LANDUSE BASED VARIATION IN SOME IMPORTANT SOIL PHYSICO- CHEMICAL PROPERTIES , FUNGAL POPULATION AND CARBON DIOXIDE EFFLUX IN CHANDAKA - DAMPARA WILD LIFE SANCTUARY

A
Thesis Submitted
To
Orissa University of Agriculture & Technology, Bhubaneswar
In partial fulfillment of the requirement for the degree of
MASTER OF SCIENCE IN ZOOLOGY

BY

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Admission No. –01PZ/11

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C E R T I F I C A T E – I

This is to certify that the thesis entitled **Landuse based variation in some important soil physico- chemical properties , fungal population and carbon dioxide efflux in Chandaka–Dampara wild life sanctuary',** submitted by **Ms. Mousumi Majhi (Adm. No 01PZ/11)**, College of Basic Science and Humanities, O.U.A.T for award of the degree of **Master of Science in Zoology** embodies a faithful and bonafide research work under my guidance and supervision. No part of this thesis has been submitted by her for any other degree or diploma.

I further certify that any help or information received during the course of investigation has been duly acknowledged by her.

Place: Bhubaneswar

Chairman

Date: **Advisory Committee**

C E R T I F I C A T E –II

This is to certify that the thesis entitled , **Landuse based variation in some important soil physico- chemical properties , fungal population and carbon dioxide efflux in Chandaka–Dampara wild life sanctuary,** submitted by **Ms Mousumi Majhi (Adm. No 01PZ/11),**College of Basic Science and Humanities, O.U.A.T, Bhubaneswar in partial fulfillment of the requirements for the award of the degree of **Master of Science in Zoology** has been approved by the Students Advisory Committee after an oral examination of the same in collaboration with the external examiner.

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Mousumi Majhi

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ABSTRACT

The population of microorganisms in soil is influenced by various abiotic parameters. The present study was conducted to assess some important soil physicochemical and biological parameters such as texture, pH, organic carbon and total organic matter and calcium carbonate content, fungal population and rate of soil respiration in three land use zones, e.g bamboo forest, sal forest and wet land of Chandaka-Dampara wild life sanctuary. This sanctuary forms part of the Eastern Ghats forest range. Soil texture analysis indicated high percent of sand, followed by clay and silt in all the soil types. pH ranged from alkaline (wet land) to acidic (sal and bamboo forests). Highest percent organic carbon, total organic matter, bacterial count and heterotrophic respiration were observed in soil from bamboo forest and the lowest values were obtained in sal forest except for percent organic carbon and total organic matter which indicated the minimum value in wetland soil. High soil fungal population and soil respiration in Sal and bamboo forests in comparison to wetland have been attributed to high organic matter and congenial pH conditions for fungal growth and metabolism. The study indicated that soils from Sal forest and Bamboo forest were congenial for fungal colonization and metabolism in the sanctuary.

C O N T E N T S

LIST OF FIGURES

ABBREVIATION

%	Percent
˚C	Degree Celsius
˚F	Degree farhenity
Cfu	Colony forming unit
NA	Nutrient agar
NB	Nutrient broth
Ca	Calcium
Mg	Magnesium
K	Potassium
KOH	Potassium hydroxide
HCl	Hydrochloric acid
NaOH	Sodium hydroxide
CO_2	Carbon dioxide
$BaCl_2$	Barium chloride
$CaCO_3$	Calcium carbonate
K_2CO_3	Potassium carbonate
$K_2Cr_2O_7$	Potassium dichromate
mg	Milligram
ml	Milliliter
gm	Gram
km	Kilometer
sq	Square
cm^2	Centimeter square
sec	Second
min	Minute
hr	Hour

SOIL

Soil is formed from rocks through a complex process of physical, chemical and biological forces that reduce rock first to regolith (rock bubble) and then to soil. The factors involved in soil formation are parent material, climate, topography and biological activity . soil contains vastly diverse microbial communities. soils also support the growth of plants. Microorganisms contribute greatly to soil fertility, that is the ability of soil to support the growth of plants. Plants also have a major influence on the microbial communities in soil. The plant cover of the soil is an important factor in determining the types and numbers of microorganisms in that soil. Plant root exudates and organic matter are important sources of nutrients for soil microorganisms. Rhizosphere and mycorrhizal interactions, as well as plant susceptibility to pathogens, exert selective influences on the soil microbial community.

PHYSICAL PROPERTIES OF SOIL

When soil forms from regolith, it typically develops a series of distinct horizons as a result of the weathering process. The O group, or organic horizons , develop above the mineral soil and contain the soil organic matter known as humus, these horizons are formed from plant and animal forms are recognizable and an oxygen horizon, where the plants and animals have decayed to a point beyond recognition. The A horizon is divided into an A1 layer , where mineral soil is mixed with humus, anA2 horizon with maximal leaching of silicate clays , iron oxide and aluminum oxide, and an A3 horizon a transition layer to the underlying B horizon. The B or illuvial , horizon is the

zone where deposition has taken place and there is a maximal accumulation of materials such as iron oxide , aluminum oxide ,and silicate clays. The combined A and B horizons are known as the solum. Biological activities do not greatly affect the C horizon, beneath the solum. The C horizon may contain accumulation of calcium and magnesium carbonates. Regardless of horizons, soil contains varying proportion of clay, slit and particles . The proportion of these different sized particles constitute the texture of the soil. Soil texture is a very important property for the ecology of microorganisms because it describes the surface area that is available as a habitat for the growth of microorganisms. Soils with greater clay composition have much higher surface available for the growth of microorganisms than soils with high sand concentrations, because clays are much smaller particle than sands. When considering soil particles as habitats for microorganisms, it is also important to consider the nature of the clay particles. Clay colloids differ significantly in their physical and chemical properties. These differences influence how many and what type of microorganisms can occupy the particular soil habitat.

CHEMICAL PROPERTIES

The chemical properties of soils are important factors for microorganisms. The soil organic matter is derived from the remains of plants, animals, and microbes. Humic substances are those portions of the soil organic matter that have undergone sufficient transformation to render the parent material unrecognizable. Humic materials present in mineral soils typically constitute

less than 10% by weight of the soil. Humic compounds are random polymers. The theories on the actual structures in humic materials are controversial and subject to constant revision and refinement. Perhaps the most accepted current theory visualizes an aromatic core consisting of single and condensed aromatic, heterocyclic, and quinoidal rings , linked and cross linked by carbon – carbon ,ether amino, and azo bonds. The rings bear a variety of functional groups, the more prominent of which carboxyl, phenolic hydroxyl, and carbonyl group. Attached to this core are amino acid ,peptide, sugar, and phenols which form further cross linkages. The result is a three dimensional sponge like structure that readily absorbs water, ions and organic molecules in an exchangeable manner and in addition ,may chemically bind suitable compounds to its reactive functional groups. As a consequence , virtually all natural organic compounds and apparently also numerous human made chemicals can occur in bound or absorbed from in humic substances, even active enzymes have been recovered in humus bound. The genesis of humic material is a process involving the predominantly microbial degradation of organic polymers to monomeric constituents ,such as phenols ,quinines, amino acids and sugars, and the subsequent polymerization of these by spontaneous chemical reactions, auto oxidation ,and oxidation catalyzed by microbial enzymes such as laccases, polyphenoloxidase, and peroxidase. The aromatic skin structure that serve as the building block of the humic acid core may originate from the microbial degradation of lignin or may be synthesized by various microorganisms

from other carbon substrates. The humic material is in a dynamic state of equilibrium, its synthesis being compensated for by gradual mineralization of the existing material. Soil contain vastly differing concentrations and chemical forms of organic carbon inorganic and organic nitrogen and available inorganic phosphorous.

