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# ECOSYSTEM DYNAMICS IN RELATION TO FIRE IN DIFFERENT FOREST TYPES

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# ECOSYSTEM DYNAMICS IN RELATION TO FIRE IN DIFFERENT FOREST TYPES

**(Final Report of the Project KFRI 347/2000 April 2000-March 2002)**

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# Abstract of Project Proposal

Project No. : KFRI 347/2000

Title : Ecosystem dynamics in relation to fire in different forest types

Objectives :
to study the changes brought about by fire on soil physical and chemical properties
to investigate the changes in vegetation with respect to regeneration status of herbs and shrubs
to quantify the litter (fire load) and assess the regeneration of important tree species
to study the physiological stress on trees due to fire
to determine the changes in soil microflora
to monitor the weather parameters
to evaluate the loss due to fire

Expected outcome : The study will bring out the effect of fire on soils, regeneration status of herbs, shrubs and important tree species and soil microflora. It will generate information on the physiological stress on trees, the loss and recovery processes due to fire.

Date of commencement : April 2000

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Funding agency : Kerala Forestry Project(WB)
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Project team

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## ABSTRACT

The study was carried out in the Chinnar Wildlife Sanctuary and at Panthanthodu in the Anakkatty range of Mannarghat Forest Division. An intense fire had occurred in 1985 at Chinnar Wildlife Sanctuary and in 1989 at Panthanthodu. After that no incidence of fire was reported from these areas.

There was marked difference in soil properties between Chinnar and Panthanthodu. With respect to recovery processes, the two ecosystems follow different trends. At Chinnar, soil fertility was the discriminating factor between burnt and unburnt plots, even after 17 years of occurrence of fire. At Panthanthodu, soil texture, alkalinity and fertility were the three discriminating factors between completely burnt, partially burnt and unburnt plots, even after 13 years of occurrence of fire. The ecosystem after the incidence of fire, even when protected fully, could not recoup to its parent stage.

In general, population of seedling in burnt areas was less compared to unburnt areas at Chinnar. The regeneration potential of trees, shrubs and herbaceous species was also relatively more in unburnt areas.

At Panthanthodu, in general, the seedlings of different height classes were observed more in unburnt areas compared to burnt areas, especially the larger seedlings, having height more than 100 cm.

Studies carried out to assess the physiological stress to species due to fire revealed that except in few species, there are no apparent differences in physiological processes. However, the study shows that more detailed investigations are necessary to arrive at meaningful conclusions in these aspects.

Quantitative assessment on microbial population in soils revealed comparatively very high population of soil fungi, bacteria, actinomycetes and vesicular arbuscular mycorrhizal fungi in burnt soils than unburnt soils in both the forest ecosystems. Soil fungal species and genera occurred more in burnt soils than unburnt soils in both the forest ecosystems.

At Chinnar, the canopy closure was 15.65 per cent less in burnt plots when compared to unburnt plots. At Panthanthodu, the canopy closure was 71.76 per cent less in burnt plots and 34.89 per cent less in the partially burnt plots when compared to unburnt plots.

Based on the annual flow of goods and services per hectare, the loss due to fire is approximately computed for both Chinnar and Panthanthodu. It is assumed that the loss of goods and service in an unit area is directly proportional to reduction in the canopy closure in both the localities. At Chinnar, the loss ranged from Rs. 507/- to Rs. 1914/- per ha per annum in the burnt areas while at Panthanthodu, the values ranged from Rs. 15,276/- to 2,31,754/- in the burnt and Rs. 7427 to 1,12,680/- per ha per annum in the partially burnt areas.

The overall results suggest that fire has affected the vegetation, soil and soil microorganisms and the ecosystem has not recovered fully even after 15-17 years of occurrence of fire. There was also considerable loss due to fire.

# 1. Introduction

**Effect of fire on ecosystem**

Pre-historic people used fire in a variety of ways which have been documented archeologically (Williams, 1994). On a global basis, fire and man, separately and together have a great role in shaping or altering vegetation (Kozlowski and Ahlgren, 1974).

## 1.1. Effct of fire on soils

Fire brings about many physico-chemical changes in the soil, some of which may be conducive to the growth and development of plants whereas others may be detrimental. Still many are ignorant that fire is one of the most potent factors which alters the forest environment leading to soil erosion, moisture stress and degradation of site and finally desertification.

Consumption of litter and soil organic matter by fire can seriously affect infiltration, moisture holding capacity and ability of soil systems to protect against rainfall. Some of the effects of fire on soil chemistry and nutrient cycling processes include reduction in cation exchange capacity, nutrient volatilization, loss of nutrients, soil particle erosion, changes in nutrient forms to less or more available forms and increases in leaching due to the disruption of nutrient uptake (Hungerford, 1996). Klopatek (1987) determined that N and P concentrations beneath pinyon-juniper canopies, 35 years after a wildfire, had not recovered to levels found in stands that had not burned in 300 years.

Apart from the physical removal of nutrients in runoff, the drying of soils diminishes the ability of recovering and colonizing microorganisms and plants to cycle nutrients. Combustion of organic matter reduce the availability of organics otherwise helpful for the growth of soil microorganisms especially nitrifying bacteria and fungi that release available nitrogen.

## 1.3. Effect of fire on regeneration

In various areas, the ground vegetation, especially shrubs, may play completely different roles in post-fire succession. The severity of impact of fire depends upon the interactions of fire temperature, duration, combustion phase, fuel load, vegetation, climate, slope, topography, soils and area burnt.

The influence of forest fire on successional status, regeneration status of forest trees, etc., requires close attention. A series of studies on the regeneration of fire-affected rain forests were conducted in the mid 1980's. Forests on sites with low water retention capacity were most seriously affected by fire (Goldammer *et al*., 1999).

Fire strongly promotes fire tolerant trees, which replace the species potentially growing in an undisturbed environment. Information regarding the regeneration status of such species is still lacking.

## 1.4. Effect of fire on physiological stress and germination of seeds

Under the influence of fire, soil microorganism populations and species composition can increase or decrease depending on the intensity of fire, maximum temperature, soil water content, duration of heating, and depth of heating (Hungerford, 1996). The effect of fire on trees is influenced by size of tree, amount of herbaceous fuel, wind speed, air temperature, stand density, vertical and horizontal fuel distribution, and season (Pieper and Wittie, 1988). Fire affects species composition and density.

Soil moisture seems to be the most critical factor in seedling establishment. Mineral soil with a light litter covering is considered the optimum seedbed (Schubert, 1974) because it allows best seed and seeding contact with available moisture.

Many seeds get scarified when subjected to mild ground fire enabling them to germinate better and establish the population. Fire can burn seeds and seedling banks (Windicsh and Good, 1991), injure or even completely kill trees of any age or size, partially kill or wilt seedlings and saplings and affect wildlife population by depleting forage (Boyce and Merrill, 1991). Forest fire will affect soil moisture availability, thus directly affecting the tree population dynamics.

### 1.5. Effect of fire on soil microflora

Information on post-fire ecology of soil micro-flora is very limited. Microbial succession occurs in the burnt sites quickly; however, the colonizers and the successors may be entirely different from the pre-burn microflora, eliminating certain heat sensitive and heat intolerant groups of microbes from the ecosystems.

### 1.6. Loss due to fire

The type and density of forests in India being variable, the economic values of intangible benefits also will vary accordingly. The value of forest varies from place to place depending upon the type of forest, density, proximity, etc. Most of the studies on valuation of forests in India are micro level ones which have been carried out in certain localities/reserve/national park. The results of these studies cannot be generalised for other areas where physical and biological conditions differ. Attempts to work out economic values of Indian forests are limited. Moreover, available studies focus on selected functions of forests and so not sufficient to calculate total economic value (TEV). As forests in India are heterogeneous, the estimates vary across the locations.

Most of the literature refers to the impact of fire on the ecosystem. However, not much information is available on what happens to the ecosystem if a fire has occurred and after that the area has been protected from fire for a period of one decade or more. Research has not been made in detail in this aspect.

It is with this in mind that a detailed project is proposed to evaluate the ecosystem dynamics in relation to fire in two forest types viz. West coast tropical evergreen and Southern dry mixed deciduous (dry deciduous) forests in Kerala. The aim of the project is to study the recuperation process, if any, in these two forest types. The objectives of the project are

1. to study the changes brought about by fire on soil physical and chemical properties
2. to investigate the changes in vegetation with respect to regeneration status of herbs and shrubs
3. to quantify the litter (five load) and assess the regeneration of important species
4. to study the physiological stress on trees due to fire
5. to determine the changes in soil microflora
6. to monitor the weather parameters
7. to evaluate the loss due to fire

## 2. Study area

The study was carried out in the Chinnar Wildlife Sanctuary and at Pathanthodu in the Anakkatty Range of Mannarghat Forest Division.

### 2.1. Chinnar Wildlife Sanctuary

The Sanctuary is comprised of an area of 90.442 $km^2$. The area lies between Latitude $10^o15'$ and $10^o$ $21'$ towards North and between Longitude $77^o$ 6' and $77^o$ 16' towards East. The terrain is undulating and rocky throughout. The elevation ranges from 500 to 2400 m. The rock is igneous and the soil is dry and the depth is very low. The area falls under the rain shadow region and is prone to fire.

The area receives mainly north - east monsoon. The south - west monsoon is very weak. Maximum annual rainfall was 831.5 mm with a monthly maximum of 212.5 mm during
September and minimum 4 mm during March. The temperature ranged from a minimum of 13 °C during the month of December to a maximum of 37.8 °C during the month of April and May. Relative humidity also varied from a minimum of 19 to a maximum of 100 per cent during rainy months of September and October. The climate is generally dry.

The vegetation at Chinnar can be broadly classified according to Champion and Seth (1968) into the following types. They are

1. Southern dry mixed deciduous forest (dry deciduous forest)
2. Southern tropical thorn forest (scrub jungle)
3. Southern moist mixed deciduous forest (moist deciduous forest)
4. Tropical riparian fringing forest (riparian forest)
5. Southern montane wet temperate forest (hill shola forest)
6. Southern montane wet grassland (grassland)

Southern dry mixed deciduous forest (dry deciduous forest) and Southern tropical thorn forest (scrub jungle) together constitute about 50 per cent of the total forest area. An intense fire occurred in 1985 at Chinnar Wildlife Sanctuary and after that no incidence of fire was reported.

### 2.2. Panthanthodu

Panthanthodu in the Anakkatty Range of Mannarghat Forest Division lies between $11^{o}$ 5'– 11 $^{o}$ 6' N Latitude and 76.26' and 76.29' E Longitude. According to the Champion and Seth classification (1968), the vegetation type is West coast tropical evergreen forest. The climate is drier and cooler. Both the south - west monsoon and the north - east monsoon cause rains in this area. The mean annual rainfall, is more than 4700 mm, the peak period being June to August. The temperature in these areas varied from a mean minimum of 12.9 °C to a mean maximum of 31.9 °C, the hottest period being March and April.

The relative humidity also varied from 19 to 100 per cent in these areas, most of the months having a maximum relative humidity of 100 per cent. A fire had taken place in 1989 which lasted for more than two weeks. Fire, starting from close to the coupe road, spread into the forest. Initially, only a ground fire had taken place which gradually intensified at the top of the hill where it persisted for more than two weeks, affecting big trees.

### 2.3. Study sites

Sites were selected at Edalichedimantha and Kalladathupara in the Chinnar Wildlife Sanctuary and at Panthanthodu (Figs.1 and 2).

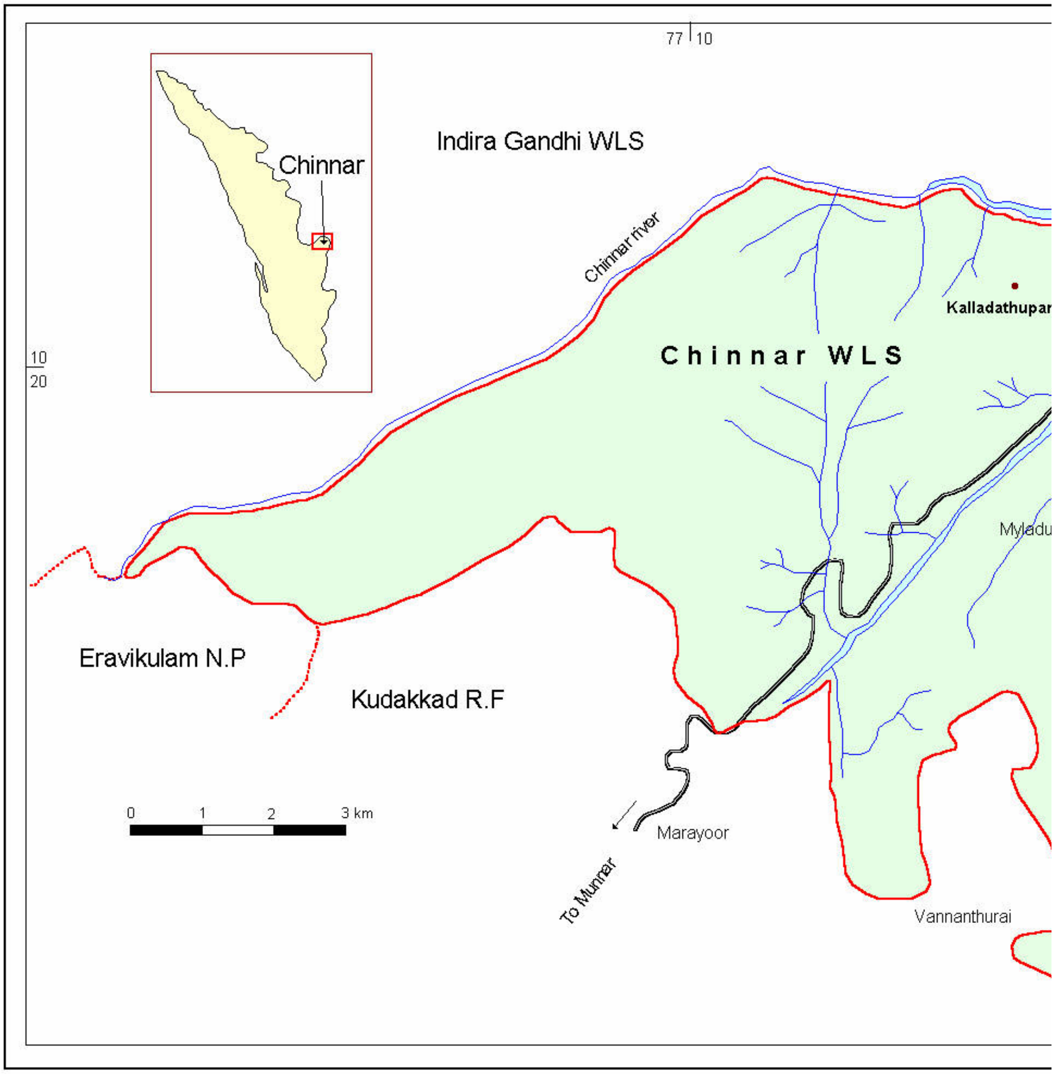


**Fig. 1. Study area at Chinnar**

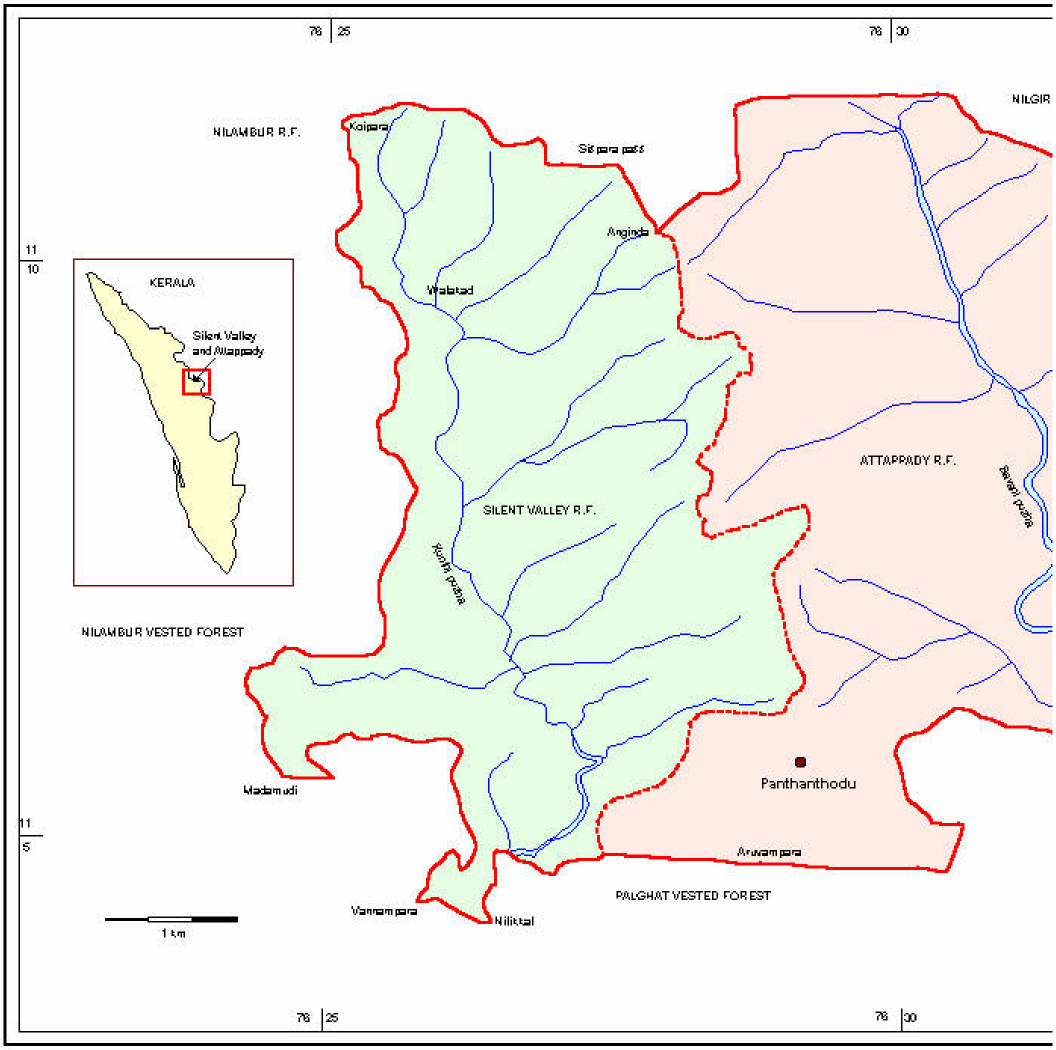


**Fig. 2. Study area at Panthanthodu**

# 3. Methodology

## 3.1. Study plots

Study plots of 25 m x 25 m size were laid out at Edalichedimantha, Kalladathupara and Panthanthodu. At Edalichedimantha and Kalladathupara, plots were taken in completely burnt and unburnt areas while at Panthanthodu, plots were laid out in completely burnt, partially burnt and unburnt areas. Area where a ground fire had occurred was classified as partially burnt and the area where standing trees were burnt was classified as completely burnt. Four plots each were demarcated in completely burnt and unburnt areas at Edalichedimantha and Kalladathupara and in completely burnt, partially burnt and unburnt areas at Panthanthodu. There were 16 plots at Chinnar and 12 plots at Panthanthodu (Plates 1-3).

## 3.2. Soils

Three soil pits were taken from each plot and samples collected from 0-20, 20-40 and 40-60 cm layers. Three soil core samples were also collected from each plot for soil microflora studies. The soil samples were processed for soil physical and chemical analyses and microflora studies.

Particle-size separates, bulk density, particle density, maximum water holding capacity, soil pH, organic carbon, available N, P, K, Ca and Mg contents of soils were determined as per standard procedures in ASA (1965) and Jackson (1958). Gravel contents were also found out. Data on soil properties were subjected to statistical analyses.

## 3.3. Regeneration

The vegetation status was evaluated using quadrat method.

### *3. 3.1. Enumeration studies*

The tagging (with aluminium tags) and enumeration of seedlings and identification of species were done in each sample plot. At Chinnar complete enumeration was done after dividing the plots into four quadrants and marking the limits of each quadrant. Each quadrant was enumerated separately and the status of the seedlings was evaluated. Approximately 4000-4500 seedlings were tagged.

In addition to the habit-wise classification of seedlings, they were further subdivided into three major groups based on height viz. below 50 cm height; 50-100 cm height and more than 100 cm height classes. The data were recorded separately with each tag number and species name as baseline information.

At Panthanthodu due to high vegetation density, complete enumeration was not done. Preliminary enumeration works indicated that within a plot, one sub plot of 18 m x 18 m could record approximately 2500-3000 seedlings. As the number of seedlings would be very high, enumeration pattern was further modified. In unburnt, partially burnt and completely burnt plots, complete enumeration (100%) was done in one plot randomly selected covering 625 $m^2$ area. Five sub sample plots of 5 m x 5 m size were demarcated in each plot of all the other three replicates, covering an area of 375 $m^2$ in one locality. Thus the area covered was 1000 $m^2$. The re-enumeration works were done periodically at an interval of two months. The seedlings dried during the re-enumeration and new seedlings emerged were also noted for evaluating the mortality status.

### *3.3.2. Diversity Indices*

Biodiversity manifests itself in two directions viz., variety and relative abundance of species (Magurran, 1988). The former is often measured in terms of species richness index (Menhinick's index), which is, Species richness index = $\frac{S}{\sqrt{N}}$

where $S$ = Number of species in a collection

$N$ = Number of individuals collected

Relative abundance is commonly measured using Shannon –Weiner index, which is calculated as

$$H' = -\sum p_i \ln p_i$$

The quantity $p_i$ is the proportion of individuals found in the $i$th species and ln indicates natural logarithm.

Simpson's index assumes that the proportion of individuals in an area adequately weights their importance to diversity. The equation for this is

$$D = 1/\sum p_i^2$$

where $D$ is the diversity and $p_i$ is the proportion of the $i$th species in the total sample. It is more of a dominance measure of diversity.

Fisher's $\alpha$ is yet another measure of diversity. When the species abundance model follows the log series where the number species represented by $n$ individuals apiece is $S(n) = \alpha x^n/n$, the parameter $\alpha$ offers an excellent measure of diversity. When log series applies, the following relation connects the number of species, S and number of individuals, N,

$$S = \alpha \ln(1+N/\alpha)$$

This can be used to estimate the value of $\alpha$ for known $S$ and $N$ by successive approximations. The above mentioned biodiversity indices were calculated for the data collected from Kalladathupara, Edalichedimantha and Chinnar for burnt and unburnt plots and Panthanthodu for burnt, partially burnt and unburnt plots, belonging to three height categories.

### 3.4. Seed germination studies

Seed germination was also noted during the re-enumeration of the seedlings. Besides, seeds of dominant tree species existing in the respective areas were collected and germination studies carried out in order to assess the germination potential of these species.

### 3.5. Physiological stress on trees due to fire

In order to assess the physiological stress due to fire, measurements on photosynthesis, transpiration and leaf conductance were carried out using LICOR 6200 portable photosynthesis system and steady state porometer (LI-1600, LICOR, USA). The canopy closure was also determined using canopy analyzer (LI-2000, LICOR, USA). For the observations on photosynthesis and evapo-transpiratory parameters of tree seedlings, candidate seedlings of important tree species were recruited and the physiological observations carried out in different plots.

### 3.6. Soil moisture and weather parameters

The moisture contents in different soil depths (0-30 cm and 30-60 cm) were found out using moisture meter (Moisture Point). The data collected were analyzed using packages available in the computer.

As the experimental plots were located inside the sanctuaries, the rainfall, temperature and relative humidity data recorded were collected.

### 3.7. Soil microflora

A soil core sampler made of GI pipe of 25 cm length and 4 cm dia was hammered to a depth of 20 cm and core sampler with soil intact was taken out, both the ends closed with caps and kept in polythene bags (Plate 4). A total of three soil core samples were taken randomly from the already laid out plots. The soil from the core sampler was pushed out using an electrically operated soil core extractor and the soil core was cut into different depth intervals, viz. 0-5, 5-10, 10-15 and 15-20 cm and stored separately. The soils from similar depths in a plot were pooled to form a composite sample. From the composite sample of about 50 g of soil was further made into working samples of 10 g each and utilized for microbiological studies. A total of 96 core samples were collected from burnt and unburnt areas at Edalichedimentha and Kalladathupara. From Panthanthodu, a total of 72 soil core samples were collected

#### *3.7.1. Isolation of fungi, bacteria and actinomycetes*

Soil dilution plate technique was employed to study the soil microflora, fungi, bacteria, and actinomycetes. The sample was shaken thoroughly and appropriate dilutions were prepared, i.e. $10^{-3}$ for fungi, $10^{-4}$ for actinomycetes and $10^{-5}$ for bacteria. Potato Dextrose Agar (PDA) and Rose Bengal Agar (RBA) media were used to isolate fungi, while Starch Casein Agar (SCA) was used for actinomycetes, and Nutrient Agar (NA) for bacteria. The microbial colonies were sub-cultured on appropriate culture media, morphological and cultural characteristics of the organisms studied and identified.

