the loose, surface and litter layers of soil. Epigeic species have adapted to the high variability of moisture and temperature at the surface of the soil and are found in the compost pile during cooler phases.