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The Influence of Microorganisms in Ecological Diversity

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ABSTRACT

The impact of each individual's usage had created an inadequacy in environment. So it is necessary to record the living beings amount in the world. Ecosystem functioning depends on multiple interactions between physical, chemical and biological determinants and ecosystem it is a combination of biotic and abiotic factors. Indeed, ecosystem processes (productivity and nutrient recycling) result directly from the diversity of functional traits in the biotic communities, which is in turn determined by the species composition and diversity. This species diversity results from both biotic introductions and environmental pressures. As a result, changes in biodiversity in response to environmental selection pressures tend to have a direct output, along with the environmental pressures, the influence of microorganisms adds up to the ecosystem processes. In this paper we try to discuss about the role of ecosystem and the importance of microbial species in the ecosystem. The major role & interaction of microbes with the ecosystem are discussed.

KEYWORDS: *Biotic, Abiotic, Ecosystem.*

INTRODUCTION

It is understood that ecosystem functioning depends on the interaction of both biotic factors and/or processes (such as species diversity and functions or species interactions) and a biotic constraints (such as climate or geology). However, the relative contribution of these two factors is still a central question in the debate about diversity and ecosystem functioning (Huston and McBride, 2002). The paper focuses to give an overall idea regarding the diversity.

For the past two decades, an increasing number of studies have focused and been published on biodiversity. This is principally due to the fact that the world’s flora and fauna are disappearing at rates greater than the historical mass extinction events (Chapin III et al., 2001). As recently suggested by Thomas et al. (2004), there is an 18% to 40% risk of species-level extinction resulting majorly from global warming and drastic change happening in the climatic conditions. Moreover, other processes such as agricultural expansion, for example, in response to an increasing demand for food have a negative impact on biodiversity as a result of habitat destruction (Tilman et al., 2001).

Most of the numerous studies of biodiversity investigate the origin of biodiversity and the main processes involved in the conservation of biodiversity. In the case of aquatic ecosystems, the astonishing species diversity in phytoplankton communities known as the paradox of phytoplankton diversity (Hutchinson, 1961) has stimulated many studies and research work on the importance of competition for light and or nutrients, or of the intermediate disturbance hypothesis (e.g. Huysman et al., 1999; Huysman et al., 2001; Elliott et al., 2001; Interlandi and Kilham, 2001; Schippers et al., 2001). More globally, an increasing number of papers also investigate the relationships between biodiversity and ecosystem functioning. With the evolution of earth each organisms began to evolve and nature was formed with an abundant plant, animal, microbial diversity but as the years advances with increase in population made the organisms living a little tougher.

In most cases, the terminology "biodiversity" has been employed with reference to a specific organizational level (species, community...), and it is only recently that it has also been considered from a functional perspective (Martinez, 1996). In the case of ecosystem functioning, two main types of function are generally considered. The first is the productivity of the system, for example in terms of biomass or nutrient fluxes. The second type of function is the "stability" of the system. As McCann (2000) points out, definitions of stability can be divided into two categories. The first concerns definitions based on the dynamic stability of a system, whereas the second concerns definitions based on the ability of a system to withstand change. In this latter case, the concepts of resistance (the degree to which a parameter changes after a disturbance) and resilience (the ability of an ecosystem to recoil back to its equilibrium or non-equilibrium state after a disturbance) are very important. In many cases, the term of "resistance" is associated with the ability of a community to resist to an invasive species (McCann, 2000).

ECOSYSTEM & ITS HABITATS

An ecosystem is a habitat of living organisms (plants, animals and microbes) along with the abiotic or non living components of their environment (things like air, water and mineral soil), interacting as a system(Brown, 2007). These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows (Brown, 2007). As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment,(Robert Valnowitz, 1997) they can come in any size but usually encompass specific, limited spaces (Brown, 2007).Energy, water, nitrogen and soil minerals are other essential abiotic components of an ecosystem. The energy that flows through ecosystems is obtained primarily from the sun. It generally enters the system through photosynthesis, a process that also captures carbon from the atmosphere. By feeding on plants which are considered as the producers and on one another, animals play an important role in the movement of matter and energy through the system, thus transfer of energy flow occurs. They also influence the quantity of plant and microbial biomass present. By breaking down dead organic matter, decomposers release carbon back to the atmosphere and facilitate nutrient cycling by converting nutrients stored in dead biomass back to a form that can be readily used by plants and other microbes (Schoener Thomas. W., 2009).