#### *3.7.2. Separating vesicular arbuscular mycorrhizal (VAM) spores from soil*

Wet sieving and decanting method (Gerdemann and Nocolson, 1963) with modification was employed for retrieving the arbuscular mycorrhizal (VAM) fungal spores from soil samples. Spore preparations with and without Melzer's reagent were made to reveal details on spore inner-wall layers.

### *3.7.3. Identification of soil microorganisms*

Identification of soil microorganisms, viz., fungi, bacteria and actinomycetes was made using the available literature. As far as possible identification of the fungal taxa was made up to species level. Attempt was made only to identify the bacteria and actinomycetes up to generic level. Following the taxonomic descriptions of Schenck and Perez (1990), identification of vesicular arbuscular mycorrhizal fungi was made. Details on spore wall characteristics were utilized for preparation of murographs and identification of the taxa.

## 3.8. Loss due to fire

The loss due to fire was calculated on the basis of leaf area index (LAI) which is directly proportional to canopy closure and the annual flow of goods and services per hectare. It is assumed that the loss of goods and service in an unit area is directly proportional to reduction in the canopy closure, which was calculated on the basis of leaf area index.

# 4. Data analyses

## 4.1. Statistical analyses

In order to evaluate the effect of fire on soils, soil properties in each layer in burnt and unburnt plots at Kalladathupara and Edalichedimantha and unburnt, partially burnt and completely burnt plots at Panthanthodu statistical analyses were carried out after applying appropriate transformations.

The mean comparison was done, wherever needed, through Duncan's multiple range test (DMRT). This may be inadequate in the presence of inter correlation among the soil properties. In order to get a better picture of the influence of fire on soil properties combinedly, discriminant analysis was done (Jeffers, 1978).

## 4.2. Discriminant analysis

Discriminant function deals with the problem of how best to discriminate two or more predefined groups, each individual of which has been measured in respect of several variables. The model provides a linear function of the measurements on each variable, such that the ratio of between group sum of squares to that of within sum of squares is maximised for the discriminant scores. This provides a convenient way of identifying the factors by which the groups differ most. Since the number of explanatory variables is more,step-wise discriminant analysis was carried out.

In the step-wise discriminant analysis, the variables are added to the discriminant function one by one until it is found that adding extra variable does not give significantly better discrimination. Step-wise discriminant analysis was carried out to identify the factors by which the soils in burnt and unburnt plots differed significantly at Kalladathupara and Edalichedimantha, and also at Panthanthodu in the completely burnt, partially burnt and unburnt plots.

When there are two groups, one function is obtained. In general, for k groups k-1 groups can be derived, each independent of the other. Since sand, silt and clay contents add up to unity, the clay content was not considered while performing stepwise discriminant analysis.

# 5. Results and Discussion

## 5.1. Soils

Analyses of variance of soil properties between burnt and unburnt plots at Kalladathupara and Edalichedimantaha are depicted in Appendices 1 and 2. The mean values of soil properties in the different layers at Kalladathupara, Edalichedimantha, Chinnar and Panthanthodu are shown in Appendices 3-18. Results of the discriminant analyses are reported in Tables 1-8.

### *5.1.1. Kalladathupara*

Statistical analyses on individual soil property for each layer revealed that there existed significant difference between burnt and unburnt plots with respect to bulk density, available Ca and calcium carbonate in the 0-20 cm layer. Organic carbon, bulk density and available Ca in the 20-40 cm layer and available Ca and calcium carbonate in the

40-60 cm layer and organic carbon, bulk density, available Ca and calcium carbonate when the whole soil volume (0-60 cm) also differed significantly (Appendix 1).

### *5.1.2. Edalichedimantha*

Available Ca, Mg and calcium carbonate in the 0-20 cm layer, particle density, available P, K, Ca and Mg in the 20-40 and 40-60 cm and calcium carbonate in the 0-60 cm layer showed significant difference between burnt and unburnt plots (Appendix 1).

### *5.1.3. Chinnar*

The soil properties at Kalladathupara and Edalichedimantha were pooled to get those at Chinnar. There was significant difference in available Ca and Mg and calcium carbonate in all layers, available K in all layers except the 0-20 cm, organic carbon in the 20-40 and 0-60 cm and bulk density and particle density in the 0-20 cm layer between burnt and unburnt plots (Appendix 1).

### *5.1.4. Panthanthodu*

Sand, silt, clay, soil pH, available N and calcium carbonate in the 0-20 cm layer differed significantly between unburnt, partially burnt and burnt plots. For these properties DMRTs were carried out.

The results revealed that completely burnt plots differed significantly from partially burnt and unburnt plots but not between themselves with respect to soil pH and silt. Unburnt, partially burnt and completely burnt plots differed significantly from each other with respect to sand and clay.

Unburnt and completely burnt plots did not differ significantly with respect to available N contents at Chinnar so also in the partially burnt and completely burnt plots at Panthanthodu. In the unburnt plots, available N differed significantly. Partially burnt plots differed significantly from unburnt and completely burnt plots with regard to calcium carbonate (Appendix 2).

In the case of gravel, sand, silt, clay, particle density, organic carbon, available N and calcium carbonate, there existed significant difference between unburnt, partially burnt and burnt plots when the whole soil volume (0-60 cm) is considered (Appendix 2).

The DMRTs revealed that partially burnt did not differ significantly from completely burnt and unburnt plots with respect to gravel and partiacle density, but they differed between themselves. Completely burnt plots differed significantly from unburnt and partially burnt plots with respect to sand, silt and clay, but these differed between themselves.

With regard to organic carbon, unburnt plots did not differ significantly from partially burnt and completely burnt plots, but the latter two differed between themselves. Unburnt, partially burnt and completely burnt plots differed significantly between each other with respect to available nitrogen. Completely burnt plots did not differ significantly from unburnt and burnt plots with respect to calcium carbonate, but the latter two differed between themselves.

### *5.1.5. Discriminant analyses*

Results obtained from step - wise discriminant analyses for each layer separately for each location are given below.

#### *5.1.5.1. Kalladathupara*

The discriminant coefficients and the correlation of each variable with the values of the discriminant function are reported in Table 1. The discriminant function was found correlated (absolute value of correlation coefficient $\geq 0.5$ ) with $CaCO_3$ and sand in the 0-20 cm layer.

In the 20-40 and 0-60 cm layers, the discriminant function was found highly correlated with BD. There was correlation in the 40-60 cm layer with $CaCO_3$. This implies that soil alkanity, texture and compactness were found to be affected due to fire and even after 17 years recuperation has not taken place.

#### *5.1.5.2. Edalichedimantha*

The discriminant functions in the 0-20, 20-40, 40-60 and 0-60 cm layers are found highly correlated with Mg (Table 3).

Table 1. Discriminant coefficients and the correlation of the discriminant function (Z) with the variables at Kalladathupara in different layers

| Depth / Variables | Discriminant coefficient | Correlation with Z |
|---|---|---|
| **0-20 cm** | | |
| $CaCO_3$ | 0.773 | 0.639 |
| Sand | -0.797 | -0.493 |
| P | 1.057 | 0.107 |
| **20-40** cm | | |
| BD | 1.000 | 1.000 |
| **40-60 cm** | | |
| BD | 1.528 | 0.367 |
| K | 0.781 | 0.141 |
| $CaCO_3$ | -1.429 | -0.428 |
| Silt | 1.517 | -0.187 |
| **0-60 cm** | | |
| BD | 1.000 | 1.000 |

The summary of discriminant analyses from different layers is given in Table 2.

Table 2. Variables and factors by which the soils in burnt and unburnt plots differ significantly at Kalladathupara in different layers

| | 0-20 cm | 20-40 cm | 40-60 cm | 0-60 cm |
|---|---|---|---|---|
| Soil variables | $CaCO_3$ | BD | $CaCO_3$ | BD |
| | Sand | | | |
| Soil factors | Soil alkalinity and texture | Compactness | Soil alkalinity | Compactness |

Table 3. Discriminant coefficients and the correlation of the discriminant function (Z) with the variables at Edalichedimantha in different layers

| Depth / Variables | Discriminant coefficient | Correlation with Z |
|---|---|---|
| **0-20 cm** | | |
| OC | 0.652 | 0.193 |
| Mg | 1.083 | 0.807 |
| **20-40 cm** | | |
| PD | -0.527 | -0.403 |
| K | -0.699 | -0.225 |
| Ca | 0.757 | 0.247 |
| Mg | 0.841 | 0.527 |
| **40-60 cm** | | |
| P | -0.902 | -0.295 |
| Mg | 1.132 | 0.648 |
| **0-60 cm** | | |
| OC | 1.011 | 0.094 |
| K | -0.779 | -0.284 |
| Mg | 1.204 | 0.568 |

The results of the discriminant analyses are shown in Table 4.

Table 4. Variables and factors by which the soils in burnt and unburnt plots differ significantly at Edalichedimantha in different layers

| | 0-20 cm | 20-40 cm | 40-60 cm | 0-60 cm |
|---|---|---|---|---|
| Soil variables | Mg | PD | Mg | Mg |
| | | Mg | | |
| Soil factors | Soil fertility | Soil compactness and fertility | Soil fertility | Soil fertility |

***5.1.5.3.Chinnar***

The discriminant function is found highly correlated with Mg in all layers and with K in the 40-60 cm layer (Table 5).

Table 5. Discriminant coefficients and the correlation of the discriminant function (Z) with the variables at Chinnar in different layers

| Depth / Variable | Discriminant coefficient | Correlation with Z |
|---|---|---|
| **0-20 cm** | | |
| Mg | 1.000 | 1.000 |
| **20-40 cm** | | |
| GR | -0.613 | -0.009 |
| OC | 0.767 | 0.330 |
| K | -0.960 | -0.248 |
| Mg | 0.830 | 0.472 |
| $CaCO_3$ | 0.461 | 0.240 |
| **40-60 cm** | | |
| K | -1.076 | -0.470 |
| Mg | 0.529 | 0.516 |
| $CaCO_3$ | 0.848 | 0.261 |
| **0-60 cm** | | |
| OC | 0.967 | 0.277 |
| K | -1.046 | -0.296 |
| Mg | 0.615 | 0.492 |
| N | -0.639 | 0.073 |
| $CaCO_3$ | 0.667 | 0.250 |

Variables and factors by which the soils in burnt and unburnt plots differ significantly at Chinnar in different layers are given in Table 6. At Kalladathupara, soil texture, compactness and alkalinity and at Edalichedimantha, soil fertility and compactness were the factors by by which the soils in burnt and unburnt plots differ significantly (Tables 2 and 4). At Chinnar, soil fertility was the only factor by which the soils in burnt and unburnt plots differ significantly (Table 6).

Table 6. Variables and factors by which the soils in burnt and unburnt plots differ significantly at Chinnar in different layers

| | 0-20 cm | 20-40 cm | 40-60 cm | 0-60 cm |
|---|---|---|---|---|
| Soil variables | Mg | Mg | K | Mg |
| | | | Mg | |
| Soil factors | Soil fertility | Soil fertility | Soil fertility | Soil fertility |

***5.1.5.4. Panthanthodu***

Since there were three groups *viz*., unburnt, partially burnt and burnt plots, two discriminant functions were generated. The discriminant coefficients and the correlation of each variable with the values of the discriminant function are reported in Table 7. The discriminant function in the 0- 20 cm layer was highly correlated (absolute value of correlation coefficient $\geq 0.5$) with sand, $CaCO_3$ and N. In the 20-40 and 40-60 cm layers, the discriminant function was found to be highly correlated with OC and N. In addition to these, the discriminant function was also correlated with sand in the 40-60 cm layer. In the 0-60 cm layer, the discriminant function was found to be highly correlated with sand, N and $CaCO_3$.

Variables and factors by which the soils in completely burnt, partially burnt and unburnt plots differ significantly at Panthanthodu are shown in Table 8. Soil texture, alkalinity and fertility were the factors in the 0-20 and 0-60 cm and soil fertility in the 40-60 cm layers by which the soils in completely burnt, partially burnt and unburnt plots differ significantly (Table 8). In addition to these, in the 40-60 cm layer, soil texture was found to differ significantly.

Table 7. Discriminant coefficients and the correlation of the discriminant functions ($Z_1$ and $Z_2$) with the variables at Panthanthodu in different layers

| Depth / Variables | Discriminant Coefficient | | Correlation with functions | |
|---|---|---|---|---|
| | Function 1 | Function 2 | $Z_1$ | $Z_2$ |
| **0-20 cm** | | | | |
| N | 0.593 | 0.379 | 0.358 | 0.687 |
| $CaCO_3$ | 0.673 | 0.425 | 0.295 | 0.773 |
| Sand | -1.099 | 0.487 | -0.536 | 0.844 |
| **20-40 cm** | | | | |
| OC | 1.494 | 0.151 | 0.588 | 0.809 |
| N | -1.214 | 0.883 | -0.100 | 0.995 |
| **40-60 cm** | | | | |
| OC | 0.756 | -0.025 | 0.497 | 0.606 |
| N | -0.810 | 0.865 | -0.334 | 0.904 |
| Sand | 0.514 | 0.437 | 0.689 | 0.532 |
| **0-60 cm** | | | | |
| P | 0.656 | 0.324 | 0.141 | 0.092 |
| Ca | -0.848 | 0.206 | -0.060 | 0.367 |
| N | 0.908 | 0.572 | 0.321 | 0.636 |
| $CaCO_3$ | 0.779 | 0.125 | 0.216 | 0.544 |
| Sand | -1.016 | 0.627 | -0.390 | 0.738 |

Table 8. Soil variables and factors by which burnt, partially burnt and unburnt plots differ significantly at Panthanthodu in different layers

| | 0-20 cm | 20-40 cm | 40-60 cm | 0-60 cm |
|---|---|---|---|---|
| Soil variables | N | OC | OC | N |
| | $CaCo_3$ | N | N | $CaCo_3$ |
| | Sand | | Sand | Sand |
| | Soil texture, alkalinity and fertility | Soil fertility | Soil texture and fertility | Soil texture, alkalinity and fertility |

### *5.1.5.5. Difference between Chinnar and Panthanthodu with respect to effect of fire*

The soils at Chinnar and Panthanthodu registered marked difference. This could be due to the difference in vegetation types, rainfall, climate, topography, etc. The trend in changes brought about by fire on soils in Chinnar and Panthanthodu is also very different.

The discriminant function obtained for 0-20 and 20-40 and 0-60 cm layers at Chinnar was found highly correlated with Mg implying that the fire produced changes largely in the status of the Mg level.

At Panthanthodu, the two discriminant functions generated could explain 89.5 per cent and 10.5 per cent of the total variance, respectively. In the 0-20 cm layer, the discriminant function was found to be highly correlated with sand, $CaCO_3$ and N implying that fire could influence soil texture, alkalinity and fertility.

In the 0-60 cm layer, factors by which the soils under burnt, partially burnt and unburnt plots differ significantly at Panthanthodu were soil texture, alkanility and fertility.

The results thus point to the fact that at Chinnar and Panthanthodu, physical properties, except water holding capacity at Chinnar and gravel and sand at Panthanthodu, might not have been affected. The recovery processes in the two ecosystems were also found to be different and so it could be assumed that the ensuing effect of fire on soils in the two ecosystems was also different. In the Chinnar area, soil fertility was found to be affected even after the occurrence of fire while at Panthanthodu, the influence was on soil texture, alkalinity and fertility.

Among the soil properties at Panthanthodu in the 0-60 cm layer (Appendix 18), gravel and sand contents registered marked difference in the burnt plots when compared with unburnt plots. Among the burnt plots, completely burnt plots had the maximum effect. Available Ca and Mg also showed considerable difference in the burnt plots. There was an increase of 24 per cent for available Ca in the completely burnt plots and a decrease of 8 per cent in the partially burnt plots. With regard to available Mg, 33 per cent increase was noted in the partially burnt plots while in the completely burnt plots, a decrease of 14 per cent was noted.

The effect of fire on soil chemical properties still persists even after several years. Due to dry deciduous nature of the vegetation at Chinnar, addition of litter was low. As the litter load was low, it could be presumed that the intensity of fire may not have been severe and hence the surface fire would not have generated high temperature. It has been reported by Neary *et al*. (1996) that surface fire can generate 80-160 $^{o}$C or a maximum of 180-350 $^{o}$C.

Thus, as ecosystem changes from dry deciduous to evergreen, the litter layer increases substantially and loss of elements, particularly N, tied up in litter and susceptible to loss by fire, increases.

Usually after fire, there will be an increase in soil pH and organic carbon as a result of ash residue which contain basic elements. The magnitude of change in soil pH depends on the amount of ash, texture and organic matter content of soils.

This phenomenon was not observed here and so it could be presumed that recuperation has taken place with respect to these properties. Even though it can be presumed that loss of nitrogen (N), which has a relatively low volatilization temperature, is very much, this is compensated and the system has reached close to the original stage. This is especially important because it is usually the most limiting plant nutrient in forest ecosystem (Maars *et al*., 1983). This agrees with the observation of Covington and Sackett (1992) that about 15-17 years after an initial burn, concentrations of N approached control levels.

Since the cycling of P is primarily through the organic-P pools, removal of vegetation all at one time by burning resulted in depletion of the above ground P pool at a rate greater than mineral weathering can replace it. This is very conspicuous at Chinnar.

Nutrient loss from the litter layer during fires and recovery is a function of fire severity. Grier (1975) noted nutrient losses from the litter layer after the intense fire that amounted to 19 (Ca), 21 (K), 31(Mg), and 97 per cent (both N and Ca) of pre-burn conditions. At Chinnar, P and K contents were less (43 and 58%) and Ca and Mg contents were considerably higher (33% and 57%) in the burnt plots. At Panthanthodu, there was an increase of 24 per cent in the available Ca content in the completely burnt plots and a decrease of 8 per cent in the partially burnt plots. With regard to available Mg, 33 per cent increase was noted in the partially burnt plots while in the completely burnt plots, a decrease of 14 per cent was noted. Hence, the recuperation processes were complex and some of the observations closely match with those of Grier (1975).
At Chinnar, the system recouped with respect to N but considerable loss for P was even now noticed. The results agreed with the findings of Klopatek (19871).

## 5.2. Regeneration studies

### 5.2.1. Vegetation Status

#### *5.2.1.1. Chinnar*

The dominant shrubs were *Grewia flavescens, G. villosa, Lantana indica, Zizyphus oenoplia and Opuntia* sp. The major herbs observed were *Barleria accuminata,B. prionitis, B, mysorensis, Hibisens micrantha, Justicia transqubariensin, Tiphrosia villosa, Occimum americanum* and *Coleus barbatus.* In total, 120 species were recorded which included trees, shrubs, herbs and climbers (Appendix 19).

#### *5.2.1. 2. Panthanthodu*

The major shrub species in the unburnt plots were *Thottea siliqosa, Sarcandra chloranthoides* and *Chassalia* sp while in the partially burnt plots the major shrub species wer *Mesa indica, Thottia siliquosa, Chromolaena odorata, Polygome chinense, Leea indica* and *Lantana camera*. The common shrubs in the burnt plots were *Mesa indica, Chromolaena odorata* and *Lantana camara* (Appendix 20).

### *5.2.2. Edalichedimantha*

#### *5.2.2.1. Regeneration status*

Regeneration status (growth status) shows that in unburnt plots, about 57 per cent of seedlings were in the < 50 cm height class; 28 per cent of seedlings were of 50-100 cm height class and 15 per cent were in the >100 cm height class. In burnt plots corresponding values were 48 per cent, 36 and 16 per cent (Table 9).

Table 9. Regeneration status of seedlings of different height classes (%)

| Seedling size (cm) | Unburnt | Burnt |
|---|---|---|
| <50 | 57 | 48 |
| 50-100 | 28 | 36 |
| >100 | 15 | 16 |

***5.2.2.2. Habit-wise status***

The habit-wise distribution status of seedlings showed that 38.55 per cent seedlings were of tree category, 56,63 per cent were shrubs and 4.82 per cent were herbs in unburnt plots. The distribution status of seedlings in the burnt plots was 39.10 per cent of trees, 57.69 per cent of shrubs and 3.21 per cent of herbs category (Table 10).

Table 10. Habit-wise status of seedlings (%)

| Habit | Unburnt | Burnt |
|---|---|---|
| Trees | 38.55 | 39.10 |
| Shrubs | 56.63 | 57.69 |
| Herbs | 4.82 | 3.21 |

***5.2.2.3. Basic statistics***

Among the 3953 tagged seedlings in the burnt plots, 1858 (47%) were in the <50 cm height class, 1423 (36%) and 672 (17%) in the 50-100 cm and > 100 cm height classes, respectively. In the unburnt plots, there were 4179 seedlings, of which 2351 (56%) were in the <50 cm height class, 1142 (27%) in the medium height class and 686 (16%) in the higher height class. The Richness, Diversity and Evenness indices of the vegetation of both burnt and unburnt plots are shown in Table 11.

Table 11. Basic statistics of plants in different classes in the burnt and unburnt plots

| | Burnt | | | Unburnt | | |
|---|---|---|---|---|---|---|
| | <50 cm | 50-100 cm | >100 cm | <50 cm | 50-100 cm | >100 cm |
| Total number of individuals | 1858 | 1423 | 672 | 2351 | 1142 | 686 |
| Total number of all species | 48 | 47 | 52 | 66 | 41 | 54 |
| Richness index | | | | | | |
| Menhinik index | 1.113572 | 1.245935 | 2.005944 | 1.361187 | 1.213251 | 2.067767 |
| Diversity index | | | | | | |
| Simpson's index | 0.142407 | 0.154195 | 0.10607 | 0.113625 | 0.152802 | 0.102226 |
| Shannon's index | 2.476681 | 2.433602 | 2.86148 | 2.700834 | 2.47258 | 2.942295 |
| Fisher's alpha | 8.998 | 9.34 | 13.156 | 12.613 | 8.318 | 13.767 |

#### *5.2.2.4. Re-enumeration status*

The species recorded during re-enumeration in the burnt plots were *Abutilon hirsutus, Carissa carandans, Crateava adansoni, Dalbergia paniculata, Ixora arborea* and *Zizyphus rugosa* (Table 12). New emergents of unburnt plots were *Glycosmis mauritiania, Hardwickia binata* and *Orthsiphon thymifloreus.*

Table 12. New species recorded in re-enumeration at Kalladathupara and Edalichedimantha

| Location | Burnt | Unburnt |
|---|---|---|
| Kalladathupara | *Jasminum trichotoma*<br>*Barleria accuminata*<br>*Acacia ferruginia*<br>*Capparis spinosa*<br>*Commiphora berryi*<br>*Grewia obtuse* | *Cardiospermum helicacabum*<br>*Commiphora berryi*<br>*Asparagus racemosus*<br>*Abutilon hirtum*<br>*Grewia orbiculata*<br>*Ocimum americanum*<br>*Plerolobium leoapetalum*<br>*Tephrosia villosa*<br>*Psilanthus wightinus* |
| Edalichedimantha | *Zizyphus rugosa*<br>*Abutilon hirtum*<br>*Carissa carandas*<br>*Crateava adansomi*<br>*Dalbergia paniculata*<br>*Ixora arboria* | *Glycosis mauritiana*<br>*Hardwikia binata*<br>*Orthosiphon thymiflorus* |

***5.2.3. Kalladathupara***

***5.2.3.1. Regeneration status***

In the unburnt plots, 36.22 per cent seedlings were of <50 cm height class, 26.43 per cent were in 50-100 cm height class and 37.35 per cent were in >100 cm height class. The corresponding values were 47.53, 39.98 and 12.48 per cent in burnt plots (Table 13).

Table 13. Regeneration status of seedlings of different height classes (%)

| Seedling size in cm | Unburnt | Burnt |
|---|---|---|
| <50 | 36.22<br>33.69 | 47.53<br>49.15 |
| 50-100 | 26.43<br>39.31 | 39.98<br>45.38 |
| >100 | 37.35<br>27.00 | 12.48<br>5.46 |

***5.2.3.2. Habit-wise status***

Thirty per cent seedlings were of tree category while 56 and 14 per cent were of shrub and herb categories in unburnt plots. The distribution status of burnt plots is as follows: 31 per cent of trees, 64 per cent of shrubs and 5 per cent of herb category (Table 14).

The low per cent of herbs at Kalladathupara and Edalichedimantha can be attributed to the general dry deciduous nature of the study sites, where rainfall is the major limiting factor for the growth of herbs.

