

## **EVALUATING PLANT DIVERSITY IN DIFFERENT FOREST TYPES OF KERALA BY LAYING OUT PERMANENT SAMPLE PLOTS**

U.M. Chandrashekhara  
A.R.R. Menon  
K.K.N. Nair  
N. Sasidharan  
K. Swarupanandan



KERALA FOREST RESEARCH INSTITUTE  
PEECHI, THRISSUR

October 1998

Pages: 86

## CONTENTS

	Page	File
Abstract	i	r.156.2
1 Introduction	1	r.156.3
2 Methodology	2	r.156.4
3 Results and Discussion	18	r.156.5
4 Conclusion	71	r.156.6
5 References	73	r.156.7
6 Appendices	76	r.156.8

## **ABSTRACT**

Four permanent plots, each of one 1-ha in size, were established in shola forest, wet evergreen forest, moist deciduous forest and dry deciduous forest in Kerala. Each 1-ha plot was in turn subdivided into 100 quadrats 10 m x 10 m in size, with quadrats permanently marked. All mature trees (gbh > 30.1 cm) in the permanent plots were tagged and identified. Saplings (gbh 10.1 cm to 30.0 cm) in moist deciduous and dry deciduous forest plots were tagged and identified in all the 100 quadrats. However, in shola and evergreen forest plots, saplings were studied only in selected 50 quadrats. Tree seedlings (girth <10.0 cm, height < 1.0 m) were enumerated in 14 quadrats each in shola and evergreen forest plots and in 50 quadrats each in moist deciduous and dry deciduous forest plots.

Tree species density was greater in the shola forest (76 species ha<sup>-1</sup>), followed by evergreen forest (41 species ha<sup>-1</sup>), dry deciduous forest (41 species ha<sup>-1</sup>) and moist deciduous forest (37 species ha<sup>-1</sup>). Species diversity index values obtained for shola and evergreen forest plots are comparable to those recorded for many tropical evergreen forests. Stand quality index of shola (RISQ = 1.178, 1.155 and 1.224 respectively for tree seedlings, saplings and mature trees) and evergreen forest (RISQ = 1.473, 1.597 and 1.164 respectively for tree seedlings, saplings and mature trees) plots indicated that these plots are undisturbed. These permanent plots, therefore could be used as benchmark sites for studies on impact of natural and man-made disturbance on the ecosystem structures and functions in similar types of forests. The plots are useful for assessment of biodiversity of various groups of flora and fauna of the region. Vegetation analysis and girth class distribution of trees in the plots established in moist deciduous and dry deciduous forests showed clear indication of human-induced disturbances. Since the basic data were collected and all trees are marked, long term monitoring of these plots can be undertaken, especially for on studies on succession and ecosystem recovery processes.

## 1.0. INTRODUCTION

Many areas in the tropics are undergoing rapid, wide ranging changes in land cover. Among these changes, tropical forest clearing is dramatic. According to the recent assessment carried out by FAO/UNEP (1981), the average rate of deforestation between 1981 and 1986 in India, for example, is 0.2% per year ( $1320 \text{ km}^2 \text{ yr}^{-1}$ ). Most of these extinctions of forests in the tropics can be attributed to pressure of poverty and population growth and a lack of technical and scientific infrastructure to support conservation efforts (Myers, 1988). Such efforts are often further hampered by the absence of basic information upon which to build conservation strategies and reliable alternatives to get rid of uncontrolled and probably dangerous development. It is also clear that too little information is available about the dynamics and changes in tropical natural forests (Hubbell and Foster, 1986). Thus, establishment of forest inventory plots with the goal of long-term monitoring of such plots is considered as one approach to documenting and monitoring plant diversity and a means for obtaining long-term data on ecosystem structure, dynamics and properties. Permanent plots established also provide an opportunity for creation of information base for research and education that will contribute to the conservation and management of forests.

The Western Ghats, one of the two geological mega relief (other one being the Himalayas) in India is also one of the mega-biodiversity centres of the World. In tune with the global biodiversity conservational efforts protection and sustainable management of forest of the Western Ghats have already been highlighted (Collins *et al*, 1991). In this context, efforts of establishment and inventory of permanent plots can expected to provide a window on species diversity and allow relatively quick and accurate characterisation of forest with a view to advance conservation objectives for large areas. With this background, the Kerala Forest Research Institute (KFRI) with the support of World Wide Fund for Nature-India (WWF-India) has launched a programme to establish permanent sample plots in the wet evergreen forest, moist deciduous forest, dry deciduous forest and shola forest in the Kerala part of the Western Ghats. As a starting point for research in the permanent plots established, the programme was also aimed at to analyse vegetation and species diversity pattern with emphasis on tree species. In this report, the methods adopted for the establishment of the

---

permanent plots and tree species distribution and diversity patterns are discussed with a view to draw a programme for long-term monitoring of permanent plots for biodiversity assessment and understanding the dynamics of the forest stand.

## **2.0. METHODOLOGY**

### **2.1. Site descriptions**

Four sites (Figure 1), each one to represent a type of forest namely the tropical montane forest (shola forest), wet evergreen forest, moist deciduous forest and dry deciduous forest have been selected. Brief description of the sites follow:

#### **2.1.1. Tropical montane forest (Shola) at Mannavan shola**

Mannavan shola is located in the Marayur Forest Range in the Munnar Forest Division ( $10^{\circ} 10' - 10^{\circ} 12' 8''$  N and  $77^{\circ} 9' 50'' - 77^{\circ} 12' 8''$  E) (Figure 2). This shola forest is nearly 370 ha in size with an elevation of approximately 1,950 msl. The mean annual temperature is  $20^{\circ}$  C; mean annual precipitation is 2000 mm - 3000 mm. The soil is red, sandy loam, oxysol, acid (pH = 4.2) with 4.6% to 14% organic carbon content.

The Mannavan shola area is a source of small timber, non-wood forest produce of near-by colony of the Muthuva tribes. People of the Perumala, Kanthalloor and Puthur settlements are wholly dependent on Mannavan shola for firewood, timber, and wood for various agricultural purposes. The firewood demand for the distillation of lemongrass that is being extensively cultivated in this location is also a threat to the forest.