EXTRINSIC & INTRINSIC FACTORS

Ecosystems are controlled both by extrinsic and intrinsic factors. Extrinsic factors such as climate, the parent material which forms the soil and topography, control the overall structure of an ecosystem and the way things work within it, but are not themselves influenced by the ecosystem (Tansley.A.G, 1939). Other external factors include time and potential biota. Ecosystems are dynamic entities invariably, they are subject to periodic disturbances and are in the process of recovering from some past disturbance. (Odum H.T, 1988). Ecosystems in similar environments that are located in different parts of the world can end up doing things very differently simply because they have different pools of species present. (Tansley A.G, 1939). The introduction of non-native species can cause substantial shifts in ecosystem function. Internal factors not only control ecosystem processes but are also controlled by them and are often subject to feedback loops. (Tansley A.G, 1939) While the resource inputs are generally controlled by external processes like climate and parent material, the availability of these resources within the ecosystem is controlled by internal factors like decomposition, root competition or shading. (Tansley A.G, 1939). Other internal factors include disturbance, succession and the types of species present. Although humans exist and operate within ecosystems, their cumulative effects are large enough to influence external factors like climate.(Tansley A.G, 1939).

INFLUENCE OF MICROOGANISMS IN DIVERSITY

Microorganisms play an integral and often unique role in ecosystem functions yet we know little about dominant populations that significantly play vital roles in these functions, nor do we know much about how these populations differ with habitat. The greatest microbial diversity at small scales appears to reside in the soil. Soil is enriched with microorganisms. Soil microbial communities are among the most complex, diverse, and important assemblages in the biosphere.

Analysis of genetic diversity in soil communities by DNA renaturation suggests that there are approximately 4–7 ×103 different genome equivalents per 30 g of soil (Torsvik et al., 1990), which, if extrapolated to species diversity, implies that there are at least 103 or even more species per g of soil.

Soil bacteria are pivotal components of terrestrial ecosystems. They play significant roles in nitrogen cycling (Lin Y.T.et.al., 2009) carbon cycling (Deiglmayr. K.et. al., 2004), transformation of metals such as iron, manganese, and mercury (Rambaugh. A., 2007), addition of organic humic content (Dunbar.J.1999) as well as soil formation (Rilling.M.C.et.al., 2006). They are also important for nutrient acquisition in the soil ecosystem and therefore contribute to plant nutrition and health (George. E. et. al., 1995). Moreover, through the production of antibiotics or growth factors like vitamins, soil bacteria can exert positive or negative control over other organisms in the environment (Hogenberg.P.et.al., 2001). A gram of soil contains as many as 103 – 106 unique bacteria, some bacteria’s include Nitobactersp, Nitrosomonassp, Klebsiellasp, Bacillus sp, E.coli, Agrobacterium sp, Proteussp (Torsvik.V et.al., 1990) and therefore, soil bacteria are genetically diverse and represent a major untapped genetic resource (Whitman W.B. et.al.,1998).

Not only are soil bacteria abundant in terrestrial ecosystems, they are also excellent indicators of soil health, soil fertility (Tringe.S.Get.al.,2005) and ecosystem status in a much more comprehensive way than physical or chemical measures (Winding.A.et.al.,2005). Bacteria from specific taxa have been linked with certain ecological characteristics. For example, the presence of nitrogen fixers such as Rhizobia and Azotobacter and nitrifying bacteria (Nitroso-) indicates high N levels in the soil. Likewise, presence of copiotrophic bacteria such as Acidobacteria indicates low nutritional status (C mineralization rate), while the presence of oligotrophic bacteria such as β-Proteobacteria and Bacteriodetes indicates high nutritional status (Fierer.N.et.al., 2006).

