

It's a Jungle down There – Micro-organisms in the Soil

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Productive, healthy soil is much more than just dirt. It is a living, breathing dynamic ecosystem! It contains untold billions (even trillions) of organisms; and the health of the soil and all it produces depend on them. Just as most of the micro-biotic community living in and on the human body, the vast majority of these organisms are beneficial. Organisms in the soil are categorized as micro or macro organisms and all have a critical role to play in making soil living, dynamic, and productive.

1. Micro-organisms: Those which cannot be seen with the naked eye.
 - a. Bacteria: In a teaspoon (5-7 grams of soil) there are typically 100 billion bacteria representing one aspect of a well-developed and functional microscopic ecosystem beneath the soil surface.¹ Aside from the possible disease aspects of bacteria, the average person has a minimal concept of the diversity and essential roles that bacteria play in the health of all living things and the soil we depend so heavily upon. There are four general categories of bacteria in the soil; *decomposers*, *mutualists*, *pathogens* (these are generally on the mind of most people), and *lithotrophs*. *Lithotrophs* are critical to nitrogen recycling and pollutant degradation.² Soil bacteria are critical to water dynamics, nutrient recycling, disease suppression, and the health and productivity of soils.
 - b. Fungi: Interestingly, while fungi are often thought of as some aberrant form of life, they are more closely related to us than bacteria, and play a critical role in decomposition of dead and/or living organic material.¹ Additionally, *mutualist* fungi such as ecto- or endo-mycorrhizae play a crucial role in the root efficiencies of a wide variety of plants facilitating the uptake of moisture, carbon, minerals. As the name indicates, they either grow on the surface areas (ecto) of the roots of woody plants and trees, or grow within the root structures of grasses, garden plants, and smaller woody shrubs. Finally, as in all good things, there are *pathogenic* and *parasitic* fungi which cause much loss in production and the death of plants in the garden and landscape. On the positive side, many fungi parasitize disease causing nematodes and damaging insects.
 - c. Protozoa: Single cell animals requiring bacteria to eat and water for movement. They will also feed on each other and can reduce bacterial diseases by consuming large number of pathogenic bacteria. The regulation of bacterial populations through grazing releases excess nitrogen in the form of ammonium (NH₄⁺)₃ providing nitrogen for plant growth as protozoa generally occupy soil zones within the rhizosphere adjacent to root structures.
 - d. Nematodes: Small diameter microscopic worms living in the water surrounding root zones are the final microbiological life form responsible for living soil. They can provide both benefits and problems in the garden.⁴ Excessive irrigation favors some parasitic omnivore nematodes which may greatly reduce production. Otherwise, similar to other micro life

forms discussed above, nematodes consume fungi, bacteria, protozoa, and each other returning nutrients to the soil and maintaining a balanced ecosystem under the soil.⁵

2. Macro-organisms: Those which can be seen with the naked eye.

- a. Arthropods; which include mites, millipedes, spiders, scorpions, and beetles are the primary macro organisms responsible for maintaining the health of our living soils. They constitute a population of predator/prey organisms which facilitate nutrient release, recycling, and utilization. They are grouped as shredders, predators, herbivores, and fungal feeders.⁶ All occupy critical roles with respect to maintaining healthy, living, and productive soils. Larger arthropods live on the soil surface and shred organic debris, and each other, into small parts aiding in decomposition and incorporation into the soil. If a gardener has ever spread organic mulch on the soil, and then marveled at how quickly it seems to vanish, blame the shredders! Examples are millipedes, sow bugs, earwigs, and some beetles. Other arthropods such as spiders and pseudo scorpions predate each other and the shredders. The results of all this frenetic interaction are copious streams of recycled organic material and body parts circulating throughout the soil ecosystem.

- b. Earthworms: The final candidate for evaluation is the most visible feature of living soil systems. What do they contribute to the conversation? Most importantly they alter and mix soil structure to better facilitate water movement and holding capacity, bury and shred surface organic material, provide channels for root growth and development, maintain nutrient dynamics, facilitate plant growth, and stimulate microbial activity.⁷

Now that we have a glimpse of the total picture concerning soil, it will never again be taken for granted. The entire process is essential for balanced, living, highly productive soil. It is truly a jungle down there and a world that few take the time to really understand or appreciate.



Pseudo scorpion: by Modenke (.5 to 1mm)

Citations:

1. Knudsen, Guy R. (2006); Bacteria, Fungi, and Soil Health. Presentation: Idaho Potato Conference, Pp. 1 & 2.
2. Inghan, Elaine R. (2000); The Living Soil: Bacteria. USDA-NRCS Soil Biology Primer. www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/ Accessed (2.14.2016) P. 2.
3. Ibid. The Living Soil: Protozoa. Soil Biology Primer: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/> Accessed (2.14.2016) P. 1.
4. Ibid. The Living Soil: Nematodes. Soil Biology Primer: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/> Accessed (2.14.2016) P. 2.
5. Neher, Deborah A. (2001); Role of Nematodes in Soil Health and their Use as Indicators. *Journal of Nematology* 33(4) Pp. 161-62.
6. Moldenke, Andrew R. (2001). The Living Soil: Arthropods. USDA-NRCS Soil Biology Primer. www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/ Oregon State University, Accessed (2.14.2016)
7. Edwards, Clive A. (2001). The Living Soil: Earthworms. USDA-NRCS Soil Biology Primer. <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/> Ohio State University, Accessed (2.14.2016)