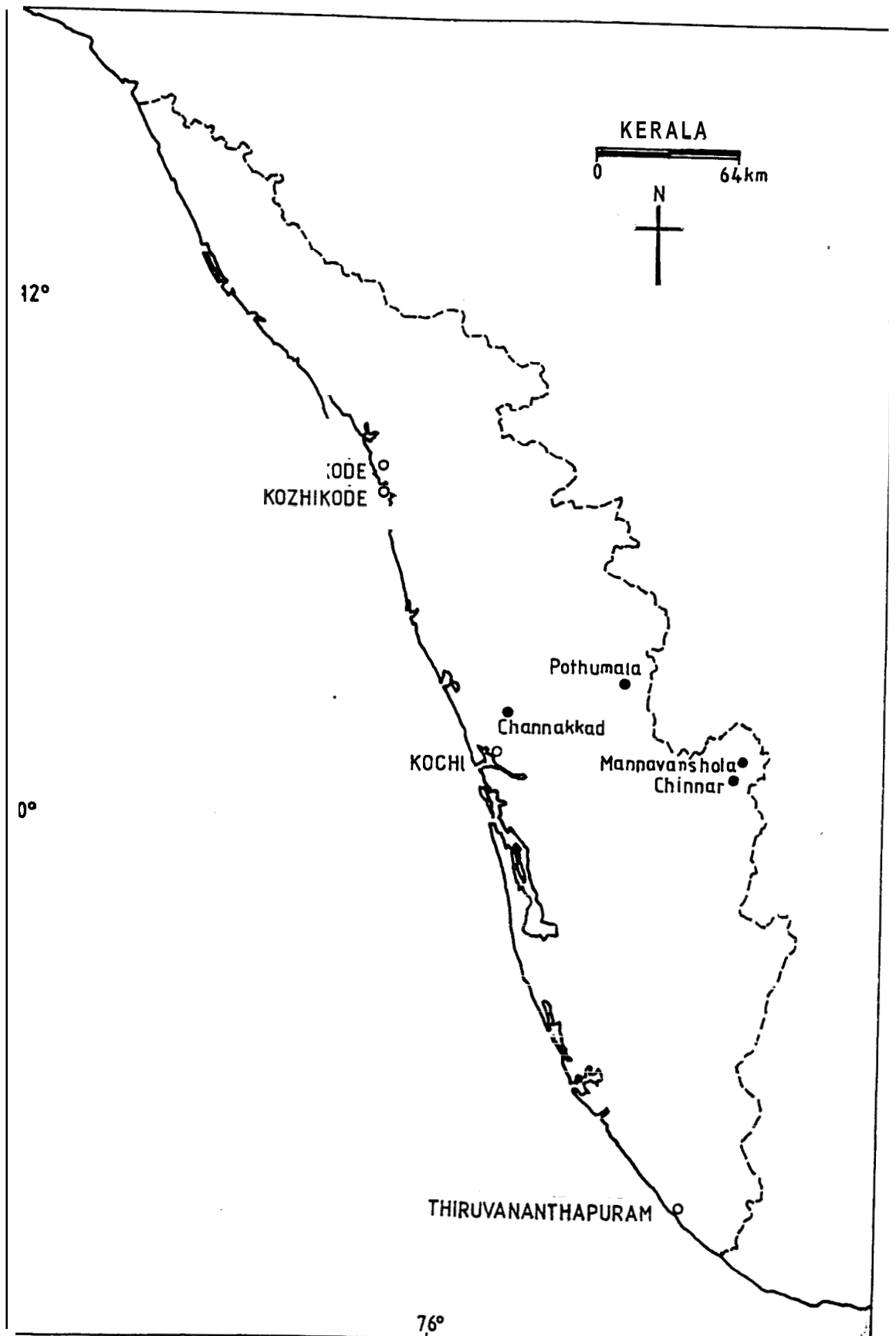


Figure 1. Map of Kerala showing study area

Several instances of smuggling of sandal and ganja and attack from the smugglers have been recorded in the files of Forest Department. Records also indicate that the villagers also cultivate ganja in remote areas of the sholas without the knowledge of forest authorities. Because of the uncontrollable smuggling, one of the bridges in the S.P. Puram road was destroyed by the Forest Department and closed for a long time. The above mentioned road is now under reconstruction and tarring, which poses a serious threat to the shola.

Many plants such as the various species of *Eriocaulon*, *Helichrysum*, *Anaphalis*, *Gnaphalium* etc., are massively harvested, by uprooting them from the grasslands adjoining the shola and exported for the dry flower industry. The leaves of the temperate tree, *Rhododendron nilagiricum* is also harvested for the same purpose. *Drosera peltata* is harvested extensively for its medicinal value. Another plant, *Gaultheria fragrantissima* (Ericaceae) is massively harvested from the grasslands and ecotones. The plant is said to contain an active ingredient for flavouring toothpastes and tooth powders. About 2 trucks full of *Gaultheria* were harvested from the shola during the second week of the month of November 1996. Thousands of plants of the *Strobilanthes homotropa* are harvested for the use of stakes for beans plants.

Measurably large areas in and around the Mannavan shola are getting converted to eucalypt and wattle plantations. About 40 ha of land along the roadsides of Mannavan shola is under wattle cultivation.

Some of the areas in the Mannavan shola were given on lease for human settlements during 1960's. This is evidenced by a number of foundation stones of houses still existing, presence of the planted economic species like orange, apple etc., in the Perumala, Kalipettumala and Thalachor kadavu regions of the shola. A lot of areas were then cleared and burnt, where now rapid regeneration of pioneer species such as *Rhododendron nilagiricum*, *Symplocos laurina*, *Viburnum punctatum*, *Daphniphyllum neilgherrense*, *Hypericum mysorense*, and several species of *Syzygium* are in progress. Later, the settlements were translocated out of the shola by a court order.