GENERAL ASPECTS

There are major geographic areas in earth like wetlands (S. Sreeremya, 2016), rangelands (Dr.S.Sreeremya, 2019a) , termite soil(S. Sreeremya et al.,2018b), formation of permafrost(S. Sreeremya,2017) being disturbed by varying anthropogenic activity. There are various reasons for ecological imbalance like bioerosion (S. Sreeremya, et al.,2018a) , effect of microplastics (Dr.S.Sreeremya,2020b), fly away of birds due to adverse climate(S. Sreeremya, et al.,2018c) and other reasons can contribute to drastic side effects in ecosystem(Dr.S.Sreeremya,2021).Nature and its ecosystem is a healer, it's the duty of each individual to conserve it(Dr.S.Sreeremya,2020a).There are several ecological indicators gives the alarm of ecological imbalance(Dr.S.Sreeremya , 2019b). El nino is one among the process of assessment of atmosphere and environment (Dr.S.Sreeremya, 2024).

ASSESING SOIL BACTERIAL DIVERSITY IN PENNISILVANIYA

The diversity and abundance of soil microbes, that serve such essential functions in the environment, can be affected by numerous factors. Factors such as availability of nutrients, pH, moisture content, and soil type all have an impact on microbial diversity, while temperature and topography do not (Klumpp.A. et.al., 2003). Soil bacterial composition and abundance are extremely quick to deviate based on any of these variables (Klumpp.A. et.al., 2003). Aside from natural variables, soil bacteria are also sensitive to artificial disturbances such as agriculture, pesticide use and pollution (Schmidt.S.K.et.al., 2007). Soil microbial communities have the metabolic and genetic capability to respond quickly to changes in the environmental conditions, resulting in rapid shifts in bacterial diversity in short time frame (Hill.G.T.et.al., 2000). Understanding soil microbial communities is therefore an ideal method to monitor the ecological changes occurring between seasons as well as over an extended period of time15.With the current expansion of gas drilling in the Marcellus shale region of Pennsylvania, and the relative newness of the drilling techniques used, it becomes paramount to establish a baseline of microbial diversity in this region to thoroughly understand the environmental impacts of drilling. To establish this baseline, soil samples were collected from within the mixed temperate forest of the 57-acre Abernathy Field Station in Southwestern Pennsylvania. Over 200 morphologically unique bacteria were cultured on different culture media. Isolated bacteria were analyzed by employing molecular techniques on the ribosomal gene, 16S rDNA, which is ubiquitously present, functionally constant and phylogenetically meaningful for prokaryotes25, 26. Sequence analysis of the 16S rDNA from the isolates revealed the presence of 71 Operational Taxonomic Units (OTUs) spread over four phyla and 30 taxonomic families. The diversity among these isolates was assessed by various statistical methods including Shannon-Weaver and Chao1 indices. Rarefaction analysis indicated that sampling saturation was not reached, suggesting that more unique bacteria could be found. Diversity indices calculated were high suggesting that the soil in this region is nutrient rich. This study has thus been successful in profiling and establishing a baseline of soil bacterial diversity. From this, it now will be possible to monitor both the short and long term effects of Marcellus shale drilling on soil bacterial diversity and overall ecosystem health.

EUKARYOTIC DIVERSITY

Eukaryotes are only one of the three domains of life, along with Bacteria and Archaea, yet we are particularly intrigued by eukaryotes. Eukaryotes has a specific significance in the world. This is at least partly because they include the organisms we can see. However, the vast diversity of eukaryotes are single celled organisms, and their importance to our understanding of ourselves, our world and our history are immense. The knowledge about each eukaryotic organism and their peculiar features and the Knowledge regarding the morphological, functional and ecological diversity of microbial eukaryotes is essential for numerous practical reasons, but also because they teach us about the must fundamental rules of biology.

Eukaryotes are by definition complex-celled organisms. Even the “simplest” have nuclei with highly structured chromatin, introns and large spliceosomal complexes to remove them (Collins & Penny, 2005), and complex membrane pores to control traffic in and out (Jékely, 2005). These are the specific features of eukaryotic system. The cytoplasm is structured by anextensive cytoskeleton facilitating intracellular traffic, endo and exocytosis, amoeboid locomotion (Cavalier-Smith, 2002).

