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Effect of soil on microbial diversity of flora and fauna in ecosystem

Akash Sharma[1], Divya.M.S[1], Deepak S Goyal[2], Mohit Mishra[3] and Prashant Shukla[3]

[1]SRM University, Chennai, Tamilnadu, India.
[2]University of Massachusetts Boston, USA
[3]Raipur Institute of Technology, Raipur, Chhattisgarh, India.

Abstract
Soil is a complex and dynamic biological system. We are limited in the determination of microbial mediated reactions because present assays for determining the overall rate of entire metabolic processes (such as respiration) or specific enzyme activities (such as urease, protease and phosphomonoesterase activity) do not allow any identification of the microbial species directly involved in the measured processes. The central problem posed by the link between microbial diversity and soil function is to understand the relations between genetic diversity and community structure and between community structure and function. Soil seems to be characterized by a redundancy of functions; for example, no relationship has been shown to exist between microbial diversity and decomposition of organic matter. Generally, a reduction in any group of species has little effect on overall processes in soil because other microorganisms can take on its function.

Keywords: Soil, microorganisms, environment

Soil is fundamental and irreplaceable part of life and it governs productivity of terrestrial ecosystems and maintains biogeochemical cycles utilizing microorganisms to degrade, ultimately, virtually all organic compounds including persistent xenobiotics and naturally occurring polyphenolic compounds. The soil provides support to variety of life forms including macrofauna, mesofauna, microfauna, macroflora and microflora. Around 80–90% of the processes in soil are reactions mediated by microorganisms (Coleman & Crossley, 1996; Nannipieri & Badalucco, 2003). Soil is highly heterogeneous and complex microhabitat, which is reflected in the spatial distribution and enormous diversity of microorganisms and their metabolic versatility. Bacteria and fungi, the major contributors of soil microbial diversity are extremely flexible and can carry out almost all known biological reactions. The importance of soil microorganisms for sustenance of all other forms of life needs no emphasis. The presence of microorganisms alters the habitat and makes it possible for other life forms to survive and function.

The relation between microbial biodiversity and function in the soil is of particular interest. The conservation of microbial biodiversity is essential for functional biosphere. Twofold premise of studying biodiversity in current scenario are (i) to be able to understand and manipulate the working of ecosystem and (ii) diversified system is better adapted to withstand sudden and large scale disturbances. On contrary there is growing body of evidences which shows that most organisms are functionally superfluous in nature and functions of component species are as important as number of species in order to maintain essential functional processes (Andren & Balandreau, 1999; Bardgett & Shine, 1999). According to insurance hypothesis given by Loreau *et al*., 2001 large numbers of species are essential for maintaining the steady processes in constantly changing environments even though for an ecosystem to function stably only a minimum number of species may be required. The links between biodiversity and functionality of soil is poorly understood because the theories developed are based on above ground observation and very few studies have been made in soil (Wardle & Giller, 1996; Ohtonen *et al*., 1997; Griffiths *et al*., 2000).

Microbial population in soil is very diverse and large. By taking the genome size of Escherichia coli as a unit, Torsvik *et al*. (1996) calculated the presence of about 6000 different bacterial genomes per gram of soil. Likewise Killham, 1994 reported that the bacterial and fungal biomass amounted to 1–2 and 2–5 t ha_1, respectively in a temperate grassland soil. This huge diversity and size limits the accurate measurement of species richness and evenness in soil. Soil being a structured, heterogeneous and discontinuous system is generally poor in nutrients and energy sources for optimal microbial growth which results in microbes living in discrete microhabitats in soil (Stotzky, 1997). These microhabitats differ in chemical, physical and biological character in both time and space. Because of the size of microorganisms the biological space occupied by the living microbes is less than 5% of the total available space (Ingham *et al*., 1985). The soil also provides distinct ‘hot spots’ which are zones of high biological activities like collections of different physicochemical properties from the bulk of the soil (Sexstone *et al*., 1985), zones with build up particulate organic matter (Parkin, 1987) or animal manures (Petersen *et al*., 1996), and the rhizosphere (Lynch, 1990; Pinton *et al*., 2001). The unevenness of availability of resources makes it difficult for microbes to find suitable conditions to survive and grow and there are very few such microhabitats which allow for growth of microorganisms. Microhabitats in soil are dynamic systems because of changing environmental factors like carbon and energy sources, mineral nutrients, ionic composition, available moisture and rate of precipitation, temperature, pressure, air composition, electromagnetic radiation, pH, oxidation–reduction potential,

*Corresponding Author

Akash Sharma
SRM University, Chennai, Tamilnadu, India.

surfaces, growth factors and spatial relationships. These factors along with genetics of microbes and there interaction maintains the balance of the ecosystem.