The composition of the soil atmosphere (Atmosphere – Lithosphere - Interface) also varies greatly between soils. The soil atmosphere exist in the porous spaces between soil particles. Bulk density is a measure of packing of soil particles and indicates the extent of space that may be occupied by the soil atmosphere. Some soil or soil layers are aerobic that is , the soil atmosphere contain oxygen whereas others are anaerobic, that is there is no free oxygen in the soil atmosphere. Even in aerobic soil layers ,there are anoxic regions devoid of free oxygen. The oxygen content of the soil atmosphere determines in large part the types of metabolism that can occur and the chemical transformations that the indigenous microorganisms can carry out, Concentration of carbon dioxide in the soil atmosphere commonly one-two orders of magnitude higher than in the above ground air. The concentration of both carbon dioxide and oxygen in the soil atmosphere are affected by gas diffusion and microbial respiration. Concentration of carbon dioxide generally increase and carbon dioxide concentration decreases with depth in the soil column. In oxygen deficiency , other gases including methane from methanogenesis, and hydrogen sulphide from anaerobic sulphate reduction, occur in high concentrations in the soil atmosphere.

SOIL MICROBIAL COMMUNITIES

Soil is generally a favorable habitat for the proliferation of microorganisms with micro colonies developing on soil particles. The number of microorganisms in soil habitats normally are much higher than those found in freshwater or marine habitats.Typically,10^{6} - 10^{9} bacteria per gram are found in soil habitats. Microorganisms found in soil include viruses, bacteria, fungi, algae, and protozoa. Concentration of organic matter are relatively high in soil ,which favour the growth of heterotrophic microorganisms. Sergei Winogardsky designated as “Autochthonous”, that part of the soil microbial community capable of utilizing refractory humic substances. Winogardsky contrasted zymogenous or opportunistic soil organisms with autochthonous microorganisms. The former generally are not able to utilize humic compound , but exhibit high levels of activity and rapid growth on easily utilizable substrates that become available in the form of plant litter, animal dropping , and carcasses. Intermittent activity with inactive resting stages is characteristics of such organisms ,such as human and animal pathogens, that do not find suitable growth conditions in soil. It is difficult to ascribe generalized adaptive features to the indigenous soil micro biota. Soils have many microhabitats, and at a particular location there may even be several micro environmental situation that would favour different indigenous populations. In rich litter horizons of surface soils, indigenous microorganisms tolerate and grow on high concentrations of organic nutrients.

Although it may not be possible to describe the general features of indigenous soil bacteria, the abiotic parameters of soils restrict the microbial populations that can develop there. For example some soils have extremely alkaline pH values, whereas others are extremely acidic. In such soils, the indigenous microbial populations must posses adaptive features that allow them to grow. Polar soil are frozen much of the year the and indigenous microorganism in such soil must be psychophilic or psychotropic. Desert soils are hot and arid. Indigenous microorganisms in desert soils must be capable of withstanding long periods of desiccation and high temperature. Herman et al examined the resource island hypothesis for microbial populations in desert soil. According to this hypothesis, soil resource such as nitrogen, phosphorous, and water are distributed relatively evenly in grassland but have a patchy distribution focused around plans in shrub lands. This hypothesis predicts that microbial numbers will follow the available resources and therefore will be evenly distributed in grasslands but concentrated around individual plants in scrub land. They will be proportional to plant density when comparing the same vegetation type.

There are various types of microorganisms present in soil like bacteria, fungi, actinomycetes, protozoans etc., which form bulk of the biological community in the soil sub system. Out of these soil fungi occupy an unique position due to the important ecological role they play during the decomposition process in addition to other functions.

FUNGI

Fungi constitute a high proportion of the microbial biomass in soil. Most type of fungi can be found in soil, mostly as indigenous and sometimes as allochthonous organisms. Soil fungi may occure as free living organisms or in mycorrhizal association with plant roots. Fungi are found primarily in the top 10cm of the soil and are rarely found below 30cm.The most frequently isolated fungi form soils are members of fungi imperfect such as species of aspergillus, geotrichum, pencillium and trichoderma, but numerous ascomycetes and basidiomycetes also occur in high numbers. Some soil fungi especially those found in association with plant roots are difficult if not impossible to isolate and identify. Yeast are common in most soils .As the filamentous fungi, most indigenous soil yeasts are fungi imperfect (deuteromycota). Species of the genera candida, rhodotorula and Cryptococcus are probably are the most abundant indigenous yeasts in the soil. Species lipomyces, schwanniomyces, kluyveromyces, schizoblastosporion, hansenula, Candida and Cryptococcus have been isolated exclusively from soil. The fact that these organisms have been found only in soil implies, but dose not prove ,that soil is their natural habitat. Most fungi in soil are opportunistic. They grow and carryout active metabolism when conditions are favorable, which implies adequate moisture, adequate aeration, and relatively high concentrations of utilizable substrates. Many soil fungi metabolize carbohydrates including polysaccharides and even allocthonous fungi that enter the soil can often grow on the major components of plant residues;

relatively few fungal species though are able to degrade lignin. Dormancy is a typical condition of soil fungi. Some fungi have been shown to remain dormant but viable for decades. In the absence of available substrates, they are inactive. Numerous fungi occur in soil as specialized dormant structures, which include spogiospores, conidia, oospores, ascosporoes, basidiospores, chlamydospores and sclerotia. Fungal mycelia may also be metabolically inactive. Study in fungal diversity is vital to shed light on any kind of terrestrial ecosystem functioning. Numerous soil fungi facilitate plant nutrient uptake through mycorrhizal associations with majoring of plants and significantly contribute to litter decomposition through saprophytic activities. (Wardle et al. 2004 De Deyn and vander puttern , 2005; Vander heijden et al , 2008). The modern methods of isolation of fungi have enabled microbiologists to begin the exploration of fundamental ecological issues such as:

(a) Do fungal assemblasses vary between different environments?

(b) What is the relative impact of environment in microbial population and diversity patterns?

(c)Finally what are the implications of fungal diversity on ecosystem sustenance?

ECOLOGICAL ROLE OF SOIL FUNGI

Fungi perform important services related to water dynamics, nutrient cycling, and disease suppression. Along with bacteria, fungi are important

as decomposers in the food web, converting hard to digest organic material into usable forms.

Fungal population dominate the soil food web ,converting hard to digest organic material into usable forms .Fungi have 40-55% carbon use efficiency so they store and recycle more carbon compared to bacteria. Bacteria are less efficient at retaining c and release more into the air as carbon dioxide. Fungi have higher c content(10:1 C:N ratio) and less nitrogen (=10%) in their cells than bacteria. Fungus help recycle both N and P to plants. Due to their smaller size and much greater surface area, fungus can efficiently scavenger for N and P better than plant root hairs and greatly increase the plant root nutrient extractions efficiency .Many plants cultivate certain species of both bacteria and fungus to increase nutrient extraction from the soil. Genetically, fungi are closely related to plants and animal. Membrane bound organelles present in each cell are similar to insect, plant and animals. They evolved about a billion years ago and are equal in rank to plants and animals. In fact, fungi have 80% or more of the same genes as humans. They generally reduced by spores(microscopic parts similar to plant seeds).The longevity of fungus has not been measured in many species but their opened growth suggests that they have a longevity measured in millions of years, because they are basically same organisms.For example, fairy fungal rings grow in ever widening circles, much like rings on a tree, and are measured in decades and centuries instead of days and weeks for most microbes.

CLASSIFICATION OF FUNGI

Fungi are classified by their method of reproduction (both sexual and asexual) Histologically they have been divided into four taxonomic divisions : zygomycota, ascomycota, basidiomycota and deuteromycota.

(A) ZYGOMYCETES:

There are less than 1000 species of zygomycetes. Common bread mold are in this group, as are a few species that parasitize plants and animals. Most zygomycetes feed on dead or decaying plant and animal material.

(B) ASCOMYCETES

Ascomycetes contain more than 30,000 species of unicellular (yeasts) to multicellular fungi. Yeasts reproduce asexually by budding and sexually by a sac (or ascus).One yeast saccharomyces cerevisiae, is important for genetic research as well as its commercial applications in baking and brewing. Sac fungi are also important in decomposing and recycling organic matter. Some Ascomycetes are parasites responsible for Dutch Elm disease and Chestnut blight. Other sac fungi are used in wine making and in the production of antibiotics.

