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ROLE OF MICROBES IN SOIL FORMATION AND AGGREGATION

Popular Article

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ABSTRACT

The diversity of microbes in soil is enormous and they drive many soil services. Soil formation is the result of a complex network of biological as well as chemical and physical processes. Mainly the role of soil microbes is of high interest in this respect, as they are responsible for most transformations and drive the development of stable and labile carbon and nutrient pools in soil, which facilitate the basis for the subsequent establishment of plant communities. Microbes play in various aggregates, increases pore space, increase glomalin content, influence bed rock formation.

Introduction

Soil organisms play a vital role in the degradation of organic matter and subsequent soil humus formation. When plants die, leaves are dropped onto the soil surface where microorganisms can "attack" and decay plant tissue. The organic matter is used as an energy source for microorganisms, increasing their population in the soil. These organisms utilize easily digestible materials (like simple sugars and carbohydrates) found in the plant material, leaving more resistant materials (such as fats and waxes) behind. The material left behind is not easily decomposed; it comprises the humus found in soil. Humus acts as a gluing agent, essentially holding primary soil particles (sand, silt, clay) together to form secondary aggregates or 'peds'. These organisms and the humus they help create aid in the soil development and the formation of soil horizons.

Role of microbes in soil aggregation

Larger soil animals such as earthworms contribution significantly to soil aggregation through the formation of wormcasts of coalesced faecal pellets. When earthworms feed on organic matter they ingest some soil, leading to aggregation of the soil particles when they are deposited in soil. Some fungi and bacteria produce polysaccharide gums that cause soil particles to attach to each other. These polysaccharide chains of simple carbon molecules are flexible and make many points of contact across the surface of soil particles. The two groups of fungi that are likely to be most importance to the process of soil aggregation are those that colonise fresh organic matter and those that form mycorrhizal associations with roots. Several studies have shown that soil aggregation can be related to the length of hyphae in the soil. In forest soils, mycorrhizal fungi are abundant at the soil surface and create

mats that stabilise the soil. Glomalin (protein) which also plays vital role in soil aggregation.

Aggregation	Mean weight of aggregates >1 mm./50 g. soil (g.)	Total no. of strains	No. of strains having the characters shown: Consistency of colonies on agar: Mucoid	Consistency of colonies on agar: Non-mucoid	Cell grouping of bacteria: Chains	Cell grouping of bacteria: Single cells	Gram stain: +	Gram stain: −
Fair	13–16	22	10	12	2	20	8	14
Poor	10–13	25	21	4	2	23	10	15
None	7–10	28	12	16	10	18	16	12
	Totals	75	43	32	14	61	34	41

Fig 1. Characteristics of some bacteria as related to their ability to aggregate soil in pure culture

Aggregation	Mean weight of aggregates >1 mm./50 g. soil (g.)	Total no. of strains
Excellent	37–45	21
Very good	29–37	15
Good	21–29	11
Fair	13–21	3
	Totals	50

Fig 2. Influence of fungi as aggregation

Influence of bed rock in soil formation

Siliceous rocks contain a number of minerals which contain essential elements (e.g. apatite is a source of phosphorous) and thus favour microbial life. In contrast, the weathering of calcareous rocks releases very few elements which facilitate the growth of microorganisms. Some rocks such as serpentinites even release toxic elements (e.g. Nickel, Cadmium) which prevent plant life (Swaby, 2007) and which may also inhibit microbial activities.

Microorganisms affect porosity of soil

Spiders, ants and other large soil animals, including earthworms, improve the water penetrability of soil by creating burrows though which water can infiltrate and flow. Very small animals influence the fine structure of soil through their movement, degradation of organic matter and production of faecal pellets. Furthermore, soil aggregation influences pore structure of soil.

Microorganisms play role in biological weathering of soil

Lichens may be an effective role in biological weathering of soil and it can be described ‘‘an association between a fungus, usually an ascomycetes but in a few cases a basidiomycetes or deuteromycete, and one or more photosynthetic partners, generally green algae or cyanobacteria. Lichens are of significance in soil formation and pedogenesis.

Physical effects of Lichen in rocks
Penetration of hyphae

Undoubtedly, physical effects of lichens on their substrates begin with penetration of hyphae of lichens through various voids in the rocks. As one of the most important mechanisms, hyphal penetration contributes directly to physical weathering and mechanical damage of both natural rocks and building stones, and also induces and accelerates other forms of physical weathering.

Swelling action of organic and inorganic salts

It is well known that crystallization of salts within pores and cracks of rocks may exert sufficient pressure to separate mineral grains or rock fragments. At the lichen–rock interface and in the lichen thallus itself, universal occurrence of secondary crystalline salts, especially various oxalates, could have brought about mechanical disruption of the immediate substrate rock.

Chemical effect of lichens in rocks

The dissolution of respiratory CO in water held by lichen thalli results in the 2 generation of carbonic acid, which advances solubilization processes by lowering the local pH values. It was concluded, therefore, that simple or complex organic acids abundant in lichen thalli could be expected to dominate the weathering processes by dissolving minerals and chelating metallic cations. This type of weathering was referred as ‘‘biochemical’’ weathering.

Oxalic acid

This is confirmed by the universal occurrence of metal oxalates at the lichen–rock interface and in the lichen thallus itself, and by the fact that dissolution and precipitation of various rocks and minerals in the presence of oxalic acid.

Weathering rate of rocks promoted by lichen

The promotion of weathering rates by lichens depends on many factors, such the effectiveness of different lichen species as weathering agents and the textures and mineralogical constituents of the colonized rocks.

Involvement of lichens in weathering and preliminary soil-forming processes

On one hand, the organic matter and cell excretions enable a heterotrophic bacterial population to thrive, especially around the hyphae or closely associated with them, representing a synergistic effect of the lichen thallus on weathering processes. On the other hand, the decomposition of some lichens, especially nitrogen-fixing species, may lead to the production of humic or fulvic acids, which are well known for their ability to form strong complexes with aluminium and iron. Furthermore, organic matter derived from lichen decomposition, together with detached particles of the substratum, and atmospherically derived dusts trapped by thalli, can all contribute to the development of primitive soils. As pioneer colonizers, lichens can create a favourable microenvironment by increasing bioavailability of mineral elements and nutrients to successive life-forms that may replace lichens during weathering of rocks and soil development. It has been shown by numerous investigators that there are positive correlations between lichen communities and vascular plant cover, because lichen communities concentrate the two essential resources necessary for plant growth, water and nutrients.

Conclusion

It may be concluded that, Activity of soil microbes is also important in the formation of organo-mineral complexes and aggregation and increase porosity. Aggregation also tends to increase with increasing root length density; extensive fibrous roots produce highest levels of macro-aggregation. Soil organisms play an important role in fundamental and specific pedogenic process. The role of soil organisms in nutrient cycling is a key biological process in all ecosystems. Microbes play role in biological weathering, increase dissolution of rocks and promotes weathering process.

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