Most well studied eukaryotes can now be assigned to one of four to five major groups. These are
(1)Unikonts, (2) Archaeplastida, (3) Rhizaria+ Alveolates+Stramenopiles (RAS), and (4) Excavates, which are probably at least two distinct groups referred to here as the 1.4.1) mitochondriate Excavates, and 1.4.2) core (amitochondriate) Excavates. Based on the evolutionary nature the heading eukaryotes occur, organism’s similar properties catergorized in each groups. Unikonts include all eukaryotes thought to be primitively uniflagellate, that is, Opisthokonts (including animals and fungi) and Amoebozoa (Cavalier-Smith, 2002).The RAS group was is presently researched group recognized and includes most of the former “chromalveolates” plus Rhizaria (Burki et al., 2007; Hackett et.al., 2007). Archaeplastida is the group in which eukaryotic photosynthesis first arose (Adlet.al., 2005; Archibald, 2005). Mitochondriate excavates include the former discicristates and core Jakobids. Thus there are large number of eukaryotic and prokaryotic species is yet to be discovered.

CONCLUSION

Ecosystem balances the creatures in the world. The diversity of the ecosystem it is a unique system of the world. The maintenances of plants, animals, insects & microorganisms are done in a correct equilibrium. There must be far more inventions have to be made to discover the undiscovered diversities.

REFFERNCES

1. Adl SM, Simpson AG, Farmer MA, Andersen RA, Anderson OR, Barta JR, Bowser SS, Brugerolle G, Fensome RA, 52: 399–451.
2. Archibald JM. 2005. Jumping genes and shrinking genomes—probing the evolution of eukaryotic photosynthesis with bacteria. Applied Environmental Microbiology 56, 782–787.Biology and Evolution 24: 1702–1713.
3. Brown, Thomas C.; John C. Bergstrom; John B. Loomis (2007)."Defining, valuing and providing ecosystem goods and services". Natural Resources Journal47(2):329–376. http://lawlibrary.unm.edu/nrj/47/2/04_brown_goods.pdf28-1.

4. Burki F, Shalchian-Tabrizi K, Minge M, SkjaevelandÅ,Nikolaev SI, Jakobsen KS, Pawlowski J. 2007.
5. Cavalier-Smith T, Chao E-Y. 2002. Phylogeny of choanozoa, apusozoa, and other protozoa and early eukaryote Chapin III, F.S., Zavaleta, E.S., Eviner, V.T., Naylor, R.L., Vitousek, P.M., Reynolds, H.L., Hooper, D.U., Lavorel, S., Sala, O.E.,cultivation and 16S rRNA gene cloning. Applied and Environmental Microbiology 65, 1662–1669.
6. Deiglmayr, K., Philippot, L., Hartwig, U. A., and Kandeler, E. (2004) Structure and activity of the nitratereducing community in the rhizosphere of Loliumperenne and Trifoliumrepens under long-term elevated atmospheric pCO, FEMS MicrobiolEcol 49, 445-454.
7. Dunbar, J., Takala, S., Barns, S. M., Davis, J. A., and Kuske, C. R. (1999) Levels of bacterial community diversity in four arid soils compared by cultivation and 16S rRNA gene cloning, Appl Environ Microbiol 65, 1662-1669.
8. Elliott, J.A., Irish, A.E., Reynolds, C.S., 2001. The effects of vertical mixing on a phytoplankton community: a modelling approach to the intermediate disturbance hypothesis. Fresh. Biol. 46, 1291-1297.
9. Fierer, N., and Jackson, R. B. (2006) the diversity and biogeography of soil bacterial communities, ProcNatlAcadSci U S A 103, 626-631.1071.
10. Fierer, N., and Jackson, R. B. (2006) the diversity and biogeography of soil bacterial communities, ProcNatlAcadSci U S A 103, 626-631.
11. Fredericq S, James TY, Karpov S, Kugrens P, Krug J,Lane CE, Lewis LA, Lodge J, Lynn DH, Mann DG,McCourt RM, Mendoza L, Moestrup Ø, Mozley-Standridge SE, Nerad TA, Shearer CA, Smirnov AV, Spiegel FW, Taylor MF. 2005. The new higher level classification of eukaryotes with emphasis on the taxonomy of protists. Journal of Eukaryotic Microbiology genomics. IUBMB Life 57: 539–547.
12. George E, M. H., Jakobsen I. (1995) Role of arbuscular fungi in the uptake of phosphorous and nitrogen FEMS MicrobiolEcol 19, 171-180.
13. Hackett JD, Yoon HS, Li S, Reyes-Prieto A, Rümmele SE, Bhattacharya D. 2007. Phylogenomic analysis supports the monophyly of Cryptophytes and haptophytes and the Association of Rhizaria with Chromalveolates. Molecular Biology and Evolution 24: 1702–1713.