Table 14. Habit-wise status of seedlings (%)

| Habit | Unburnt | Burnt |
|---|---|---|
| Trees | 30.00 | 31.01 |
| Shrubs | 56.00 | 63.57 |
| Herbs | 14.00 | 5.43 |

***5.2.3.3. Basic statistics***

Among the total 4710 seedlings tagged in the burnt plots, 2182 (46%) were of <50 cm height class; 1845 (39%) were between 50 -100 cm height and 683 (15%) were of >100 cm height. In the unburnt plots, among the total 3727 seedlings, 1139 (30%) were of <50 cm height class; 1027 (28%) were of 50 - 100 cm height and 1561 (42%) were of >100 cm height class (Table 15). The basic statistics of Chinnar is given in Table 16.

***5.2.3.4. Re-enumeration status***

During the re-enumeration of seedlings, *Acacia ferrugenia, Barleria accuminate, Capparis spinosa*, *Commiphora berryi*, *Grewia obtusa* and *Jasminum trichotoma* were recorded in the burnt plots. *Asparagus racemosus, Abutilon hersutum, Cardiospermum helicacabum, Commiphora berryi, Grewia orbiculata, Ocimum americanum, Plerolobium peoapetalam, Psilanthus wightianus* and *Tephrosia villosa* were observed in the unburnt plots (Table 12).

***5.2.4. Panthanthodu***

***5.2.4.1. Regenerartion status***

In the unburnt plots, 76.33 per cent seedlings were in the <50 cm height, 10.56 per cent in the 50 - 100 cm height and 13.10 per cent in >100 cm height classes whereas those in the partially burnt plots were 40.15, 21.82 and 38.03 per cent, respectively. The distribution of various seedling height classes in the burnt plots was as follows:

<50 cm height class – 14.95 per cent, 50 - 100 cm height class – 22.45 per cent and

>100 cm height class – 62.46 per cent (Table 17).

Table 15. Basic statistics of plants in different classes in the burnt and unburnt plots

| | Burnt | | | Unburnt | | |
|---|---|---|---|---|---|---|
| | <50 cm | 50-100 cm | >100 cm | <50 cm | 50-100 cm | >100 cm |
| Total number of individuals | 2182 | 1845 | 683 | 1139 | 1027 | 1561 |
| Total number of all species | 43 | 39 | 43 | 51 | 36 | 57 |
| Richness index | | | | | | |
| Menhinik index | 0.920537 | 0.907959 | 1.645349 | 1.511153 | 1.123356 | 1.442691 |
| Diversity index | | | | | | |
| Simpson's index | 0.168611 | 0.181605 | 0.126302 | 0.089063 | 0.151935 | 0.156003 |
| Shannon's index | 2.221745 | 2.210944 | 2.661749 | 2.85091 | 2.334326 | 2.523645 |
| Fisher's alpha | 7.592 | 6.99 | 10.193 | 10.962 | 7.26 | 11.614 |

Table 16. Basic statistics of plants in different classes in the Chinnar burnt and unburnt plots

| | Burnt | | | Unburnt | | |
|---|---|---|---|---|---|---|
| | <50 cm | 50-100 cm | >100 cm | <50 cm | 50-100 cm | >100cm |
| Total number of individuals | 4040 | 3268 | 1355 | 3490 | 2169 | 2245 |
| Number of species | 62 | 57 | 63 | 63 | 53 | 71 |
| Richness index | | | | | | |
| Menhinik index | 0.975441 | 0.997089 | 1.711476 | 1.066419 | 1.13801 | 1.499145 |
| Diversity | | | | | | |
| Simpson's index | 0.135249 | 0.125551 | 0.102234 | 0.095061 | 0.106314 | 0.126727 |
| Shannon's index | 2.551337 | 2.571911 | 2.979155 | 2.841534 | 2.710278 | 2.838114 |
| Fisher's alpha | 10.394 | 9.808 | 13.681 | 10.918 | 9.81 | 13.963 |

Table 17. Regeneration status of seedlings (%)

| Seedling size in cm | Unburnt | Partially burnt | Burnt |
|---|---|---|---|
| <50 | 76.33 | 40.15 | 14.95 |
| 50-100 | 10.56 | 21.82 | 22.45 |
| >100 | 13.10 | 38.03 | 62.46 |

***5.2.4.2. Habit-wise status***

The habit-wise status of seedlings in the Panthanthodu was highly different from that at Chinnar. Tree seedlings occupied 75 per cent, shrubs 22 per cent and herbs 3 per cent in the unburnt plots. The trend is almost similar in both partially burnt and burnt plots of the study site (Table 18).

Table 18. Habit-wise status of seedlings

| Habit | Unburnt | Partially burnt | Completely burnt |
|---|---|---|---|
| Trees | 75 | 71 | 59 |
| Shrubs | 22 | 28 | 37 |
| Herbs | 3 | 1 | 4 |

In the partially burnt plots trees, shrubs and herbs were 71, 28 and 1 per cent, respectively whereas corresponding values in the burnt plots were 59, 37 and 4 per cent.

### *5.2.4.3. Basic statistics*

Out of the total 4156 seedlings in burnt plots, 621 (15%), 933 (22%) and 2602 (63%) were of <50 cm, 50 - 100 cm and > 100 cm height classes, respectively. In the partially burnt plots, 1509 (40%) seedlings were in <50 cm height class, 820 (22%) in 50 - 100 cm height class and 1426 (38%) in >100 cm height class, totalling 3755 seedlings. The status of seedlings in the unburnt plots was that out of the 8698 seedlings, <50 cm height class were 6607 (76%), 50 -100 cm height class were 919 (11%) and >100 cm height class were 1172 (13%) (Table 19).

Thus a wide difference was observed in burnt and unburnt plots, especially in the distribution of seedlings of lower height classes. Other basic statistics regarding various indices viz. Richness, Diversity and Evenness indices are also given in Table 19.

### *5.2.4.4. Re-enumeration status*

*Ardisia stocksii, Gomphandra coriacea, Holigarna arnottiana, Mangifera indica* were recorded from burnt plots and *Cinnamomum zeylanica, Eucalyptus serratus, Neolitsea zeylanica, Polygonun chinensis* and *Olea dioica* from the unburnt plots (Table 20).

Table 19. Basic statistics of plants in different classes in the burnt, partially burnt and unburnt plots

| | Burnt | | | Partially burnt | | | Unburnt | | |
|---|---|---|---|---|---|---|---|---|---|
| | <50 cm | 50-100 cm | >100 cm | <50 cm | 50-100 cm | >100 cm | <50 cm | 50-100 cm | >100 cm |
| Total number of individuals | 621 | 933 | 2602 | 1509 | 820 | 1426 | 6607 | 919 | 1172 |
| Total number of all species | 43 | 37 | 42 | 73 | 56 | 68 | 84 | 64 | 70 |
| Richness index | | | | | | | | | |
| Menhinik index | 1.72553 | 1.211336 | 0.82337 | 1.87922 | 1.95561 | 1.80073 | 1.03342 | 2.11117 | 2.04472 |
| Diversity index | | | | | | | | | |
| Simpson's index | 0.12110 | 0.41160 | 0.44818 | 0.12750 | 0.09652 | 0.10895 | 0.16143 | 0.09630 | 0.07013 |
| Shannon's index | 2.69223 | 1.59635 | 1.35369 | 2.83355 | 2.88458 | 2.91130 | 2.56559 | 3.05967 | 3.29747 |
| Fisher's alpha | 10.496 | 7.701 | 7.113 | 16.027 | 13.610 | 14.870 | 13.571 | 15.650 | 16.331 |

Table 20. New species recorded in re-enumeration

| Treatments | Species |
|---|---|
| Partially burnt | *Ardisia stocksii*<br>*Gomphandra coriacea*<br>*Mangifera indica*<br>*Holigarna arnotiana* |
| Burnt | *Cinnamomum zeylanicum*<br>*Eucalyptus serratus*<br>*Neolitsea zeylanica*<br>*Polygonum chinensis*<br>*Olea dioica* |

***5.2.4.5. Species diversity***

In general, diversity has been suggested to vary with one or more ‘environmental variables’ (eg. temperature, moisture, resource abundance, etc.) Some processes eg. competition, reproductive rate etc. usually are suggested or hypothesized to either vary in intensity with the changing environment or produce difference in second order process (eg. speciation rate, niche breadth, niche overlap, community structure, etc.) in different environments. These processes are then proposed to control directly or indirectly the observed diversity patterns.

It has become conventional to separate diversity into the following major categories. First the species richness indices, represented by a measure of the number of species in the community. Secondly, there are the species abundance models (evenness) and indices based on the proportional abundance of species form the final group. In this category come the indices such as those of Shannon and Simpson, which seek to crystallise richness and evenness into a single figure. These are called heterogeneity indices (Peet, 1974). Such indices have been worked out for the study area.

Ecological hypotheses about how these species continue to coexist are often cast into equilibrium or non-equilibrium frameworks. According to competitive exclusion principle, competition occurs in a stable uniform environment for precisely the same limiting resource at the same time and equilibrium achieved. Competitive exclusion must occur and one species eliminate the other (Pileou, 1975).

According to Huston (1994) most communities exist in a state of non-equilibrium where competitive equilibrium is prevented by periodic population reductions and environmental fluctuations. When competitive equilibrium is prevented, a dynamic balance may be established between the rate of competitive displacement and the frequency of population reduction, which result in a stable level of diversity.

Under conditions of infrequent reductions, an increase in the population growth rate of competitors generally results increased diversity. This is true with unburnt plots of Panthanthodu where similar observations can be noted with respect to diversity index. The low diversity index (Shannon’s index) of 2.57 in height class <50 cm when compared to that of 3.06 of 50-100 cm class and 3.30 of >100 cm height class in unburnt plots can be explained in this context (Table 13) whereas the general trend in burnt plots is of reverse in nature with Shannon’s index value 2.69 in <50 cm, 1.60 in 50-100 cm and 1.35 in >100 cm height classes, respectively. The values in the partially burnt plots were intermediary when compared to burnt and unburnt plots. Similar trends in vegetation diversity cannot be observed at Edalichedimantha and Kalladuthupara (Tables 14-16) probably because of the difference in vegetation types.

As per the environmental heterogeneity hypothesis, increased heterogeneity should increase diversity (Levin, 1974). The environmental stability, predictability and productive hypothesis are closely related, since these parameters increase together from temperate to tropical regions (Pieleou, 1975).

Pieleou (1975) suggested that unpredictable and severe environments have low diversity based on the argument that unpredictability forces organism to have broader niches which allow fewer species to be ‘packed in’ as well as causing a great chance of extinction for marginal species. The low diversity at Chinnar locations can be viewed under this assumption.

### 5.3. Seed germination studies

Seed germination and establishment of new seedlings were recorded during the re-enumeration of the seedlings. Besides, seeds of dominant tree species existing in the respective areas were collected and germination studies carried out in order to assess the germination potential of these species. Germination details of selected species are given in Table 21.

Table 21. Germination details of selected species at Chinnar

| Sl. No | Species | Mean no. of seeds sown | Mean no. of seeds germinated | Germination per cent | Mean no. of days taken for germination |
|---|---|---|---|---|---|
| 1 | *Dalbergia paniculata* | 100 | 9 | 9 | 10 |
| 2 | *Bahunia retusa* | 100 | 2 | 2 | 15 |
| 3 | *Catanarangam torulosa* | 100 | 4 | 4 | 60 |
| 4 | *Opuntia vulgaris* | 100 | 23 | 23 | 55 |
| 5 | *Acacia caesia* | 100 | - | 0 | - |
| 6 | *Gyrocarpus asiaticus* | 100 | 3 | 3 | 45 |

The per cent of germination obtained for different tree species varied from 0 to 23, the maximum being obtained in *Opuntia vulgaris.* Species like *Catunaragum*, *Opuntia* and *Gyrocarpus* are observed to be slow germinating species requiring 45-60 days for germination while the other two species took only 10-15 days for germination.

The germination study details of selected species at Panthanthodu are depicted in Table 22. In general, there was good percentage of seed germination observed in evergreen species except for *Cullenia exarillata, Garcinia morella,* and *Mesua ferrea.* Maximum per cent of germination (68) was obtained in *Clerodendron viscosum,* followed by *Artocarpus hirsutus* (63).

Minimum percentage of germination (3.33) was recorded in *Garcinia morella.* Much variation was observed in these species with regards to the time taken for seed germination. *Mesua ferrea* needed 22 days for germination while *Clerodendron viscosum* and *Artocarpus hirsutu* germianted within a period of 8-10 days. Seed germination and consequent establishment of different age group seedlings of species appear not to face any serious problem.

**5.4. Physiological stress on trees due to fire**

In order to assess the physiological stress due to fire, measurements on photosynthesis, transpiration and leaf conductance were carried out using LICOR 6200 portable photosynthesis system, and steady state porometer (LI-1600, LICOR, USA). The canopy closure was also determined using canopy analyzer (LI-2000, LICOR, USA).

Table 22. Germination details of selected species at Panthanthodu

| Sl. No | Species | Mean no. of seeds sown | Mean no. of seeds germinated | Germination per cent | Mean no. of days taken for germination |
|---|---|---|---|---|---|
| 1 | *Artocarpus hirsutus* | 30 | 19 | 63 | 10 |
| 2 | *Bischofia javaanica* | 30 | 0 | 0 | - |
| 3 | *Calicarpa lanata* | 100 | 26 | 26 | 22 |
| 4 | *Cinnamomum zeylanicum* | 100 | 52 | 52 | 12 |
| 5 | *Clerodendron viscosum* | 100 | 68 | 68 | 8 |
| 6 | *Cullenia exarillata* | 30 | 3 | 10 | 15 |
| 7 | *Garcinia morella* | 30 | 1 | 3.3 | 18 |
| 8 | *Mesua ferrea* | 30 | 5 | 16.7 | 24 |

For the observations on photosynthesis and evapo-transpiratory parameters of tree seedlings, candidate seedlings of important tree species occurring in the experimental plots were recruited and the physiological observations carried out in burnt and unburnt plots. The observations were carried out during summer months (Jan.- Mar.).

### *5.4.1. Edalichedimantha*

Ten different species were subjected to measurements on transpiration and leaf conductance in the burnt and unburnt plots. Most of the species, except few like *Cleospermum alatum*, *Cordia monica*, *Sapindus emerginatus* and *Premna serratifolia* are amphistomatal in nature.

The stomatal conductance and transpiration were relatively higher in *Cordia monica* in unburnt plot than in burnt, while species like *Atlantia monophila, Sapindus emerginatus, Canthium coromondalicum,* the leaf conductance and transpiration values obtained were more in burnt plots than in unburnt plots. In general, the values obtained for these parameters showed relative increase in all species in burnt plots than in unburnt plots under similar conditions of light, humidity and temperature (Appendices 21-24).

### *5.4.2. Panthanthodu*

On an average 13 different species were selected and subjected to measurements on their stomatal conductance, transpiration and leaf temperature (Appendices 25-27). Most of the species are amphistomatal and showed relatively high values for leaf conductance and transpiration in burnt plots, except few species like *Achronychia pedunculata, Clerodendron viscosum* and *Mallotus philippinensis*.

Maximum values for leaf conductance (294 μ mol $m^{-2}s^{-1}$) and transpiration (6.76 M mol $m^{-2}s^{-1}$) was obtained in *Bischofia javanica, followed by Litsea indica and Trema orientalis* in the burnt plots. All other species showed moderate values for these measurements (Appendix 25). In partially burnt plots, the values obtained were lesser than those obtained in burnt plots (Appendix 26).

Transpiration and leaf conductance did not show much variation in unburnt plots except in *Achronychia pedunculata, Garcinia morella* and *Mesua ferrea*. Compared to burnt and partially burnt plots, in unburnt plots, majority of the species studied showed lower values for the different parameters measured. In general, most of the species studied showed comparative values for the parameters studied, except few species. *Trema orientalis* showed higher rate of stomatal conductance and transpiration values. This may be attributed to the capacity of this species to adapt to the existing environmental conditions.

### 5.5. Leaf area index

Leaf area index measured in both the unburnt and burnt plots at Chinnar and Panthanthodu showed that the unburnt plots had higher leaf area index than the burnt plots (Table 23). This clearly indicated that the full canopy closure has not occurred in the burnt plots.

Table 23. Leaf area index in the different plots at Chinnar

| Sl. No | Location | Leaf area index |
|---|---|---|
| | **Edalichedimantha** | 1.04 |
| 1 | Burnt plots | |
| 2 | Unburnt plots | 1.25 |
| | **Kalladathupara** | |
| 3 | Burnt plots | 1.27 |
| 4 | Unburnt plots | 1.48 |
| | **Panthanthodu** | 1.57 |
| 5 | Burnt plots | |
| 6 | Partially burnt plots | 3.62 |
| 7 | Unburnt plots | 5.56 |

### 5.6. Soil moisture

The expression of physiological process of species very much depends upon the soil properties of the area. The soil moisture is an important parameter to be considered when stomatal conductance and transpiration of species are considered. The soil moisture varied to a great extent (Tables 24)

Table 24. Soil moisture content (%) at different depths

| Sl. No | Locality | Soil moisture content (%) and depth (cm) | |
|---|---|---|---|
| | | 0-30 | 30-60 |
| | **Edalichedimantha** | | |
| 1 | Burnt plots | 4.87 | 11.70 |
| 2 | Unburt plots | 5.10 | 12.10 |
| | **Kalladathupara** | | |
| 1 | Burnt plots | 5.10 | 12.10 |
| 2 | Unburnt plots | 5.10 | 15.07 |
| | **Panthanthodu** | | |
| 1 | Burnt plots | 5.00 | 12.37 |
| 2 | Partially burnt plots | 5.78 | 12.20 |
| 3 | Unburnt plots | 16.83 | 20.50 |

The soil moisture contents were low in all plots at Kalladathupara and Edalichedimantha. The mean moisture per cent in the 0-30 cm in the unburnt plots at Chinnar was 5.10 while in the burnt plots, it was 4.99. In the 30-60 cm, it was 13.59 and 11.90 per cent in the unburnt and burnt plots, respectively.

At Panthanthodu, the soil moisture contents in the burnt, partially burnt and unburnt plots were 5.00, 5.78 and 16.83 in the 0-30 cm layer, respectively.

Corresponding values were 12.37, 12.20 and 20.50 per cent in the 30-60 cm layer. In the evergreen plots, there was significant increase in moisture content in both layers of soil of unburnt plots compared to burnt or partially burnt plots.

## 5.7. Soil microflora

### 5.7.1. Kalladathupara and Edalichedimantha

#### *5.7.1.1. Soil fungi*

There was a rich soil fungal flora. Soil samples from Kalladathupara recorded comparatively large number of fungal colony forming units (cfu) in all the soil core depths, i.e., 0-5, 5-10, 10-15 and 15-20 cm than that from the Edalichedimantha. Fungal population was found more in burnt soils in both the locations than in unburnt soils.

From the burnt soils at Kalladathupara, a mean number of 29.25 x $10^{3}$ fungal cfu/g of dry soil was recorded on PDA medium while the corresponding figure for fungal population retrieved on RBA medium was only 19.83 x $10^{3}$ cfu/g soil (Appendix 28).

At Edalichedimantha, the mean number was 16.66 x $10^{3}$ cfu/g and 18 x $10^{3}$ cfu/g of dry soil on PDA and RBA medium, respectively. Mean number of fungal colony forming units as well as number of fungal species and genera were found more in upper soil layer (0-5 cm) than in other lower layers (Appendix 28).

From the soil samples from Kalladuthapara, a total of 33 fungi belonging to 18 genera were recorded. Of these, 23 fungi belonging to 13 genera were obtained from the burnt plots while 27 fungi belonging to 18 genera were recorded from the unburnt plots on both PDA and RBA media (Appendices 29-32). From the soils of burnt plots at Edalichedimantha, 21 fungal species belonging to 12 genera were yielded on PDA medium, whereas only 12 fungal species falling in six genera were detected on RBA medium (Appendices 33-37). Soils from unburnt plots gave almost same number of fungal species and genera on both the media.

A total of 51 fungi belonging to 28 genera and a few unidentified fungi belonging to Ascomycetes and Deuteromycetes groups were detected from the soil core samples from both the study areas.

From the burnt plots at Edalichedimantha, on RBA medium, a total of 20 fungi belonging to 10 genera were encountered, while 26 fungal species belonging to 14 genera were recorded on PDA medium. From the unburnt plots, 16 fungi belonging to 9 genera were isolated on RBA medium, whereas 24 fungi belonging to 14 genera were yielded on PDA medium (Appendices 33-37) (Plates 5 - 7).

***5.7.1.2. Vesicular arbuscular mycorrhizal fungi***

Soils from burnt and unburnt plots at Edalichedimantha recorded more number of spores of vesicular arbuscular mycorrhizal (VAM) fungi than soils from Kalladathupara. As in the case of soil fungi, the 0-5 cm layer in both the locations in burnt as well as unburnt plots had more number of VAM fungal spores than in other lower layers. In burnt plots at Kalladathupara and Edalichedimantha, a mean of 184 and 244 VAM fungal spores per 10 g of soil were obtained in the 0-5 cm layer while the corresponding figures for unburnt plots were 106.25 and 111.25, respectively (Table 25) (Plate 8).

Table 25. Mean number of VAM fungal spores retrieved from the burnt and unburnt soils

| Soil depth (cm) | Kalladathupara | | Edalichedimantha | |
|---|---|---|---|---|
| | Burnt | Unburnt | Burnt | Unburnt |
| | Mean No. of spores/ 10 g of soil | Mean No. of spores/ 10 g of soil | Mean No. of spores/ 10 g of soil | Mean No. of spores/ 10 g of soil |
| 0-5 | 184 | 106.25 | 244 | 111.25 |
| 5-10 | 86.25 | 74.75 | 193.25 | 84.25 |
| 10-15 | 71.5 | 48.75 | 139.25 | 79.5 |
| 15-20 | 48.5 | 27.25 | 134.75 | 49.25 |

At Kalledathupara, maximum number of VAM fungal species were recorded in burnt plots and the distribution pattern is given in Appendix 38.

### *5.7.1.3. Soil bacteria*

Bacterial population was comparatively high in burnt plots at both the locations than in unburnt soils (Table 26). From burnt plots at Edalichedimantha, a mean number of 330 x $10^{4}$ cfu could be recorded while only 260.60 x $10^4$ cfu were obtained from burnt plots at Kalladathupara. As in the case of other soil microbes, bacteria were also found distributed more in the 0-5 cm layer.

### *5.7.1.4. Soil actinomycetes*

As in the case of bacteria and soil fungi, actinomycetes were also found high in burnt soils than in unburnt soils. In Edalichedimantha, burnt soils yielded a mean population of 109.08 x $10^{4}$ cfu/ g soil in the 0-5 cm layer while the corresponding figures in unburnt soils from the same localities was 100 x $10^{4}$ cfu/g soil. As in the case of other soil micro-organisms, as soil depth increases, the number of actinomycetes propagules diminished.

The same trend on distribution of actinomycetes population was recorded in soils at Kalladathupura. The highest mean of 155.34 x $10^{4}$ cfu/g soil was recorded in the 0-5 cm layer of unburnt soils. This discrepancy was noticed only in the topmost soil layer in unburnt plots and the mean number of actinomycetes colony from all the soil depths in burnt plots was much higher than that from the unburnt plots (Table 26).

Table 26. Distribution of actinomycetes and bacterial population at different soil depths in unburnt and burnt plots at Kalladathupara and Edalichedimantha

| Soil depth (cm) | Edalichedimantha | | | | Kalleduthapara | | | |
|---|---|---|---|---|---|---|---|---|
| | Actinomycetes x $10^4$ cfu /g soil | | Bacteria x $10^4$ cfu /g soil | | Actinomycetes x $10^4$ cfu/g soil | | Bacteria x $10^4$ cfu /g Soil | |
| | Unburnt | Burnt | Unburnt | Burnt | Unburnt | Burnt | Unburnt | Burnt |
| 0 - 5 | 100 | 109.08 | 240.16 | 330.24 | 155.34 | 130.83 | 260.5 | 260.58 |
| 5 - 10 | 79.66 | 88.05 | 170.66 | 330.16 | 108.42 | 139.58 | 210.74 | 180.5 |
| 10 -15 | 59 | 67.25 | 140.34 | 110.99 | 97 | 131.42 | 210.08 | 190.84 |
| 15 - 20 | 72.58 | 78.83 | 210.92 | 90.66 | 76.58 | 109.08 | 120.58 | 180 |

***5.5.2. Panthanthodu***

***5.5.2.1. Soil fungi***

The soil fungi in the burnt soils accounted 31.16 x $10^3$ cfu/g soil on PDA medium and 21.08 x $10^3$ cfu/g soil on RBA medium from the 0-5 cm depth. Soils from partially burnt plots recorded 25. 08 x $10^3$ and 23.23 x $10^3$ cfu/g soil on PDA and RBA, respectively. (Table 27).

