More than half of life on Earth is found in soil—here's why that's important

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Springtails (Fasciosminthurus quinquefasciatus) are found in any damp soil. Credit: Andy Murray/chaosofdelight.org, CC BY-NC-ND

A recent study has found that soil is home to 59% of all life on Earth, from an insect feeding on the soil surface to a tiny microbe nestled in a soil pore. This discovery crowns soil as the most biodiverse habitat on the planet.

The paper estimates that around 2 million species of arthropod (think

insects and spiders) inhabit the soil—some 30% of all known arthropod species. There are far fewer species of soil specialists such as enchytraeidae (resembling mini earthworms) and oligochaeta (worms), with only 770 and 6,000 species respectively. That might not seem like a lot, but it still represents around 98% and 63% of these animal groups.

The variety of mammals living in soil is, by comparison, quite limited. Only 3.8% of mammal species are associated with this habitat. On the other hand, 85% of plants have their roots buried in the soil and around 43% of nematode (tiny worms) species call soil their home, or reside within the plants and animals that inhabit it.

However, the number of animal and plant species that live in soil are dwarfed by microscopic organisms. The researchers estimate that a mind-blowing 430 million species (or more than 50%) of bacteria and 5.6 million species (or 90%) of fungi have made soil their home.

But perhaps more important than the raw numbers are the functions that this biodiversity performs. The life within the soil not only helps to produce the food we eat, it also plays a crucial role in holding the soil together and even gives us potential sources for new antibiotics and medicines.

Helping plants grow

Small animals, including earthworms and springtails, break down plant material and other forms of organic matter, such as dead insects, and incorporate them into the soil. This process releases the nutrients that most plants rely on to grow. But it's not the only way that soil organisms help plants gain more nutrition.

Mycorrhizal fungi (a species of fungi that grow in association with plant roots), for instance, embed themselves in the roots of plants where they

extract energy-rich compounds. In return, the fungi help plants expand their reach in the soil, allowing them to access a greater amount of nutrients.

Other species that are vital for food production include nitrogen-fixing bacteria. They are commonly associated with legumes such as beans and clover. These bacteria convert nitrogen gas from the atmosphere into compounds that the plants can use—an undertaking that can otherwise only be done synthetically, using vast amounts of energy.

Holding soil together

As organisms penetrate the soil, whether by burrowing, creating nests or as a means of anchoring themselves, they engineer pathways through the soil and contribute to its structure. Notable examples include termites rearranging the soil to create channels for air and water to filter through, as well as roots and root hairs enmeshing soil.

The incorporation of decomposed plant material into the soil serves a similarly crucial purpose. It helps to hold the soil together and creates pores that protect the soil from erosion and increase its capacity to store water.

Some of this organic material is also locked away with soil minerals, leading to the storage of carbon. In fact, soils hold three times as much carbon as vegetation and twice as much as the atmosphere.

Biodiversity increases resilience

In many cases, these functions involve a variety of species. Having multiple species perform the same function offers a safety net if conditions change, such as during a drought or a flood.

Some species are more resilient to these events than others. When conditions change, unaffected organisms within the soil can step in to fulfill the same functions as those that might have suffered—a process ecologists call "functional redundancy." This improves the ability of an ecosystem, such as soil, to withstand and recover from environmental shocks.

Soil biodiversity is also a key reservoir for new drugs. Soil bacteria have produced most of our antibiotics, including streptomycin, chloramphenicol and tetracycline. Unfortunately, the rise of antibiotic resistance has rendered many early antibiotics ineffective. However, searching through different soils is yielding promising new antibiotics with the potential to kill "superbugs" that are resistant to existing drugs.

Soil biodiversity plays an important role in producing the food we eat, sustaining soil health and helping to deliver a range of other services, from sourcing medicines to reducing the impact of floods and droughts. The importance of protecting our soils for future generations becomes ever clearer.

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