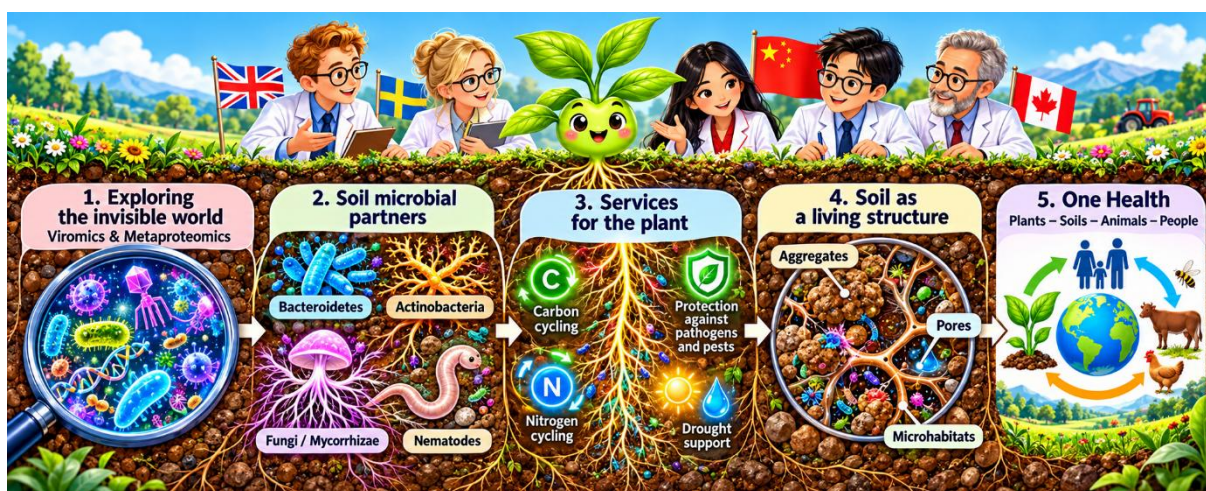




BOOK REVIEW



Understanding and utilising soil microbiomes for a more sustainable agriculture, edited by Kari E. Dunfield. Cambridge, UK: Burleigh Dodds Science Publishing, 2025. xxiv + 424 pp. Hardback, £155.00. Hardback. ISBN 978-1-80146-474-1. eISBN 978-1-80146-476-5. DOI: 10.19103/AS.2024.0136



What an extraordinary feeling it is to begin reading this book! So richly documented is this guide to soil microbiomes that it quickly carried me away, to the point of living the story in detail within the imagination of an invisible underground world beneath our feet, and looking through the eyes of a young plant growing in a soil already inhabited and so finely coordinated.

Larafa, Fall, Nannipieri *et al.* reveal the secret codes of viromics and metaproteomics that allow us to unlock the great door to this invisible universe (pp. 3–37), and to become acquainted with its inhabitants and their functions. Technology has considerably advanced these means of access through sequencing, as well as mass spectrometry and bioinformatics. At first sight, one can distinguish the dominant microbial community and its virome (pp. 12–15). The relationship between these two partners is never uniform: a virus may represent a catastrophe for one

bacterium and a formidable enemy when it is able to infect it; yet, for another antagonistic bacterium, it may be perceived as a means of eliminating rivals and freeing space and nutrients. Yes, but the possible advantages are not always systematic. And for the ecosystem? The outcome depends on a multitude of factors, including the identity of the species affected, their interactions and the local ecological conditions. In this world, so meticulously structured and organized, the soil remains the chronicler of the “tasks performed”, the guardian of memory and traceability. Every task carried out is recorded in the archive of each inhabitant’s activities, and this archive can be deciphered only through metaproteomics (pp. 27–37).

During the official ceremonies marking the young plant’s visit to this buried world, sixteen scientists from four countries — the United Kingdom, Sweden, China and Canada — stand in line. These scholars, coming from different horizons, form three delegations of scientific ambassadors: (1) Lidbury *et al.*, experts in resource transformation (pp. 45–73); (2) Bao *et al.*, specializing in bacterial diversity (pp. 73–84); and (3) Weerasuriya *et al.*, responsible for relations between fungi and plants (pp. 89–113).

The delegations are then invited to present their discoveries to our young plant.

The Lidbury *et al.* delegation proposes a visit to the processing factories and the carbon and phosphorus supply stations. It explains that skilful workers are active in these factories: the “Bacteroidetes”. This is a bacterial group, some members of which possess remarkable molecular equipment enabling them to transform complex carbon resources. Some also have mechanisms for acquiring organic phosphorus. The work is organized into several specialized workshops, because not all Bacteroidetes possess the same metabolic skills.

Some workshops even possess genuine genetic plans known as PULs (Polysaccharide Utilisation Loci) (p. 52) for exploiting complex resources. These are groups of genes involved in the recognition, degradation and acquisition of polysaccharides (pp. 50–53). The delegation acknowledges that many functions still remain to be deciphered, particularly under real soil conditions.

When the second delegation takes the floor, our young plant discovers, to her surprise, that some inhabitants of this bacterial community look strangely like fungi. But appearances are deceptive: Actinobacteria are all bacteria. They display great morphological, genetic and

metabolic diversity. Some are distinguished by a misleading filamentous, almost fungal appearance (pp. 73–84).

These bacteria are adapted to inhabit different environments, but their establishment is not left to chance: pH, moisture, temperature, organic resources and vegetation all help determine their abundance and distribution. Actinobacteria are very helpful and sociable, living in close interaction with the other inhabitants of this underground world. They perform a wide range of functions within the community. Some willingly put their talents to work in defence through their ability to produce antibiotics, antifungals and other secondary metabolites; some can be mobilized for biological control; others undertake remediation operations. Still others work in recycling, breaking down complex plant residues and thereby contributing to the carbon cycle.