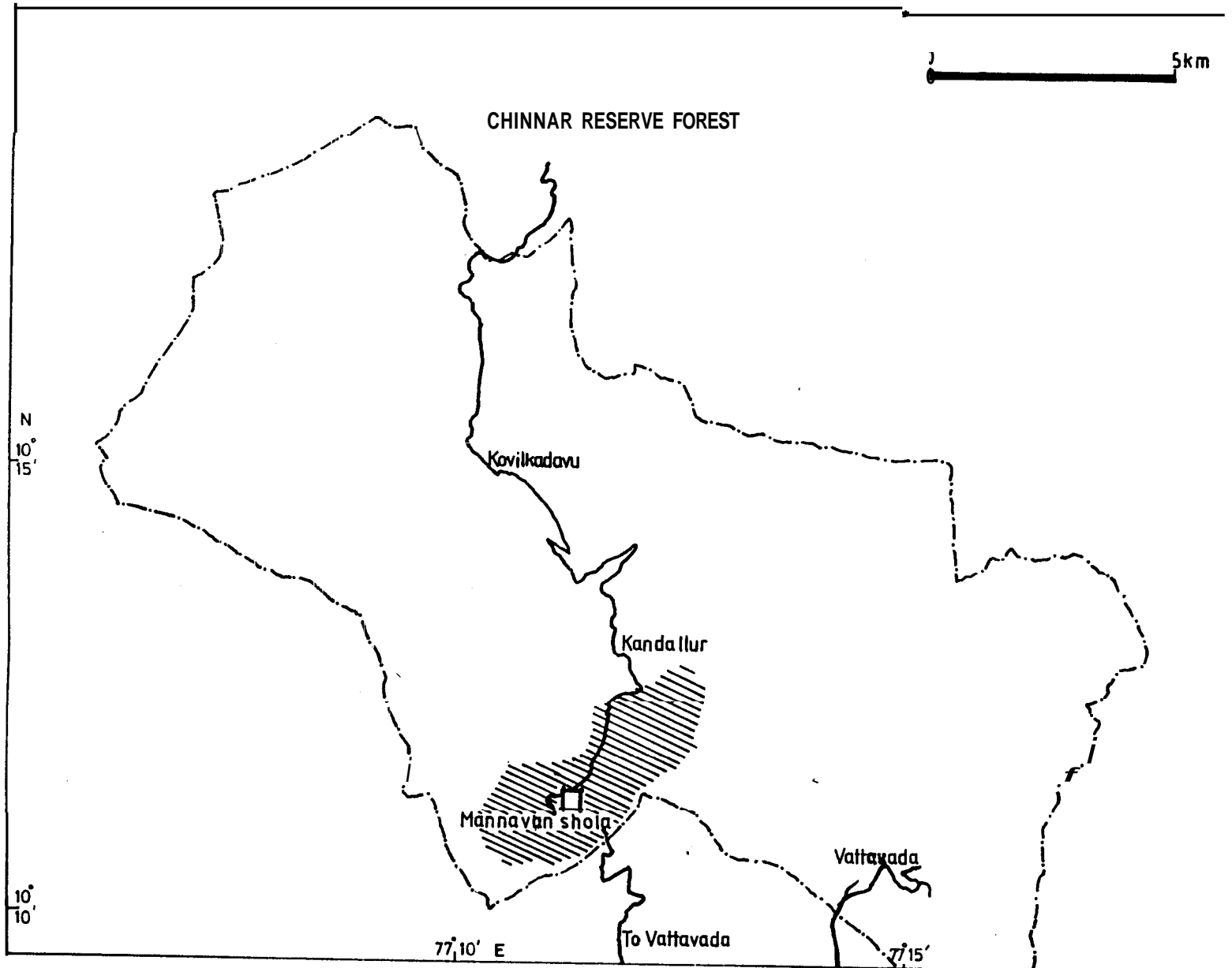


Figure 2. Location of the permanent sample plot established in a shola forest at Mannavan shola, Kerala

Relatively undisturbed patch of the shola forest is selected for the establishment of permanent plot.

### **2.1.2. Tropical evergreen forest at Pothumala**

Pothumala is located in Pothumala in the Nelliampathy Range of Nemmara Forest Division ( 10° 25' - 30° 30' N and 76° 35' - 76° 40'E) (Figure 3) at an elevation of approximately 1050 msl. The mean annual temperature is 22°C. The mean annual precipitation is 3400 mm. The soil is red, sandy loam, porous, oxysol, acidic (pH = 5.0) with 4.9% to 12% organic carbon content.

During the last few decades, a substantial portion of these forests have been encroached and felled particularly for agriculture, for construction of hydro-electric projects, for raising monoculture plantations of hill produce like cardamom, coffee, tea, teak and rubber. In addition, the Division has some tribal settlements of Medusas, Kadas, Malasars and Malai Malasars. The vast extent of the natural evergreen forests have been eliminated by cash crops and only two significant patches are still left undisturbed, the one in the catchment of a tributary of Kuriarkutty river and the other along the southern and adjoining Sholayar hydel project.

During the year 1985, 723 trees yielding approximately 3269 m<sup>3</sup> of timber were earmarked for selection felling from an area of 118 ha. *Cullenia exarillata* and *Palaquium ellipticum*, the two plywood species constituted roughly 98.5% of the harvested timber. The rest were *Holigarna arnottiana*, *Calophyllum tomentosum*, *Mesua ferrea*, *Artocarpus heterophyllus* and *Myristica dactyloides* (Balasubramanyan, 1987).

The permanent plot was established where there is no indication of disturbance in the recent past.