A total of 49 fungi belonging to 23 genera and unidentified fungi belonging to Ascomycetes and Deuteromycetes groups were recorded from the soils collected from burnt, partially burnt and unburnt plots at Panthanthodu. Interestingly, more number of species and genera were encountered in soils from burnt plots. Thirty three species belonging to 18 genera were obtained from soils in burnt plots and 24 fungal species belonging to 14 genera in partially burnt plots (Appendices 32 - 46), while only 23 fungal species belonging to 11 genera could be recorded from the unburnt plots.

Table 27. Distribution of fungal population at different soil depths in unburnt, partially burnt and burnt plots

| Soil depth (cm) | Fungal cfu (x10 $^3$) in PDA | | | Fungal cfu (x(10 $^3$) in RBA | | |
|---|---|---|---|---|---|---|
| | Unburnt | Partially burnt | Burnt | Unburnt | Partially burnt | Burnt |
| 0 -5 | 17.99 ( 16 ) | 25.08 ( 19 ) | 31.16 ( 19 ) | 14.16 ( 14 ) | 23.23 ( 15 ) | 21.08 ( 17 ) |
| 5 – 10 | 14.83 ( 14 ) | 17.66 ( 15 ) | 17.41 ( 19 ) | 12.74 ( 14 ) | 13.99 ( 12 ) | 13.08 ( 17 ) |
| 10 -15 | 4.91 ( 15 ) | 13.16 ( 16 ) | 10.91 ( 18 ) | 8.16 ( 13 ) | 13.41 ( 13 ) | 9.83 (15 ) |
| 15-20 | 4.83 ( 8 ) | 12.49 (13 ) | 8.41 ( 16 ) | 6.49 ( 8 ) | 11.91 (10 ) | 8.5 (14 ) |

- Figures given in parenthesis are the number of fungal species recorded in each category

***5.5.2.2. Vesicular arbuscular mycorrhizal fungi***

Soils from burnt, partially burnt and unburnt plots yielded a large number of spores of vesicular arbuscular mycorrhizal (VAM) fungi. As observed in the case of other soil microorganisms, the topmost soil layer (0-5 cm depth) recorded highest number of VAM fungal spores in all the plots.

From the soil core depth of 0-5 cm in burnt plots, the highest mean number of 129.25 spores was recorded while the corresponding figures in partially burnt and unburnt plots were 104.5 and 61, respectively (Table 28).

Table 28. Mean number of VAM fungal spores retrieved from the burnt, partially burnt and unburnt soils

| ***Soil depth*** (cm) | ***Unburnt*** | ***Partially burnt*** | ***Burnt*** |
|---|---|---|---|
| | Mean no. of spores per 10 g soil | Mean no. of spores per 10 g soil | Mean no. of spores per 10 g soil |
| 0-5 | 61 | 104.50 | 129.25 |
| 5-10 | 34.75 | 88.75 | 72.25 |
| 10-15 | 25.75 | 75.25 | 69.50 |
| 15-20 | 33.25 | 61.25 | 34.25 |

#### *5.5.2.3. Soil bacteria*

Soils from burnt, partially burnt and unburnt plots at Pathanthodu recorded a large number of soil bacterial propagules in all the soil core depths studied. Bacterial cfu was found more or less same in upper soil layers (0-5 cm, 5-10 cm depths) in unburnt soils and burnt soils. Bacterial population was much lower in partially burnt plots than in burnt or unburnt plots (Table 29).

From the burnt plots, a mean number of 272 x $10^{4}$ cfu/ g soil was recorded from all the soil depths, while in partially burnt plots it was 250 x $10^{4}$ cfu/ g soil, and unburnt plots it was only 165 x $10^{4}$ cfu/g soil (Plate 9).

#### *5.5.2.4. Soil actinomycetes*

Actinomycetes population was found more in unburnt plots than in burnt or partially burnt plots. From unburnt plots a mean population of 128.5 x $10^{4}$ cfu/ g soil was recorded with a maximum number of 142.5 x $10^{4}$ cfu /g soil at soil core depth of 10-15 cm while mean population number was 89.6 x $10^{4}$ cfu/g soil and 104. 17 x $10^{4}$ cfu/g soil in partially burnt and burnt plots respectively (Table 29) (Plate 9).

Information on soil microflora in burnt sites and their post-fire ecology is meagre, especially in soils of tropical forests.

Table 29. Distribution of bacterial and actinomycetes population at different soil depths in unburnt, partially burnt and burnt plots

| Soil depth (cm) | Actinomycetes (x10 $^4$ cfu / g) | | | Bacteria (x 10 $^4$ cfu/g) | | |
|---|---|---|---|---|---|---|
| | Unburnt | Partially burnt | Burnt | Unburnt | Partially burnt | Burnt |
| 0 - 5 | 136.9 | 128.4 | 118.57 | 350.67 | 220.6 | 350.22 |
| 5 - 10 | 127.47 | 101.25 | 104.97 | 320.5 | 140.47 | 290.5 |
| 10 - 15 | 142.57 | 72.85 | 88.1 | 200.67 | 180.1 | 300.5 |
| 15 - 20 | 107.43 | 56.17 | 105.35 | 130 | 120.32 | 150.6 |

Usually, changes in microbial populations following fire are most evident in the upper soil layers. The depth to which the effect can be detected increases with increase in burn intensity. In the present study also fungal species and genera obtained were comparatively higher in soil layer of 0-5 cm depth in burnt plots than partially and unburnt plots.

It was found that population of soil fungi was more in acidic soil than in basic soils. Ash from burning often increases the soil pH and makes the soil less favourable to fungal growth. However, post-fire soil pH varies from alkaline to more acid condition later, as the ash minerals become gradually leached out. Consequently, the species of fungi found in the burnt soils varied with age of burn.

All the soils from burnt, partially burnt and unburnt plots at Chinnar and Panthanthodu were acidic and the soil pH ranged from 5.2 to 6.7. Even though, not much difference in soil pH was noticed in burnt and unburnt soils in both the study areas, soil pH was comparatively low in all the plots at Panthanthodu.

Apart from soil pH, other soil physical and chemical characteristics play a major role in fungal population dynamics in burnt soils. Among the factors related to the presence or absence of certain groups fungi on burnt and unburnt soils are soil nitrification, sterilization of soil by heat, effect of heat on spore germination, changes in chemical properties of soil, altered biotic competition, etc. are the important ones.

A general decrease in fungal populations after fire because of unfavourable conditions was assumed by few workers (Mohanan, 1992; Sankaran, 2001). Sankaran (2001) reported that fungal population in deeper layer of soil was not affected by a ground fire of moderate intensity and the population reverted back to pre-burnt condition at 2-4 cm depth within seven days without affecting the species richness. No significant post-fire differences were detected at 8 cm soil depth (Ahlgren and Ahlgren, 1965).

However, several workers have indicated that after burning, it takes several months to a few years for restoration of the fungal population to pre-burn status (Chwaliski, 1987; Pietikainen and Fritze, 1993). Neal *et al*. (1965) detected a slight reduction in fungi throughout the first post-fire year; shortly afterwards, the numbers returned to pre-burn levels.

The soils from Chinnar and Panthanthodu harboured rich soil fungal flora, irrespective of their types of forest ecosystems. Soil fungi are heterogeneous group of organisms and the fungal species in burnt soils may differ from those in unburnt soils. These differences in fungal species composition may vary with various post-fire edaphic and climatic conditions, vegetation and also with age of the burn. A change in fungal species composition in burnt sites was observed in the present study also.

Of the different types of mycorrhizal associations reported, vesicular arbuscular mycorrhizas (VAM) are important. VAM fungi are associated with more than 80 per cent of the plant species in different ecosystems. Studies have proven that mycorrhizal activity decreases with increasing level of disturbance (Klopatek *et al*., 1988).

The results of the present study showed that in both the forest types, occurrence of fire affected the VAM fungal distribution, density and species diversity. Burnt soils in both the forest types recorded high spore density as well as VAM fungal genera and species. More than 50 VAM fungi were recorded from soils in both the study areas.

In the natural ecosystems, the diversity of the host population may influence the diversity of soil microorganisms, especially the microbial symbionts. The VAM fungal species richness observed in both the study areas suggested their possible role in maintenance of plant biodiversity and ecosystem functioning. VAM spore numbers were found significantly lower in lower soil depth (15-20 cm) in burnt areas.

This result suggested that the response of VAM fungi to fire may be attributed to changes in the host plants rather than direct effect of fire. Fire temperatures did not reach a level high enough to kill all the plants, leaving a large residual VA mycorrhizal pool in the soil and plant roots. Usually, the initial decrease in VA mycorrhizal population due to fire may be compensated by better growth of tree seedlings in burnt sites due to increased nutrition of the ash. The VA mycorrhizal pool may revive, activate and form better association.

Changes in microbial populations following fire are most evident in the upper soil layers. The depth to which the effect can be detected increased with burn intensity. The sudden availability of mineral nutrients along with other soil chemical changes associated with burning undoubtedly can have a profound effect on bacterial population.

Since bacteria are generally favoured on more alkaline soils and majority of the fungi thrive on more acid soils, pH differences are probably the reason for the many reports that bacteria are favoured over fungi on burnt sites (Wright and Tarrant, 1957).

A decrease in bacterial population after burning has been reported by Sankaran (2001) while Ahlgren and Ahlgren (1965) noted an initial depression in numbers of bacteria followed by increase in 5-8 cm below the surface during second and third growing seasons after burning. An increase in bacterial population in the upper layer of 5 cm soil on burnt site than in unburnt site after 7 months of incidence of fire has also been reported (Wright and Tarrant, 1957). Heat generated by fire can cause immediate reduction in bacterial populations.

The population decline was recorded only in upper 2 cm soil. In areas where moisture is a limiting factor, these population declines are temporary, lasting only until the first post-fire rainfall. In moist soil, bacterial populations may respond differently to fire than in drier soil.

Reductions in bacterial populations are often recorded in dry zones immediately after fire (Ahlgren and Ahlgren, 1965). In moist soils of humid tropical areas, an increase in microbial populations immediately after fire and return to pre-burn numbers within nine months has been reported (Corbet, 1934).

In contrast to fungi, these are very sensitive to acidity and more or less absent at soil pH 4.7 or lower. It is estimated that actinomycetes may constitute up to 30 per cent of the living organisms in the soil. Most workers have reported that soil actinomycetes and bacteria behave similarly in response to fire (Jorgensen and Hodges, 1970,1971). The largest percentage occurred in the surface level immediately after fire.

The smallest per cent was in the surface level of the burnt soils after the first post-fire rainfall. Differences between bacteria and actinomycetes population in post-fire soils have also been noted. Wright and Tarrant (1957) found that the ratio of bacteria to actinomycetes remained the same on unburnt and lightly burnt soils, but increased sharply on severely burnt area.

In Northern Minnesota jack pine prescribed burning studies, the ratio of bacteria to actinomycetes was reduced immediately after fire in the surface soil on both moderate and severe burns, with greater reduction on the severe burn (Ahlgren, 1974). The ratio increased strikingly after the post-fire rainfall. These results suggest that the actinomycetes are more resistant to heat than bacteria and are less affected by moisture changes.

### 5.8. Loss due to fire

Some of the values given in the studies carried out in India are presented in Appendix 47. There is a decrease of 16.8 per cent in the LAI values in the burnt plots at Kalladathupara and 14.5 per cent that in Edalichedimantha. In the Panthanthodu, the decrease in LAI values in the completely burnt plots was 71.76 per cent, while that in the partially burnt plots it was 34.89 per cent. In other words, the canopy closure was 16.8 per cent in the burnt plots at Kalladathupara and 14.5 per cent in Edalichedimantha. At Panthanthodu, the decrease in the canopy closure in the completely burnt plots was 71.76 per cent, while that in the partially burnt plots it was 34.89 per cent.

Annual values of selected benefits of forests and minimum and maximum values of annual flow of goods and services per hectare (Rs) for open and dense forests, as estimated by Muraleedharan *et al.* ( 2001) are presented in Appendices 6.2 and 6.3, respectively. As per their estimate, the value of annual flow of goods and services per hectare of open forest having 10-40 per cent crown density ranges from Rs. 3239 to Rs.12227 ( the present values worked out at 5% rate for a period of 20 years are Rs. 40365 to 152375/-) and that for a dense forest having crown density greater than 40 per cent, these are Rs.21287 to Rs.322957/- ( present values Rs. 265283 and Rs. 4024758). The forest at Chinnar belongs to open one while that at Panthanthodu is dense. When the above values are taken into consideration, it is possible to work out the loss of annual flow of goods and services per hectare due to fire.

At Chinnar, the canopy closure was 15.65 per cent less in burnt plots when compared to unburnt plots. At Panthanthodu, the closure was 71.76 per cent less in burnt plots, while that in the partially burnt plots, it was 34.89 per cent when compared to unburnt plots. As the forest type at Chinnar is open one, a further loss of 15.65 per cent is high, though numerically it is low.

Based on the annual flow of goods and services per hectare as per the estimate of Muraleedharan *et al.* (2002), the loss due to fire is approximately computed for both Chinnar and Panthanthodu (Table 30). It is assumed that the loss of goods and services in an unit area is directly proportional to reduction in the canopy closure in both the localities.

At Chinnar, in the burnt plots, the loss was ranging from Rs. 507 to 1914/- while at Panthanthodu, the values ranged from Rs. 15276 to 231754/- in the burnt and Rs. 7427 to 112680/- in the partially burnt areas.

Table 30. Loss due to fire at Chinnar and Panthanthodu on the basis of annual flow of goods and services per hectare

| Location | Treatment | Minimum(Rs/ha) | Maximum(Rs/ha) |
|---|---|---|---|
| Chinnar | Burnt area | 507 (6317) | 1914 (23,847) |
| Panthanthodu | Partially burnt area | 7427 (1,90,367) | 1,12,680 (28,88,166) |
| Panthanthodu | Burnt area | 15,276 (92,557) | 2,31,754 (14,04,238) |

Figures within brackets indicate loss calculated on the basis of present value of goods and services per hectare as given in Appendices 47-49.

# 6. Conclusions

On the basis of the studies on soils, regeneration status of herbs, shrubs and important tree species, seed germination, physiological stress on trees and soil microflora at Chinnar and Panthanthodu, the following conclusions are made:

## 6.1. Effect of fire on different components

### *6.1.1.Chinnar*

- Soil fertility was the discriminating factor between burnt and unburnt plots.
- Available P and K contents were less (43 and 58%) and Ca and Mg contents were considerably higher (33% and 57%) in the burnt plots.
- The per cent of the lower height class seedlings was less in the unburnt plots when compared to burnt plots.
- The regeneration potential of trees, shrubs and herbaceous species is also relatively more in unburnt areas.
- There was not much difference in physiological processes of trees in the burnt and unburnt plots.
- Very high population of soil fungi, bacteria, actinomycetes and vesicular arbuscular mycorrhizal fungi was found in burnt plots than unburnt plots. Distribution of fungi, bacteria, actinomycetes and VAM fungi was also more in the upper soil layer of 0-5 cm depth than in lower soil depths.
- Qualitative assessment on soil microbes revealed that soil fungal species and genera occurred more in burnt soils than unburnt soils.
- The loss due to fire ranged from Rs. 507 to 1914/- per ha per annum in the burnt plots.

### *6.1.2.Panthanthodu*

- Soil texture, alkalinity and fertility were the three discriminating factors between completely burnt, partially burnt and unburnt plots.
- There was an increase of 24 per cent for available Ca in the completely burnt plots and a decrease of 8 per cent in the partially burnt plots. With regard to available Mg, 33 per cent increase was noted in the partially burnt plots while in the completely burnt plots, a decrease of 14 per cent was noted.
- The per cent of lower height class seedlings was less in burnt plots. The seedling mortality was negligible.
- The regeneration potential of trees, shrubs and herbaceous species was relatively more in unburnt areas.
- There was not much difference in physiological processes of trees in the burnt, partially burnt and unburnt plots.
- Microbial population of fungi, bacteria, actinomycetes and vesicular arbuscular mycorrhizal fungi in burnt soils was more than unburnt soils. Distribution of fungi, bacteria, actinomycetes and VAM fungi was found more in the upper soil layer of 0-5 cm depth than in lower soil depths.
- Qualitative assessment on soil microbes revealed that soil fungal species and genera occurred more in burnt soils than unburnt soils.
- The loss due to fire ranged from Rs. 15276 to 231754/-per ha per annum in the burnt and Rs. 7427 to 112680/- per ha per annum in the partially burnt areas.

### *6.1.3. Difference between the two ecosystems in relation to fire*

- The soils at Chinnar and Panthanthodu registered marked difference.
- The recovery processes in the two ecosystems were also found to be different.

- Soil fertility was the discriminating factor between burnt and unburnt plots at Chinnar while at panthanthodu, soil texture, alkalinity and fertility were the three discriminating factors between completely burnt, partially burnt and unburnt plots.
- The per cent of the lower height class seedlings was less in the unburnt plots at Chinnar when compared to burnt plots and it was vice versa at Panthanthodu.
- The loss due to fire ranged from Rs. 507 to 1914/- per ha per annum in the burnt plots at Chinnar while at Panthanthodu, the loss varied from Rs. 15276 to 231754/- per ha per annum in the burnt and Rs. 7427 to 112680/- per ha per annum in the partially burnt areas.

**The study revealed that the two ecosystems function in different ways with respect to recovery processes and even after several years of occurrence of fire, 17 years at Chinnar and 13 years at Panthanthodu, the recouperation is not complete with respect to soils regeneration status of herbs, shrubs and important tree species and soil microflora**.

## 7. References


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Appendix 1 Analysis of variance of soil properties in different layers at Kalladathupara, Edalichedimantha and Chinnar

| Properties | Kalladathupara | | | | Edalichedimantha | | | | Chinnar | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Layers | | | | Layers | | | | Layers | | | |
| | 0-20 | 20-40 | 40-60 | 0-60 | 0-20 | 20-40 | 40-60 | 0-60 | 0-20 | 20-40 | 40-60 | 0-60 |
| Organic carbon | | * | | * | | | | | | * | * | |
| Bulk density | ** | ** | | ** | | | | | | * | | |
| Particle density | | | | | | ** | ** | | | * | | |
| Water holding capacity | | | | | | | | | | | | |
| Available P | | | | | | * | * | | | | | |
| Available K | | | | | | * | ** | * | | * | ** | ** |
| Available Ca | * | * | * | * | ** | * | ** | | ** | ** | * | ** |
| Available Mg | | | | | ** | ** | ** | ** | ** | ** | ** | ** |
| Calcium Carbonate | * | | * | * | * | | * | ** | * | * | * | * |

*, ** denote significant at P =0.05 and 0.01, respectively. All others are not significant.

Appendix 2

Analyses of variance of soil properties in different layers at  Panthanthodu

| Properties | Pathanthodu | | | |
|---|---|---|---|---|
| | Layers | | | |
| | 0-20 | 20-40 | 40-60 | 0-60 |
| Gravel | | | * | * |
| Organic carbon | | * | * | * |
| Particle density | | | | * |
| Available Ca | | * | | |
| Available Mg | | | * | |
| Calcium carbonate | ** | | | * |
| Soil pH | * | | | |
| Available N | ** | * | * | * |
| Sand | ** | * | * | * |
| Silt | ** | * | * | * |
| Clay | ** | * | * | * |

*, ** denote significant at P =0.05 and 0.01, respectively. All others are not significant.

## Appendix 3

Mean values of soil properties in the 0-20 cm layer at Kalladathupara

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Unburnt | 18.84 | 87 | 5 | 8 | 1.18 | 2.72 | 29.53 | 6.4 | 0.53 | 0.03 | 2.10 | 30.63 | 93.17 | 20.17 | 0.14 |
| Burnt | 29.58 | 90 | 3 | 7 | 1.24 | 2.58 | 28.84 | 6.3 | 0.41 | 0.03 | 1.86 | 36.85 | 64.75 | 15.00 | 0.02 |

## Appendix 4

Mean values of soil properties in the 20-40 cm layer at Kalladathupara

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Unburnt | 32.17 | 87 | 5 | 8 | 1.16 | 2.52 | 29.42 | 6.4 | 0.43 | 0.03 | 1.11 | 21.24 | 112.33 | 24.42 | 0.14 |
| Burnt | 36.55 | 89 | 4 | 7 | 1.23 | 2.54 | 27.79 | 6.3 | 0.31 | 0.02 | 1.22 | 23.80 | 78.33 | 20.67 | 0.19 |

## Appendix 5

Mean values of soil properties in the 40-60 cm layer at Kalladathupara

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Unburnt | 31.46 | 86 | 5 | 9 | 1.16 | 2.48 | 30.32 | 6.4 | 0.40 | 0.03 | 0.84 | 11.13 | 126.00 | 29.42 | 0.15 |
| Burnt | 41.55 | 89 | 4 | 7 | 1.22 | 2.50 | 54.47 | 6.2 | 0.30 | 0.02 | 1.03 | 13.54 | 91.75 | 25.67 | 0.02 |

Appendix 6

Mean values of soil properties in the 0-60 cm layer at Kalladathupara

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Unburnt | 27.49 | 87 | 5 | 8 | 1.17 | 2.57 | 29.76 | 6.4 | 0.45 | 0.03 | 1.35 | 21.00 | 110.50 | 24.67 | 0.14 |
| Burnt | 35.89 | 89 | 4 | 7 | 1.23 | 2.54 | 37.03 | 6.3 | 0.34 | 0.03 | 1.37 | 24.73 | 78.28 | 20.45 | 0.02 |

Appendix 7

Mean values of soil properties at Edalichedimantha in the 0-20 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 34.07 | 87 | 6 | 7 | 1.17 | 2.54 | 25.98 | 6.5 | 0.61 | 0.03 | 0.86 | 48.73 | 121.92 | 33.25 | 0.08 |
| Unburnt | 29.44 | 86 | 6 | 8 | 1.17 | 2.60 | 26.16 | 6.6 | 0.53 | 0.03 | 2.1 | 64.03 | 93.00 | 17.92 | 0.10 |

## Appendix 8

Mean values  of soil properties at Edalichedimantha  in the 20-40 cm layer

| Treatments | Properties | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 45.00 | 84 | 7 | 9 | 1.13 | 2.43 | 26.41 | 6.5 | 0.42 | 0.03 | 0.04 | 25.70 | 190.00 | 49.00 | 0.13 |
| Unburnt | 41.31 | 84 | 6 | 10 | 1.13 | 2.54 | 26.30 | 6.7 | 0.34 | 0.03 | 1.09 | 57.07 | 125.17 | 23.67 | 0.10 |

## Appendix 9

Mean values of soil properties at Edalichedimantha  in the 40-60 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 45.05 | 86 | 6 | 8 | 1.16 | 2.45 | 24.74 | 6.7 | .28 | .02 | 0.12 | 12.41 | 162.75 | 53.33 | .07 |
| Unburnt | 43.36 | 84 | 6 | 10 | 1.14 | 2.46 | 25.80 | 6.6 | 0.32 | 0.03 | 1.20 | 48.21 | 136.08 | 29.33 | 0.09 |

## Appendix 10

Mean values of soil properties at Edalichedimantha in the 0-60 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | PH | OC % | N Ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 41.37 | 86 | 7 | 7 | 1.15 | 2.47 | 25.71 | 6.5 | 0.43 | 0.03 | 0.34 | 28.95 | 158.22 | 45.19 | 0.09 |
| Unburnt | 38.04 | 85 | 6 | 9 | 1.15 | 2.53 | 26.08 | 6.6 | 0.40 | 0.03 | 1.47 | 56.44 | 118.08 | 23.64 | 0.10 |

## Appendix 11

Mean values of soil properties in burnt and unburnt plots at Chinnar in the 0-20 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 87 | 5 | 8 | 26.46 | 1.18 | 2.63 | 27.70 | 6.4 | 0.57 | 0.03 | 1.48 | 39.68 | 107.54 | 26.71 | 0.11 |
| Unburnt | 88 | 4 | 8 | 29.51 | 1.20 | 2.59 | 27.50 | 6.4 | 0.47 | 0.03 | 1.99 | 50.44 | 78.88 | 16.46 | 0.06 |

## Appendix 12

Mean values of soil properties in burnt and unburnt plots at Chinnar in the 20-40 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | PH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 38.58 | 86 | 6 | 8 | 1.14 | 2.48 | 27.92 | 6.4 | 0.42 | 0.03 | 0.57 | 23.47 | 151.17 | 36.71 | 0.13 |
| Unburnt | 38.93 | 86 | 5 | 9 | 1.18 | 2.54 | 27.05 | 6.5 | 0.32 | 0.03 | 1.15 | 40.43 | 101.75 | 22.17 | 0.06 |