The third delegation could not have found a better moment to show the young plant who the true fungi are, and what role they play in this underground society (pp. 89–113). It is as if, without even realizing it, the previous delegations had, through the questions they left unresolved, prepared a perfect introduction to their intervention. At last, the plant meets her mycobiome (pp. 95–99), the species most intimately associated with her roots, with which she continuously exchanges resources in mycorrhizae (p. 97), until they become indispensable to one another. But not every encounter between plant and fungus ends in a happy alliance: everything depends on who meets whom, and under what conditions.

The third delegation believes it is instructing a naïve plant about her own root neighbourhood, when in fact the plant herself plays an active part in its selection. Regmi *et al.* come to reveal her little secret: is she not herself chairing the “Host selection” council (p. 131) and helping to organize this community around her own roots? She even possesses an entire chemical arsenal, released by her roots, capable of influencing those who come to settle in her neighbourhood. The rhizosphere is a highly mysterious and extremely dynamic zone. One can almost read it in her eyes, even as she tries to deny it. And it is difficult for her to hide the game: this is a genuine scientific inspection brigade, capable of spying on her influence through omics approaches (pp. 155–158).

The plant quickly wants to change the subject and divert attention towards the tiny inhabitants moving through the soil: the nematodes. “Oh! How charming they are!” she exclaims, as if nothing were happening. The reality is that some of them are plant parasites capable of attacking her roots. These tiny creatures are great eaters, but each group has its own menu: some are

bacterivores, others fungivores, plant parasites, predators or omnivores; these “charming ones” in fact belong to several trophic groups. Ruess presents them to our star as highly widespread multicellular organisms, present in virtually all habitats, with very diverse lifestyles and functions (pp. 175–176).

The Jetter and Schäfer delegation nevertheless remains suspicious and keeps wondering: but after all, who does this plant work for? For herself, for the inhabitants of the soil, for the ecosystem... or for all this little world at once? The answer takes them far beyond her roots alone: in this society, the health of some cannot be considered independently from that of others. It is here that the concept of One Health takes on its full meaning (pp. 205–220).

It is now time to present the catalogue of services. At the fourth station (pp. 231–322), our young plant cannot help but feel proud, because the offer proves to be more generous than she had imagined: carbon management (pp. 231–250), nitrogen management (pp. 255–265), protection against pathogens and pests (pp. 271–283), and assistance in the face of drought (pp. 293–321). Our young plant finally begins to understand everything she gains from maintaining good relations with all her neighbours. And when the activity of this underground society departs from the ordinary, she now knows that something may not be quite right (pp. 231–250).

Shi arrives at just the right moment to remind our young plant that an offer exists only when one responds to demand, and that the most lasting relationships are those in which each gives at least as much as is being received. He illustrates this through the example of soil (pp. 335–356). He first explains that soil is not simply a support. In one direction, its texture, particles, aggregates and pores, together with the circulation of water, air and resources, create a multitude of microhabitats for the microbiota. The size and organization of the pores also influence the distribution, movement and interactions of microorganisms. In the other direction, microorganisms themselves help to assemble and stabilize the aggregates that structure the soil.

The young plant had long admired the services provided by her neighbours, and all the sacrifices and assistance they so generously offer, yet at the same time she remains convinced that all of this is not enough to guarantee a sustainable and optimized life.

The final two delegations, coordinated by Whalen and Mendes *et al.* (pp. 365–419), perhaps give her the most important lesson of all: this invisible society can be profoundly disturbed by our own interventions, by our own agricultural and fertilization practices intended to increase

yields. Optimizing the soil therefore no longer means simply growing a plant; it means learning to consider and care for the living world that makes that plant grow and that lies beneath her feet.

And I, because I like to move forward with clarity, find myself trapped in an endless circle beside the delegation of the two German scientists, Jetter and Schäfer, at once suspicious and questioning, still waiting for an answer to these questions: but after all, who does this plant work for? For herself, for the inhabitants of the soil, for the ecosystem... or for all this little world at once? And in the end, who works for whom? We work for her, she works for others, the others work among themselves... and here I am back at my starting point.

Fortunately, one single expression was enough to escape this mechanism: One Health. Perhaps it was simply necessary to understand that there was no “who works for whom”, but rather “everyone works with everyone”. In this society, each gives, receives and depends on the others; the health of some cannot be considered independently from that of others. One Health may be a relatively recent term, but the story it tells is immemorial: beneath our feet as above them, the health of some has always been built together with that of others (pp. 205–220).

Indeed, this book conveys the same advice: let us walk gently upon the earth, because beneath our steps the balance is very fragile, life works in silence, and the hope of future generations depends upon it; that hope, too, is already beginning to germinate.

From its inhabitants to their functions, from their alliances to their rivalries, from their services to their fragile balances, this extraordinary underground society seemed to have carried me away with it, delightfully. Our young plant slowly disappears between the pages as the end approaches, unfortunately. After such a journey beneath our feet, so well accompanied, I still want her to remain. For although all these secrets have now been unlocked, another question still remains. Beneath her roots, yes, she seems to have solved every mystery; but in the very title of the book, one riddle still resists me, and I keep asking myself the same question: why “utilising” rather than “using” [1–3]? As Eric Partridge states, '**utilize, utilization** are, 99 times out of 100, much inferior to *use*, v. [*verb*] and n. [*noun*]; the one other time, it is merely inferior [4].

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nadia.boutaleb@fstm.ac.ma

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