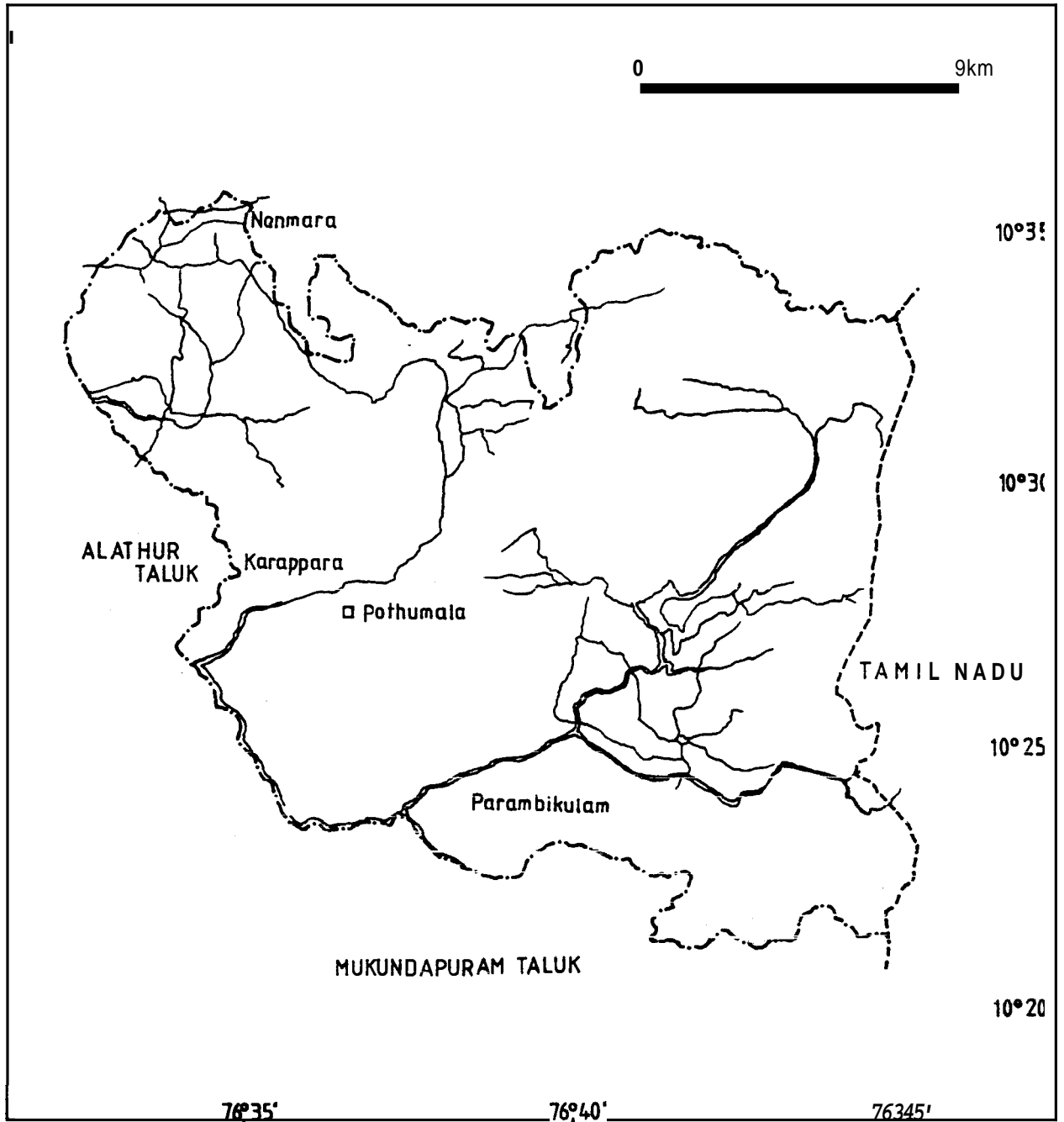


Figure 3. Location of the permanent sample plot established in a wet evergreen forest at Pothumala, Kerala.

### **2.1.3. Moist deciduous forest at Channakkad**

Channakkad lies at an elevation of 200 msl in the Pattikkad hills in the Trichur Forest Division (10° 20' - 10° 50' N and 75° 95' - 76° 30' E) (Figure 4). The mean annual precipitation is 2793 mm (Kallarackal and Somen, 1997) and the mean annual temperature is 28° C. The soil is red, sandy loam with pH = 6.3 and 1.3% to 2.0% organic carbon.

The Channakkad forest is degraded due to heavy biotic pressure of anthropogenic origin. This has resulted in the paucity of sapling and pole crops, low stocking, excessive opening of canopy and establishment of exotic weeds like *Chromolaena odorata* and *Lantana camara*. The major causes of degradation of this forest is the recurrent incidence of fire.

Farmers often burn the forests for their agricultural lands in order to get their fields enriched by ash brought down by rain water. Fire also helps new grass growth and this facilitates grazing and browsing of cattle and goats driven by people living in the neighbourhood area.

Malaya tribes and the local people collect minor forest products such as soap nut, honey, medicinal plants etc. People living in nearby settlements depend on the forests for small timber, fire wood, green manure, charcoal making etc. Lopping for green manure, illicit cutting of saplings and poles, charcoal making and heavy grazing and browsing are the main reasons for the paucity of regeneration in these forests.

No undisturbed forest patch was observed in this region. The permanent plot established in this forest, thus also is severely disturbed one.

### **2.1.4. Dry deciduous forest at Chinnar Wildlife Sanctuary**

The Chinnar Wildlife Sanctuary is located in the Eravikulam Wildlife Sanctuary Division (10° 15' - 10° 21' N and 76° 52' - 77° 13' E) (Figure 5). This Sanctuary being situated in the rain shadow region of the Western Ghats provides a dry facet of the Western Ghats with a warmer arid climate receiving not more than 600 mm of rain

