The importance of earthworms for soil health

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In this article, Lynette Abbott from The University of Western Australia, highlights the importance of earthworms for soil health

Earthworms are common soil organisms and have attracted the attention of many of us because they occur in gardens, parks, agricultural regions, and natural ecosystems. They can be grouped according to their feeding habits and life cycles, influencing where they occur in the soil profile and how they contribute to soil health.

Some earthworms live mainly in the litter layers, and feed primarily on plant organic matter before it is broken down into finer particles. They may prefer plant matter which has a relatively high nitrogen content. Ingestion of these plant residue fragments contributes to its decomposition into smaller particles, which become colonised by other soil organisms, including fungi and bacteria.

Another group of earthworms feeds on surface plant organic matter and transfers it into the soil through their underground burrows. This group of earthworms commonly deposits small piles of worm casts on the soil surface as they move back and forth from their burrows.

Other earthworms live in deeper soil layers, in more permanent burrows. These earthworms also ingest organic matter combined with soil particles and deposit worm casts inside burrows, lining their walls.

In all cases, worm casts can enhance soil health qualities and increase organic matter's degradation rate, partly due to enzyme activity within the earthworm gut.

Charles Darwin had a great interest in earthworms

Darwin's book "The Formation of Vegetable Mould: Through the Action of Worms with Observations on their Habits" is a seminal text based on his detailed observations of earthworms in his own garden and on farms. The first edition of this book was published in 1881, and the recording of information within this text is extraordinary.

Darwin lived in Kent in England and placed a ‘worm stone’ on the lawn in his garden. He noted the time it took for the stone to be buried due to earthworm activity. Earthworms ingest and re-distribute soil within the profile. Darwin’s book details the habits of earthworms, the amount of fine earth they bring to the surface, their role in the burial of ancient buildings, and their role in developing soil profiles devoid of larger rock particles.

This latter process is facilitated in part by depositing finer soil particles (as worm casts) above stones and rock fragments, which effectively sink deeper into the soil profile. While earthworms are clearly more abundant and active in soils in humid environments, they have a role in the distribution of soil organic matter and in improving soil conditions across climatic zones and soil types.

Earthworms in agricultural, horticultural, and garden soils

Earthworms are common in gardens due to the high organic matter load that is present following applications of compost or manure. Similarly, earthworms commonly occur in agricultural soils, which are exposed to relatively high rainfall (and hence are moist for much of the time) and in soils that contain high levels of soil carbon, including more clayey soils with high plant density under grassland or pasture.

Earthworms are present worldwide but vary in abundance, mainly in response to moisture and organic matter resources. Their abundance in surface soil layers may be reduced in the dryer season because some species retreat more deeply into the soil and aestivate, and others form egg capsules. Aestivation is a period of reduced metabolic activity or dormancy; when conditions improve, they become active again or re-colonise the soil from egg capsules.

Disturbance of soil by cultivation or addition of amendments such as lime or fertiliser can alter the physical, chemical, and biological environment to which earthworms are exposed. Cultivation of soil can reduce earthworm numbers by increasing the rate of degradation of organic matter, which decreases their food supply.

While there may be some physical damage to earthworms caused by tillage, the indirect influence of tillage on their food source is likely to have a greater impact on their abundance. Changes in soil pH can alter soil suitability for some groups of earthworms, but not others.

The abundance of earthworms changes seasonally with the availability of various types of organic matter, and some species prefer organic resources with a higher nitrogen content than others. A few species typically dominate earthworm communities at a particular location; the distribution and abundance of species largely depend on the types of plants present, the amount of organic matter, soil structure, and soil moisture.

Earthworms can have a significant impact on the condition of soil and its health for plant production. By ingesting soil and organic matter, earthworms function as natural ‘ploughs’ and aerate the soil, re-distribute soil particles, including organic matter, throughout the

soil profile, and provide channels for roots to penetrate to deeper layers. This may facilitate the access of roots to groundwater, or channel water more deeply into the soil.

Earthworms in natural ecosystems

Although earthworms are most noticeable in highly managed soil environments such as gardens and farms, they also occur in natural ecosystems. Indeed, there is a high diversity of earthworm species in forests and heathlands where moisture levels and plant debris support their activities for at least some time during the year. The species of earthworms that dominate in disturbed environments like home gardens, compost heaps, and agricultural soils generally differ from those that dominate in natural ecosystems.

For example, in south-western Australia, the earthworm species commonly present in agricultural soils have been accidentally introduced from Europe and ports in Cape Town, South Africa, on the early sailing ships that transported pots with citrus trees and other horticultural plant species. The points of origin of introducing these exotic earthworm species into agricultural lands in south-western Australia were likely to have been farm homestead gardens.

Consequently, the dominant earthworms in this region do not originate from the naturally occurring earthworm community. However, there is one remarkable exception to this: a very large earthworm (Megascolex imparicystis, mean length 21.5 cm) [(1)] found in agricultural soils around Dandaragan and Lancelin, north of Perth, Western Australia, has managed to survive in soils under agricultural production. This is very unusual. In contrast, another even larger earthworm (Megascolides australis, mean length 75 cm) [(2)], a native species in south Gippsland, in south-eastern Australia, does not occur in soils that have been converted to agricultural production.

The role of earthworms in soil health processes

Earthworms play important roles in improving soil structure so roots can penetrate the soil. They facilitate the mineralisation of organic matter, releasing nutrients for plants. They support the development of cohesion among soil particles as they ingest soil and organic matter before releasing wormcasts into the soil with enhanced soil health properties.

Earthworms interact with other soil organisms, improving their environment and re-distributing fungi and bacteria within the soil habitat.

Soils with high earthworm abundance may have increased soil aggregation, improved bulk density, increased soil organic carbon, greater friability and a capacity to avoid erosion, improved moisture-holding capacity and enhanced water infiltration.

Earthworms have roles at the interface between soil physical, biological, and chemical processes that support soil health and help retain soil carbon. They may be present to different extents under different climates and soil environments, but when soils are

managed to support their survival and multiplication, they contribute significantly to the health of agricultural ecosystems.

References

1. Ian Abbott (1982) The distribution of earthworms in the Perth Metropolitan Area. Records of the Western Australian Museum 10: 11-34.
2. Beverley Van Praagh (1992) The biology and conservation of the giant Gippsland earthworm Megascolides australis McCoy, 1878. Soil Biology and Biochemistry 24: 1363-1367.

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