(C) BASIDIOMYCETES

Mushrooms, toadstools and puffballs are commonly encountered Basidiomycetes. Club fungi are important as commercial crops. They also cause may diseases that result in loss or reduction of grain yield. Agaricus

campestris is the common mushroom found in grocery stores; Lentinus edodes is the less commonly bought shitake mushroom; more than $14 billion per year of these products are sold.

(D) DEUTEROMYCOTA : LICHENS AND MYCORRHIZAE

Lichens are a symbiosis between a photosynthetic organism(alga or cyan bacterium) and a fungus (sac or club). Mycorrhizae are fungi (usually a zygomycete or basidiomycete) symbiotic with the roots of plants. Both relationships are mutualistic: both parties benefit. Fungi provide nutrients from the substrate, the prototroph's provide food. Plants with mycorrhizae grow better the plant gets nutrients from the fungus in exchange for carbohydrate.

There are generally three groups of soil fungi.

1. Decomposers of saporophyphytic fungi convert dead organic material into fungal biomass, carbon dioxide, and small molecules such as organic acids. Fungi generally decompose complex substrate such as the cellulose and lignin, in wood, and are essential in decomposing the carbon ring structures in some pollutants. Some fungi consume the same simple sugar as bacteria, fungi are important for immobilizing or retaining nutrients in the soil. Many of the secondary metabolites of fungi are organic acids, which increase humus organic matter that is resistant to degradation and may stay in the soil for thousands of years. Most bacteria are early discomposure along with the sugar

fungus (zygomycetes) but the majority of the fungi help to decompose more resistant organic matter(recalcitrant) high in cellulose and lignin.

2. Fungus that are pathogens or parasites cause reduced production or death when they colonize roots and other organisms. Root – pathogenic fungi such as verticillium , pythium and rhizoctonia, phytophthora, and downy mildew; cause major economic losses in agriculture each year. Many pathogenic fungi are not true fungi (Oocytes) and are classified as unicellular in the soil genera" pythium". Many true fungi help control diseases

For ex- nematode trapping fungi that parasitize disease causing nematodes and fungi that feed on insects may be useful as bio control agents.

Fungus common to agricultural or grassland soils include the ascomycetes fungus (soil genera saccharomycetes), which are microscopic in size while forest soils are dominated by basidiomycetes (soil genera boletus) with large fruiting bodies(mushrooms) dependent on high organic matter residues.

3. The third group of fungus is mycorrhizal fungus which are mutualist, creating a symbiotic relationship (mutually beneficial) with many plants. There are more than 5000 mycorrhizal fungal species. Endo mycorrhizae grow within the root cells and are coommenly associated with grasses, row corps, vegetables and shrubs. Arbuscular

mycorrhizal(AM) fungi are a type of endonycorrhizal fungi. Arbuscular mycorrhizal fungi have a symbiotic relationship with plants. Arbuscular mycorrhizal fungi from a mycorrhizal network with plant root, helping the plant roots be more efficient at gathering soil nutrients especially N and P. Arbuscular Mycorrhizal fungi produce enzymes such as Proteases and phosphatases that mineralize release N and P. Arbuscular Mycorrhizal and rhizobacteria evolved from plants with a common plant microbe interaction ancestor, likely fungal in nature. This position is supported by the fact that arbuscular mycorrhizal fungus and rhizobia shares proteins that regulate both Arboscular mycorrhizal fungus and rhizobia association with plants.

BENEFITS OF SOIL MYCORRHIZAL FUNGUS

Fungal hyphae have advantages over bacteria in some soil environments. Under dry conditions, fungi may bridge gaps between. Pocket of moisture and continue to survive and grow, even when soil moisture is too low for most bacteria to be active. Fungi are able to bring nitrogen up from the soil, allowing them to decompose surface residue which is often low in nitrogen. Fungus hyphal filaments translocate and store deficient nutrients to distant part of the soil where nutrients may be lacking, allowing reproduction and growth to continue. The plant supplies simple sugars to the fungus while fungus supply N,P, other nutrients and possibly water to the plant. As much as 20% of the total carbon assimilated by the plant may

be transferred to the fungal partner. The mycorrhizal network of fungi hyphae greatly increased the surface area for plant roots and efficiency transport nutrients back to the plant. Mycorrhizal networks explore up to 20% of the soil volume due to their smaller size compared to only 1% of the soil volume for a typical plant root hair. However, when excess nutrients like N and P are supplied by commercial fertilizer to plant roots, the arbuscular mycorrhizal fungi stop working. Tillage also decreases the effectiveness of the arbuscular mycorrhizal fungus by destroying the the mycorrhizal network associated with plant roots. Fungal hyphae physically bind soil particles together, creating stable micro aggregates that that help increase water infiltration and soil water holding capacity. Typically there are form 1-20 meters of arbuscular mycorrhizal hyphae in each gm of soil. Arbuscular Mycorrgizal fungi produce a sticky substance call glomalin. Glomalin is an aminopolysacharide composed of sugars from the plant root and protein from the fungus forming a glycoprotein. Glomalin sarrounds the microaggregate soil particles and glues them together to from microaggregate soil particles. Polysacharides lke glomalin enhance good soil tilth and good soil structure. Some inoculums of mycorrhizal fungi are commercially available and may be added to the soil at planting time. Conventional tilled soils are dominated by bacteria , which do not produce glomalin. Tillage disrupts and breaks down the macroaggregate into microaggregates and results in denser , more compacted soils, lacking soil structure. Tilled soils lack soil organic matter(SOM) and the ideal soil habitat to feed and

keep large numbers of beneficial fungal populations healthy. Fungus need well aerated soils and cannot tolerate saturated or anaerobic (lack of o_2) soil conditions that occure under tilled compacted soils. Tillage also injects excess oxygen into the soil, stimulating bacterial populations to increase , and the expanding bacteria populations consume active carbon (polysaccharides and glomalin) for food. In a good soil, glomalin may represent 1-5% of the total carbon in the soil. Glomalin is 30% carbon, 1-2% nitrogen, and upto 5% iron, which gives it a reddish soil colour. Broad spectrum fungicides are are toxic to mycorrhizal fungi populations. So tillage ,excess commercial fertilizer, pesticides, short crop relations, and long follow periods tend to decrease fungal populations and decrease the production of glomalin in the soil. See" biology of soil compaction" for more information about soil structure. Some plant species like the cruciferae family(e.g. Broccoli, mustard), and the chenopodiaceae family(e.g lambsquarter ,spinach, beets) do not form mycorrhizal associations .The level of dependency on arbuscular mycorrhizal fungus varies greatly among varieties of some crops, including wheat and corn, however, greater than 90% plants have an association with arboscular mycorrhizal fungus.

PLANT- MICROBE INTERACTION

Plant microbe interactions in the rhizosphere are responsible for a no of soil process that include carbon sequestration , ecosystem services,, and nutrient recycling . the composition and quantity of microbes in the soil influence the ability of plants to obtain nitrogen and other nutrients.