Communities generally compete because the majority of species are rare and a few species are abundant (Loreau *et al*., 2001), which is due to competitive interactions among species. Tiedje *et al*. (2001) suggested that competition in microbial communities of surface soils was absent because the various microbial species inhabiting soil are spatially separated for most of the time. As interaction increases between communities of microorganisms, it results in dominance of some species (Tiedje *et al*., 2001). The lack of competition among microbial communities on surface can also be explained by diversity of organic compounds present on the surface of soils. As the diversity of organic matter increase the options for microorganisms increase. This increased in options for microbes decrease their reliance on few organic compounds thereby decreasing the competition among the microbial communities. Plants greatly influence the composition of microbial communities in soil by their own interaction with soil and by addition of organic compounds via dead plant matter in the soil. Brimecombe *et al*., 2001 have stated that the strict nature of interaction between plants and microbes in rhizosphere is due to co-evolution. It has been shown by using molecular techniques that the microorganisms are unique and not ubiquitous. Even though similar types of microorganisms can be found in similar types of habitats all over the world a microbial community at one given place is native to that place and differs significantly with microbial communities of similar habitats world over (Tiedje *et al*., 2001). This diversity is more of genetic diversity than species diversity and this arises due to subtle changes in composition of organic compounds found at the place.

Even though soil quality depends on a complex of physical, chemical and biological properties, microbial and biochemical characteristics are used as potential indicators of soil quality (Kennedy & Papendick, 1995). This is because of their central role in cycling of C and N and their sensitivity to change (Nannipieri *et al*., 1990). The need to measure the activities of a large number of enzymes and to combine these measured activities in a single index has been emphasized to provide information on microbial activity in soil (Nannipieri *et al*., 2002). Most of the assays used to determine microbiological activities in soil present the same problem: measuring potential rather than real activities (Burns, 1982; Nannipieri *et al*., 1990). This is due to the reason that assays are generally made at optimal pH and temperature and at saturating concentration of substrate and synthetic rather than natural substrates are often used, and soil is incubated as slurry (Nannipieri *et al*., 1990).

The links between microbial diversity and soil functioning, as well those between stability (resilience or resistance) and microbial diversity in soil, are unknown because, as stated above, it is difficult to measure microbial diversity. In addition, we generally measure soil functions by determining the rates of microbial processes, without knowing the microbial species effectively involved in the measured process. According to O'Donnell *et al*. (2001), the central problem of the link between microbial diversity and soil function is to understand the relations between genetic diversity and community structure and between community structure and function.

Measurement of the level of soil biodiversity is important, greater species diversity indicates a healthy environment. A large, diverse, and active population of soil organisms is thus the most important indicator of a healthy soil. The effects of physical and chemical degradation of soils are obvious. But the effects of biological degradation which is caused due to loss of specific soil organic matter (SOM) fractions (and consequently the loss of microbial species/communities dependent on them for nutrition) as well as and specific toxicity influences on soil flora and fauna are insidious. The loss of the diversity is difficult to measure and even more difficult to link with loss of specific soil functions. This is because there is a lot of functional redundancy for most of the soil biological processes-in the sense that loss of one species is compensated by others that can do the same function. Thus a reduction in soil biodiversity may not immediately translate into a complete loss of a function. But it would reduce its resistance and make it vulnerable to further loss of value/function if a new disturbance or stress event occurs. Proper management of soil biodiversity will help in sustainable agriculture and reduce the cost of external inputs especially for nutrient supply and crop protection (Rao & Patra, 2009).

CONCLUSION

Soil biodiversity is very important factor controlling the ecosystem. It drives the ecosystem and maintains it. Microflora creates the diversity which maintains the functionality of the soil and run the ecosystem. Management of ecosystem can be done by maintaining the microflora in the soil which differs according to the habitats.

REFERENCES

[1]Andren, O. & Balandreau, J. 1999. Biodiversity and soil functioning – from black box to can of worms? Applied Soil Ecology, 13, 105–108.

[2]Bardgett, R.D. & Shine, A. 1999. Linkages between plant litter diversity, soil microbial biomass and ecosystem function in temperate grasslands. Soil Biology and Biochemistry, 31, 317–321.

[3]Brimecombe, M.J., De Leij, F.A. & Lynch, J.M. 2001. The effect of root exudates on rhizosphere microbial populations. In: The Rhizosphere: Biochemistry and Organic Substances at the Soil–Plant Interface (eds R. Pinton, Z. Varaninin & P. Nannipieri), pp. 95–140. Marcel Dekker, New York.

