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An Earthworm primer

Some amazing facts about life below ground

BY JANET WALLACE

When I turn the soil in my garden, I am pleased when I see many earthworms. It makes me feel like I'm doing a good job. I know that their abundance reflects my gardening methods, particularly my use of mulch and minimal tillage. Whenever I expand my garden, I am surprised by how few worms are found in the new ground compared to the established garden.

An abundance of earthworms is often considered an indicator of good soil health. That's true in agriculture but outside fields and gardens, the situation is more complex. Talk to certain ecologists, and you'll hear about the 'earthworm invasion' and the negative impact of worms on forest ecology, salamander populations and soil organic matter.

I wanted to learn more about these creatures, so I delved into scientific literature and discovered these facts about the humble earthworm.

“The plough is one of the most ancient and most valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed by earthworms. It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organised creatures.”

The formation of vegetable mould, through the action of worms. p.313, Charles Darwin, 1881

Introducing earthworms

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Fertilizing effect

Worms eat decaying organic material and then leave their excrement in tiny piles, called casts, on the soil surface. Compared to the surrounding topsoil, casts are generally five times richer in available nitrogen, seven times richer in available phosphates and 11 times richer in available potassium. In one year, worms can add up to ten kilograms of casts per square metre.

Foraging on farms

Partially decomposed plant material makes up the bulk of a worm's diet, but the worms don't simply graze. They actively harvest and process fresh food.

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The slime produced by earthworms is rich in microbes and nutrients.

How to support your local earthworm population:

- Use a diverse crop rotation
- Plant green manures and cover crops
- Avoid bare soil: Keep soil covered with either crops, stubble or mulch as much as possible
- Plough or till as little as possible
- Minimize soil compaction (e.g. avoid heavy machinery, particularly on damp soils)
- Use compost or aged manure rather than raw manure or synthetic fertilizers
- Avoid using pesticides

Worms are hermaphroditic; the swollen, light-coloured sections (right) contain both male and female reproductive organs.



At a Guelph Organic Conference many years ago, I recall a lively debate about the sudden disappearance of day-old pea seedlings. The speaker said he saw one seedling get pulled into the soil, then another. He dug around and found the pea shoots in a tunnel with a large earthworm. Others in the audience admitted they had suspected earthworms were eating seedlings. In 1881, Charles Darwin reported watching earthworms pull fresh leaves into tunnels.

The earthworms weren't eating fresh leaves or seedlings, or not right away. Worms lack teeth and can't eat a fresh pea shoot, but they can pull fresh material underground and stash it for a few weeks. Meanwhile soil microbes start to break down the material — the result is worm food. Just as humans find yogurt more digestible than fresh milk and sauerkraut easier to digest than raw cabbage, the worms use microbes to process their food. In turn, their castings (excrement) make nutrients readily available for plants. Quite a benefit compared to the loss of a few pea shoots.

Tunnels

In a cubic metre of unploughed soil, there can be 900 metres of earthworm tunnels. Tunnels can go as deep as 6 metres. The tunnels allow water and air to penetrate the soil and reduce water-runoff, which can cause soil erosion and nutrient loss.

When plant roots encounter tunnels, they tend to follow them; 90 per cent of earthworm tunnels are infiltrated by plant roots. Not only is it easier for a root to grow in a tunnel rather than forcing its way through soil, but also the tunnels are rich in nutrients (from the slime) and have ample air and water. Plants can grow better when their roots are inside worm tunnels.

Slimy stowaways

Earthworms may be hardy but they are not tough enough to survive for millennia under ice. Almost all of North America's native earthworm species went extinct in the last ice age and most of the species we see in our gardens and fields came to the continent in the ballast of ships. The current marine practice is to use seawater for ballast, a practice that has led to the introduction of invasive aquatic species such as the zebra mussel. A few centuries ago, soil was used to weigh down the wooden sailing ships as they travelled from the Old World. After arriving in North America, the soil (with worms) was dumped and replaced with more valuable cargo. The worms moved across the continent, sometimes as eggs in the hooves of livestock, in soil surrounding plants and tubers, or as fishing bait.

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Red wigglers travel as herds. In adverse conditions, such as freezing temperatures or drought, they will group together. Each worm will then have relatively little flesh exposed and will be less vulnerable to moisture and heat loss.