Plant can influence these ecosystem changes through the deposition of root exudates or carbon rich substances into the soil to attract or inhibit the growth of specific organisms. The carbon rich substances can range from less than 10% to as much as 44% of a plant's total carbon production. Soil microbes utilize this abundant carbon source, implying that the plant's selective secretion of specific compounds between plants and microbes may encourage beneficial symbiotic and protective relationships against pathogenic microbes. Plant basically feed, raise and encourage certain microbes just like farmers raise and feed plants and livestocks for food and fibre. Fungi benefit most plants by suppressing plant root diseases and promoting healthier plants by attacking plant pathogens with fungal enzymes. Fungi enhances and cultivate good bacteria, especially rhizobia bacteria for nitrogen fixation, which help legumes plant grow. Fungi aids plants in N and P soil extraction and help in drought stress to supply more water to plants through the fungal hyphal network and by providing a protective sheath around plants root under dry conditions. During drought stress, as soils dry down P becomes limiting even in soils with high P availability. Fungi protects the plants by supplying a protective sheath to supply both water and P to the plant roots. When environmental conditions decline, fungus from spores which stores large amounts of nutrients to allow the fungus to survive until environmental conditions recover. Fungus with specialized nutrient requirements are more likely to decline or die out when a non host plant is included in a crop rotation while a fungus with a

wide host range will survive and possibly flourish. Soil fungi often have enough resiliency to convert from one resting stage to another when nutrient levels are low. These patterns are important in agricultural management systems that involve fallow periods between cropping cycles. Fungal hyphae must be in close contact with living or dead organic soil residues to absorb nutrients, so they usually grow in association with other soil microorganisms. They complete aggressively for scarce nutrients, and competition usually results in a succession or change in microbial composition as nutrients are absorbed or depleted. Initial colonizers absorb simple sugars, amino acids and vitamins from plant parts such as fruits, seeds and vegetables and are classified as “Sugar fungus” .cellulose degraders appear next and they are the most diverse an competitive. Degradation of straw as a high C;N ratio(80;1) and requires that fungus parasitize or decompose other fungi to obtain nitrogen for growth and enzyme production. Degradation of lignin is stimulated by low nitrogen. Lignin make up 60% of the total mass of humus, but the low number of fungal species that can degrade lignin reduces competition. Fungi also use antagonism to reduce competition by producing antibodies which suppress other microorganisms for growing. In understanding of the relationship between the composition of the microbial community and its physiological capacity is particularly important in both tropical and subtropical forests as well as agro ecosystems. In many parts of the world, there is conversion in land-use from forest to cultivated soils. In the later frequent soil disturbance

carbon and other nutrient alterations and changes in the water and light regimes alter the composition of the microbial communities, have reported a consistent decline in pH %C and % N and and avilalibility of some micro- nutrients when a tropical forest was converted to pine apple plantation. The microbial biomass was 4 times larger in the forest than in the plantation area.

HETEROTROPIC SOIL RESPIRATION

Soil respiration is a principal mechanism of carbon transfer from the soil to the atmosphere and and is a key component of the global carbon cycle on a global scale, carbon dioxide released from the soil is in an order of magnitude larger than carbon dioxide release from burning fossil fuels and land use change combined. Carbon released from soil includes three biological processes namely microbial respiration, root respiration, plant root respiration and and faunal respiration primarily at the soil surface or with in a thin upper layer where the bulk of plant residue is concentrated. Microbial communities contributed to soil heterotrophic respiration are mainly composed of bacteria and fungi. Soil micro flora contribute 99% of the carbon dioxide arising of the decomposition of organic matter. Heterotrophic soil is generally influenced by environmental factors such as soil temperature, moisture, texture pH, salinity, soil perturbations etc. .it has been reported that the co_2 efflux in a subtropical mixed oak forest varies widely between forest strands and is considerably

influenced by environmental factors, altitude and season. Hence, measurement of soil respiration will give an indirect indication of the rate of soil biochemical processes, vital for maintaining a stable nutrient pool.

OBJECTIVES

The major objectives of the study were ;

1.Texture analysis and measurement of pH ,percent organic carbon and total organic matter, calcium carbonate content of soil samples collected from various landuse zones of Chandaka - Dampara sanctuary.

2.Isolation and enumeration of fungal colonies in the soil types.

3.To measure the rate of heterotrophic soil respiration from surface soil in various land use zones.

4.To find out the relationship between the fungal count and soil metabolism with the abiotic parameters.

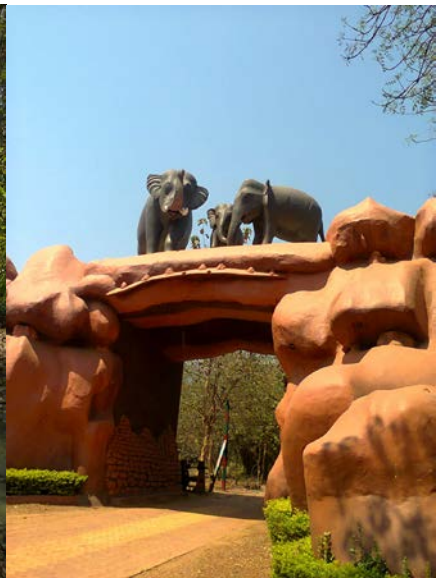
REVIEW OF LITRETURE

The dynamic effects of environmental variability and of shifting agriculture on the composition of soil microfungi in tropical rain forests have been studied by Perciani et al in (1998) . The aerobic heterotrophic microbial community in soil decomposes organic compounds in order to obtain reducing potential for energy and carbon to build biomass have been reported by M.P. Waldrop, T.C. Balsor, M.K. Firestone in (2000). They have also reported the universal process clearly underlies sustainable landuse and ecosystem carbon balance. Lan. C. Anderson and W.G. Cairny have been reported that "True" fungi are ubiquitous in the environment and fulfill a range of important ecological functions, particularly those associated with nutrient and carbon cycling processes in soil.

Pang et al, (2009) . have reported fungal diversity is vital if we are to shed light on terrestrial ecosystem functioning , Lantendu et al in (2011) have been observed that the numerous soil fungi facilitate plant nutrient uptake through mycorrihizal association with the majority of plants and significantly contribute to litter decomposition through saprophytic activities. The earth's habitats and biota's are undergoing dramatic loss and biological impoverishment have been reported by Orgazzi et al , (2012). They have reported human actions are causing a biodiversity crisis ,with Species extinction rates up to 1000 times higher than background. Russel

and David (2006) reported that in most terrestrial carbon sequestration at mid latitudes in the northern hemisphere occurs in seasonal , montane forest ecosystems.Soil surface carbon dioxide i.e. the output of soil respiration , exceeds all other terrestrial atmospheric carbon exchanges except for the volume of the output of the gross photosynthesis have been reported by Bijaylaxmi Devi and Yadava (2008). Soil metabolism or the metabolism of soil biota is an important indicator for the intensity of organic matter decomposition in an ecosystem this has reported by Mohanty and Panda (2011).

A **B**



C **D**

Bamboo forest (A), Sal forest (B) ,Wet land (C) and Entry gate (D) in Chandaka Dampara Sanctuary.

use. Necessary cares were taken to keep the sample cool and dry till analysis by storing them in a cool and dry place.

ANALYSIS OF SOIL PHYSIOCHEMICAL PARAMETERS

Soil texture

This was done by hydrometer method (Piper,1950) , soil was dispersed in water with sodium oxalate and the soil minerals particles were allowed to settle. The amount of solid particles remaining in the suspension at different time intervals was determined by putting the Boysch hydrometer into the suspension. Time taken depended upon the rate by a particular size group to settle out from the suspension of fall which varied inversely with size as per the strokes law. The hydrometer reading the density of the suspension was expressed in g/lt. the percentage of sand, silt and clay in the sample was found out as;

Corrected reading= Hydrometre reading + (temperature in ˚f- 68˚f× 0.2)

% of silt +clay =first corrected reading×2

% of clay =second corrected reading ×2

% of sand = 100 (% of silt + clay)

% of silt =(% silt + clay) -(% clay)

Soil pH

One gram dried soil was taken in a 50ml beaker to which 20ml distilled water was added fallowed by stirring a glass rod for 1 minute.

It was then stirred intermittently and left for hour. pH was measured by a pH meter(Systronics, India) was checked with standard buffer solution. The soil

suspension was stirred immediately before measuring the pH by dipping the electrode in soil suspension. The reading was taken and the electrode was washed properly before and after each measurement.