## Appendix 13

Mean values of soil properties in burnt and unburnt plots at Chinnar in the 40-60 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | PH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 38.26 | 86 | 6 | 8 | 1.16 | 2.47 | 27.53 | 6.5 | 0.34 | 0.02 | 0.48 | 11.77 | 144.38 | 41.38 | 0.11 |
| Unburnt | 42.45 | 86 | 5 | 9 | 1.18 | 2.48 | 40.13 | 6.4 | 0. 31 | 0.02 | 1.11 | 30.87 | 113.92 | 27.50 | 0.05 |

Appendix 14

Mean values of soil properties in burnt and unburnt plots at Chinnar in the 0-60 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg Ppm | $CaCO_3$ % |
| Burnt | 34.43 | 86 | 6 | 8 | 1.16 | 2.52 | 27.73 | 6.5 | 0.44 | 0.03 | 0.84 | 24.97 | 134.36 | 34.93 | 0.11 |
| Unburnt | 36.96 | 87 | 5 | 8 | 1.19 | 2.53 | 31.56 | 6.4 | 0.37 | 0.03 | 1.42 | 40.58 | 98.18 | 22.04 | 0.06 |

Appendix 15

Mean values of soil properties in burnt, partially burnt and unburnt plots at Panthanthodu in the 0-20 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N Ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Unburnt | 21.03 | $79^{a}$ | $11^{a}$ | $10^{a}$ | 0.96 | 1.92 | 57.23 | $5.8^{a}$ | 3.82 | $0.10^{a}$ | 12.08 | 6.39 | 101.32 | 30.82 | $0.059^{a}$ |
| Partially burnt | 19.77 | $82^{b}$ | $9^{a}$ | $9^{b}$ | 0.97 | 1.99 | 54.41 | $5.9^{a}$ | 3.09 | $0.08^{b}$ | 11.08 | 3.20 | 109.82 | 39.08 | $0.035^{b}$ |
| Burnt | 14.94 | $85^{c}$ | $8^{b}$ | $7^{c}$ | 0.99 | 2.02 | 53.11 | $6.2^{b}$ | 3.33 | $0.09^{ab}$ | 11.08 | 4.60 | 146.58 | 32.83 | $0.050^{a}$ |

Appendix 16

Mean values of soil properties in burnt, partially burnt and unburnt plots at Panthanthodu in the 20-40 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Burnt | 23.89 | 74[a] | 12[a] | 14[a] | 1.03 | 1.99 | 52.61 | 5.9 | 1.24[a] | 0.07[a] | 5.58 | 4.02 | 67.10[a] | 14.63 | 0.038 |
| Partially burnt | 19.86 | 75[a] | 11[a] | 14[a] | 1.03 | 2.02 | 50.23 | 5.8 | 1.13[a] | 0.06[b] | 4.75 | 4.18 | 49.87[b] | 17.20 | 0.029 |
| Unburnt | 14.29 | 80[b] | 9[b] | 11[b] | 1.02 | 2.07 | 53.34 | 5.9 | 1.84[b] | 0.07[ab] | 4.75 | 3.07 | 76.81[a] | 17.53 | 0.035 |

Appendix 17

Mean values of soil properties in burnt, partially burnt and unburnt plots at Panthanthodu in the 40-60 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | PH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCo_3$ % |
| Unburnt | 28.63[a] | 71[a] | 13[a] | 16[a] | 1.01 | 2.03 | 49.93 | 5.7 | 0.91 | 0.06[b] | 2.75 | 3.53 | 56.83 | 8.93[a] | 0.034 |
| Partially burnt | 25.14[a] | 73[a] | 11[a] | 16[a] | 1.01 | 2.02 | 52.66 | 5.8 | 0.95 | 0.05[a] | 2.33 | 4.49 | 47.48 | 16.23[b] | 0.027 |
| Burnt | 13.57[b] | 78[b] | 9[b] | 13[b] | 1.03 | 2.09 | 53.35 | 5.8 | 1.42 | 0.06[a] | 2.58 | 2.87 | 59.22 | 13.07[ab] | 0.030 |

Appendix 18

Mean values of soil properties in burnt, partially burnt and unburnt plots at Panthanthodu in the 0-60 cm layer

| Treatments | Properties | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel % | Sand % | Silt % | Clay % | Bulk density | Particle density | WHC % | pH | OC % | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | $CaCO_3$ % |
| Unburnt | 24.52[a] | 74[a] | 12[a] | 14[a] | 1.00 | 1.98[a] | 53.25 | 5.8 | 1.99[ab] | 0.08[a] | 6.75 | 4.65 | 75.08 | 18.13 | 0.044[a] |
| Partially burnt | 21.59[ab] | 76[a] | 10[a] | 14[a] | 1.00 | 2.01[ab] | 52.43 | 5.8 | 1.72[a] | 0.06[b] | 6.08 | 3.95 | 69.06 | 24.17 | 0.030[b] |
| Burnt | 14.27[b] | 81[b] | 9[b] | 10[b] | 1.01 | 2.06[b] | 53.26 | 6.0 | 2.20[b] | 0.07[c] | 6.17 | 3.52 | 94.20 | 21.14 | 0.038[ab] |

Appendix 19

Species found in the burnt and unburnt areas at Chinnar

| Sl. No | Botanical name | Family | Habit |
|---|---|---|---|
| 1 | *Acacia caesia (L.)* Willd. | *Mimosaceae* | Straggling shrub |
| 2 | *Acacia ferruginea* Dc. | *Mimosaceae* | Tree |
| 3 | *Albizia amara (Roxb.)* Boivn. | *Mimosaceae* | Tree |
| 4 | *Dichrostachys cinerea (L.)* Wight&Arn. | *Mimosaceae* | Small Tree |
| 5 | *Prosopis juliflora (Sw.)* Dc. | *Mimosaceae* | Tree |
| 6 | *Barlaria acuminata* Nees in Wall. | *Acanthaceae* | Shrub |
| 7 | *Barlaria mysorensis* Heyne ex Roth. | *Acanthaceae* | Shrub |
| 8 | *Barlaria prionitis* L. | *Acanthaceae* | Shrub |
| 9 | *Blepharis madraspatensis (L.)* Heyne ex Roth. | *Acanthaceae* | Herb |
| 10 | *Justicia tranquebariensis* L. | *Acanthaceae* | Subshrub |
| 11 | *Grewia flavescens* Juss. | *Tiliaceae* | Shrub |
| 12 | *Grewia hirsuta* Vahl. | *Tiliaceae* | Undershrub |
| 13 | *Grewia obtusa* Wall ex Dunn. | *Tiliaceae* | Shrub |
| 14 | *Grewia orbiculata* Rottl. | *Tiliaceae* | Shrub |
| 15 | *Grewia villosa* Willd. | *Tiliaceae* | Large shrub |
| 16 | *Triumfetta pilosa* Roth. | *Tiliaceae* | Subshrub |
| 17 | *Orthosiphon thymiflorus* (Roth) Sleensen | *Lamiaceae* | Woody herb |
| 18 | *Ocimum sanctum* L. | *Lamiaceae* | Undershrub |
| 19 | *Ocimum americanum* L. | *Lamiaceae* | Herb |
| 20 | *Ocimum basilicum* L. | *Lamiaceae* | Woody herb |
| 21 | *Alphonsea sclerocarpa* Thw. | *Annonaceae* | Small trees |
| 22 | *Asparagus racemosus* Willd. | *Liliaceae* | Shrub |
| 23 | *Acalypha fruticosa* Forssk. | *Euphorbiaceae* | Subshrub |
| 24 | *Drypetes elato*(Bedd.) Pax Hoffm | *Euphorbiaceae* | Tree |
| 25 | *Givotia rottleriformis* Griff. | *Euphorbiaceae* | Tree |
| 26 | *Jatropha glandulifera* Roxb. | *Euphorbiaceae* | Shrub |
| 27 | *Securinega leucopyrus* (Willd.) Muell. | *Euphorbiaceae* | Shrub |
| 28 | *Achyranthes bidentata* Blume. | *Amaranthaceae* | Large herb |
| 29 | *Abutilon hirtum (Lam.)* Sweet. | *Malvaceae* | Subshrub |
| 30 | *Abutilon indicum (L.)* Sweet. | *Malvaceae* | Shrub |
| 31 | *Hibiscus micranthus* | *Malvaceae* | Subshrub |
| 32 | *Anogeissus latifolia (*Roxb.ex Dc.) Wall.ex. Guillsperr. | *Combretaceae* | Tree |
| 33 | *Atalantia monophylla* (Roxb.) Dc. | *Rutaceae* | Small tree |
| 34 | *Glycosmis mauritiana* (Lam.) Tanaka | *Rutaceae* | Shrub |
| 35 | *Pleiospermium alatum* Wall.ex Wight & Arn. | *Rutaceae* | Medium tree |
| 36 | *Canthium coromandelicum* Burm.f. | *Rubiaceae* | Small tree |
| 37 | *Canthium dicoccum* (Gaertn.) Teij sm. & Binn. | *Rubiaceae* | Small tree |
| 38 | *Catunaregam torulosa* (Dennst.) Tirv; Mathew. | *Rubiaceae* | Small tree |

| | | | |
|---|---|---|---|
| 39 | *Psilanthus wightianus* (Wight & Arn.) J. Leroy. | *Rubiaceae* | Shrub |
| 40 | *Tarenna asiatica* (L.)O.ktze.ex K. schum. | *Rubiaceae* | Shrub |
| 41 | *Cadaba fruticosa* (L.) Druce. | *Capparaceae* | Wiry shrub |
| 42 | *Capparis brevispina* Dc. | *Capparaceae* | Shrub |
| 43 | *Capparis sepiaria* L. | *Capparaceae* | Straggling shrub |
| 44 | *Capparis spinosa* L. | *Capparaceae* | Climbing shrub |
| 45 | *Crataeva adansonii* Dc ssp.odora Buch- Ham | *Capparaceae* | Small tree |
| 46 | *Carmona retusa* Vahl | *Boraginaceae* | Shrub |
| 47 | *Cordia monoica* Roxb. | *Boraginaceae* | Small tree |
| 48 | *Ehretia ovalifolia* Wight | *Boraginaceae* | Small tree |
| 49 | *Ipomea obscura*.(L.) Ker. Gawl. | *Convolvulaceae* | Twining herb |
| 50 | *Solanum pubescens* Willd. | *Solanaceae* | Shrub |
| 51 | *Carissa carandas* L. | Apocynaceae | Shrub |
| 52 | *Gymnema sylvestre*(Retz.) R.br. ex Schult. | *Asclepiadaceae* | Straggling shrub |
| 53 | *Pergularia daemia* (Forssk.) Chiov. | *Asclepiadaceae* | Twining ndershrub |
| 54 | *Sarcostemma brunonianum* W&A. | *Asclepiadaceae* | Shrub |
| 55 | *Cissus quadrangularis* L. | *Vitaceae* | Shrub |
| 56 | *Commiphora berryi* Arn. | *Burseraceae* | Shrub |
| 57 | *Commiphora pubescens* Wight & Arn. | *Burseraceae* | Medium tree |
| 58 | *Cassine glauca* (Rottb.) O.Ktze. | *Celastraceae* | Tree |
| 59 | *Maytenus ovatus* (Wall.ex Wight & Arn.)Loes | *Celastraceae* | Small tree |
| 60 | *Diospyros cordifolia* Roxb. | *Ebenaceae* | Tree |
| 61 | *Diospyros ebenum* Koen. | *Ebenaceae* | Tree |
| 62 | *Diospyros ovalifolia* Wight. | *Ebenaceae* | Tree |
| 63 | *Dioscorea pentaphylla* L. | *Dioscoreaceae* | Twiner |
| 64 | *Gyrocarpus asiaticus* Willd. | *Hernandiaceae* | Tree |
| 65 | *Jasminum trichotomum* Heyne ex Roth. | *Oleaceae* | Shrub |
| 66 | *Lantana camara* L. | *Verbenaceae* | Shrub |
| 67 | *Lantana indica* Roxb. | *Verbenaceae* | Shrub |
| 68 | *Premna latifolia* Roxb. | *Verbenaceae* | Small tree |
| 69 | *Premna serratifolia* L. | *Verbenaceae* | Small tree |
| 70 | *Premna tomentosa* Willd. | *Verbenaceae* | Tree |
| 71 | *Cardiospermum halicacabum* L. | *Sapindaceae* | Herb |
| 72 | *Lepisanthes tetraphylla* (Vahl.) Radlk Sitzungsber. | *Sapindaceae* | Medium tree |
| 73 | *Sapindus emarginata* Vahl. | *Sapindaceae* | Small tree |
| 74 | *Loeseneriella obtusifolia* (Roxb.) A.C. Smith | *Hippocrateaceae* | Straggling shrub |
| 75 | *Ziziphus mauritiana*. Lam. | *Rhamnaceae* | Small tree |
| 76 | *Ziziphus rugosa*. Lam. | *Rhamnaceae* | Shrub |
| 77 | *Opuntia vulgaris* Mill. | *Cactaceae* | Subshrub |
| 78 | *Strychnos potatorum* . L.f. | *Loganiaceae* | Small tree |
| 79 | *Tinospora cordifolia* (Willd.) Miers ex Hook.f.& Thoms. | *Menispermaceae* | Shrub |
| 80 | *Bauhinia racemosa* Lam. | *Caesalpiniaceae* | Tree |
| 81 | *Hardwickia binata* Roxb. | *Caesalpiniaceae* | Tree |

| | | | |
|---|---|---|---|
| 82 | *Tamarindus indica* L. | *Caesalpiniaceae* | Tree |
| 83 | *Indigofera linnaei* .Ali. | *Papilionaceae* | Herb |
| 84 | *Tephrosia villosa* (L.) Pers. | *Papilionaceae* | Subshrub |
| 85 | *Pterolobium hexapetalum* (Roth.) Sant.& Wagh | *Papilionaceae* | Straggling shrub |
| 86 | *Waltheria indica*,L. | *Sterculiaceae* | Undershrub |
| 87 | *Ziziphus trinervia*,Roxb. | *Rhamnaceae* | Tree |
| 88 | *Euphorbia trigona*,Haw. | *Euphorbiaceae* | Tree |
| 89 | *Tectona grandis*,L.f. | *Verbenaceae* | Tree |

Appendix 20

Species found in all the plots at Panthanthodu

| Sl No | Botanical name | Family | Habbit |
|---|---|---|---|
| 1. | *Acronychia pedunculata* (L) Miq | *Rutaceae* | Small tree |
| 2. | *Actinodaphne bourdillonii* | *Lauraceae* | Tree |
| 3. | *Aglaia anamallayana* (Bedd.) Kosterm | *Meliaceae* | Tree |
| 4. | *Aglaia lawii* (Wight.) Sald. | *Meliaceae* | Tree |
| 5. | *Allophyllus concanicus* Radlk. | *Sapindaceae* | Small tree |
| 6. | *Allophyllus distachys* (Dc.) Radlk. | *Sapindaceae* | Shrub |
| 7. | *Allophyllus serrulatus* L. | *Sapindaceae* | Small tree |
| 8. | *Ammomum muricatum* Roxb. | *Zingiberaceae* | Large herb |
| 9. | *Ancistrocladus heyneanus* Wall. | *Ancistrocladaceae* | Climbing shrub |
| 10. | *Antidesma menasu* Miq ex Tul | *Euphorbiaceae* | Tree |
| 11. | *Apollonias arnottii* Nees. | *Lauraceae* | Tree |
| 12. | *Aporosa acuminata* Thw. | *Euphorbiaceae* | Small tree |
| 13. | *Artocarpus heterophyllus*.Lam. | *Moraceae* | Tree |
| 14. | *Artocrarpus hirsutus*.Lam. | *Moraceae* | Tree |
| 15. | *Atalantia sp.* | *Rutaceae* | Tree |
| 16. | *Bischofia javanica* Bl. | *Euphorbiaceae* | Tree |
| 17. | *Callicarpa lanata* L. | *Verbenaceae* | Small tree |
| 18. | *Calophyllum austroindicum* Kosterm. ex. Stevens | *Clusiaceae* | Tree |
| 19. | *Calophyllum polyanthum* Wall. ex Choisy | *Clusiaceae* | Tree |
| 20. | *Canarium strictum* Roxb. | *Burseraceae* | Large tree |
| 21. | *Casearia tomentosa* Roxb. | *Samydaceae* | Small tree |
| 22. | *Casearia wynadensis* Bedd. | *Samydaceae* | Small tree |
| 23. | *Cassia fistula* L. | *Caesalpiniaceae* | Tree |
| 24. | *Cinnamomum malabathrum* (Burm.f.) Bl. | *Lauraceae* | Tree |
| 25. | *Cinnamomum sulphuratum* Nees | *Lauraceae* | Tree |
| 26. | *Clerodendron viscosum* Vent. | *Verbenaceae* | Small tree |
| 27. | *Croton malabaricus* Bedd. | *Euphorbiaceae* | Small tree |
| 28. | *Cullenia exarillata* Robyns. | *Bombacaceae* | Tree |
| 29. | *Cyclea peltata* (Lam.) Hook.f. & Thoms. | *Menispermaceae* | Climbing shrub |
| 30. | *Dendrocnid sinuate* | *Urticaceae* | Small tree |
| 31. | *Dimocarpus longan*. Lour. | *Sapindaceae* | Tree |

| | | | |
|---|---|---|---|
| 32. | *Diospyros paniculata* Dalz. | *Ebenaceae* | Tree |
| 33 | *Drypetes elata* (Bedd.) Pax & Hoffm. | *Euphorbiaceae* | Tree |
| 34. | *Elaeocarpus munronii* (Wight) Mast. | *Elaeocarpaceae* | Tree |
| 35 | *Elaeocarpus serratus* L. | *Elaeocarpaceae* | Tree |
| 36 | *Elettaria cardamomum* (L) Maton | *Zingiberaceae* | Herb |
| 37 | *Erythropalum scandens* Bl. | *Erythropalaceae* | Climbung shrub |
| 38 | *Eupatorium glandulosum* Roxb. | *Asteraceae* | Shrub |
| 39 | *Flacourtia montana* Graham. | *Flacourtiaceae* | Small tree |
| 40 | *Garcinia morella* Desr. | *Clusiaceae* | Tree |
| 41 | *Glochidion ellipticum* Wight | *Euphorbiaceae* | Tree |
| 42 | *Gomphandra coriaceae.*Wight. | *Icacinaceae* | Small tree |
| 43 | *Holigarna arnottiana* Hook.f. | *Anacardiaceae* | Tree |
| 44 | *Hymenodictyon obovatum* Wall. | *Rubiaceae* | Small tree |
| 45 | *Ixora brachiata* Roxb. | *Rubiaceae* | Small tree |
| 46 | *Jasminum rottlerianum* Wall.ex.Dc | *Oleaceae* | Climbing shrub |
| 47 | *Justicia santapaui* Bennet. | *Acanthaceae* | Shrub |
| 48 | *Knema attenuata* (Wall. ex Hook.f. & Thoms) Warb | *Myristicaceae* | Tree |
| 49 | *Lantana camara* L. | *Verbenaceae* | Shrub |
| 50 | *Lasianthus jackianus* Wight. | *Rubiaceae* | Shrub |
| 51 | *Leea indica* (Burm.f.) Merr. | *Leeaceae* | Large shrub |
| 52 | *Litsea floribunda* (Bl.) Gamble. | *Lauraceae* | Tree |
| 53 | *Litsea stocksii* Hook.f. | *Lauraceae* | Tree |
| 54 | *Macaranga indica* Wight | *Euphorbiaceae* | Tree |
| 55 | *Mallotus philippensis* (Lam.) Muell. | *Euphorbiaceae* | Small tree |
| 56 | *Mangifera indica* L. | *Anacardiaceae* | Tree |
| 57 | *Measa indica* (Roxb.) Dc. | *Myrsinaceae* | Shrub |
| 58 | *Meliosma pinnata* (Roxb.) Wallp. | *Sabiaceae* | Tree |
| 59 | *Mesua ferrea*(Burm.f.) Kosterm | *Clusiaceae* | Tree |
| 60 | *Myristica dactyloides* Gaertn. | *Myristicaceae* | Tree |
| 61 | *Neolitsea scorbiculata* (Meiss.) Gamb. | *Lauraceae* | Tree |
| 62 | *Neolitsea zeylanica* Merr. | *Lauraceae* | Tree |
| 63 | *Olea dioica* Roxb. | *Oleaceae* | Tree |
| 64 | *Palaquium ellipticum* (Dalz.) Baill | *Sapotaceae* | Tree |
| 65 | *Paramignya armata* Thw. | *Rutaceae* | Climbing shrub |
| 66 | *Pavetta calophylla* L. | *Rubiaceae* | Shrub |
| 67 | *Persea macrantha* (Nees.) Kosterm | *Lauraceae* | Tree |
| 68 | *Photinia integrifolia* L. | *Rosaceae* | Tree |
| 69 | *Piper nigrum* L. | *Piperaceae* | Piperaceae |
| 70 | *Piper* sp. | *Piperaceae* | Climber |
| 71 | *Polyalthia coffeoides* (Thw. Ex Hook.f. & Thoms) Bedd. | *Annonaceae* | Tree |

| | | | |
|---|---|---|---|
| 72 | *Polyalthia fragrans* (Dalz.) Bedd. | *Annonaceae* | Tree |
| 73 | *Pouzolzia zeylanica* (L.) Benn. | *Urticaceae* | Herb |
| 74 | *Psychotria globicephala* Gamb. | *Rubiaceae* | Shrub |
| 75 | *Pterocarpus marsupium* Roxb. | *Papilionaceae* | Tree |
| 76 | *Rhus.sp.* | *Anacardiaceae* | Small tree |
| 77 | *Sarcandra chloranthoides* Gardn. | *Chloranthaceae* | Shrub |
| 78 | *Sauropus saksenianus (*Mani.) Prw & Sivar. | *Euphorbiaceae* | Shrub |
| 79 | *Semecarpus anacardium* L.f. | *Anacardiaceae* | Medium tree |
| 80 | *Smilax zeylanica* L. | *Smilacaceae* | Climber |
| 81 | *Solanum giganteum* Jacq. | *Solanaceae* | Shrub |
| 82 | Sterculia guttata Roxb.ex..Dc. | *Sterculiaceae* | Large tree |
| 83 | Symplocos pulchra Wight | *Symplocaceae* | Large tree |
| 84 | *Syzygium cumini* (L.) Skeels | *Myrtaceae* | Tree |
| 85 | *Syzygium laetum* (Buch-Ham) Gandhi | *Myrtaceae* | Tree |
| 86 | *Syzygium mundagum* (Bourd.) Chithra | *Myrtaceae* | Tree |
| 87 | *Syzygium munronii* (Wight.) Chithra. | *Myrtaceae* | Tree |
| 88 | *Thottea siliquosa* (Lam.) Ding Hou. | *Aristolochiaceae* | Scandent shrub |
| 89 | *Thunbergia mysorensis* (Wight) T.And | *Acanthaceae* | Climbing shrub |
| 90 | *Toddalia asiatica* (L.) Lam | *Rutaceae* | Scandent shrub |
| 91 | *Toona ciliata* Roem. | *Meliaceae* | Tree |
| 92 | *Ventilago bombaiensis* Dalz. | *Rhamnaceae* | Climbing shrub |
| 93 | *Wattakaka volubilis* (L.f.) Stapf. | *Asclepiadaceae* | Woody climber |

Appendix 21

Stomatal conductance, transpiration, leaf temperature of selected species in the Edalichedimantha burnt plots

| Species | Side | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Alphensia schlerocarpa* | **L** | 43.20 | 158.00 | 154.00 | 4.28 | 32.80 |
| | **U** | 43.20 | 183.00 | 21.00 | 0.62 | 33.70 |
| *Atlantia monophila* | **L** | 43.20 | 280.00 | 94.30 | 2.78 | 33.40 |
| | **U** | 43.20 | 400.00 | 21.90 | 0.69 | 34.20 |
| *Canthium coromandalicum* | **L** | 43.20 | 1080.00 | 319.00 | 14.98 | 35.20 |
| | **U** | 43.20 | 1310.00 | 60.60 | 2.26 | 36.70 |
| *Cassia glauca* | **L** | 43.20 | 300.00 | 539.00 | 15.46 | 33.60 |
| | **U** | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Cleospermum alatum* | **L** | 43.20 | 1620.00 | 246.00 | 11.40 | 39.10 |
| | **U** | 43.20 | 1570.00 | 74.00 | 3.36 | 38.90 |
| *Cordia monoica* | **L** | 43.20 | 380.00 | 404.00 | 12.28 | 34.00 |
| | **U** | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Diospyrous cardifolia* | **L** | 43.20 | 1510.00 | 213.00 | 8.55 | 37.80 |
| | **U** | 43.20 | 1680.00 | 8.31 | 0.36 | 38.80 |
| *Premna serratifolia* | **L** | 43.20 | 208.00 | 476.00 | 15.87 | 35.70 |
| | **U** | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sapindus emerginatus* | **L** | 43.20 | 166.00 | 341.00 | 9.75 | 34.30 |
| | **U** | 43.20 | 629.90 | 0.00 | 0.00 | 35.40 |
| *Strychnous potatorum* | **L** | 43.20 | 92.00 | 551.00 | 14.19 | 32.30 |
| | **U** | 43.20 | 76.00 | 25.60 | 0.70 | 32.60 |
| *Trema latifolia* | **L** | 43.20 | 127.00 | 151.00 | 5.15 | 35.60 |
| | **U** | 43.20 | 116.00 | 6.30 | 0.19 | 33.70 |
| *Tripetus sepiari* | **L** | 43.20 | 320.00 | 289.00 | 7.69 | 32.40 |
| | **U** | 43.20 | 232.00 | 16.20 | 0.46 | 33.00 |

