EDITOR: ROB McCORMICK
745-4641 ext. 244
fax 743-4581
life@peterboroughexaminer.com

LIVING

The drama of decomposition

The next time you sit down for a meal, take a moment to reflect on the fact that everything we eat can be directly linked back to organisms of decay

OUR CHANGING SEASONS
Drew Monkman

Just a few short weeks ago the forests of the Kawarthas were ablaze in the reds, oranges and yellows that make fall foliage so spectacular. But now, in one of the nature's most radical changes, nearly all our deciduous trees are bare and grey. Once the leaves are on the ground, however, we no longer give them any thought. This is unfortunate because without fanfare, a profound transformation is occurring on the forest floor. It is a process that is unmatched in its importance for continued life on Earth. What exactly happens to the billions of dead leaves and other types of organic waste that litter forest, field and stream every fall?

The forest floor can best be thought of as a gigantic recycling centre. In this, the last stage of the ecological cycle, dead organic matter is being softened, shredded, digested and decomposed by countless billions of organisms into simpler compounds that can be reused by the forest's plant communities. In fact, the biological activity happening in the leaf litter and soil is probably greater than that of above-ground ecosystems.

Decomposition is best thought of as a feeding process. Micro-organisms feed on the organic waste from plants and animals and take from it the nutrients and energy they need to live. Just like us, decomposers respire — the process in which food is oxidized (burned) to release energy. Respiration uses up oxygen and releases energy. The sun's energy that was captured in the leaves by photosynthesis is now being used by decomposers to survive.

Without the legions of decomposers, essential nutrients such as carbon, nitrogen and phosphorous would remain locked up in the dead leaves instead of being recycled back into the soil where they can be reused. Nitrogen, for example, is a major component of chlorophyll, the magical green compound in plants that converts sunlight to chemical energy through photosynthesis. Phosphorous is used in the manufacture of compounds like ADP, which plays a key role in energy storage and transfer reactions. The breakdown of organic matter also releases carbon to the atmosphere, in the form of carbon dioxide, where it can once again be used by the plants through photosynthesis to manufacture their food.

Drew Monkman, special to The Examiner

Freshly fallen maple and beech leaves on the forest floor.

The rate of decomposition depends on factors such as temperature, humidity, the availability of oxygen and the type of leaf involved. The higher the temperature and humidity, such as during the warm summer months, the faster decomposition will be. If oxygen is lacking, such as in saturated soil, decomposition is nearly impossible.

Different types of leaves disappear faster than others. For example, birch and basswood leaves can be broken down quite quickly. Beech and oak, on the other hand, are much slower to decompose.

Who exactly are the players in the decomposition process and what are their specific roles?

When leaves first fall to the ground, they become packed down by rain and snow. Water-soluble compounds are quickly dissolved and carried down into the leaf litter and soil. The lion's share of the work is carried out by fungi, however. They are the primary decomposers of plant tissues on the forest floor and in the soil. Fungi are capable of decomposing many of the large plant molecules that cannot be broken down by decomposers such as bacteria.

Fungal spores, present in countless billions in the fall, land on the fallen leaves and, depending on conditions, may begin to germinate. However, the real action begins in the spring, when the weather warms. The spores produce white or colourless thread-like strands called hypha, which in turn secrete enzymes that render the dead leaves soft and spongy. Just 28 grams, or one ounce,) of fertile soil may contain more than two kilometres of these strands.

Larger organisms then take over. Although they do not change the leaves chemically, they do shred apart the partially decomposed leaves. Millipedes, for example, act like grinding machines and break up a great deal of the soil litter layer. Sowbugs, too, chew up plant material and mix material in the top layer of the soil. Mites, ants, beetles and, of course, earthworms also play key roles.

Earthworms are especially important. With upwards of a half million present in every acre of woodland, they dramatically increase soil fertility. The worms literally eat their way through the soil by ingesting both organic and inorganic material. In this way, dead leaves are converted into rich feces known as castings. The partially digested leaf matter is thereby rendered much more susceptible to microbial breakdown and to increased nutrient release.

Just as importantly, worms mix the different layers of soil and aerate it through their extensive tunnel systems. This also allows water to penetrate down into the rooting zone of the soil, where it can be used by plants. The tunnels also allow roots to move more easily into new spaces.

Earthworms come in a variety of different species and colours. Some species are specialists in burying surface residue, while others are more involved in the process of decomposition. Virtually all of the 20 or so species of earthworms in Ontario were introduced from Europe or from unglaciated areas of the U.S. It is believed that nearly all of Canada's native earthworms disappeared as a result of the ice ages.

However, by far the most abundant soil organisms are the numerous kinds of bacteria. A gram of soil contains billions of bacteria representing thousands of different species. Bacteria take part in almost all soil decomposition reactions. Many promote vital biochemical reactions. For example, bacteria are involved in the oxidation of ammonia to nitrates. Nitrates are the only form in which nitrogen can be used directly by plants.

All of this biological activity in the soil constitutes an extremely complicated food web.

The fungi that decompose organic matter are themselves the food of choice for mites and springtails, better known as snow fleas. Nematode worms along with single-celled protozoa are important predators of both fungi and bacteria. To further complicate matters, some nematodes are actually eaten by fungi. Further up the chain, ground beetles and centipedes prey on springtails, millipedes, mites, snails and sowbugs; they in turn are eaten by moles, shrews and salamanders. Weasels, hawks and snakes comprise still another level.

The forest floor is not the only theatre where the decomposition drama takes place. Countless dead leaves also end up in lakes and streams. As in the leaf litter, numerous underwater organisms await the arrival of the rich energy reserves contained in the leaves. Many streams derive nearly all of their energy from leaves and other organic matter that come into them from the land. Bacteria and fungi coat the dead leaves and soften them up. Aquatic creatures like caddisfly larvae shred the leaves apart as they eat bits and pieces. Smaller insects like mayfly nymphs and midge larvae filter out the smaller leaf fragments. These plant eaters in turn fall prey to predators like dragonfly nymphs, water bugs and fish.

The next time you sit down for a meal, take a moment to reflect on the fact that everything we eat can be directly linked back to these vastly under-appreciated organisms of decay that are nature's recyclers. They do nothing less than make life on this planet possible.

Drew Monkman is a Peterborough teacher and author of Nature's Year in the Kawarthas. He can be reached at dmonkman1@cogeco.ca.