Soil organic carbon

The soil organic carbon was measured titrometrically by Balkley and Black method in a dry 500ml conical flask 1gm of soil was taken to which 5ml of 1N $K_2Cr_2O_7$ was mixed thoroughly. Then 5ml of concentrated H_2SO_4 was mixed and swirled for 1 minute , then left for 30 minute. To it 100ml of water and 5ml of concentrated H_3PO_4 were added, followed by 10-30 drops diphenyl amine indicator to ensure deep violet color of the solution. It was then titrated against ferric ammonium sulphate ($Fe(NH_4)_2(SO_4)_26H_20$) (0.5) to a parrot green color .A blank titration was run in the same manner without taking soil. Organic carbon in percentage was estimated as follows:

1ml of 1N $K_2Cr_2O_7$=0.03g of C

% of organic carbon in soil

=10(B-S)/ B×0.03×100/W×1.3

=10(1-S/B)×0.039×100/W

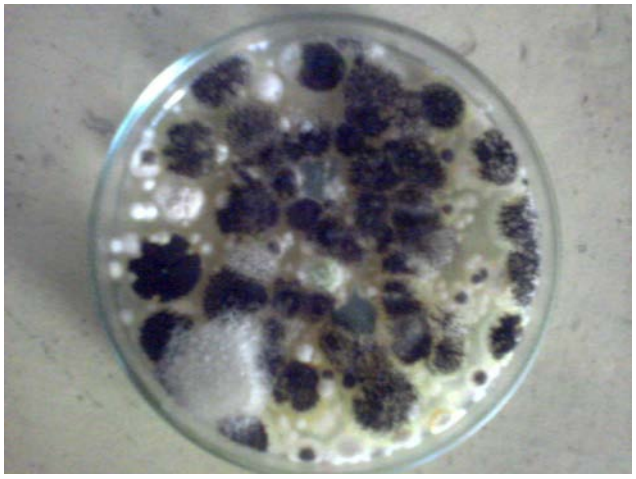
Where, B=ml of $Fe(NH_4)_2(SO_4)_2 6H_2O$ FOR Blank

S=ml of $Fe(NH_4)_4 6H_2O$ FOR SAMPLE

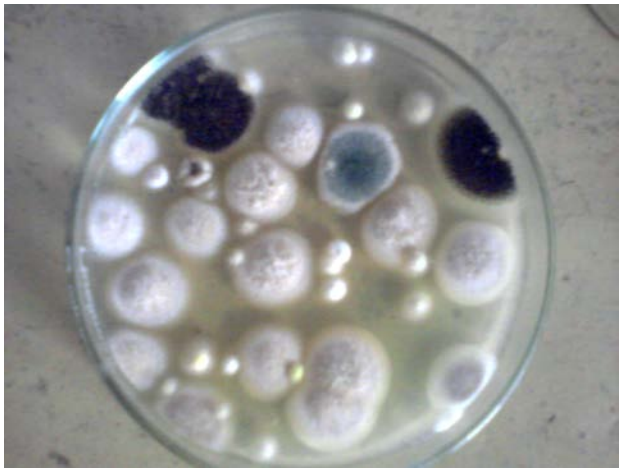
W= Weight of soil carbon

Soil Calcium carbonate

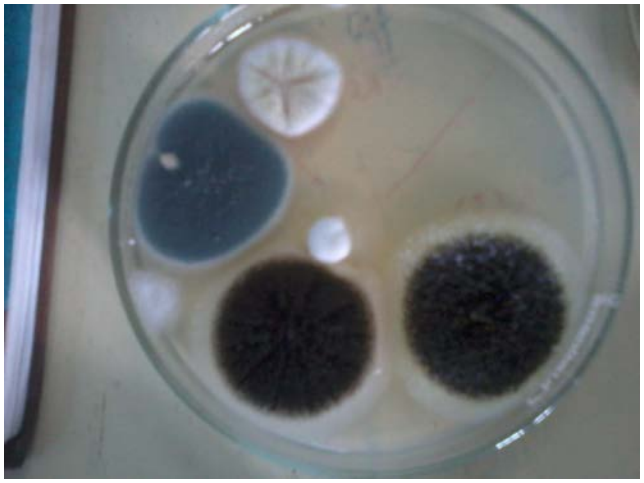
5gm of dried soil was taken and transferred to 150ml beaker . Exactly 100ML OF 1N HCL was added preferably with a watch glass. At least 1 hour allowed to stand with vigorous stirring intermittently .it was allow



Sal forest (A)



Bamboo forest (B)



Wet land (C)

Fig 2 Petriplates showing fungal colonies in Sal forest (A) ,Bamboo forest (B) ,Wet land (C) soil.

to settle finally and 20ml of supernatant was removed with the help of pipette in a conical flask. 6-8 drops of bromothymol blue indicator was added and titrated with 1N NaoH, At the end point color with change to blue.

CALCULATION

$$\%Caco_3 = (B\text{-}T) \times 5$$

Where, B=Reading with blank

T=Reading with soil

ISOLATION AND ENUMORATION OF FUNGI

For enumeration of fungal population by dilution plate technique (Johnson and Curl , 1972) ,the primary suspension of the soil was prepared to serial dilution. Inoculations of the diluted samples were made to petriplates with solidified patato dextrose agar (PDA) medium (Appendix I ,9) the plates were incubated at 28ċ for 72 hours and then counting and colony characteristics were noted. The isolated

cultures were maintained and regularly subcultured.The isolated are subjected to lactophenol cotton blue staining which is commonly used for making semipermanet microscopic preparation of fungi. It stain the fungal cytoplasm and provides a light blue background against which walls of hyphae can readily be seen. It has four constituents phenol (Serve as disinfectant) ,lactic acid (Clearing agent), cotton blue (Serves as outer walls of fungus) and glycerine (Temporary mounting) . A clean glass slide was taken on which a drop of lactophenol cotton blue was added along with a drop of water. By the help of a sterile loop, the fungal culture was taken from old preserved culture and was put on the slide. Then the culture was teased with the help of a sterilize needle followed by covering with a coverslip taking care to avoid bubble formation. Then the slide was observed under the microscope (Barnett and Hunter ,1972 ;Onions and Allsopp ,1981).

SOIL RESPIRATION

The respiration of soil was measured by alkali absorption method (Witkamp, 1966). At the onset of the experiment the respiration chambers were fixed to the ground at random determined location in the study sites after clipping all the green vegetation one day before the start of the experiment. For this, soil samples were exposed to 50ml of (0.25) N KOH (1N KOH = 56g KOH in 1000ml DW) (100ml beaker with surface area of 28.8 cm^2) in air tight glass jars (15x 25) for 24hours by inserting the jars 10cm deep into the ground. After exposure, the KOH solution

was removed, the K_2CO_3 converted, and when a part of CO_2 was absorbed by KOH was precipitated with saturated solution of (5ml of 10%) $BaCl_2$ to form $BaCO_3$ and the residual KOH was titrated with an equivalent strength of HCL (0.25 N) using phenolphthalein as indicator. A jar without soil, containing same amount of KOH, was also run simultaneously as a blank. Hence the volume of KOH converted into K_2CO_3 was estimated and from this, the amount of CO_2 absorbed was calculated and expressed as CO_2 mg/m^2 /h using the following equation.

CALCULATION

Volume of KOH converted (to $K_2CO_{3)\times}$ 0.222= wt (g) of CO_2 absorbed

= wt of CO_2 evolved from the enclosed soil during the period of exposure (Parkinson *et al.*, 1971)

CO_2 evolved in mg/hr/m^2=22 (HCL B - HCL E) 24 × 0.09

HCL B= Blank titration HCL used

HCL E= Experimental titration reading

PHYSIOCHEMICAL CHEMICAL CHARACTERISTICS OF SOIL

TEXTURE

Fig-3 show the percentage of sand, silt, and clay in soil samples from different land use zones of Chandaka - Damapara sanctuary. Bamboo forest soil has 82.6% sand, 10.5% clay, and 3.3% silt and therefore is loamy sand soil with 89.2% sand, 7.5%clay, and 3.3%silt, The soil from Sal forest was found to be sandy soil . Wet land soil with 81.4%sand, 15% clay , and 3.6% silt can be categorized as sandy loam. As evident from the results of texture analysis wide variation was observed in different components of the soil in different land use zones of the

pH

The pH values of soil samples from bamboo forest, Sal forest wet land are mentioned in and fig-4 The results indicated that wet land soil had the highest pH value of 8.21 . The soil from from bamboo and Sal forest Had acidic pH with the values 6.40 and 5.54 respectively .