- L= Abaxial side; U= Adaxial side

Appendix 22

Stomatal conductance, transpiration and leaf temperature of selected species in the Edalichedimantha unburnt plots

| Species | Side * | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Alphensia schlerocarpa* | L | 43.20 | 194.00 | 99.00 | 3.60 | 36.50 |
| | U | 43.20 | 1150.00 | 9.84 | 0.34 | 36.00 |
| *Atlantia monophila* | L | 43.20 | 98.99 | 12.50 | 0.42 | 35.80 |
| | U | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Canthium coromondalicum* | L | 43.20 | 420.00 | 84.00 | 2.67 | 34.90 |
| | U | 43.20 | 0.00 | 0.00 | 0.00 | 34.90 |
| *Cordia monica* | L | 43.20 | 360.00 | 783.00 | 23.34 | 34.70 |
| | U | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Drypetus sepiatus* | L | 43.20 | 1220.00 | 76.90 | 2.85 | 37.10 |
| | U | 43.20 | 1400.00 | 84.80 | 2.98 | 36.70 |
| *Glycosmis monotiium* | L | 43.20 | 184.00 | 67.60 | 2.13 | 34.90 |
| | U | 43.20 | 160.00 | 0.21 | 0.01 | 34.40 |
| *Ixora species* | L | 43.20 | 1460.00 | 196.00 | 6.97 | 36.40 |
| | U | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleosperma alatum* | L | 43.20 | 84.00 | 121.00 | 3.89 | 35.20 |
| | U | 43.20 | 186.00 | 17.90 | 0.56 | 34.80 |
| *Sapindus emerginatus* | L | 43.20 | 92.99 | 23.20 | 0.72 | 34.90 |
| | U | 43.20 | 0.00 | 0.00 | 0.00 | 34.90 |
| *Trema latifolia* | L | 43.20 | 280.00 | 21.80 | 0.72 | 35.50 |
| | U | 43.20 | 0.00 | 0.00 | 0.00 | 0.00 |

- L= Abaxial side; U= Adaxial side

Appendix 23

Stomatal conductance, transpiration and leaf temperature of selected species in the Kalladathupara burnt plots

| Species | Side * | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Attantia monphila* | L | 52.80 | 181.00 | 58.10 | 1.20 | 30.60 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bohunia recemosa* | L | 52.80 | 660.00 | 151.00 | 3.63 | 32.30 |
| | U | 52.80 | 789.90 | 27.50 | 0.61 | 31.70 |
| *Canthium coromandalicum* | L | 52.80 | 86.99 | 136.00 | 2.60 | 29.80 |
| | U | 52.80 | 100.00 | 25.90 | 0.50 | 29.70 |
| *Diospyrus cordifolia* | L | 52.80 | 239.00 | 308.00 | 6.26 | 31.10 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Kattunarakum tomillosa* | L | 52.80 | 220.00 | 697.00 | 11.43 | 28.60 |
| | U | 52.80 | 270.00 | 22.30 | 0.43 | 29.80 |
| *Pleospermia alatum* | L | 52.80 | 380.00 | 27.90 | 0.58 | 30.20 |
| | U | 52.80 | 809.90 | 12.10 | 0.28 | 31.20 |
| *Premna tomentosa* | L | 52.80 | 909.00 | 428.00 | 9.72 | 32.00 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Psilanthus wightianum* | L | 52.80 | 340.00 | 193.00 | 3.95 | 30.50 |
| | U | 52.80 | 349.90 | 0.00 | 0.00 | 30.20 |
| *Tripetus sepiari* | L | 52.80 | 599.90 | 155.00 | 3.37 | 31.00 |
| | U | 52.80 | 182.00 | 35.20 | 0.79 | 31.40 |

- L= Abaxial side; U= Adaxial side

Appendix 24

Stomatal conductance, transpiration and leaf temperature of selected species in the Kalladathupara unburnt plots

| Species | Side * | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Atlantia monophila* | L | 52.80 | 629.90 | 12.60 | 0.33 | 33.50 |
| | U | 52.80 | 560.00 | 11.00 | 0.12 | 33.10 |
| *Canthium coromandalicum* | L | 52.80 | 689.90 | 201.00 | 4.79 | 32.50 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 32.50 |
| *Cordia monoica* | L | 52.80 | 929.90 | 795.00 | 15.98 | 31.20 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Pleospermia alatum* | L | 52.80 | 162.00 | 68.80 | 1.60 | 32.40 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Psilanthus wightiana* | L | 52.80 | 560.00 | 49.90 | 1.24 | 33.10 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 33.10 |
| *Sapindus emerginatus* | L | 52.80 | 100.00 | 23.10 | 0.49 | 31.40 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Zygipus rugosa* | L | 52.80 | 270.00 | 336.00 | 6.75 | 33.30 |
| | U | 52.80 | 0.00 | 0.00 | 0.00 | 0.00 |

- L= Abaxial side; U= Adaxial side

Appendix 25

Stomatal conductance, transpiration, leaf temperature of selected species in the Panthanthodu burnt plots

| Species | Side* | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Artocarpus heterophyllus* | L | 42.00 | 1580.00 | 141.00 | 4.10 | 31.20 |
| | U | 42.00 | 550.00 | 132.00 | 3.20 | 29.20 |
| *Acronychia pedunculata* | L | 42.00 | 102.50 | 64.10 | 1.23 | 26.15 |
| | U | 42.00 | 100.50 | 0.00 | 0.00 | 26.35 |
| *Agalia anamallayana* | L | 37.20 | 52.00 | 32.50 | 0.78 | 28.65 |
| | U | 37.20 | 43.00 | 45.60 | 0.39 | 28.70 |
| *Bischofia javanica* | L | 42.00 | 134.00 | 294.00 | 6.76 | 29.20 |
| | U | 42.00 | 154.00 | 235.00 | 4.78 | 27.80 |
| *Clerodendron viseosum* | L | 42.00 | 705.00 | 69.40 | 1.30 | 25.90 |
| | U | 42.00 | 1420.00 | 0.00 | 0.00 | 29.50 |
| *Dimocarpus longum* | L | 42.00 | 899.90 | 23.20 | 0.64 | 30.80 |
| | U | 42.00 | 1650.00 | 25.20 | 0.59 | 29.40 |
| *Diospyrous paniculata* | L | 42.00 | 9.00 | 34.50 | 0.77 | 28.70 |
| | U | 42.00 | 31.00 | 13.60 | 0.30 | 28.40 |
| *Litsea indica* | L | 42.00 | 182.00 | 295.50 | 6.11 | 27.55 |
| | U | 42.00 | 471.90 | 18.30 | 0.41 | 27.95 |
| *Mallotus philippinensis* | L | 37.20 | 588.50 | 13.95 | 0.38 | 30.20 |
| | U | 37.20 | 88.00 | 0.00 | 0.00 | 30.80 |
| *Mesua ferrea* | L | 42.00 | 1050.00 | 31.30 | 0.88 | 31.30 |
| | U | 42.00 | 789.00 | 44.10 | 1.01 | 29.30 |
| *Neolitsea serobiculata* | L | 42.00 | 113.00 | 25.60 | 0.56 | 28.50 |
| | U | 42.00 | 96.00 | 8.82 | 0.19 | 28.20 |
| *Polyalthia fragnance* | L | 42.00 | 370.00 | 63.10 | 1.55 | 29.90 |
| | U | 42.00 | 74.00 | 48.10 | 1.58 | 33.20 |
| *Smilax species* | L | 37.20 | 110.00 | 22.60 | 0.59 | 30.00 |
| | U | 37.20 | 429.00 | 20.30 | 0.54 | 30.10 |
| *Syzygium lactum* | L | 42.00 | 919.00 | 237.00 | 6.59 | 31.20 |
| | U | 42.00 | 103.00 | 216.00 | 4.64 | 28.70 |
| *Syzygium munromii* | L | 37.20 | 34.00 | 39.30 | 0.99 | 29.30 |
| | U | 37.20 | 33.00 | 37.90 | 0.68 | 28.70 |
| *Trema orientalis* | L | 37.20 | 224.00 | 270.00 | 6.16 | 28.30 |
| | U | 37.20 | 36.00 | 155.00 | 3.76 | 28.90 |

*L= Abaxial side; U= Adaxial side

Appendix 26

Stomatal conductance, transpiration, leaf temperature of selected species in the Panthanthodu partially burnt plots

| Species | Side* | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Bischofia javanica* | L | 41.60 | 60.00 | 91.10 | 1.78 | 26.50 |
| | U | 41.60 | 22.00 | 36.30 | 0.77 | 27.50 |
| *Cullinea exrillata* | L | 41.60 | 31.00 | 16.05 | 0.31 | 26.40 |
| | U | 41.60 | 11.50 | 9.11 | 0.18 | 26.25 |
| *Calophyllum polyanthem* | L | 41.60 | 17.50 | 11.28 | 0.55 | 24.45 |
| | U | 41.60 | 26.50 | 6.71 | 0.12 | 24.50 |
| *Dimocarpus longum* | L | 41.60 | 290.00 | 7.65 | 0.16 | 27.00 |
| | U | 41.60 | 14.00 | 23.40 | 0.49 | 27.00 |
| *Litsea indica* | L | 41.60 | 6.00 | 19.80 | 0.39 | 26.00 |
| | U | 41.60 | 8.00 | 131.10 | 0.60 | 25.90 |
| *Mesua ferrea* | L | 37.60 | 2.00 | 25.60 | 0.46 | 24.60 |
| | U | 37.60 | 4.00 | 0.00 | 0.00 | 24.60 |
| *Mesua indica* | L | 41.60 | 429.50 | 153.50 | 2.72 | 25.40 |
| | U | 41.60 | 315.50 | 18.90 | 0.37 | 26.15 |
| *Neolitsea serobiculata* | L | 41.60 | 90.00 | 16.70 | 0.32 | 25.70 |
| | U | 41.60 | 11.00 | 19.30 | 0.39 | 26.30 |
| *Palaquium elliplium* | L | 41.60 | 12.50 | 22.80 | 0.41 | 24.70 |
| | U | 41.60 | 30.50 | 11.50 | 0.21 | 24.75 |
| *Persea macarantha* | L | 37.60 | 27.50 | 13.20 | 0.27 | 26.15 |
| | U | 37.60 | 7.00 | 0.00 | 0.00 | 26.25 |
| *Smilax species* | L | 41.60 | 13.00 | 11.10 | 0.24 | 25.10 |
| | U | 41.60 | 12.00 | 21.00 | 0.38 | 25.10 |
| *Thottea species* | L | 41.60 | 2.00 | 19.45 | 0.34 | 24.10 |
| | U | 41.60 | 3.00 | 9.25 | 0.16 | 24.55 |

*L= Abaxial side; U= Adaxial side

Appendix 27

Stomatal conductance, transpiration, leaf temperature of selected species in the Panthanthodu unburnt plots

| Species | Side * | RH (%) | Quantam (μ mol $m^{-2}s^{-1}$) | Conductance (m mol $m^{-2}s^{-1}$) | Transpiration (m mol $m^{-2}s^{-1}$) | Leaf temperature (°C) |
|---|---|---|---|---|---|---|
| *Acronyehia pedunculata* | L | 37.60 | 2.50 | 58.70 | 1.13 | 24.90 |
| | U | 37.60 | 4.50 | 0.05 | 0.00 | 24.85 |
| *Agalia anamallyana* | L | 37.60 | 5.00 | 12.88 | 0.26 | 25.50 |
| | U | 37.60 | 14.50 | 15.95 | 0.32 | 25.55 |
| *Calophyllum polyanthum* | L | 37.60 | 8.00 | 28.80 | 0.61 | 26.50 |
| | U | 37.60 | 7.00 | 21.20 | 0.45 | 26.50 |
| *Dimocarpus longum* | L | 37.60 | 3.50 | 34.90 | 0.70 | 30.40 |
| | U | 37.60 | 6.00 | 13.30 | 0.27 | 25.10 |
| *Garcinia morella* | L | 37.60 | 6.00 | 20.80 | 3.43 | 26.00 |
| | U | 37.60 | 3.00 | 0.00 | 0.00 | 26.10 |
| *Litsea indica* | L | 37.60 | 3.50 | 48.35 | 0.95 | 25.10 |
| | U | 37.60 | 2.00 | 12.65 | 0.25 | 25.30 |
| *Mesua farrea* | L | 37.60 | 27.50 | 44.1 | 0.939 | 26.5 |
| | U | 37.60 | 7.00 | 57.2 | 1.242 | 26.5 |
| *Neolitsea serobiculata* | L | 37.60 | 4.50 | 14.40 | 0.30 | 26.10 |
| | U | 37.60 | 5.00 | 0.00 | 0.00 | 26.20 |
| *Palaquium ellipticum* | L | 37.60 | 2.50 | 11.40 | 0.23 | 25.65 |
| | U | 37.60 | 2.00 | 17.45 | 0.35 | 25.60 |
| *Smilax species* | L | 37.60 | 15.50 | 13.20 | 0.27 | 26.15 |
| | U | 37.60 | 3.00 | 0.00 | 0.00 | 26.25 |
| *Syzygium laetum* | L | 37.60 | 7 | 37.9 | 0.801 | 26.5 |
| | U | 37.60 | 16 | 40.7 | 0.866 | 26.4 |
| *Thottea species* | L | 37.60 | 2.50 | 21.25 | 0.43 | 25.40 |
| | U | 37.60 | 5.00 | 3.85 | 0.08 | 25.25 |

*L= Abaxial side; U= Adaxial side

Appendix 28

Distribution of fungal population at different soil depths in unburnt and burnt plots at Edalichedimantha and Kalladathupara

| Soil core depth | Edalichedimantha Fungal population (cfu X $10^3$ /g of soil) | | | | Kalladathupara Fungal population (cfu X $10^3$ /g of soil) | | | |
|---|---|---|---|---|---|---|---|---|
| | Unburnt | | Burnt | | Unburnt | | Burnt | |
| | PDA | RBA | PDA | RBA | PDA | RBA | PDA | RBA |
| 0 – 5 cm | 16.66 ( 17 ) | 13.91 ( 15 ) | 15.33 ( 20 ) | 18 ( 18 ) | 24.5 ( 18 ) | 21.66 ( 18 ) | 29.25 ( 17 ) | 19.83 ( 10 ) |
| 5 – 10 cm | 8.22 ( 12 ) | 7.75 ( 12 ) | 19.49 ( 19 ) | 19 ( 15 ) | 14 ( 17 ) | 8.67 ( 17 ) | 14.25 ( 17 ) | 13.17 ( 10 ) |
| 10 – 15 cm | 9.56 ( 9 ) | 5.08 ( 13 ) | 15.41 ( 16 ) | 11.42 (10 ) | 21.75 ( 17 ) | 11.41 ( 19 ) | 15.42 ( 15 ) | 13.51 ( 12 ) |
| 15 – 20 cm | 6.11 ( 12 ) | 6.41 (9 ) | 20.66 ( 11 ) | 7.58 ( 7 ) | 17.92 ( 15 ) | 16.08 ( 11 ) | 18.74 ( 14 ) | 12.25 ( 11 ) |

- Mean value of three replicates from four plots in each treatment; figures given in parenthesis are the number of fungal species recorded in each category

Appendix 29

Fungal species recorded at different soil depths from burnt plots at Edalichedimantha on PDA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Pl ot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | - | - | - | - | 15.9 | 3.1 | - | - | 11 | 3.2 | 6.7 | - | 6.5 | 3.6 | 9.1 | 19 |
| *A. glaucus* | 6.1 | 17.9 | 6.82 | 13 | 2.27 | 3.1 | - | - | 11 | 22 | 37 | 10 | 3.2 | 3.6 | 4.5 | 39 |
| *A. kanagawaensis* | - | - | - | - | - | - | - | - | 24 | 48 | - | 5 | 1.6 | - | - | - |
| *A. niger* | 36 | 14.3 | 20.7 | - | 43.2 | 6.3 | 3.6 | - | 13 | - | 10 | - | - | - | - | - |
| *A. restrictus* | 18 | 10.7 | 6.9 | 13 | - | 3.1 | - | - | - | - | - | - | - | - | - | - |
| *A. viridinutans* | - | - | - | - | - | - | - | - | - | - | - | - | 21 | 7.1 | - | - |
| *Aspergillus sp.* | - | - | - | - | - | - | - | - | - | - | - | - | 9.7 | 32 | - | - |
| *Botryotrichum* sp. | 15 | 7.14 | 3.45 | 13 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cladosporium cladosporioides* | | | - | - | 4.54 | 13 | 11 | - | - | - | - | 5 | - | - | - | - |
| *Cladosporium oxysporum* | | - | - | - | - | - | - | - | - | - | - | - | 8.1 | 3.6 | - | - |
| *Colletotrichum Gloeosporioides* | | | - | - | - | - | 7.1 | - | - | - | - | - | - | - | - | - |
| *Curvularia lunata* | | - | - | - | 4.54 | 13 | 11 | - | - | - | - | - | - | - | - | - |
| *F. oxysporum* | 6.1 | - | - | 6.3 | 4.55 | 13 | 7.1 | 8.3 | - | - | - | - | - | - | - | - |
| *Fusarium solani* | - | - | 10.3 | - | - | - | - | - | 5.3 | 3.2 | 6.7 | 5 | 1.6 | - | - | - |
| *Geotrichum candidum* | | - | - | - | - | - | 2.1 | - | - | - | - | - | - | - | - | - |
| *Humicola fuscoatra* | - | - | - | 6.3 | 2.27 | - | - | - | 7.9 | - | - | - | - | - | - | - |
| *Melanospora* sp. | 3 | 3.57 | 3.45 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Paecilomyces fumosoroseus* | - | 3.57 | 27.6 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Paecilomyces viridis* | - | - | - | - | - | - | - | 8.3 | - | - | - | - | - | - | - | - |
| *Paecilomyces* sp. | | | | | | | | | | | | | | | | |
| *Penicillium* spp | 15 | 42.9 | 27.6 | 50 | 9.09 | 28 | 29 | 67 | 5.3 | 6.5 | 17 | 35 | 34 | 43 | 73 | 39 |
| *Rhizomucor pucillus* | - | - | - | - | - | - | 3.6 | - | - | - | 20 | 30 | - | - | 4.6 | - |
| *Trichoderma harzianum* | | - | - | - | 13.6 | 22 | - | 17 | 18 | 3.2 | - | - | - | - | - | - |
| *T. polysporum* | - | - | - | - | - | - | - | - | 5.3 | - | 3.3 | - | 3.2 | 7.1 | - | 3.2 |
| *Verticillium fungicola* | - | - | - | - | - | - | - | - | - | - | - | - | 1.6 | - | - | - |
| *Verticillium psaliotae* | - | - | - | - | - | - | - | - | - | 23 | - | - | - | - | - | - |

*A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.
PDA: Potato Dextrose Agar

Appendix 30

Fungal species recorded at different soil depths from unburnt plots at Edalichedimantha on PDA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | 7.4 | 3.6 | 2 | 2.3 | 8 | - | - | - | 10 | 6.7 | - | 15.8 | - | - | 14.3 | 54 |
| *A. fumigatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 17 |
| *Aspergillus glaucus* | 27 | 25 | 26 | 40 | 24 | 6.3 | - | 20 | - | 6.7 | 10 | 5.26 | 13 | 21.4 | 7.69 | 16.7 |
| *A. kanagawaensis* | - | - | - | - | - | - | - | - | 30 | 27 | - | 26.3 | - | - | - | - |
| *A. niger* | 24 | - | - | 12 | 4 | - | - | - | 10 | - | - | 5.26 | 4.3 | - | 15.4 | 17 |
| *A. parasiticus* | - | - | - | - | - | - | 10 | - | - | - | - | - | - | - | - | - |
| *A. versicolor* | - | - | - | - | - | - | - | - | - | - | - | - | 22 | 21 | - | 17 |
| *A. viridinutans* | - | - | - | - | - | - | - | - | - | - | 10 | 5.26 | - | - | - | - |
| *Alternaria* sp. | - | - | - | - | - | - | - | - | - | - | - | - | 4.4 | - | - | - |
| *Aspergillus* sp. | 15 | 3.6 | - | - | 16 | 19 | - | - | - | - | - | - | - | - | - | - |
| *Chaetomella raphigera* | - | - | - | - | 16 | - | - | - | - | - | - | - | - | - | - | - |
| *Cladosporium cladosporioides* | 2.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *F. oxysporum* | - | - | - | - | 8 | - | - | - | - | - | - | - | - | - | - | - |
| *Fusarium solani* | - | - | - | - | - | - | - | - | 17 | - | - | - | 8.7 | 7.1 | 15.4 | - |
| *Gibillula* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | 36 | - | - |
| *Paecilomyces* sp. | - | - | - | - | 4 | - | 10 | - | 3.3 | - | 10 | - | - | - | - | - |
| *Penicillium* spp. | 24 | 39 | 68 | 28 | 8 | 44 | 20 | 40 | - | 47 | 30 | 31.6 | 4.4 | - | 7.69 | - |
| *Pestalotiopsis* sp. | - | 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Rhizomucor pucillus* | - | 7.1 | - | - | - | - | - | - | - | 6.7 | 10 | 5.26 | - | - | - | - |
| *Rhizopus microsporus* | - | - | - | - | 12 | - | - | - | - | - | - | - | - | - | - | - |
| *Rhizopus stolonifer* | - | - | - | - | - | - | - | - | - | - | - | - | 4.4 | - | - | 33 |
| *T. polysporum* | - | 3.6 | - | - | - | 31 | 60 | 40 | 20 | 6.7 | 30 | - | 39 | - | - | - |
| *Verticillium* sp. | - | 3.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Thielaviopsis* sp. | - | - | - | - | - | - | - | - | 10 | - | - | 5.26 | - | - | - | - |

*A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.; PDA: Potato Dextrose Agar Medium

Appendix 31

Fungal species recorded at different soil depths from burnt plots at Edalichedimentha on RBA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | 3.19 | 7.14 | 27.3 | - | 4.17 | - | - | - | 3.33 | 7.69 | - | - | 25 | 7.14 | - | 25 |
| *A. glaucus* | 1.06 | 9.52 | 6.82 | 12.5 | 2.08 | 15.6 | 25 | - | - | - | 27.3 | 25 | 2.77 | 10.7 | - | - |
| *A. niger* | 27.65 | 28.6 | - | - | 37.5 | - | - | - | 6.66 | - | - | - | - | - | - | - |
| *A. restrictus* | 20.21 | 11.9 | 11.4 | - | 10.4 | - | 10 | - | - | - | - | - | - | - | - | - |
| *A.kanagawaensis* | - | - | - | - | 2.08 | 3.13 | 10 | - | 13.3 | 38.5 | - | - | 2.77 | - | - | 25 |
| *Aspergillus* spp. | - | - | - | - | - | - | - | - | 16.7 | - | - | - | 16.7 | 25 | - | - |
| *Cladosporium cladosporioides* | - | - | - | - | - | - | - | 38.5 | 3.33 | - | - | - | - | - | - | - |
| *F. oxysporum* | 1.06 | 4.76 | 6.82 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Fusarium solani* | - | - | 2.27 | 12.5 | - | - | - | - | - | - | 9.09 | - | - | - | - | - |
| *Humicola fuscoatra* | 2.13 | - | - | - | 6.25 | - | - | - | - | - | - | - | - | - | - | - |
| *Melanospora* sp. | 2.13 | 4.76 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Paecilomyces fumosoroseus* | 1.06 | 4.76 | 11.4 | 37.5 | - | - | - | - | - | - | - | - | - | - | - | - |
| *P. lilacinus* | - | - | - | - | - | - | - | - | - | - | 9.09 | - | - | - | - | - |
| *P. viridis* | - | - | - | - | 8.33 | 12.5 | 5 | 7.69 | - | - | 9.09 | - | - | - | - | - |
| *Paecilomyces* sp. | - | - | - | - | - | - | - | - | 3.33 | - | - | - | 8.33 | - | - | - |
| *Penicillium* spp. | 41.49 | 28.6 | 34.1 | 37.5 | 18.8 | 68.8 | 50 | 53.9 | 36.7 | 38.5 | 45.5 | 12.5 | 36.1 | 42.9 | 85.3 | - |
| *Rhizomucor pucillus* | - | - | - | - | - | - | - | - | - | - | - | 25 | 2.78 | 3.57 | - | - |
| *Trichoderma hamatum* | - | - | - | - | 10.4 | - | - | - | 16.7 | 15.4 | - | 37.5 | - | - | - | - |
| *T. polysporum* | - | - | - | - | - | - | - | - | - | - | - | - | 5.55 | 3.57 | | - |
| *Verticillium* sp. | - | - | - | - | - | - | - | - | - | - | - | - | 7.14 | 5.55 | - | - |