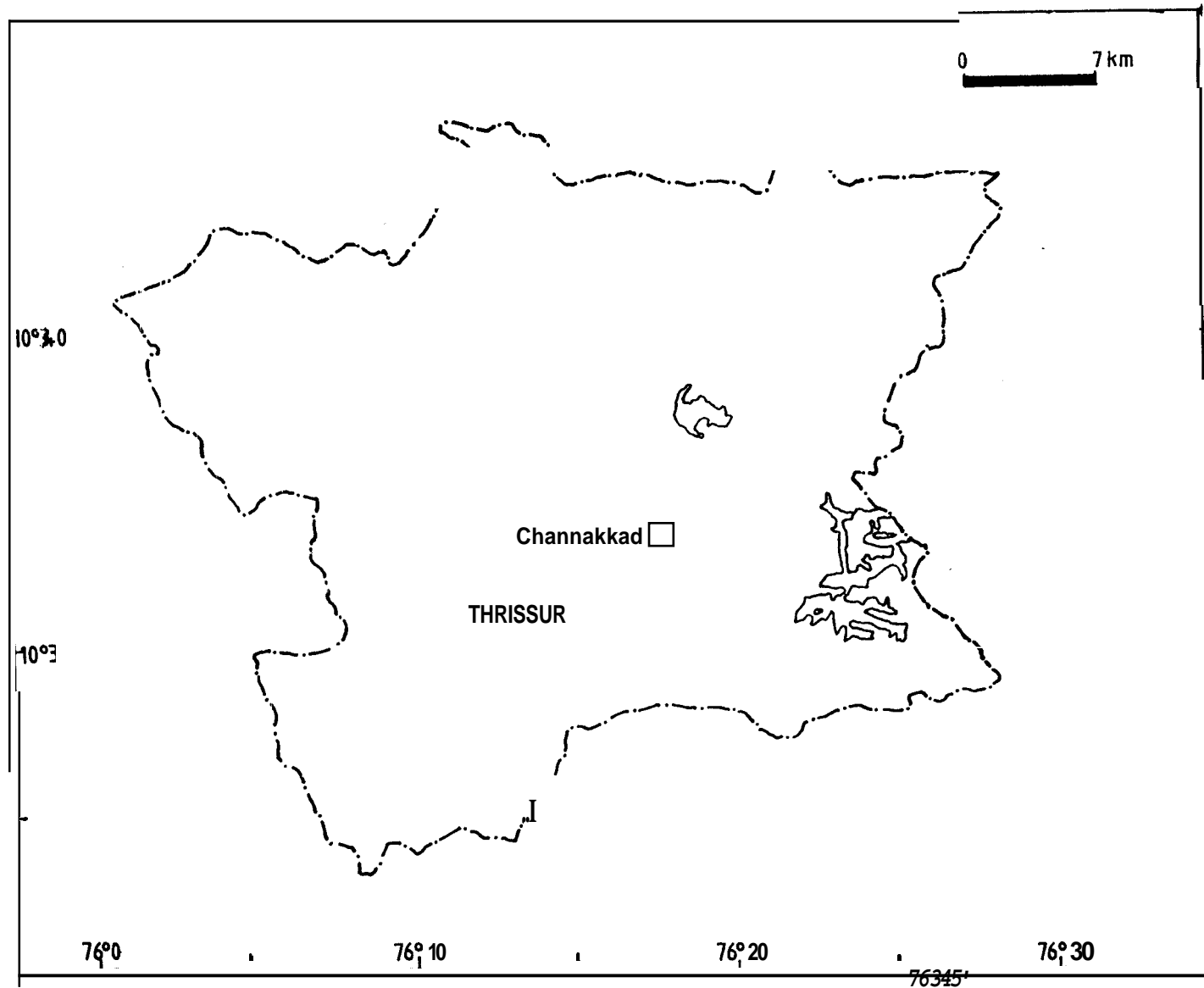


Figure 4. Location of the permanent sample plot established in a moist deciduous forest at Channakkad, Kerala

per year. The mean minimum temperature is 12° C and the mean maximum temperature is 36° C. Average elevation of the site is 400 msl. The soil is red, sandy loam, gravelly (12% to 32%), slightly alkaline (pH = 7.3) and with low organic carbon content (0.76% to 2.1%).

Before the declaration of Chinnar Wildlife Sanctuary it was known as Chinnar Reserved Forest. Selection felling operations were carried out in 1979 in some localities. The area has further degraded by grass invasion and fire and been reduced to discontinuous thorny thickets and pseudosteppis. The erosion of surface soil has been a serious threat to fire exposed soil. This is indicated by high gravel content of the soil in most part of the forest area. Apart from this, anthropogenic pressures mainly from outside the forest are in the form of road traffic, firewood collection, grazing, agricultural activities and fire also pose problems. In 1984, the area has been declared as the Wildlife Sanctuary. According to the sources from the Forest Department, the declaration of Wildlife Sanctuary and related efforts are giving promising results in terms of wildlife conservation and ecosystem rehabilitation. They claim that after the declaration of the area as Sanctuary smuggling, poaching and incidence of fire, illegal harvesting of natural resources have declined. But, mounting evidences suggest that introduction of some inappropriate planning and implementation and an over optimistic drive of planners to enforce a totally different type of landuse systems, impacts of insecurity in land tenure, local effects of structural adjustment programmes and people-park conflict are often leading to poor results in conservation and ecosystems rehabilitation efforts in the Sanctuary (Chandrashekara and Sankar, 1998).

The area selected for the establishment of permanent plot showed no indication of human-induced disturbance occurred after the establishment of the Sanctuary.