ORGANIC CARBON AND TOTAL ORGANIC MATTER

The percent organic carbon and total organic matter of the various soil types have been depicted in and fig-5 The results indicated that both percent organic carbon and total organic matter was highest in bamboo forest soil fallowed by Sal forest and was the lowest in wet land soil. Bamboo forest indicated the highest value of percent organic carbon.

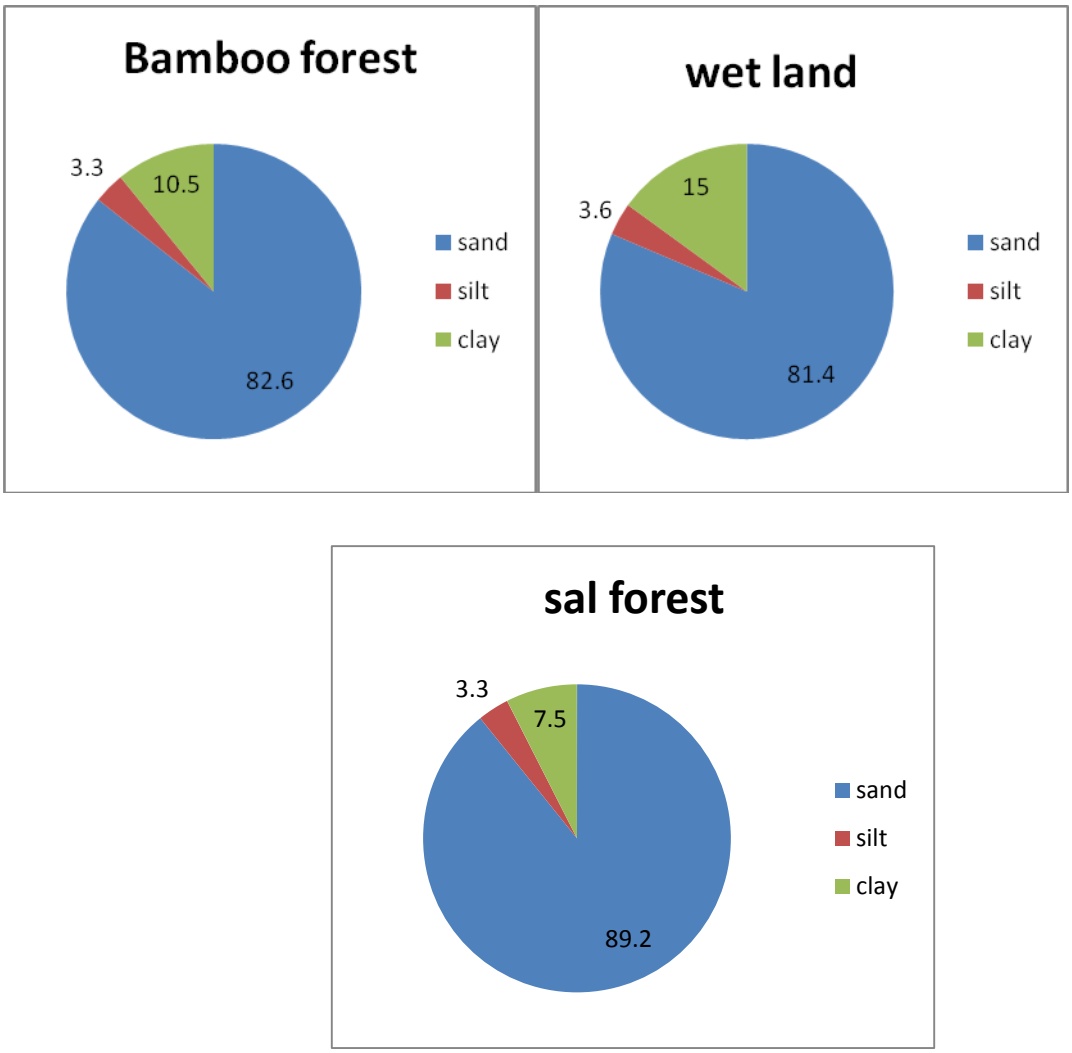


Fig. 3 Percent sand, silt and clay in soils from bamboo forest, sal forest, wet land of Chandaka-Dampara sanctuary.

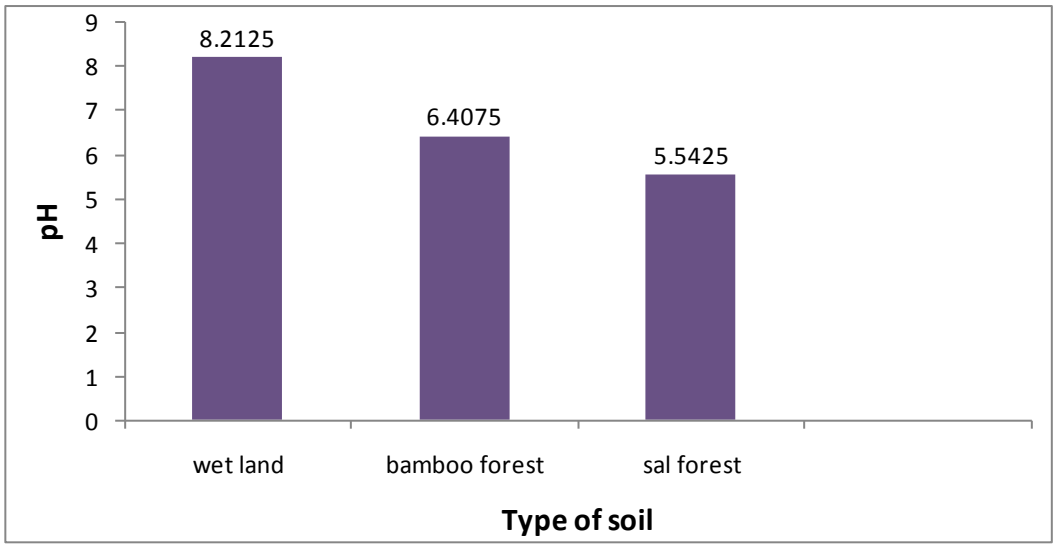


Fig. 4 pH of different land use zones in Chandaka- Dampara sanctuary

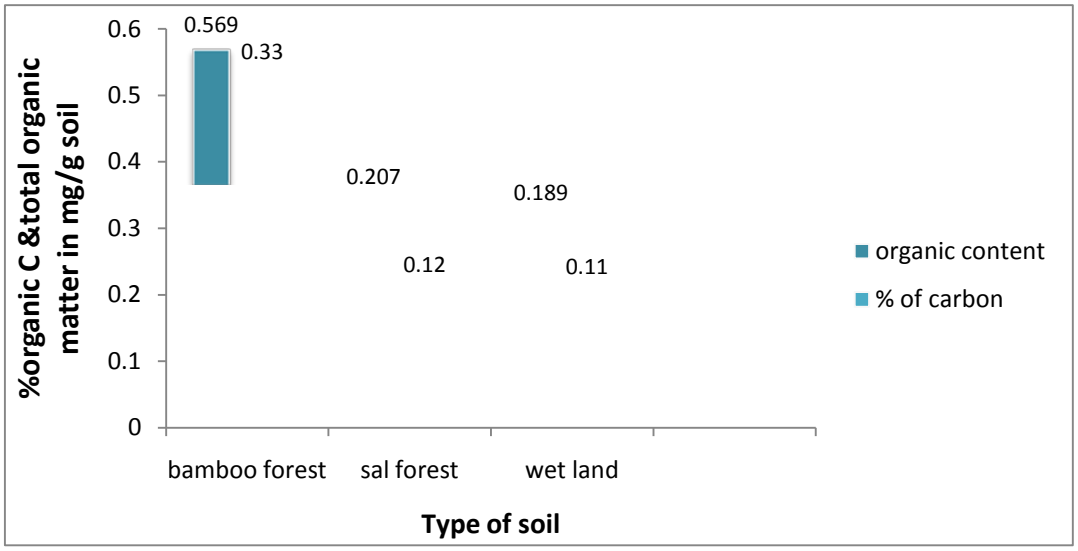


Fig. 5 percent organic carbon and total organic matter of soil types in chandakadampara sanctury