A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm;
D: soil core depth 15-20 cm.
RBA: Rose Bengal Agar Medium

Appendix 32

Fungal species recorded at different soil depths from unburnt plots on RBA medium at Edalichedimantha and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus* sp. | 37 | 32 | - | 31 | 3.77 | - | 13 | 2.1 | - | - | - | - | 22 | 18 | 5.6 | - |
| *A. glaucus* | 13 | 17 | 5.9 | - | 47.2 | 20 | 13 | 19 | 39 | 18 | 27 | 60 | - | - | - | - |
| *A. flavus* | 2.2 | - | 8.8 | 6.3 | 3.77 | 16 | 25 | 25 | 8.7 | 24 | 18 | - | - | 24 | 11 | - |
| *A. fumigatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | 5.9 | - | 25 |
| *A. niger* | 36 | - | - | 6.3 | 5.66 | 28 | - | - | 22 | 12 | - | - | 19 | 12 | 17 | 13 |
| *A. versicolor* | - | - | - | - | - | - | - | - | - | - | - | - | 7.4 | - | 5.6 | - |
| *Fusarium solani* | - | - | - | - | 5.66 | - | - | - | - | - | - | - | 3.7 | - | - | - |
| *F. oxysporum* | - | - | - | - | 3.77 | - | 13 | - | 8.7 | 24 | - | - | - | - | - | - |
| *Gibillula* sp. | - | - | - | - | - | - | - | - | - | - | - | - | 3.7 | 12 | 11 | - |
| *Paecilomyces* sp. | 1.5 | 7.3 | 8.8 | 13 | - | - | - | - | 4.4 | - | - | - | - | - | - | - |
| *Penicillium* spp. | 9.5 | 41 | 65 | 44 | 11.3 | 36 | 13 | 44 | - | 12 | 55 | 40 | 11 | 24 | 28 | 50 |
| *Rhizomucor pucillus* | 1.5 | 2.4 | 5.9 | - | - | - | - | - | - | 5.9 | - | - | - | - | - | - |
| *Rhizopus microsporus* | | | - | - | - | - | - | - | - | - | - | - | 7.4 | 5.9 | 11 | 13 |
| *Thielaviopsis* sp. | - | - | - | - | - | - | - | - | 4.4 | - | - | - | - | - | - | - |
| *Trichoderma hamatum* | - | - | - | - | 9.43 | - | 13 | 10 | - | - | - | - | - | - | - | - |
| *T. polysporum* | - | - | 5.9 | - | 9.43 | - | 13 | - | 13 | 5.9 | - | - | 26 | - | 11 | - |

*A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.
RBA: Rose Bengal Agar Medium

Appendix 33

Fungal species recorded at different soil depths from burnt plots on PDA medium at Kalladathupara and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *A. flavus* | 2.63 | 11.9 | 11 | 2.8 | 14 | 4.4 | - | - | 26 | 4.9 | 3.7 | - | 9.4 | 22 | 2.94 | 3.45 |
| *A. fumigatus* | - | - | - | - | - | - | - | - | 20 | 3.7 | - | - | - | - | - | - |
| *Aspergillus glaucus* | 2.63 | 9.52 | 6.4 | 2.8 | 15 | 17 | 34 | 20 | 2.4 | 2.4 | 11 | 4.6 | 14 | - | - | 6.9 |
| *A. niger* | 3.95 | 9.52 | 6.4 | 2.8 | 10 | 2.2 | 11 | - | 12 | 2.4 | 3.7 | 6.8 | 6.3 | 9.4 | 2.94 | 10.3 |
| *A. restrictus* | - | - | 4.3 | 8.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| *A. viridinutans* | 3.94 | 4.76 | 13 | 8.3 | 5.1 | 8.7 | 21 | 14 | 9.5 | 24 | 15 | - | - | 13 | 17.6 | - |
| *Aspergillus* sp. | - | - | - | - | 22 | 13 | 2.3 | 20 | - | - | - | 2.3 | 14 | 22 | 11.8 | 6.9 |
| *Amniosporium* sp. | 1.32 | - | - | - | - | - | - | | - | - | - | - | - | - | - | - |
| *Chaetomella raphigera* | | - | - | - | 1.3 | 2.2 | - | - | - | - | - | - | - | - | - | - |
| *Fusarium solani* | 3.95 | 2.38 | 2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Fusarium* sp. | - | - | - | - | 4.4 | - | - | - | - | - | - | - | - | - | - | - |
| *Mucor* sp. | - | - | - | - | - | - | - | - | - | 9.8 | 3.7 | 2.3 | - | - | 17.6 | 17.2 |
| *Paecilomyces fumosoroseus* | 40.8 | 28.6 | 15 | 22 | 5.1 | 11 | 9.1 | 11 | - | 17 | 7.4 | - | 1.6 | - | 2.94 | 6.9 |
| *Penicillium* spp. | 7.89 | 21.4 | 13 | 17 | 13 | 17 | 16 | 26 | 24 | 12 | 26 | 41 | 4.7 | 6.3 | 5.88 | 27.6 |
| *Rhizomucor pucillus* | 11.8 | - | 11 | 2.8 | - | - | - | - | 19 | 2.4 | 22 | 21 | 7.8 | 16 | - | 13.8 |
| *Rhizopus stolonifer* | - | 7.14 | - | 2.8 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Trichoderma hamatum* | | - | - | - | 2.6 | 6.5 | 4.6 | 8.6 | 7.1 | 2.4 | 3.7 | 14 | 38 | 13 | 29.4 | - |
| *Trichoderma harzianum* | 3.94 | 2.38 | 6.4 | 19 | - | - | - | - | - | - | - | - | - | - | 5.88 | 6.9 |
| *T. polysporum* | - | - | - | - | - | - | - | - | - | - | - | - | 4.7 | - | 2.94 | - |
| *Ascomycetes* fungus | - | - | - | - | 6.4 | 4.4 | 2.3 | - | - | - | - | - | - | - | - | - |
| Unidentified | - | - | - | - | 5.1 | 8.7 | - | - | - | 2.4 | - | 9.1 | - | - | - | - |

*A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

PDA: Potato Dextrose Agar Medium

Appendix 34

Fungal species recorded at different soil depths from unburnt plots on PDA medium at Kalladathupara and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | 14.5 | 4.17 | 15 | - | 35 | 23 | 15 | 4.2 | - | - | - | 18 | 1.9 | - | 11 | 5.4 |
| *A. glaucus* | 25 | 12.5 | | 6.9 | 9.3 | 6.7 | 9.8 | 2.1 | - | 7.7 | 5.6 | 33 | 9.3 | 7.4 | 11 | 2.7 |
| *A. kanagawaensis* | - | - | - | - | - | - | - | - | - | - | - | - | 9.3 | 7.4 | 2.8 | 16 |
| *A. niger* | - | - | - | - | - | - | - | 2.1 | - | - | 5.6 | - | 7.4 | 37 | 11 | 2.7 |
| *A. viridinutans* | - | - | - | - | - | - | - | - | 8.6 | - | - | - | - | - | - | - |
| *Aspergillus* sp. | - | - | - | - | 41 | 6.7 | - | 2.1 | - | - | - | - | 19 | 3.7 | 2.8 | 5.4 |
| *Circinella* sp. | - | - | - | - | - | - | - | - | - | 23 | 17 | - | 5.6 | 3.7 | 2.8 | 16 |
| *Cunninghamella echinulata* | | | 9.1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Curvularia* sp. | 10.5 | 4.17 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *F. oxysporum* | - | - | - | - | - | - | - | - | - | - | - | - | 3.7 | 11 | - | 5.4 |
| *Fusarium solani* | - | 4.17 | 18 | 3.5 | 0.9 | 6.7 | 17 | - | - | - | - | - | - | - | - | - |
| *Gongronella* sp. | - | - | - | - | - | - | - | - | - | 7.7 | 17 | - | - | - | - | - |
| *Mucor* sp. | - | - | - | - | - | 3.3 | 2.4 | - | - | - | - | - | - | - | - | - |
| *Paecilomyces lilacinus* | | - | - | - | - | - | - | - | - | - | - | 6.1 | 1.9 | 3.7 | 11 | 8.1 |
| *Penicillium* spp | 25 | 62.5 | 49 | 38 | - | 50 | 51 | 60 | 49 | 31 | 17 | 31 | 7.4 | 26 | 17 | 5.4 |
| *Phoma* sp. | - | - | - | - | - | - | - | - | 17 | - | - | - | - | - | - | - |
| *Rhizomucor pucillus* | | - | - | 45 | - | - | - | - | - | 7.7 | 28 | - | 3.7 | - | 8.3 | 8.1 |
| *Rhizopus stolonifer* | 1.32 | 4.17 | | 3.5 | 0.9 | | | 23 | | 15 | - | 7.3 | - | - | - | - |
| *Trichoderma hamatum* | | - | - | - | - | - | - | - | 2.9 | - | - | - | 20 | - | 2.8 | 14 |
| Ascomycetes | 19.7 | 4.17 | - | - | - | - | - | - | 8.6 | 7.7 | 5.6 | 2.4 | - | - | - | - |
| Unidentified | 1.32 | 4.17 | - | 3.5 | 13 | 3.3 | 4.9 | 6.3 | 14 | - | 5.6 | 2.4 | 9.3 | - | 17 | - |

*A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

PDA: Potato Dextrose Agar Medium

## Appendix 35

Fungal species recorded at different soil depths from burnt plots at Kalladathupara on RBA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | 22.6 | 14.6 | 8.3 | 23 | 15 | 1.8 | 5.1 | 2.8 | 3 | 8.8 | 4.4 | 1.3 | 4.3 | 28 | - | 3.3 |
| *A. glaucus* | 3.77 | 14.6 | 17 | 18 | 15 | 25 | 13 | 28 | 1 | 5.9 | - | - | 13 | - | - | 4.9 |
| *A. niger* | 1.88 | 2.44 | - | - | - | - | 7.7 | 2.8 | 6 | 15 | 3.3 | 6.3 | 6.1 | 3.9 | - | 6.6 |
| *A. restrictus* | 9.43 | 9.76 | 2.1 | 25 | - | - | - | - | - | - | - | - | - | - | - | - |
| *A. viridinutans* | - | - | - | - | - | - | - | - | - | - | - | - | 6.1 | 29 | 44 | 1.6 |
| *Aspergillus* sp. | 18.9 | - | 23 | - | 12 | 49 | - | 5.6 | 6 | 5.9 | 1.1 | 16 | 8.7 | 14 | - | - |
| *Amniosporium* sp. | - | 2.44 | 2.1 | 4.6 | - | 1.8 | 2.6 | - | - | - | - | - | - | - | - | - |
| *Paecilomyces fumosoroseus* | 1.88 | - | 4.2 | 4.6 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Penicillium* spp. | 28.3 | 41.5 | 42 | 23 | 32 | 14 | 54 | 61 | 83 | 65 | 68 | 73 | 62 | 26 | 56 | 84 |
| *Rhizomucor pucillus* | | - | - | - | - | - | - | - | - | - | 23 | 3.8 | - | - | - | - |
| *Trichoderma hamatum* | 11.3 | 14.6 | 2.08 | 2.27 | 27 | 3.5 | 13 | - | 1 | - | - | - | - | - | - | - |
| *T. polysporum* | 1.88 | - | - | - | - | 5.3 | 5.1 | - | - | - | - | - | - | - | - | - |

*A: soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm;
D: soil core depth 15-20 cm.
RBA: Rose Bengal Agar Medium

Appendix 36

Fungal species recorded at different soil depths from unburnt plots on RBA medium at Kalladathupara and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | 2.89 | 7.41 | 13 | 39 | 12 | 5 | - | 4.6 | 16 | 18 | 17 | 24 | 23 | 16 | 13 | 6.7 |
| *A. glaucus* | 30.4 | 29.6 | 13 | - | 2 | - | 21 | 1.5 | 26 | 14 | 10 | 39 | 4.5 | - | 4.8 | 20 |
| *A. niger* | - | - | 6.3 | 11 | - | - | - | - | - | 3.5 | 10 | 6.3 | 9.1 | 19 | 7.9 | - |
| *A. viridinutans* | - | - | - | - | 25 | 23 | 42 | 9.1 | 5.3 | 8.8 | - | 13 | - | - | - | - |
| *Aspergillus* sp. | 14.5 | 22.2 | - | - | 40 | 2.5 | 0.6 | 44 | - | - | - | - | 14 | - | 13 | - |
| *Amniosporium* sp. | 1.45 | - | - | - | - | 2.5 | 2.4 | - | 2.6 | - | - | - | - | - | - | - |
| *Circinella sp.* | - | - | - | - | - | - | - | - | - | - | - | 1.3 | - | 14 | - | - |
| *Colletotrichum gloeosporioides* | | | - | - | - | - | - | - | 1.3 | 11 | - | - | - | - | - | - |
| *Dictyoarthrinum* sp. | - | - | - | - | - | - | - | - | 2.6 | - | 3.5 | 1.3 | 1.5 | 2.7 | - | - |
| *F. oxysporum* | 4.35 | - | 25 | 28 | - | 2.5 | 0.6 | - | 2.6 | 1.8 | - | - | - | 5.4 | 16 | 23 |
| *Fusarium solani* | - | - | - | - | - | - | - | - | - | - | - | - | 14 | 5.4 | 18 | 6.7 |
| *Fusarium* sp. | 7.25 | - | - | - | 1 | 2.5 | 2.4 | 6.1 | 12 | 5.3 | 3.5 | - | - | - | - | - |
| *Mucor* sp. | - | - | - | - | - | - | - | - | 2.6 | - | 8.6 | - | - | - | - | - |
| *Penicillium* spp. | 17.4 | 40.7 | 44 | 22 | 16 | 63 | 30 | 35 | 18 | 26 | 29 | 14 | 12 | 35 | 19 | 20 |
| *Rhizomucor pucillus* | - | - | - | - | - | - | - | - | - | 7 | 3.5 | - | 15 | - | 3.2 | - |
| *Rhizopus stolonifer* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3.2 | - |
| *Thielaviopsis* sp. | - | - | - | - | 3 | - | 0.6 | - | - | - | - | - | - | - | - | - |
| *Trichoderma hamatum* | | - | - | - | - | - | - | - | 3.9 | 3.5 | 1.7 | 2.5 | 3 | - | 1.6 | 23 |
| *Trichoderma harzianum* | | - | - | - | - | - | - | - | 6.6 | 1.8 | 1.7 | - | - | - | - | - |
| *Trichoderma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.6 | - |
| Ascomycetes fungus | - | - | - | - | - | - | - | - | - | - | 10 | - | - | - | - | - |
| Unidentified | 21.7 | - | - | - | - | - | - | - | - | - | - | - | 4.5 | 2.7 | - | - |

*: Soil core depth 0-5 cm; B: Soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

RBA: Rose Bengal Agar Medium

Appendix 37

Fungi recorded from burnt and unburnt soils at Kalladathupara and Edalichedimantha

| Sl.No. | Fungi | Edalichedimentha | | Kalleduthapura | |
|---|---|---|---|---|---|
| | | Burnt | Unburnt | Bunt | Unburnt |
| 1 | *Alternaria* sp. | - | + | - | - |
| 2 | *Amniosporium* sp. | - | - | + | - |
| 3 | *Aspergillus flavus* | + | + | + | + |
| 4 | *A. flavipus* | - | + | - | - |
| 5 | *A. fumigatus* | - | + | + | _ |
| 6 | *A. glaucus* | + | + | + | + |
| 7 | *A. kanagawaensis* | + | + | + | + |
| 8 | *A. niger* | + | + | - | + |
| 9 | *A. restrictus* | + | - | + | - |
| 10 | *A. versicolor* | - | + | - | - |
| 11 | *A. viridinutans* | + | + | + | + |
| 12 | *Aspergillus* sp. | + | + | + | + |
| 13 | *Botryotrichum* sp. | + | - | - | - |
| 14 | *Chaetomella raphigera* | - | + | + | - |
| 15 | *Cladosporium cladosporioides* | + | + | - | - |
| 16 | *C. oxysporum* | + | - | - | - |
| 17 | *Colletotrichum gloeosporioides* | + | - | - | + |
| 18 | *Cunninghamella echinulata* | - | - | - | + |
| 19 | *Curvularia lunata* | + | - | - | - |
| 20 | *Curvularia* sp. | - | - | - | + |
| 21 | *Dictyoarthrinium* sp. | - | - | - | + |
| 22 | *Fusarium oxysporum* | + | + | - | + |
| 23 | *F. solani* | + | + | + | + |
| 24 | *F. tricinctum* | - | - | + | + |
| 25 | *Fusarium* sp. | - | - | + | + |
| 26 | *Geotrichum candidum* | + | - | - | - |
| 27 | *Gibellula* sp. | - | + | - | - |
| 28 | *Gongronella* sp. | - | - | - | + |
| 29 | *Humicola fuscoatra* | + | - | - | - |
| 30 | *Melanospora* sp. | + | - | - | - |
| 31 | *Mucor* sp. | - | - | + | + |
| 32 | *Paecilomyces fumosoroseus* | + | - | + | - |
| 33 | *P. lilacinus* | + | - | + | - |
| 34 | *P. viridis* | + | - | - | - |
| 35 | *Paecilomyces* sp. | + | + | - | - |
| 36 | *Penicillium* spp. | + | + | + | + |
| 37 | *Pestalotiopsis* sp. | - | + | - | - |
| 38 | *Phoma* sp. | - | - | - | + |

| | | | | | |
|---|---|---|---|---|---|
| 39 | *Rhizomucor pusillus* | + | + | + | + |
| 40 | *R. microcarpus* | - | + | - | - |
| 41 | *Rhizopus stolonifer* | - | + | + | + |
| 42 | *Thielaviopsis* sp. | - | + | - | + |
| 43 | *Staphylotrichum coccosporum* | - | + | - | - |
| 44 | *Syncephalastrum recemosum* | + | - | - | - |
| 45 | *Trichoderma hamatum* | + | + | + | + |
| 46 | *T. harzianum* | + | - | + | + |
| 47 | *T. polysporum* | + | + | + | + |
| 48 | *Trichoderma* sp. | - | - | - | + |
| 49 | *Verticillium fungicol* | + | - | - | - |
| 50 | *V. psaliotae* | + | - | - | - |
| 51 | *Verticillium* sp. | + | + | - | - |
| 52 | Unidentified Ascomycetes | - | - | + | + |
| 53 | Unidentified Deuteromycetes | - | - | + | + |
| | Total | 30 (16) | 26 ( 15) | 23 ( 11 ) | 27 ( 16) |

Appendix 38

VAM fungal spores recorded in burnt and unburnt plots

| VAM fungi | Edalichedimantha | | | | | | | | Kalladathupara | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Burnt | | | | Unburnt | | | | Burnt | | | | Unburnt | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Acaulospora appendiculata* | | | | | * | * | * | | * | * | * | * | | * | | * |
| *A. bireticulata* | | | * | | * | | | | * | * | * | * | | | | |
| *A. delicata* | * | | | | * | | | | * | * | * | | | * | | |
| *A. foveata* | | | | | | | | | * | * | | | | | | |
| *A. rehmii* | * | | | | | | | | * | | | * | | * | | |
| *A. scrobiculata* | * | * | | | * | * | | | * | * | * | * | * | | | * |
| *Acaulospora* sp. | * | | | | * | * | | | * | * | | * | * | | | |
| *Gigaspora candida* | | * | * | | * | * | | | * | | * | | | | | * |
| *G. candida* | | | | | | | | | | * | | * | | | | * |
| *G. decipiens* | * | * | * | | * | * | | | * | * | * | * | | | * | * |
| *G. gigantia* | * | * | * | * | | * | * | | * | * | * | * | * | * | | |
| *G. margerita* | | | | | * | * | | | | | | | | | | |
| *G. rosea* | | | | | | | | | | | | | * | | | |
| *Gigaspora* sp. | | | | * | * | * | * | | * | | * | | | | | |
| *Glomus albidum* | | | * | | | | | | | * | | | | | | |
| *G. australe* | | | | | | | | | * | | | | | * | | |
| *G. botryoides* | | | | | | * | | | * | | | | | * | | |
| *G. candense* | | | | | * | | | | * | | | | | | | |
| *G. claroideum* | | | | | | | | | | | * | | | | | |
| *G. constrictum* | | | | | | | | | * | | | | | | | |
| *G. deserticola* | | | | | * | | * | | * | * | * | * | * | * | | |
| *G.delhiense* | | | | | * | | | | * | | | | | | | |
| *G. fasciculatum* | * | * | * | | * | * | * | | * | * | * | | * | * | | * |
| *G. geosporum* | | | | | * | | * | | * | | * | | | * | | |
| *G. globiferum* | | | | | | | | | * | | * | | | | | |
| *G. glomerulatum* | | | | | * | | | | | | | | | | | |
| *G. hoi* | | | | | * | | | | * | | | | | | | |
| *G. invermaium* | * | | | | * | | | | | | | | | | | |
| *G. lacteum* | | | | | | * | | | * | * | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *G. macrocarpum* | | * | | | * | * | | | * | * | * | | | * | | |
| *G. maculosum* | * | | | | * | * | * | * | * | | * | * | * | | | |
| *G. melanosporum* | | * | * | | | * | * | * | * | * | * | * | * | * | | * |
| *G. microcarpum* | | * | | | * | | | | * | * | | * | * | | | |
| *G. mosseae* | * | * | * | | * | * | | * | * | * | * | | | * | * | |
| *G. multisubtensum* | | | | | | | | | * | | | | | | | |
| *G. reticulatum* | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| *G. tenue* | | | | | * | | | | * | | * | | | | | |
| *G. tortuosum* | | | | | | | | | * | | | | * | | | |
| *Glomus* sp, | | | | | | * | | | * | | * | * | * | | | * |
| *Sclerocystis microcarpus* | | | | | * | | | | | | | | | | | |
| *Scutellospora auriglob*a | | * | | | | | | | | * | | | | | | |
| *S. calospora* | | | | | | * | | | | | | | | | | |
| *S.erythropa* | * | | | | * | | | | * | * | | | | | * | |
| *S. gregaria* | | | | | | | | | | * | | | | | | |
| *S. heterogama* | | | | | | | | | * | | | | * | | | |
| *S. .nigra* | * | * | * | * | * | * | | | * | * | * | * | | * | * | * |
| *S. persica* | | * | | | * | | | | | * | * | | | | | |
| *S. reticulata* | | | | | | | | | * | * | | | | | | |
| *Scutellospora* sp. | * | * | * | | * | * | | | * | * | * | | | * | | |
| *Entrophospora* sp | | * | | | * | * | * | | * | | | | | | | |

## Appendix 39

Fungi recorded from unburnt plots on PDA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | *A* | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | | | | | | | | | 4.4 | 2.2 | 11 | | | 2.9 | | 5.9 |
| *A. fumigatus* | | | | | | | | | | 4.4 | 14 | 38 | 21 | 15 | 21 | 47 |
| *A. glaucus* | | | | | | | | | | 6.5 | 2.7 | | | | | |
| *A. niger* | 8.33 | | | 7.7 | 5.9 | 5.7 | | | | 2.2 | | | | 2.9 | 7.1 | |
| *Aspergillus* sp. | 4.17 | 5.26 | | | | | | | | | | | | | | |
| *Chaetophoma* sp. | 4.17 | | | | | | | | | | | | | | | |
| *Humicola* sp. | | | | | | | | | | 4.4 | 2.2 | | | | | |
| *Paecilomyces fumosoroseus* | | | | | | | | | 8.7 | 4.4 | 5.4 | | 16 | 27 | | |
| *Paecilomyces lilacinus* | 41.7 | 47.4 | 27 | 15 | 47 | 54 | 25 | 24 | 22 | 4.4 | 2.7 | | | | | |
| *Penicillium variens* | | | | | | | | | | | | 4.2 | | | | |
| *Penicillium* spp. | | 26.3 | 9.1 | 31 | 5.9 | 14 | 13 | 4.8 | 17 | 33 | 19 | 21 | 30 | 27 | 7.1 | 29 |
| *Pestalotiopsis uvicola* | | | | | | | | | | 2.2 | 14 | | 9.3 | | | 5.9 |
| *R. microsporus var. rhizopodiformis* | | | | | | | | | 13 | 8.7 | | | 4.7 | 2.9 | 7.1 | |
| *Rhizopus stolonifer* | | | | | 2.9 | | 13 | | | | | | | | | |
| *Thielaviopsis* sp. | | | | | | | | | | 2.2 | 8.1 | 4.2 | | | | |
| *Trichoderma hamatum* | 29.2 | 15.8 | 36 | 46 | 21 | 11 | | 24 | 13 | 6.5 | 5.4 | 13 | | 12 | 14 | 5.9 |
| *Trichoderma harzianum* | | | | | | | | | 4.3 | 2.2 | | | | | | |
| *T.piluliferum* | 8.33 | 5.26 | 27 | | | | | | | | | | 2.3 | | 14 | |
| *T. polysporum* | 4.17 | | | | 18 | 14 | 50 | 48 | 17 | 8.7 | 5.4 | 13 | 16 | 12 | 29 | 5.9 |
| Ascomycetes | | | | | | | | | | 6.5 | | | | | | |

