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Review of Soil Microbial Flora Associated with Forest Floor Litter in Tropical Rainforest Zone- A Case in South Eastern Nigeria

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ABSTRACT

Forest floor as is the case with Eastern Nigerian rain forest serves as habitat for a variety of microbial pathogens (fungi, bacteria, actinomycetes, viruses and nematodes) because leaf litter blankets the forest floor and provides a microhabitat those impacts positively on the fauna and insulation of flora roots. Fungi, bacteria, saprophytes other microbes are components of forest floor (soil) biota and play an important role in leaf litter decomposition. The decomposing wood of fallen trees serves as a saving account of nutrients and organic materials in the forest floor. Decomposition of organic matter is one of the ecological processes critical to the functioning of forest ecosystems. Vegetation has been shown to affect not only the diversity and species composition of litter-inhibiting microbes but also the decomposition rate of leaf litter. The importance of leaf litter as shelter for saprophytes and saprobionts, as well as for soil health preservation cannot be over emphasized.

Keywords: Litter, decomposition, forest, microbes

INTRODUCTION

Rainforests have dense leafy canopies and highly productive plant communities that have relatively high litter falls. Tropical forests that experience larger annual variations in rainfall, such as tropical dry or semi deciduous forests, exhibit larger seasonal fluctuations in litter production, with peak litter production occurring during the dry season because drought stimulates leaf litter production and inhibits decomposition (Cleveland *et al.*, 2004, Austin and Vitousek, 2000).

Tropical forest ecosystems is an important source of biodiversity (Berry *et al.* 2010), though there are biodiversity losses because of some anthropogenic factors (Morris, 2010). According to FAO reports (2009) between 1990 and 2005, conversion of forest to oil palm plantations accounted for 94% of deforestation in Malaysia. Trees usually shed their leaves throughout the year particularly during the dry season, November to March (Odiwe and Muoghalu, 2003). Comparatively annual litter deposition in the tropical forests is much higher than the forest litter in low land tropics which is broken down within a year due to decomposition influenced by climate, litter quality, soil types and litter biota (Plowman, 2012). In humid tropical forests nutrient availability is intimately tied to litter inputs and decomposition (Read and Lawrence; 2003; Alhamd *et al*., 2004). This paper therefore x-rays the biodiversities and variation in forms as well as the significance of the tropical rain forests as it is magnified by the Southern Eastern Nigeria.

SEASONAL AND CLIMATE CHANGE AND TROPICAL FORESTS FLOOR

In seasonal tropical forests, forest floor litter mass can increase substantially during the dry season because drought stimulates leaf litter production and inhibits decomposition (Austin and Vitousek, 2000). Decomposition and nutrient release processes are very important in the tropics, where soils can be naturally low in fertility and nutrient status (Okeke and Omaliko, 1992). Aderopo (1991; 2003) examined bark microflora of 12 rainforest of Southwestern Nigeria and crustose, foliose, and fruticose forms of lichens were observed while moisture was regarded as the most critical factor in growth of bark microflora, other factors like texture of the bark, insolation and especially chemical characteristics of the barks may play a key role in occurrence and distribution of micro-organisms on them.

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Many kilograms of leaves, twigs, excrement, and other debris are produced which has to be decomposed by these biotic agents to create space for the cycle to continue. This cycle takes care of depletion of nutrients to allow plants to grow. The biotic agents in the forest floor are also part of the forest food web. Nutrient concentrations in woody litter are different from those of foliage, much lower in wood than in foliage litter (Berg and McClaugherty, 2008). There are four principal groups of soluble organic material in litter: sugars, phenotics, hydrocarbons and glycerides (Berg and McClaugherty 2008). The chemical composition of the living plant is reflected in its litter. This particular applies to structural components like lignin, hemicelluloses and to a smaller extent, nutrients.

Forest floor which is a bridge between the above ground living vegetation and the soil can also be referred to as detritus, duff or horizon (organic horizon). It is a very important feature of a forest ecosystem. The forest floor is made up of shed vegetative parts, like leaves, from branches, barks seeds, nuts, logs, reproductive organs and stems from trees. It is also made up of various varieties of fauna and flora which are largely decomposers and predators. The components of the forest floor are quite rich because of the decomposition of the vegetative material above the soil surface. This serve as a litter banks of nutrients and organic materials. These decomposers and microbes mostly belong to invertebrate like fungi, algae, bacteria and actinomycetes. Eighty to ninety percent of the decomposition of dead plant and animal matter is accomplished by bacteria and fungi (Johnson and Catley, 2002). Carbon fixed by forest is added to the forest floor through litter fall plant litter, leaf, tree litter, soil litter, litter matter and the nutrient required by the forest ecosystems is supplied by decomposition of organic matter in the forest floor and soil surface. Litter production and decomposition is determined by site and the vegetation that occupies the site. For example leaf tissues account for about 70 percent of liter fall in forest, woody litter increases with forest age. In grass lands, there is very litter perennial tissue so the annual litter fall is very low. Soil litter is classified into organic horizon characterized by undecomposed plant material, organic horizon with partly decomposed organic matter.

The factors that influence breakdown of litters especially lignocellulose (lignin and cellulose from woody plants) are of great consequence in tropical forest. This is because tropical forests produce more carbon than any other ecosystem (Schlesinger, 1997). Litter deposition is significant because it is the means whereby litter layer on the forest floor is formed and it links the plant components to the soil through organic matter decomposition (Oziegbe *et al.*, 2011).

According to Prescott *et al.* (2004) decomposition is slow in cold forests (forest at high elevation or northern altitudes), faster in clear cuts than in forests and broader leaf litter decompose more rapidly than needle litter.