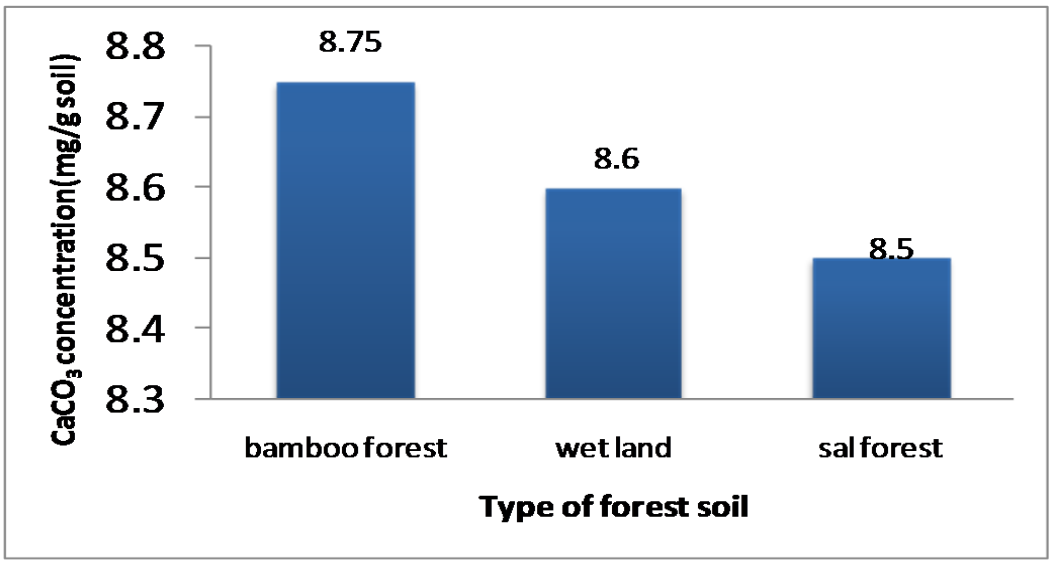


Fig.6 Soil Calcium carbonate content in different land use zones of Chandaka Dampara sanctuary.

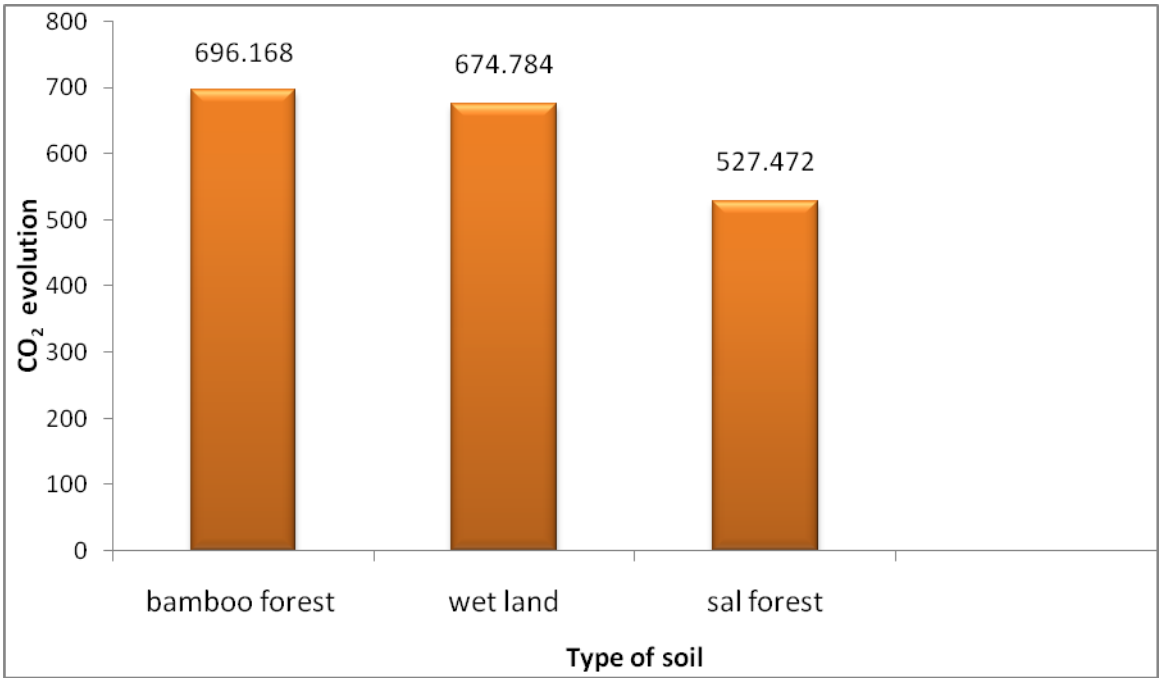


Fig. 7 Soil respiration variation in different soil types collected from Chandaka Dampara sanctuary.

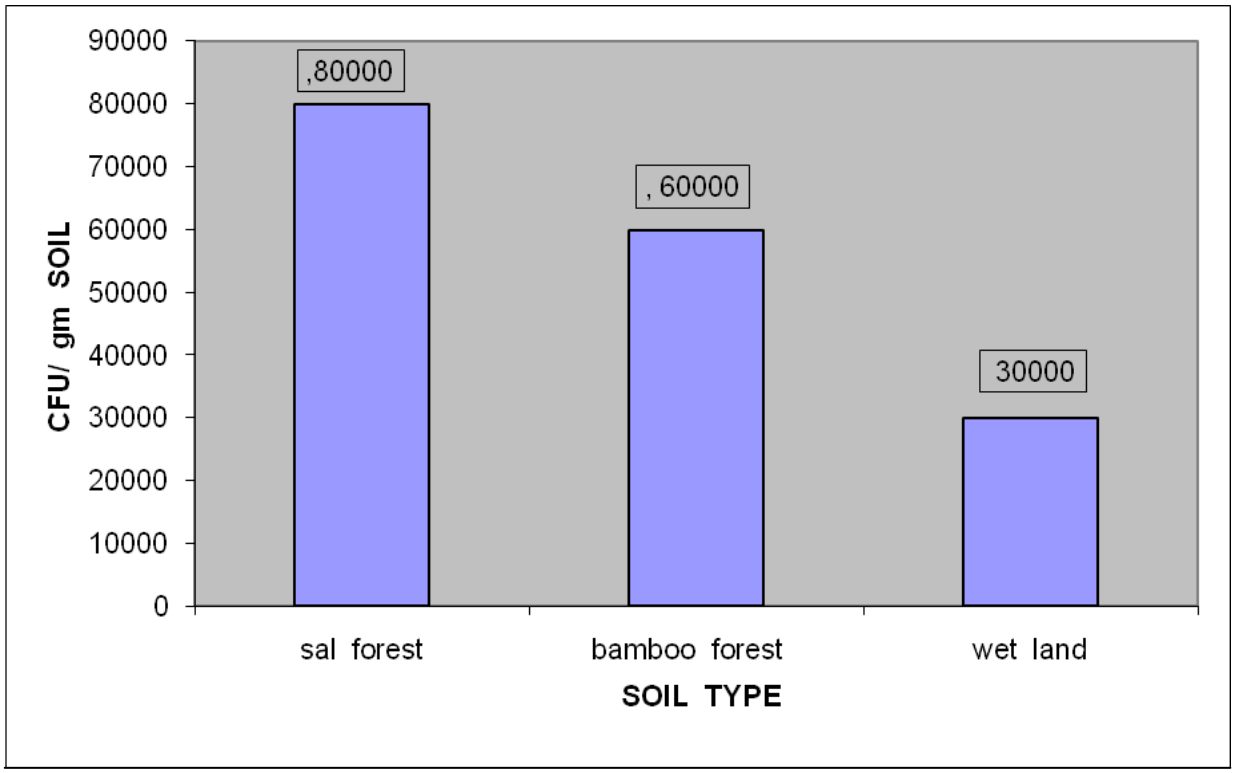


Fig 8 Fungal colony count in soils of different land use zones

carbon (0.33). in bamboo forest which also indicated the highest total organic matter (0.569 mg/gm soil) . These values were found to be lowest (0.11, 0.189 mg/ gm soil) in wet land soil.