Voracious appetites

The traits that lead us to welcome earthworms in our compost piles and fields can create havoc in forests. The hardwood forests of North America have evolved a complex ecological food web that does not include earthworms. Before Europeans arrived on the continent, nutrient dynamics was a slow process governed by microbial life. The forest floor was covered with a thick 'duff,' a layer of organic matter in various stages of decomposition. This provided habitat for spiders, insects, bacteria and fungi, and was also the rooting zone for most plants. Seeds from many forest plants, from trees to orchids, require the presence of specific fungi that live in the duff. Earthworms consume the loose organic matter leaving a relatively bare forest floor and, in doing so, destroying the habitat for many forest creatures including salamanders and ground-nesting birds, such as ovenbirds and hermit thrushes.

The silver lining is that the earthworms destroy the habitat for the larvae of the deer (black-legged) tick, the organism responsible for transmitting Lyme disease.

Equal opportunity sex

Earthworms are hermaphroditic, which means each individual has both male and female sexual organs. It's uncommon for a worm to mate with itself. Instead, two worms mate and connect all four sexual organs at the same time. After nearly an hour of clasping and unclasping each other, both worms end up with cocoons containing ova and spermatozoa. "Their sexual passion is strong enough," writes Charles Darwin, "to overcome for a time their fear of light."

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Bad things in your water aren't always **THIS** clear.



There could be something scary lurking in your water. You can't see it. You can't smell it. You can't taste it. But it's there, and it can make you sick.

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Earthworms are hardy creatures that can survive periods of flooding and drought. If the soil is flooded for many weeks, however, earthworm populations will suffer.



Long lives

Red wigglers can often live for 1-2 years, field worms live for 3-5 years and night crawlers can survive for 4-8 years.

Herd behaviour

Red wigglers travel in herds by communicating with each other. It appears that they communicate through touch, like tapping each other on the shoulder. They don't seem to leave chemical messages in their slime but might communicate over larger distances by the release of volatile compounds. The herding behaviour can lead a group to abandon a site with poor environmental conditions. They can also congregate in a ball that keeps them moist and warm during severe dry or cold spells.

Pest and disease control

Researchers have found that earthworms can reduce the incidence of pests and disease including apple scab and leafminers. Worms pull dropped leaves into their tunnels, and in the growing season, diseased and damaged leaves are the first to drop. Underground, the soil microbes destroy the pathogens and pests that would have survived if left on the soil surface.

Earthworms and pollution

Worms are sometimes used for soil remediation. The creatures can survive high levels of toxins including pesticides and PCBs. They can break down the



Mulch helps protect earthworm populations.

compounds, often reducing their toxicity. However, by ingesting material and leaving their waste on the soil surface, the worms can transport chemicals from deep in the soil to the surface, so it might be necessary to remove their castings and/or topsoil.

When worms consume organic material, the resulting castings are higher in carbon than the initial material. In this way, worms help sequester (bind) carbon and can help reduce levels of atmospheric CO₂. But this only applies in gardens and fields. In forest floors, where the leaf litter is rich in carbon, worms can actually release more CO₂ through their rapid consumption of organic matter.

Skin breathers

Worms don't have lungs. Instead, they breathe through their skin. Oxygen mixes with water on the skin and then penetrates into blood vessels. To compensate for this passive system of respiration, their blood contains a type of hemoglobin with a strong affinity for oxygen.

Worshipping worms

Cleopatra recognized the value of earthworms in Egyptian agriculture and declared the earthworm to be sacred. Killing or removing an earthworm from Egypt were crimes punishable by death.

On Canadian farms and gardens, earthworms perform valuable ecological roles. While killing an earthworm might not be grounds for a death sentence, nurturing earthworm populations is a great way to improve soil health and help increase crop yields (see sidebar for tips). The worms, and your crops, will appreciate these practices.

To assess the earthworm population, count the number of casts you see in a 50 cm X 50 cm area in optimal earthworm conditions (e.g., warm spring morning when soil is moist). If you find five or fewer casts, your soil is likely low in worms. Ten casts indicates a moderate population. If you have twenty or more, the earthworms are thriving. Cleopatra would be pleased.



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For more information

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