14. Hill, G. T., Mitkowski, N. A., Aldrich-Wolfe, L., Emele, L. R., Jurkonie, D. D., Ficke,A., Maldano-Ramirez,S., Lynch, S. T., and Nelson, E. B. (2000) Methods for assessing the composition and diversity of soil microbial communities, Applied Soil Ecology 15, 25-36.
15. Hogberg, P., Nordgren, A., Buchmann, N., Taylor, A. F., Ekblad, A., Hogberg, M. N., Nyberg, G., Ottosson- Lofvenius, M., and Read, D. J. (2001) Large-scale forest girdling shows that current photosynthesis drives soil respiration, Nature 411, 789-792.
16. Hutchinson, G.E., 1961. The paradox of the plankton. Am. Nat. 95, 137-145.
17. Huysman, J., Johansson, A. M., Folmer, E. O., Weissing, F. J., 2001. Towards a solution of the plankton paradox: the importance of physiology and life history. Ecol. Lett. 4, 408-411.
18. Huysman, J., Jonker, R.R., Zonneveld, C., Weissing, F. J., 1999. Competition for light between phytoplankton species: experimental tests of mechanistic theory. Ecology 80, 211-222.
19. Kilham S.S.,,Interlandi, S.J., 2001. Limiting resources and the regulation of diversity in phytoplankton communities. Ecology 82, 1270-1282.
20. Klumpp, A., Hintemann, T., Lima, J. S., and Kandeler, E. (2003) Bioindication of air pollution effects near a copper smelter in Brazil using mango trees and soil microbiological properties, Environ Pollut 126, 313-321.
21. Lin, Y. T., Huang, Y. J., Tang, S. L., Whitman, W. B., Coleman, D. C., and Chiu, C. Y. (2009) Bacterial community diversity in undisturbed perhumidmontane forest soils in Taiwan, MicrobEcol 59, 369-378.
22. Martinez, N.D., 1996. Defining and measuring functional aspects of biodiversity. In: K.J. Gaston (Ed.), Biodiversity - A biology of numbers and differences, pp. 114-118. Blackwell Science, Oxford.
23. McCann, K.S., 2000. The diversity - stability debate.Nature 405, 228-233.megaevolution. Journal of Molecular Evolution 56:540–563.
24. Odum, EP (1971) Fundamentals of ecology, third edition, Saunders New York
25. Phylogenomics reshuffles the eukaryotic supergroups. PLoS ONE 8: 790–795.
26. Rambaugh, A. (2007) Fig Tree: Molecular evolution, phylogenetics and epidemiology.
27. Rillig, M. C., and Mummey, D. L. (2006) Mycorrhizas and soil structure, New Phytol 171, 41-53