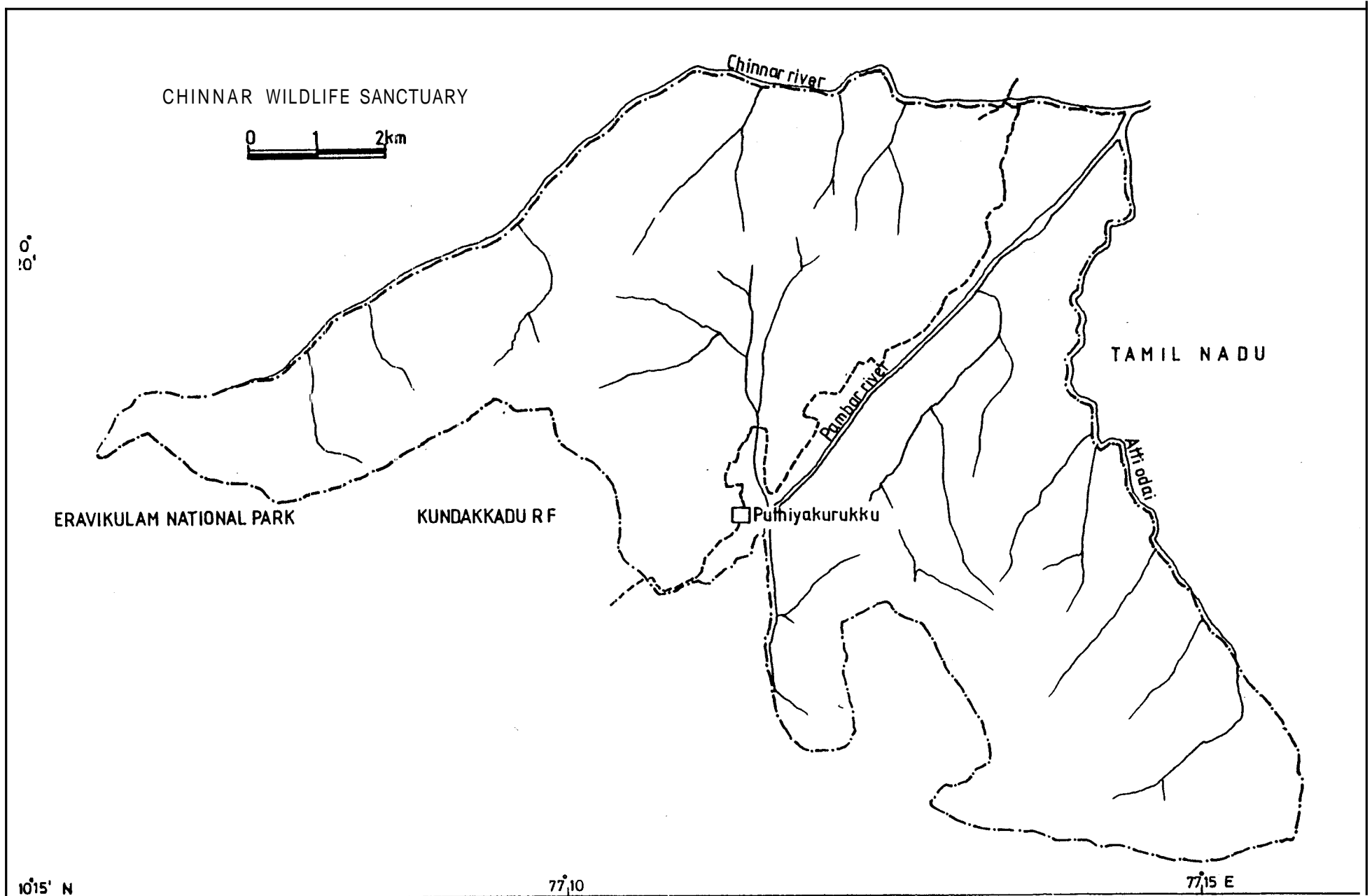


Figure 5. Location of the permanent sample plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala

## **2.2. Establishment of permanent sample plots**

In each site, a 1-ha plot was marked and which in turn subdivided into 100 quadrats 10 m x 100 m in size (Figure 6).

Surveying to establish quadrat corners was proceeded from the baseline of the plot. First, a baseline of 100 m was established in a given direction. Ten points, each at an interval of 10 m were marked on the baseline. At each such point a stone was fixed. From each point, measured a distance of 10 m perpendicular to the baseline. However, before fixing stones at each new point, measurements were made to confirm that the distance between two adjacent points was 10 m and that the 2nd line passing through 10 new points was horizontal to the baseline. Thus a row of ten quadrats was established. The next step was to repeat the same process by considering the new line as the baseline to establish remaining 90 quadrats. As the establishment of corners proceeded three measurements namely- the 'back' measurement (from the new set up point back to the previous stake on the same line), the 'check' measurement (to previous established stakes below the current line), and the 'new' measurement (to set next stake on the current line) were made to ensure that the size of each quadrat was 10 m x 10 m.

Once the corners of all 100 quadrats were established, the quadrats were permanently marked at each of their corners with rectangular stones fixed to the ground. The portion of all corner stones well above the forest floor were painted to increase the visibility and each corner stone is labelled with a number to differentiate its location in the plot. In each permanent plot, a name board to indicate the type of forest, area and year of establishment of the sample plot was fixed.






### **2.3. Tree species diversity and regeneration pattern in permanent plots**

In the plot established, a rope was tied along the border of each quadrat. In each permanent plot tree tagging and identification was carried out in three stages. In the first stage, all trees above 30.1 cm girth at breast height (gbh; measured with tape at 1.37 m from the ground) were considered. They were categorised as mature trees. In each of 100 quadrats (Figures 6a, 6b, 6c and 6d) mature trees were located and tagged with the numbered aluminium label facing towards the baseline. Tags were fixed above 1.37 cm level to avoid interference with gbh measurement. Each tree was identified and recorded the number allotted to it, and its gbh. For the trees with large buttresses, girth was measured just above the level of buttress. The line of gbh measurement was marked with paint. Conditions of all labelled trees were assessed and categorised them into alive-undamaged and alive-damaged. Causes for damage were also recorded. These data were collected for reuse in recensuses or following cataclysmic events.

In the second stage of tree tagging and identification, all trees with gbh ranging from 10.1 cm to 30.0 cm were considered and they were designated as saplings. Tagging, gbh measurement, identification and assessment of tree conditions followed the methods already discussed. However, the number of quadrats to be sampled for the saplings was determined using species-area curve (Misra, 1968). Thus, while the saplings in dry deciduous and moist deciduous forest site were monitored in all 100 quadrats (Figures 6c and 6d) those in shola forest and wet evergreen forest were monitored only in 50 quadrats (Figures 6a and b).

Third stage of tree tagging and identification covered plants less than 10 cm girth and the height less than 1m. This group of tree population was considered as tree seedlings. In the case of plots established at shola forest and wet evergreen forest, fourteen sub quadrats of 5 m x 5 m, each one in a 10 m x 10 m quadrat (Figures 6a and 6b) were marked to tagging, height measurement, labelling and identification of tree seedlings. On the other hand, in case of moist deciduous and dry deciduous plots, seedlings were studied in fifty 5 m x 5 m sub-quadrats one each laid out in a 10 m x 10 m quadrat.

Figure 6. Diagrammatic maps of four 1-ha permanent plots established in (a) Tropical montane forest (Shola) at Mannavan shola, (b) Wet evergreen forest at Pothumala, (c) Moist deciduous forest at Channakkad, and (d) Dry deciduous forest at Chinnar. Each plot is divided into 100 quadrats (each 10m X 10m)

-  Quadrats where only mature trees were enumerated
-  Quadrats used to enumerate both mature trees and saplings
-  Quadrats used to enumerate monitored for mature trees, saplings and seedlings

a

100	99	98	97	96	95	94	93	92	91
81	82	83	84	85	86	87	88	89	90
80	79	78	77	76	75	74	73	72	71
61	62	63	64	65	66	67	68	69	70
60	59	58	57	56	55	54	53	52	51
41	42	43	44	45	46	47	48	49	50
40	39	38	37	36	35	34	33	32	31
21	22	23	24	25	26	27	28	29	30
20	19	18	17	16	15	14	13	12	11
1	2	3	4	5	6	7	8	9	10

b

100	99	98	97	96	95	94	93	92	91
81	82	83	84	85	86	87	88	89	90
80	79	78	77	76	75	74	73	72	71
61	62	63	64	65	66	67	68	69	70
60	59	58	57	56	55	54	53	52	51
41	42	43	44	45	46	47	48	49	50
40	39	38	37	36	35	34	33	32	31
21	22	23	24	25	26	27	28	29	30
20	19	18	17	16	15	14	13	12	11
1	2	3	4	5	6	7	8	9	10

N



N ← S

c

100	81	80	61	60	41	40	21	20	1
99	82	79	62	59	42	39	22	19	2
98	83	78	63	58	43	38	23	18	3
97	84	77	64	57	44	37	24	17	4
96	85	76	65	56	45	36	25	16	5
95	86	75	66	55	46	35	26	15	6
94	87	74	67	54	47	34	27	14	7
93	88	73	68	53	48	33	28	13	8
92	89	72	69	52	49	32	29	12	9
91	90	71	70	51	50	31	30	11	10

d

100	99	98	97	96	95	94	93	92	91
81	82	83	84	85	86	87	88	89	90
80	79	78	77	76	75	74	73	72	71
61	62	63	64	65	66	67	68	69	70
60	59	58	57	56	55	54	53	52	51
41	42	43	44	45	46	47	48	49	50
40	39	38	37	36	35	34	33	32	31
21	22	23	24	25	26	27	28	29	30
20	19	18	17	16	15	14	13	12	11
1	2	3	4	5	6	7	8	9	10

N



S

N ← S

Most of the trees species were identified in the field while others were identified with the samples collected and referring the herbaria. The sample herbarium specimens collected were deposited in the KFRI herbarium.

