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Branching Out

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138

Exotic earthworms in the boreal forest: *vermes non grata*?

While earthworms were already present in North America before the last ice age, the ice age wiped them out from almost the entire Canadian boreal forest. Subsequently, exotic species were introduced during European colonization. Their spread to more isolated regions is now facilitated by human activities, particularly their use as bait for recreational fishing. Earthworms are burrowing organisms that mix soil layers. They are known for their positive effect on soil fertility and plant growth in agricultural areas and gardens. The boreal forest has evolved in the absence of earthworms for thousands of years, so their presence has an impact on soil biogeochemical processes and ecosystem functioning. A research team including the Canadian Forest Service is studying these impacts.

Effects on habitat and diversity

The introduction of exotic earthworms into boreal forests causes a cascade of effects on the soil food chain. These effects result in particular from the rapid decomposition of litter and humus, which form the organic layer of the soil, leading to a loss of habitat for several species. This layer is home to a wide variety of bacteria and fungi and shelters several detritivorous species such as insects, mites, and springtails. These species are themselves prey for spiders, birds, amphibians, and small mammals, which in turn are affected if they disappear. The reduction in the thickness of the organic soil layer, a germination bed for several plant species, also leads to changes in the composition of plant communities by reducing their diversity and promoting the emergence of invasive species.

Furthermore, earthworm activity leads to the development of new soil horizons characterized by higher pH, clay content, and organic carbon content. However, this activity reduces the amount of organic matter on the soil surface, thereby decreasing the availability of nutrients for soil organisms such as insects and mites and, in the long term, disrupting the functioning of the ecosystem.

Dendrobaena octaedra (epigeal), a species common in boreal forests (Credit: thirty_legs)

Effects on soil carbon and greenhouse gas emissions

In addition to its effect on boreal forest biodiversity, increased decomposition of organic matter by earthworms can affect key ecological processes such as carbon sequestration in forest soils. These changes in soil carbon stocks are most commonly observed in surface horizons, specifically in the organic layer, which can be reduced by 94% depending on the soil type. The consumption of organic matter by earthworms directly results in the release of a significant amount of CO_2 into the atmosphere through respiration. In addition, the presence of earthworms increases CO_2 emissions by stimulating microbial activity and can also increase the release of nitrous oxide (N_2O), a gas with a greenhouse effect 300 times greater than that of CO_2.

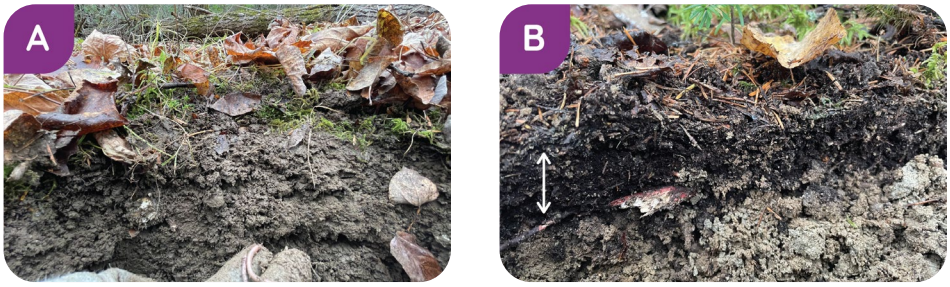
Although earthworms have colonized only a tiny portion of the boreal forest since their introduction, the intensification of human activities could significantly increase their presence across the vast boreal region in the coming decades. Therefore, their effects on soil carbon emissions combined with climate change would likely have major consequences on ecological functioning and the carbon balance at the national level.

Three ecological groups

- **Epigeic:** pigmented worms that occupy the organic horizons on the soil surface (humus) and feed on this organic matter.
- **Endogeic:** non-pigmented worms that occupy the mineral layer and dig horizontal tunnels.
- **Anecic:** large worms that dig deep vertical tunnels and feed on leaves on the surface.

Common exotic species in the boreal forest

- *Dendrobaena octaedra* (epigeic)
- *Aporrectodea* spp. (endogeic)
- *Octolasion* spp. (endogeic)
- *Lumbricus rubellus* (epi-anecic)
- *Lumbricus terrestris* (anecic)



Effect of earthworm presence on soil profile. The organic layer has disappeared in soil heavily infested with earthworms (A) compared to uninfested soil (B).

Mitigation measures?

Exotic earthworms are now part of boreal forest ecosystems, and there is no way to remove them from forests where they are already present. Although they were introduced to North America several centuries ago, the growth of recreational and industrial activities in the boreal region has accelerated their spread in recent decades. Earthworms have been found in soils in Nunavut, Labrador, and the Northwest Territories. Fishing enthusiasts use earthworms as bait and sometimes leave unused worms in the forest near lakes. This contributes to the establishment of worms in new locations. To limit this spread, it is recommended that unused bait be taken back to be disposed of or reused for future fishing trips. Citizens can also contribute to this effort to curb the spread of earthworms in forests by reporting their presence on apps such as iNaturalist.ca or WormWatch

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