28. Robert Ulanowicz (1997). Ecology, the Ascendant Perspective. Columbia Univ. Press.ISBN 0-231-108.
29. Schippers, P., Verschoor, A.M., Vos, M., Mooij, W.M., 2001. Does "supersaturated coexistence resolve the paradox of the plankton"? Ecol. Let. 4, 404-407.
30. Schmidt, S. K., Costello, E. K., Nemergut, D. R., Cleveland, C. C., Reed, S. C., Weintraub, M. N., Meyer, A.F., and Martin, A. M. (2007) Biogeochemical consequences of rapid microbial turnover and seasonal succession in soil, Ecology 88, 1379-1385.
31. Schoener, Thomas W. (2009). "Ecological Niche". In Simon A. Levin. The Princeton Guide to Ecology. Princeton: Princeton University Press. pp. 2–13. ISBN978-0-691-12839-9soil, Ecology 88, 1379-1385.
32. Tansley, AG (1939) The British islands and their vegetation. Volume 1 of 2.Cambridge University Press, United.Kingdom.484 pg. The soil, Critical reviews in Biotechnology 15, 257-270.
33. Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., Schindler, D., Schlesinger, W.H., Simberloff, D., Swackhamer, D., 2001. Forecasting agriculturally driven global environmental change. Science 292, 281-284.
34. Torsvik, V., Goksoyr, J., and Daae, F. L. (1990) High diversity in DNA of soil bacteria, ApplEnviron.Microbiol 56, 782-787.
35. Torsvik, V., Goksoyr, J., Daae, F., 1990. High diversity in DNA of soil.
36. Tringe, S. G., von Mering, C., Kobayashi, A., Salamov, A. A., Chen, K., Chang, H. W., Podar, M., Short, J. M., Mathur, E. J., Detter, J. C., Bork, P., Hugenholtz, P., and Rubin, E. M. (2005) Comparative metagenomics of microbial communities, Science 308, 554-557.
37. Whitman, W. B., Coleman, D. C., and Wiebe, W. J. (1998) Prokaryotes: the unseen majority, ProcNatlAcad.Sci U S A 95, 6578-6583.
38. Winding, A., Hund-Rinke, K., and Rutgers, M. (2005) the use of microorganisms in ecological soil. classification and assessment concepts, Ecotoxicol Environ Saf 62, 230-248.
39. Winding, A., Hund-Rinke, K., and Rutgers, M. (2005) the use of microorganisms in ecological soil classification and assessment concepts, Ecotoxicol Environ Saf 62, 230-248.

40. Yao, H., He, Z., Wilson, M. J., and Campbell, C. D. (2000) Microbial Biomass and Community Structure in a Sequence of Soils with Increasing Fertility and Changing Land Use, MicrobEcol 40, 223-237.
41. S.Sreeremya, Invertis Journal of Renewable Energy, Wetland conservation: Indian Scenario: Review, Vol (6)2, pp:1-4, 2016.
42. S. Sreeremya, International Journal of Environmental Planning and Development, Permafrost – Review, S.Sreeremya, Vol: 3(1),pp:1-4,2017.
43. S. Sreeremya, M. Flory Shobana, International Journal of Biochemistry and Biomolecules, Sponge Bioerosion –Review, 2018a,Vol. 4: Issue 1.
44. S. Sreeremya, M. Flory Shobana ,IJIRT, Assessment of Cellulolytic Activity from the Microorganisms Isolated From Lower Termite Soil,2018b,Volume 4 Issue 10 ,ISSN: 2349-6002
45. S. Sreeremya, Journal of Transportation Engineering and Its Applications, Flyway of Birds, 2018c.Vol(3):3,1-12.
46. Dr.S.Sreeremya, Journal of Trauma Management and Critical Care Nursing, Combined Effect of Walking and Forest (Shinrin-Yoku) Environment on Salivary Cortisol Concentration,2020a.Vol 2(1):1-9.
47. Dr.S.Sreeremya, Journal of Water Resource Engineering & Pollution Studies, Effect of Microplastics, 2020b.Vol 5(1):1-7.
48. Dr.S.Sreeremya, Journal of Remote Sensing, Environmental Science & Geotechnical Engineering, Soil Liquefaction, 2021.Vol 6(2):1-10.
49. Dr.S.Sreeremya, Journal of Biological Sciences and Environmental Research Rangeland Management, 2019a.Vol 1(1):1-14.
50. Dr.S.Sreeremya, Journal of Remote Sensing, Environmental Science & Geotechnical Engineering, Ecological Indicator-General Perspective, 2019b.Vol 4(1):1-8.
51. Dr. S. Sreeremya, Journal of Remote Sensing, Environmental Science and Geotechnical Engineering, El Nino Effect –An Overview, Vol 9(3),pp-152-159.2024.