- A: Soil core depth 0-5 cm; B: soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

Appendix 40

Fungi recorded from partially burnt plots on PDA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Acremonium* sp. | | | | | | | | | 2.5 | 3.7 | | | | | 4 | 10 |
| *Aspergillus flavus* | | 4.9 | | | 13 | | 19 | 9.4 | 10 | | 17 | 27 | 12 | | | |
| *A. fumigatus* | 20 | | 26 | 32 | 11 | | 43 | 19 | | | | | 10 | | | 10 |
| *A. glaucus* | 5.6 | 2.4 | 7.4 | 14 | | | 7.6 | 9.4 | 5 | 15 | 2 | 12 | | 6 | | |
| *A. niger* | 7.4 | 2.4 | | 4.6 | | | 3.8 | | | | | 5.9 | | | | |
| *A. ornatus* | | | | | 6.5 | 9 | 1.9 | 3.1 | | | | | 12 | 6 | 4 | 5 |
| *Aspergillus* sp. | | | | 14 | | | | | | | | | | | | 5 |
| *Chaetophoma* sp. | | | | | | | | | | | | | | 6 | | |
| *Eurotium* sp. | | | | | 2.2 | | 1.9 | | | | | 2.9 | 16 | 18 | | |
| *F.nivale* | 7.4 | | 1 | 4.6 | | | | | | | | | | | | |
| *Fusarium* sp. | | | | | 2.2 | | | | | | | | | | | |
| *Mucor* sp. | 7.4 | 2.4 | 3.7 | | | | | | | | | | | | | |
| *Paecilomyces fumosoroseus* | 26 | 7.3 | 22 | | 6.5 | 9 | | 13 | 10 | | | 12 | 14 | 29 | 17 | 5 |
| *Paecilomyces lilacinus* | 42 | | | | | | | | | | | | | | | |
| *Penicilliumspp* | 3.7 | 22 | 30 | 27 | 15 | 16 | 38 | 16 | 15 | 41 | 38 | 29 | 20 | 12 | 46 | 43 |
| *Rhizomucor* sp. | 9.3 | | | | 2.2 | 4 | 15 | 3.1 | 15 | 3.7 | 25 | 8.8 | 6 | | 4 | |
| *Rhizopus* sp. | | | | | 6.5 | | | 28 | | | | | | | | |
| *Thielaviopsis* sp. | | | 3.7 | | | | | | | 7.4 | | | | 6 | 8 | |
| *Trichoderma hamatum* | | 7.3 | | | | | | | 13 | | 2 | | 2 | 6 | | |
| *Trichoderma harzianum* | 1.9 | | | | | | | | 7.5 | 3.7 | 9 | | | | | |
| *T.piluliferum* | 11 | | | | 33 | 44 | | | | | | | 6 | | 4 | |
| *T. polysporum* | | 49 | 3.7 | 4.6 | 2.2 | 18 | | | 2.5 | | | | | | | |
| *Verticillium* sp. | | | 3.7 | | | | | | | | | | | | | |

- A: Soil core depth 0-5 cm; B: soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

Appendix 41

Fungi recorded from burnt plots on PDA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Actinomucor* sp. | | | | | 1.5 | 9 | 5.7 | 3.7 | | | | | | | | |
| *Aspergillus flavus* | | | | | | | | | 16 | 8.7 | | | | | | 42 |
| *A. fumigatus* | | 5.9 | 13 | 31 | 1.4 | | 14 | 7.4 | 8.9 | 2.2 | 38 | | | | | 42 |
| *A. glaucus* | 4.2 | | 8.3 | 31 | | | | | 1.8 | 6.5 | | | | | | |
| *A. niger* | 4.2 | 5.9 | | 7.7 | | 3 | 2.9 | | 1.8 | 2.2 | | | | | | |
| *Aspergillus* sp. | | | | | | 8 | 6.4 | 21 | | | | | | | 14 | |
| *Bahuskala* sp. | | | | | | | | | | | | | | | 7 | |
| *Chaetomella* sp. | | | | | | | | | | | | | | 2 | | |
| *Cunninghamella echinulata* | | | | | | | | | | | | | | | 4 | |
| *Eurotium* sp. | | | | | | | | | | | | | 17 | 2 | | |
| *Fusarium dimerum* | | | | | | | | | | | | | 2 | | | |
| *Fusarium solani* | | | | | 2.9 | | 14 | | | | | | | | | |
| *Gongronella butleri* | | | | | | | | | | | 4 | | | | | 8 |
| *Gongronella* sp. | | | | | 1.5 | | | 3.7 | | | | | | | | |
| *Mucor* sp. | 33 | 35 | 46 | | 10 | 13 | 17 | 15 | | | | | | | | |
| *Paecilomyces fumosoroseus* | 13 | | | | | | | | 7.1 | 11 | 17 | 42 | 15 | 24 | 36 | |
| *Paecilomyces* sp. | | | | | | | | | 5.4 | | 17 | | | 2 | 11 | |
| *P. varigatum* | | | | | | | 5.7 | 52 | | | | | | | | |
| *Penicillium* spp. | 17 | 12 | 4.2 | 7.7 | 16 | 19 | 17 | | 8.9 | 54 | | 19 | | 19 | 11 | 42 |
| *Rhizomucor* sp. | | | | | | | | | 29 | 8.7 | 4 | | 21 | 5 | | |
| *Rhizopus stolonifer* | 17 | | 13 | | 30 | | 11 | | | 2.2 | | 19 | | | | |
| *Staphylotrichum* sp. | | | | | | | | | | | | | | | | 4 |
| *Trichoderma hamatum* | | | 17 | | 1.5 | 38 | | 3.7 | 8.9 | 2.2 | 21 | | 13 | 2 | | |
| *Trichoderma harzianum* | 8.3 | 35 | | | 1.5 | | | | 1.8 | | | | 22 | 41 | 4 | |
| *T. polysporum* | | | | | 30 | 16 | 11 | 3.7 | 11 | 2.2 | | 19 | 2 | | 14 | |
| *Verticillium psaliotae* | | | | | | | | | | | | | 7 | 2 | | |
| Unidentified | 4.2 | 5.9 | | 23 | 2.9 | 3 | | 11 | | | | | | | | |

*A: Soil core depth 0-5 cm; B: soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

Appendix 42

Fungi recorded from unburnt plots on RBA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot 1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Aspergillus flavus* | 11 | 17 | | | 18 | 5 | | | 9.6 | 3.5 | | | 4 | 19 | | 12 |
| *A. fumigatus* | | | | | | | | | 5.8 | | | | 12 | 6 | 5 | |
| *A. glaucus* | | | | | | | | | 19 | 1.8 | | | 6 | 12 | 14 | |
| *A. kanagawaensis* | | | | | 8.9 | 18 | | | | | | | | | | |
| *A. niger* | 3.3 | 11 | 22 | 29 | 4.4 | 4 | 9.5 | 16 | | 1.8 | | | | | | |
| *Aspergillus* sp. | 1.6 | 28 | 11 | 29 | 11 | 5 | 4.8 | 4 | 5.8 | 1.8 | | | | | | |
| *Colletotrichum gloeosporioides* | | | | | | | | | | | | | | 2 | 5 | 12 |
| *Paecilomyces lilacinus* | | 17 | 11 | | 2.2 | | | | 1.9 | | | | | | | |
| *Penicillium variens* | | | | | 2.2 | 7 | 14 | 20 | 3.8 | 56 | 47 | 33 | | | | |
| *Penicillium* spp. | 56 | 11 | 11 | 43 | 20 | 9 | 24 | 24 | 19 | 25 | 7 | 27 | 29 | 33 | 48 | 72 |
| *Rhizopus microsporus* | | | | | | | | | 9.6 | | | 27 | | | | |
| *R. microsporus var. rhizopodiformis* | | | | | | | | | | | | | 6 | 4 | 14 | |
| *Trichoderma hamatum* | 13 | 5.6 | 44 | | | 16 | | | 9.6 | 5.3 | | | 10 | 2 | 5 | |
| *Trichoderma harzianum* | | | | | | | | | 15 | 1.8 | 13 | | 14 | | 10 | |
| *T.piluliferum* | | | | | | 9 | | | | | | | | | | |
| *T. polysporum* | 15 | 11 | | | 27 | 14 | 9.5 | 4 | | 3.5 | 13 | | 8 | 14 | | |
| Unidentified | | | | | | 12 | 9.5 | | | | 20 | 13 | 10 | 10 | | 4 |

- A: Soil core depth 0-5 cm; B: soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

Appendix 43

Fungi recorded from partially burnt plots on RBA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Absida* sp. | | | | | | | | | | | 4.8 | | | | | |
| *Acremonium* sp. | | | | | | | | 3.5 | 1.8 | | 2.4 | 2.8 | | | 3.5 | 4 |
| *Aspergillus flavus* | 7.1 | | 11 | 6.1 | 3.5 | | | 1.7 | 3.5 | | 9.5 | 2.8 | | | 3.5 | |
| *A. fumigatus* | 2.4 | | 5.7 | | 5.2 | 12 | | 17 | | 3.3 | 24 | 11 | | 23 | 24 | |
| *A. glaucus* | 14 | | 13 | 3 | 3.5 | | | 3.4 | | 3.3 | 12 | 2.8 | | 3 | | |
| *A. niger* | 9.4 | 4 | | 9.1 | 5.2 | 1 | | 1.7 | 3.5 | | 2.4 | 2.8 | | | 3.5 | |
| *A. ornatus* | 3.5 | | 1.4 | | | | | | | | | | | | | |
| *Aspergillus* sp. | | | | | | | | | 11 | | 2.4 | | | 3 | | |
| *Eurotium* sp. | | | | 3 | | | | 1.7 | 5.3 | | | | 30 | 3 | 3.5 | |
| *Fusarium* sp. | 3.5 | 8 | | | | | | | | | | | | | | |
| *Penicillium* spp. | 41 | 64 | 61 | 79 | 45 | 70 | 79 | 71 | 14 | 77 | 38 | 75 | 59 | 36 | 59 | 73 |
| *Rhizomucor* sp. | 8.2 | 4 | 2.9 | | 6.9 | | 3.5 | 1.7 | 7 | 17 | 4.8 | | | 3 | 3.5 | 4 |
| *Rhizopus* sp. | | | | | | | | 1.7 | | | | | | | | |
| *Thielaviopsis* sp. | | | | | | | | | | | | | | 3 | | |
| *Trichoderma hamatum* | 7.1 | 16 | | | 14 | | 14 | | 54 | | | 2.8 | 11 | 26 | | 19 |
| *Trichoderma harzianum* | | | | | 1.7 | | | | | | | | | | | |
| *T. polysporum* | 3.5 | 4 | 4.3 | | 16 | | | | | | | | | | | |
| Unidentified | | | | | | 16 | | | | | | | | | | |

- A: Soil core depth 0-5 cm; B: soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

Appendix 44

Fungi recorded from burnt plots on RBA medium and their mean per cent to the total number of colony

| Fungi | Per cent to total number of colony | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plot1 | | | | Plot 2 | | | | Plot 3 | | | | Plot 4 | | | |
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Absida* sp. | | | | | | | | | 1.8 | | | | | | | |
| *Actinomucor* sp. | 3.9 | 7.6 | | | 4.2 | 8 | 19 | | | | | | | | | |
| *Aspergillus flavus* | 7.8 | 7.6 | | | 10 | 7 | 7.4 | 14 | 11 | 2.9 | | 2.9 | 3 | | | 4 |
| *A. fumigatus* | | | | | 5.2 | 5 | | 4.6 | | | | | 3 | 2 | | |
| *A. glaucus* | 9.8 | 3.8 | | | | | | | 3.6 | 8.6 | 18 | 2.9 | 6 | 2 | | |
| *A. niger* | 3.9 | | 6.4 | 2.9 | | 5 | | | | 14 | | | | | 19 | |
| *Aspergillus* sp. | | 7.6 | 6.4 | 21 | 31 | 7 | 15 | | | | | | | | | |
| *Eurotium* sp. | | | | | | | | | | | 5.9 | | | | | |
| *Fusarium solani* | | | | | | | | | | 8.6 | | | | | | |
| *Gongronella butleri* | | | | | | | | | | | | 18 | 1 | | 4.8 | 19 |
| *Mucor* sp. | 7.8 | 9.4 | 17 | 2.9 | 2.1 | 13 | 19 | 41 | 26 | 11 | 5.9 | | 7 | 12 | 4.8 | 8 |
| *Paecilomyces* sp. | | | | | | 3 | 3.7 | 9.1 | | | | | | | | |
| *P. varigatum* | 12 | 1.9 | | | | | | | | | | | | | | |
| *Penicillium* spp. | 24 | 25 | 23 | 38 | 22 | 18 | 26 | 23 | 32 | 31 | 65 | 65 | 29 | 26 | 57 | 35 |
| *Rhizomucor* sp. | 2 | 1.9 | 2.1 | | | | | | | | | | 6 | 5 | 9.5 | 19 |
| *Rhizopus stolonifer* | | | | | 4.2 | 12 | | | 2.7 | 2.9 | | | | | | |
| *Trichoderma hamatum* | 5.9 | 1.9 | 11 | 2.9 | 1 | 12 | | 4.6 | | | | | 6 | 5 | 4.8 | 15 |
| *Trichoderma harzianum* | | 3.8 | 4.3 | 8.8 | 8.3 | 2 | 11 | 4.6 | 8.1 | 2.9 | | 12 | | | | |
| *T. polysporum* | | 9.4 | 6.4 | 8.8 | 10 | 2 | | | 14 | 2.9 | 5.9 | | 40 | 48 | | |
| Unidentified | 24 | 21 | 23 | 15 | 1 | 8 | | | | | | | | | | |

* A: Soil core depth 0-5 cm; B: soil core depth 5-10 cm; C: soil core depth 10-15 cm; D: soil core depth 15-20 cm.

Appendix 45

Fungi recorded from burnt, partially burnt and unburnt plots at Panthanthodu

| Sl.No. | | Burnt | Partially burnt | unburnt |
|---|---|---|---|---|
| 1 | *Absida* sp. | + | + | - |
| 2 | *Acremonium* sp. | - | + | - |
| 3 | *Actinomucor* sp. | + | - | - |
| 4 | *Aspergillus flavus* | + | + | + |
| 5 | *A. fumigatus* | + | + | + |
| 6 | *A. glaucus* | + | + | + |
| 7 | *A. kanagawaensis* | - | - | + |
| 8 | *A. niger* | + | + | + |
| 9 | *A. ornatus* | - | + | - |
| 10 | *Aspergillus* sp. | + | + | + |
| 11 | *Bahuskala* sp. | + | - | - |
| 12 | *Chaetomella* sp. | + | - | - |
| 13 | *Chaetophoma* sp. | - | + | - |
| 14 | *Colletotrichum gloeosporioides* | - | - | + |
| 15 | *Cunninghamella echinulata* | + | - | - |
| 16 | *Eurotium* sp. | + | + | - |
| 17 | *Fusarium dimerum* | + | - | - |
| 18 | *Fusarium nivale* | - | + | - |
| 19 | *F. solani* | + | - | - |
| 20 | *Fusarium* sp. | - | + | - |
| 21 | *Gongronella butleri* | + | - | - |
| 22 | *Gongronella* sp. | + | - | - |
| 23 | *Humicola* sp. | - | - | + |
| 24 | *Mucor circinelloides* | + | - | - |
| 25 | *Mucor recimosus* | + | - | - |
| 26 | *Mucor* sp. | + | + | - |
| 27 | *Paecilomyces fumosoroseus* | + | + | + |
| 28 | *P. lilacinus* | - | + | + |
| 29 | *Paecilomyces* sp. | + | - | - |
| 30 | *Penicillium variegatum* | + | - | - |
| 31 | *Penicillium variable* | - | - | + |
| 32 | *Penicillium* spp. | + | + | + |
| 33 | *Pestalotiopsis uvicola* | - | - | + |
| 34 | *Rhizomucor pucillus* | + | - | - |

| | | | | |
|---|---|---|---|---|
| 35 | *Rhizomucor* sp. | + | + | - |
| 36 | *Rhizopus rhizopodiformis* | - | - | + |
| 37 | *Rhizopus microsporus* | - | - | + |
| 38 | *Rhizopus stolonifer* | + | - | + |
| 39 | *Rhizopus* sp. | + | + | - |
| 40 | *Staphylotrichum* sp. | + | - | - |
| 41 | *Thielaviopsis* sp. | - | + | + |
| 42 | *Trichoderma hamatum* | + | + | + |
| 43 | *T. harzianum* | + | + | + |
| 44 | *T. piluliferum* | + | + | + |
| 45 | *T. polysporum* | + | + | + |
| 46 | *V. psaliotae* | + | - | - |
| 47 | *Verticillium* sp. | - | + | - |
| 48 | Unidentified Ascomycetes | - | - | + |
| 49 | Unidentified Deuteromycetes | + | - | + |
| | Total | 33 (18) | 24 (13) | 23 (11) |

Appendix 46

AM fungal spores recorded in burnt, partially burnt and unburnt plots at Panthanthodu

| AM fungi | Unburnt | | | | Partially burnt | | | | Burnt | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | A | B | C | D |
| *Acaulospora appendicula* | * | * | * | * | * | * | * | * | * | * | * | |
| *A. bireticulata* | * | | | | * | | * | * | * | * | | |
| *A. delicata* | * | * | | | * | | * | * | * | * | | |
| *A. foveata* | * | * | | * | * | * | | * | * | * | * | |
| *A. rehmii* | | | | | * | | * | | * | * | * | * |
| *A. scrobiculata* | * | * | | * | * | * | * | * | * | * | * | * |
| *A. denticulate* | | | | | | | * | | | | | * |
| *Acaulospora* sp. | * | * | | | * | * | * | * | * | * | * | |
| *Gigaspora albida* | | | | | | | | | | | | * |
| *G. candida* | | * | | | * | * | | | | * | | * |
| *G. decipiens* | | * | | * | * | | | | * | * | | |
| *G. gigantia* | | * | | | | | | * | * | | * | |
| *G. margerita* | | | | | | | | | | * | | |
| *Gigaspora* sp. | | * | | | * | * | * | | * | * | * | |
| *Glomus albidum* | * | | * | | | | | * | * | | * | |
| *G. australe* | | * | | | * | | | | | | | |
| *G. botryoides* | * | | | | * | * | * | | * | | | |
| *G. caledonium* | | | | | | | | | | * | | |
| *G. claroideum* | | * | | | | | | | | | | |
| *G. constrictum* | | | | | | * | * | | * | | | |
| *G. deserticola* | | * | | | * | * | * | * | * | * | * | |
| *G. fasciculatum* | * | * | * | * | * | * | * | * | * | * | * | * |
| *G. geosporum* | * | | | | * | * | * | | * | * | | |
| *G. globiferum* | | | | * | * | | * | | | | | |
| *G. hoi* | | | | | | * | * | | | | | |
| *G. intraradices* | | | | | | | | | | | * | |
| *G. lacteum* | | | | | * | * | | * | | | * | * |
| *G. macrocarpum* | | * | * | * | | * | * | * | * | * | * | |
| *G. maculosum* | | | | * | * | | * | * | * | * | * | |
| *G. melanosporum* | | * | | | | * | * | * | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *G. microcarpum* | * | * | | * | * | * | * | | * | * | * | |
| *G. mosseae* | * | * | * | * | * | * | * | * | * | * | * | * |
| *G.multisubstensum* | | | | | * | | | | | | | |
| *G. multicaule* | * | * | | | * | * | * | * | * | * | | |
| *G. pulvinatum* | | | | | | | | | * | | | |
| *G. reticulatum* | | * | * | * | * | * | * | * | * | * | * | * |
| *G. tenue* | | | | | * | | | | | | * | |
| *Glomus* sp, | * | * | | * | | * | * | * | * | * | * | |
| *Sclerocystis clavispora* | | | | | * | | * | | | | | |
| *S. microcarpus* | | | | | | | | * | | | | |
| *Sclerocystis* sp. | | | | | * | | * | | | | | |
| *Scutellospora heterogama* | | * | | | * | * | * | * | * | | | |
| *S.erythropa* | * | * | | * | * | * | * | * | * | * | * | |
| *S. gregaria* | | | | | | | | | * | | | |
| *S. nigra* | * | * | | * | * | * | | * | * | * | * | * |
| *S. persica* | * | | | * | * | * | * | * | | * | * | * |
| *S. wersubiae* | | | | | * | | | | | | | |
| *Scutellospora* sp. | | | * | * | * | * | | * | * | * | * | * |
| *Enterophospora* sp. | | * | | | * | | | | | * | | |
| *E. colombiana* | | | | | | | | | | | | * |

Appendix 47

Economic values of intangible benefits of forests derived from Indian case studies*.

| Intangible benefit | Annual Value | Location | Methodology used | Source |
|---|---|---|---|---|
| Eco-tourism | Rs.427.04 per Indian visitor<br>Rs.432.04 per foreign visitor<br>(Rs.16197 per ha) | Keoladeo National Park, Bharatpur | Travel Cost Method | Chopra (1998) |
| Eco-tourism | Rs.519 per Indian visitor and Rs.495 per foreign visitor<br>(Rs.20,944 per ha) | Keoladeo National Park | Contingent Valuation Method | Murthy and Menkhuas (1994) |
| Eco-tourism and other benefits | Rs.90/- per household per year.<br>(Rs.23,300 per ha) | Boriveli National Park, Mumbai | Contingent Valuation Method | Hadker *et al.* (1995) |
| Eco-tourism | Rs.9.5 per local (Kerala) visitor<br>(Rs.676 per ha) | Periyar Tiger Reserve | Contingent Valuation Method, Travel Cost Method | Manoharan (1996) |
| Water supply | Annual rental = Rs.4745 per ha | Almora Forests | Indirect Methods | Chathurvedi (1992) |
| soil conservation | Cost of soil erosion Rs.21,583 per ha | Doon Valley | Replacement Cost approach | Kumar (2000) |
| Ecological functions (use value) for local residents | Rs.624 per ha | Yamuna Basin | Contingent Valuation Method | Chopra and Kadekodi (1997) |
| Carbon store | Rs.1,292 billions (total forests)<br>(Rs.20,125 per ha) | Indian forests | Species wise forest inventory data | Haripriya (1999) |
| Carbon Store | Rs.1.2 lakh per ha | All India | Indirect estimates | Kadekodi and Ravindranath (1997) |
| Watershed Values (Soil conservation) | Rs.2.0 lakh per ha of soil | Lower Siwalikh (Yamuna Basin) | Indirect method (Reduced cost of alternate technology ) | Chopra and Kadekodi (1997) |

* Source: Muraleedharan *et al.* (2002)

## Appendix 48

Annual Values of Selected Benefits of Forests*

| Sl. No. | Economic Benefit | Value of annual flow of goods and services per hectare (Rs.) | |
|---|---|---|---|
| | | Minimum | Maximum |
| 1 | Timber | 2701 | 9270 |
| 2 | Non-timber forest products | 538 | 2957 |
| 3 | Watershed | 624 | 2.0 lakh |
| 4 | Eco-tourism | 676 | 20,444 |
| 5 | Carbon store | 20125 | 1.2 lakh |

* Source: Muraleedharan *et al.* (2002)

## Appendix 49

Economic values of various kinds of forest land in India*

| Sl. No | Nature of Forest land | Value of annual flow of goods and services per hectare (Rs.) | | Present Value** of goods and services per hectare (Rs.) | |
|---|---|---|---|---|---|
| | | Minimum | Maximum | Minimum | Maximum |
| 1 | Plantations | 2701 | 9270 | 33660 | 115525 |
| 2 | Open forests crown density 10 - 40%) | 3239 | 12227 | 40365 | 152375 |
| 3 | Dense forests (crown density >40%) | 21287 | 322957 | 265283 | 4024758 |
| 4 | Protected Areas | 21425 | 340444 | 267003 | 4242685 |

* Source: Muraleedharan *et al.* (2002)
** At 5% rate for a period of 20 years.