BIOTIC DRIVERS IN LITTER DECOMPOSITION

The leaf litter layer is full of life, as it provides food, shelter to abiotic agents (Johnson and Catley, 2002), which decompose the litter into soluble chemicals and minerals such as nitrogen, calcium and sulphur. These are then used up by the trees and other plant and the cycle continues.

According to Beare *et al.* (1992), fungi are better adapted to invading coarse litter with hyphae and withstand dessication than bacteria which perform better with fine litter fragments, and that fungal exclusion from the decomposition process in forest floor led to 36% reduction in surface litter decomposition. Microorganisms like fungi and bacteria are crucial for the mineralization of leaf litter (Johnson and Catley, 2002) and also render it more palatable for leaf shedding microbes. Fungi especially aquatic hyphomycetes are important intermediaries in energy flow (Gulis and Suberkrtopp, 2003), and leaf decomposing fungi have strong host preferences according to Cornejo *et al.* (1994). Aderopo (2003) in his work reported that *Bacillus* sp., *Erwinia* sp., *Micrococcus* sp., *Proteus* sp., and *Pseudomonas* sp. were the five genera of bacteria recorded while three genera of *Cyanobacteria; Entophysalis*, *Gleocapsa* and *Stigonema* were observed in the rainforest of Ibadan South Eastern Nigeria. In the algal division, three genera of Chlorophyta found are *Chlorococcum*, *Pleurococcus* and *Physolinum*. He concluded that most of the epiphytic microflora found were mainly terrestrial and their spores might have been deposited on the barks by air, or dust-currents.

Johnson and Catley (2002) reported that algae and some bacteria are producers (heterotrophs), they are able to convert the sun's energy into food. While others are decomposers (facultative microbes), mainly bacteria and fungi that feed on dead plants and animals breaking them down chemically into simple nutrients. According to their findings, 80 to 90 percent of the decomposition of dead plant and animal is done by bacteria and fungi (Johnson and Catley, 2002).

Fungi, get their food from the nutrients in the environment through their hyphae. They are a very important component of forest litter. They are capable of decomposing lignin in logs and fallen branches, and are also form food for mites, nematodes and beetles. Most of the leaf and other litter on the floor of the rainforest is decomposed by fungi (primary decomposers) and that most of these fungi are mycorrhizal in nature.

The primary saprotrophs are usually active on dead leaves and are members of the group zygomycota (sugar loving fungi which are non-cellulolytic and depend on readily available sugars like hexoes and pentoses for their activities). The mucorales appear in the final stages of decomposition and are mostly soil inhabiting. The primary colonizers (folicolous fungi) are found inhabiting on the leaf litters (Shanthi and Vittal, 2010).

Basidiomycetous litter fungi are considered important due to their production of ligninolytic enzymes for degradation of plant parts the lignin (Osono and Takeda, 2002). Ascomycetous fungi constitute a larger parts of the fungal community in forest litter. The saprophytic litter decomposers are restricted to the upper litter layer while the fungal community in the deeper layers are dominated by mycorrlizal fungi (O'Brien *et al.,* 2005). Berg and McClaugherty (2008) divided wood degrading fungi into three main groups: white rot, brown rot and soft rot fungi. The soft rot fungi is similar to the white rots fungi because they have cellulose degrading enzymes. Brown-rots fungi do not have enzymes that are found in white rots. Mycorrhizae are aggressive decomposers under certain circumstances at a high rate according to Berg and McClaugherty (2008).

In boreal forest ecosystems, bacteria and fungi carry out more than 95% of litter decomposition (Boberg, 2009). Bacteria and fungi are important agents of forest litter decomposition (Kuri-hara and Kikkawa, 1986). The relative importance of fungi and bacteria in litter decomposition varies with forest type (Elliott *et al*., 1993). Bacteria decompose the leaf litter primarily and also serve as food for protozoan (Padma *et al*., 2003). The degradation of cellulose by bacteria has been suggested to be hydrolytic, but the mechanism is different from those found in fungi (Berg and McClaugherty, 2008). Bacteria coexist with fungi particularly basidiomycotes and yeast as far as litter decomposition is concerned and their presence has been shown to double the rate of fungal growth on wood and also increase the overall rate of decay. Three types of bacteria degradation are known namely; tunneling, erosion and cavitation (Blanchette, 1995).

Nematodes (roundworms) that live in soil play a very important role in recycling dead organic materials. According to Liang *et al.* (2005) nematodes are the most important taxa in the soil food web, with soil nematode communities sensitive to changes in the environment (Cao *et al*., 2004).

Protozoa are ubiquitous and essential component in terrestrial ecosystems, and are major consumers of bacterial products. They are a link between primary producers and higher trophic levels (Bonkowski, 2004; Domonell *et al.,* 2013). Grazing of bacteria by soil protozoans play an important role in mineralization and recycling of nutrients in soil food webs. Actinomycetes, in contrast to some bacterial groups, appear to degrade cellulose in a similar way to that of the fungi generae(Finlay *et al*., 2000).

CONCLUSION

Leaf litter provides shelter for micro-organisms like detrivores and saprobionts. These organisms help in the energy cycle because the decomposing leaf results in breakdown of carbon compounds which produces carbon dioxide, water, nitrogen and phosphorus ion unto the top layer of soil to be reabsorbed by the living for soil health prevention. Leaf litter makes the group rich and provide diversity in the ecosystem

In forested ecosystems, litter fall is the largest source of organic material and nutrients for the humus layer. Leaf litter and the organisms that inhabit it play a vital role in preserving soil health. The value of leaf litter represents biodiversity. The more leaves on the ground the more rich and diverse the ecosystem becomes.

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