[4]Burns, R.G. 1982. Enzyme activity in soil: location and a possible role in microbial ecology. Soil Biology and Biochemistry, 14, 423–427.

[5]Coleman, D.C. & Crossley, D.A. 1996. Fundamentals of Soil Ecology. Academic Press, London.

[6]Griffiths, B.S., Ritz, K., Bardgett, R.D., Cook, R., Christensen, S., Ekelund, F. *et al*. 2000. Ecosystem response of pasture soil communities to fumigation-induced microbial diversity reductions: an examination of the biodiversity–ecosystem function relationship. Oikos, 90, 279–294.

[7]Ingham, R.E., Trofymow, J.A., Ingham, E.R. & Coleman, D.C. 1985. Interactions of bacteria, fungi, and their nematode grazers: effects on nutrient cycling and plant growth. Ecological Monographs, 55, 119–140.

[8]Kennedy, A.C. & Papendick, R.I. 1995. Microbial characteristics of soil quality. Journal of Soil and Water Conservation, 50,

243–248.

[9]Killham, K. 1994. Soil Ecology. Cambridge University Press, Cambridge.

[10] Loreau, M., Naeem, S., Inchausti, P., Bengtsson, J., Grime, J.P., Hector, A. *et al*. 2001. Biodiversity and ecosystem functioning:current knowledge and future challenges. Science, 294, 804–808.

[11] Lynch, J.M. 1990. The Rhizosphere. John Wiley & Sons, Chichester.

[12] Nannipieri, P. & Badalucco, L. 2003. Biological processes. In: Processes in the Soil–Plant System: Modelling Concepts and Applications (eds D.K. Bembi & R. Nieder). The Haworth Press, Binghamton, NY, in press.

[13] Nannipieri, P., Grego, S. & Ceccanti, B. 1990. Ecological significance of the biological activity in soil. In: Soil Biochemistry, Volume 6 (eds J.-M. Bollag & G. Stotzky), pp. 293–355. Marcel Dekker, New York.

[14] Nannipieri, P., Kandeler, E. & Ruggiero, P. 2002. Enzyme activities and microbiological and biochemical processes in soil. In: Enzymes in the Environment (eds R.G. Burns & R. Dick), pp. 1–33. Marcel Dekker, New York.

[15] O'Donnell, A.G., Seasman, M., Macrae, A., Waite, I. & Davies, J.T. 2001. Plants and fertilisers as drivers of change in microbial community structure and function in soils. Plant and Soil, 232, 135–145.

[16] Ohtonen, R., Aikio, S. & Va¨ re, H. 1997. Ecological theories in soil biology. Soil Biology and Biochemistry, 29, 1613–1619.

[17] Parkin, T.B. 1987. Soil microsites as a source of denitrification variability. Soil Science Society of America Journal, 51, 1194–1199.

[18] Petersen, S.O., Nielsen, T.H., Frostega˚ rd, A ˚ . & Olesen, T. 1996. O2 uptake, C metabolism and denitrification associated with manure hot-spots. Soil Biology and Biochemistry, 28, 341–349.

[19] Pinton, R., Varanini, Z. & Nannipieri, P. 2001. The Rhizosphere: Biochemistry and Organic Substances at the Soil–Plant Interface.Marcel Dekker, New York.

[20] Rao, D.L.N. and Patra, A.K. (2009) Soil Microbial Diversity and Sustainable Agriculture, J. Ind. Soc. Soil Sc., 57(4), 513-530

[21] Sexstone, A.J., Revsbech, N.P., Parkin, T.B. & Tiedje, J.M. 1985. Direct measurement of oxygen profiles and denitrification rates in soil aggregates. Soil Science Society of America Journal, 49, 645–651.

[22] Stotzky, G. 1997. Soil as an environment for microbial life. In: Modern Soil Microbiology (eds J.D. van Elsas, J.T. Trevors & E.M.H. Wellington), pp. 1–20. Marcel Dekker, New York.

[23] Tiedje, J.M., Cho, J.C.,Murray, A., Treves, D., Xia, B. & Zhou, J. 2001. Soil teeming with life: new frontiers for soil science. In: Sustainable Management of Soil OrganicMatter (eds R.M. Rees, B.C. Ball, C.D. Campbell & C.A. Watson), pp. 393–412. CAB International, Wallingford.

[24] Torsvik, V.L., Sørheim, R. & Goksoyr, J. 1996. Total bacterial diversity in soil and sediment communities – a review. Journal of Industrial Microbiology, 17, 170–178.

[25] Wardle, D.A. & Giller, K.E. 1996. The quest for a contemporary ecological dimension to soil biology – Discussion. Soil Biology and Biochemistry, 28, 1549–1554.