The total number of stems per hectare was estimated separately for mature trees, saplings and tree seedlings. Similarly, basal area of all stems of a species in mature tree and saplings categories was also calculated. In the case seedlings, basal area was not calculated, as the exact girth of individuals seedlings was not recorded. Formula used to calculate the relative density, relative frequency and relative dominance and the importance value index (IVI) are following:

$$\text{Relative density} = \frac{\text{total number of individuals of a Species} \times 100}{\text{total number of individuals of all species}}$$

$$\text{Frequency} = \frac{\text{number of quadrats in which a species found}}{\text{number of quadrats studied}}$$

$$\text{Relative frequency} = \frac{\text{frequency of a Given species} \times 100}{\text{sum of frequency of all species}}$$

$$\text{Relative dominance} = \frac{\text{total basal area of a given species} \times 100}{\text{total basal area of all species}}$$

Importance value Index (IVI) of a species = sum of relative density, relative dominance and relative frequency

However, in the case of seedling population, IVI was calculated as the sum of relative density and relative frequency. Species diversity was calculated using a formula given by Margalef (1968) as:

$$H = - \sum [ (n_i / N) \log_2(n_i / N) ]$$

where H = Shannon index of species diversity,  $n_i$  = number of individuals of species i, N = total number of individuals of all species in the community.

The index of dominance of the community was calculated by Simpson's index (Simpson, 1949) as:

$$C = \sum (n_i / N)^2$$

where C= index of dominance; n, and N being the same in the Shannon index of general diversity.

#### **2.4. Determination of stands quality of shola and wet evergreen forests**

Considering the life history pattern, shola forest and wet evergreen forest species can be categorised into primary (shade-tolerant species), late secondary species and early secondary species (strong light demanders). Based on the available literature (Gamble, 1915-1935; Chandrasekharan, 1960; Rai, 1979; Rai and Proctor, 1986; Pascal, 1988; Chandrashekara and Ramakrishnan, 1994), species encountered in shola forest and evergreen forest sites were categorised into three groups, each group with a number, its pioneer index of 1 for the group requiring a small gap for regeneration and 3 for the group of strong light demanders, with a strong canopy disturbance requirements. The procedure to determine the stand quality (Chandrashekara, 1998) is followed as:

$$\text{RISQ} = \sum \left\{ \left( \frac{n_i}{N} \right) \times \text{Species pioneer index} \right\}$$

Where, RISQ= Ramakrishnan index of Stand Quality;  $n_i$  = importance value index of a species and N= sum of importance value index of all species; Pioneer index is 1 for the species whose seedlings establish in closed canopy area but need small canopy gaps to grow up, Pioneer index is 2 for the species whose seedlings establish in small gaps but need small to medium size gaps to grow up, and Pioneer index is 3 for the species whose seedlings need larger canopy gaps for both establishment and growth.

The RISQ of a given site can vary from 1.0 (all stems, group 1 species; forest stand undisturbed) to 3.0 (all stems strong light -demanding species, group 3; forest stand is highly disturbed).

### 3.0. RESULTS AND DISCUSSION

#### 3.1. TREE SPECIES DIVERSITY AND STAND STRUCTURE

##### 3.1.1. Mannavan Shola

A description of the vegetation in the Mannavan shola plot is presented in Table 1. Among mature tree population, *Hydnocarpus alpina*, *Isonandra stocksii*, *Gomphandra coriacea*, *Chionanthus ramiflorus* and *Mastixia arborea* are the first five dominant species. Tree sapling population is dominated by *Lasianthus acuminatus* followed by *Mastixia arborea*, *Ardisia rhomboidea*, *Hydnocarpus alpina*, and *Chionanthus ramiflorus*. In the case of tree seedling population also *Lasianthus acuminatus* is the dominant species followed by *Beilschmedia wightii*, *Chionanthus ramiflorus*, *Ardisia rhomboidea* and *Hydnocarpus alpina*. It may be noted here that species like *Lasianthus acuminatus*, *Ardisia rhomboidea* and *Chionanthus ramiflorus* showed higher values for IVI in the seedling and sapling population are species of the understorey with small girth class.

Tables 2, 3 and 4 respectively represent the distribution pattern of mature trees, saplings and seedlings in different quadrats laid out in the permanent plot. These Tables will help in recensuses and to know the impact of any cataclysmic event on the health and survivability of these species. For the easy identification of species in the plot one to five plants together with their location (quadrat number) and tag number are given in Appendix 1.

The Mannavan shola forest site is a natural forest without major disturbance where RISQ values for tree seedlings, saplings and mature trees were 1.178, 1.155 and 1.224 respectively (Table 5). Compared to a shola forest situated at Kurunjalu in Chikmagalore District in the Western Ghat part of Karnataka where the number of tree species encountered was 20 (Swamy, 1988), the Mannavan shola plot is richer in terms of species richness. Stem density recorded in Kurunjalu was 235 and 475 for saplings and mature trees. Therefore, when compared to the shola forest at Kurunjalu, the Mannavan shola is richer in terms of stem density also. The species diversity in the Mannavan shola is quite higher than in Kurunjalu shola ( $H = 3.612$ ; Swamy, 1988) because of presence of numerous rare species.

Table 1. Density (individuals ha<sup>-1</sup>) and importance value index (IVI) of mature trees (gbh ≥ 30.1 cm), saplings ( gbh 10.1 cm to 30.0 cm) and seedlings (girth ≤ 10.0 cm and height ≤ 1 m ) in the permanent plot established in a Shola forest at Mannavan shola, Kerala.