Calcium carbonate

fig-6 indicate the calcium carbonate content of various soil types.

Highest calcium carbonate (8.6 mg/gm soil). The lowest (8.5 mg/gm soil) was obtained from Sal forest soil.

FUNGAL POPULATION AND HETEROTROPHIC SOIL RESPIRATION

The fungal colonies in different soil types are shown in FIG 2A-C.

Fig -8 depicts the variation in fungal population in the soils of different land use zones of Chandaka –Dampara sanctuary. The highest fungal colony count was in Sal forest soil fallowed by bamboo forest and wet land. Sal forest soil had 80000 cfu/gm soil, bamboo forest 60000 cfu/gm soil and wet land 30000 cfu/gm soil. Fungi thus indicating that the soil in Sal forest seems to be best suitable for fungal colonization in comparisons to the other soil types.

CARBON DIOXIDE EVOLUTION

The heterotrophic soil respiration indicated a variation between soil types. The highest carbon dioxide efflux of 570.24mg/m^2/hr was observed from bamboo forest soil , the second highest values of 520.34 from wet land soil the least 475.2mg/m^2 from Sal forest.(FIG 7).

Examination of colonies in the culturePlates and the study of their morphological features under microscope indicated that the dominant fungal strains were *Aspergillus niger* , *Aspergillus flavus,* and *Aspergillus terius* .

DISCUSSION

The soil habitat is a complex system with various types of soil aggregates of different sizes(Sylvia et al , 2005) . Wixon and Balsor (2009) have proposed that the soil habitat is greatly influenced by various abiotic variables present in the soil subsystem which in turn affect the density and diversity of microbial communities. In our study texture analysis of soil obtained from bamboo forest, sal forest along with wet land indicated the variation in composition of the component such as sand, silt and clay. Soil physical composition varied widely at different locations in a dry tropical forest of rajastan (Kumar et al, 2011) . Hence, our study reveals that composition of soil components are variable in different land use zones of Chandaka - Dampara sanctuary.

Tripathy et al,(2012) have proposed from their studies that the highest fungal population was obtained at the soil pH close to neutral. They have also found that the fungal count differs in soil with different pH values in the same type of forest.in our study Sal and bamboo forest soil indicated pH value in the acidic range where as the wet land soil showed an alkaline pH .a drop in pH value generally results due to high rate of leaching. since, the Sal and bamboo forest soil with high sand content had presumerbly higher porocity, the leaching of nutrient must be high in these types of soil resulting in lower pH value in wet land soil may be attributed to relatively high level of calcium carbonate in this type of soil.

Brady and Weil (2002) have reported that top 1mm of Soil contains up to 3 times more carbon than the amount stored in above ground vegetation. Jobbagy and Jackson (2000) have reported that soil organic carbon happens to be the largest component of global carbon budget. The upper 20-30cm of soil is biologically most active portion of the soil profile (Fierer et al, 2000 ; Jobbagy and Jackson, 2000; Valdkamp et al; 2003, Baisden and Parfitt, 2007; Goberna et al, 2006). In our study we found high percent of organic carbon and total organic matter in bamboo forest soil relative to other types of soils. Arunachalam et al (1997) reported that total organic matter of soil can be linked to input of litter mass in a forest. Hence; the higher level of organic carbon and total organic matter in bamboo forest may be attributed to higher litter biomass. Land use change generally influences' microbial communities in soil. Significant variation in soil microbial community in a mature forest soil an and adjacent pasture soil have been reported by Borneman and Tripplet (1972).

The study of fungi is important to understand terrestrial ecosystem functioning. In general fungi are highly diversified and are widely different in different environmental conditions. The forest soil characteristics significantly influences fungal population and diversity [Lentendu et al(2011)].in soil the the primary and best known role of fungi is the decompositionand mineralizalition of complex compounds of plant and animal origins such as cellulose, Hemi cellulose , lignin and chitin (Schwarz et al , 2004 Boddy et al , 2007). Other major roles of soil fungi include their involvement in beneficial , symbiosis

with plant roots. Moreover, fungi play a key role in structure and soil water content and the above ground diversity (Coleman, 2010). Due to the large number and in important ecological functions fungi are also excellent bioindicators (Jonsson and Jonseli, 1999; Parmasto 2001) . Micro fungal biomass has been reported to be highest in the Region in a tropical forest soil with the maximum organic carbon concentration (Basu et al, 1992) . Further (Persiani et al , 1998) have observed That the soil fungal population density is dependent on various a biotic variables including organic carbon and total organic matter . in our study The maximum fungal population have been observed in Sal and bamboo Forest and the minimum in the soil from wet land forest . The percent organic carbon and total organic matter was also correspondingly high in Bamboo and Sal forest in comparison to the wet land soil. Hence, it appears their the fungal population is dependent on the quantity of organic carbon and total organic matter in soil. Our observation are further supported by the studies of Pang et al (2009) in a subalpine coniferous forest in western Sichuan, china. They have reported significant correlation between the microorganism population and metabolism with soil organic matter , nitrogen, phosphorous, and potassium.

Soil metabolism or the metabolism of soil biota is an important indicator for the intensity of organic matter decomposition in an ecosystem (Coleman and Sasson, 1978) . Soil respiration rate i.e. the amount of carbon dioxide released for soil surface and time has long been considered as an authentic index of the abundance and activity of soil organisms. (Basu et al , 1991;

Bentham et al ,1992; Domsch , 1962 ,Panda , 2010). Richle et al (1975) and Behera et al (1990) concluded that soil microorganisms contribute 99% of the total soil respiration. Mohanty and Panda (2011) have correlated soil respiration rate with the microbial population in a tropical deciduous forest. In our study the maximum rate of soil respiration Was observed in bamboo forest fallowed by wet land and Sal forest . The fungal colony count was highest in Sal forest fallowed by bamboo forest and wet land. In this study the bamboo forest with moderate fungal count indicating the highest soil respiration rate support the earlier proposal by (Behera et al 1990) that soil respiration is not necessarily correlated to fungal population alone, rather is also influenced by the population of bacteria and plant roots . our observations on soil respirations are also in agreement with reports of Bijaylaxmi Devi and Yadava (2008) on a subtropical mixed oak forest that, the rate of soil respiration shows considerable variation betweendifferent regions of the forest. In the present study the differences in carbon dioxide efflux in different types of soil may be attributed to the variation in population of microorganisms, nutrient status and the rate of organic matter decomposition carried out by the fungi and other microbes.

CONCLUSION

Soil physico-chemical parameters such as texture, pH, organic carbon, total organic matter and calcium carbonate content influence the population of fungi and rate of soil respiration. The study also indicated that fungal population and soil respiration vary widely in forest soil of different land use zones. Since the soil nutrient status, fungal colonisation and metabolism are good indicators of soil health, further studies on depth wise variation in fungal population metabolism with variation in nutrients will throw more light on fore microbiology.

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