Species	Mature trees		Saplings		Seedlings]	
	Density	IVI	Density	IVI	Density	IVI
<i>Acronychia pedunculata</i>	12	5.7	2	1.14	114	2.41
<i>Actinodaphne bourdillonii</i>	15	9.72	44	16.41	771	9.58
<i>Aglaia elaeagnoidea</i>	2	1.25	2	0.79	--	--
<i>Alseodaphne semecarpifolia</i>	7	5.31	--	--	257	4.38
<i>Ardisia rhomboidea</i>	--	--	72	19.69	1400	14.22
<i>Beilschmiedia wightii</i>	42	22.56	6	2.52	2400	21.48
<i>Bhesa indica</i>	7	3.93	--	--	229	3.04
<i>Canthium dicoccum</i>	2	1.26	--	--	--	--
<i>Celtis philippensis</i>	2	0.91	--	--	--	--
<i>Chassalia curviflora</i>	--	--	8	3.26	--	--
<i>Chionanthus ramiflorus</i>	41	25.01	50	18.00	2457	20.60
<i>Cinnamomum</i> sp.1	1	0.47	--	--	--	--
<i>Cinnamomum</i> sp.2	1	0.44	--	--	--	--
<i>Cinnamomum</i> sp.3	1	0.65	2	1.22	--	--
<i>Cinnamomum</i> sp.4	--	--	--	--	114	3.01
<i>Cinnamomum sulphuratum</i>	10	6.83	12	5.52	--	--
<i>Clerodendrum viscosum</i>	1	0.43	--	--	286	2.16
<i>Cryptocarya</i> sp.	1	0.74	4	1.61	--	--
<i>Cryptocarya lawsonii</i>	16	8.8	14	6.20	--	--
<i>Cyathea crinita</i>	--	--	6	3.52	--	--
<i>Cyathea nilgiriensis</i>	8	2.53	--	--	--	--
<i>Elaeocarpus recurvatus</i>	--	--	--	--	29	0.75
<i>Elaeocarpus serratus</i>	1	1.53	--	--	--	--
<i>Elaeocarpus tuberculatus</i>	--	--	2	0.79	--	--
<i>Eugenia</i> sp.	1	0.46	2	0.80	--	--
<i>Eurya nitida</i>	2	1.02	4	1.66	29	0.75
<i>Glochidion neilgherrense</i>	5	2.34	4	2.00	--	--
<i>Glochidion</i> sp.	--	--	--	--	200	4.07
<i>Gomphandra coriacea</i>	67	26.29	4	2.56	57	1.50
<i>Gomphandra</i> sp.	--	--	8	3.51	--	--
<i>Hydnocarpus alpina</i>	121	56.9	42	18.59	1257	14.03
<i>Ilex denticulata</i>	--	--	4	2.67	--	--
<i>Ilex</i> sp.	--	--	--	--	29	0.75
<i>Isonandra stocksii</i>	67	39.99	6	2.96	200	4.07
<i>Lasianthus acuminatus</i>	--	--	270	86.67	4628	33.69
<i>Litsea floribunda</i>	1	0.44	2	1.52	--	--
<i>Litsea ligustrina</i>	1	0.69	--	--	29	0.75
<i>Litsea</i> sp.1	--	--	8	2.27	--	--
<i>Litsea</i> sp.2	--	--	2	0.82	--	--
<i>Litsea</i> sp.3	--	--	--	--	29	0.75
<i>Litsea wightiana</i>	--	--	--	--	29	0.75

Table 1(cont'd). Density (individuals ha<sup>-1</sup>) and importance value index (IVI) of mature trees (gbh ≥ 30.1 cm), saplings ( gbh 10.1 cm to 30.0 cm) and seedlings (girth ≤ 10.0 cm and height ≤ 1 m ) in the permanent plot established in a Shola forest at Mannavan shola, Kerala.

Species	Mature tree		Saplings		Seedlings	
	Density	IVI	Density	IVI	Density	IVI
<i>Mallotus tetracoccus</i>	1	0.67	--	--	--	--
<i>Mastixia arborea</i>	60	22.84	148	49.41	800	7.36
<i>Microtropis ramiflora</i>	--	--	10	4.68	--	--
<i>Murraya paniculata</i>	--	--	--	--	57	1.50
<i>Neolitsea scrobiculata</i>	1	0.54	--	--	114	2.41
<i>Neolitsea zeylanica</i>	--	--	4	1.72	486	6.23
<i>Olea dioica</i>	--	--	--	--	29	0.75
<i>Persea macrantha</i>	10	8.13	2	0.83	600	9.83
<i>Phoebe lanceolata</i>	3	0.91	16	8.99	257	3.79
<i>Photinia sp.</i>	--	--	8	2.28	--	--
<i>Photinia integrifolia</i>	2	0.93	--	--	--	--
<i>Polygala arillata</i>	--	--	2	1.09	--	--
<i>Prunus ceylanica</i>	1	0.54	2	0.82	--	--
<i>Psychotria sp.</i>	--	--	2	1.02	--	--
<i>Randia sp.</i>	2	1.37	--	--	--	--
<i>Rapanea sp.</i>	--	--	--	--	29	0.75
<i>Rauvolfia densiflora</i>	--	--	2	0.84	--	--
<i>Saprosma foetens</i>	16	6.92	22	12.24	200	4.67
<i>Scheffera racemosa</i>	1	0.45	2	1.32	--	--
<i>Symplocos cochinchinensis</i>	--	--	--	--	29	0.75
<i>Symplocos pendula</i>	--	--	2	0.79	--	--
<i>Symplocos sp.</i>	--	--	--	--	371	5.61
<i>Syzygium cumini</i>	1	0.52	--	--	--	--
<i>Syzygium densiflorum</i>	10	11.24	2	1.07	229	4.82
<i>Syzygium gardneri</i>	3	2.08	--	--	--	--
<i>Syzygium tamilnadensis</i>	--	--	8	2.81	--	--
<i>Temstroemia japonica</i>	7	5.95	--	--	--	--
<i>Turpinia nepalensis</i>	6	2.9	4	2.01	29	0.75
<i>Vaccinium leschenaultii</i>	--	--	2	1.34	--	--
Unidentified -1	4	2.32	--	--	--	--
Unidentified-2	3	2.05	--	--	--	--
Unidentified-3	1	0.43	--	--	--	--
Unidentified-4	--	--	--	--	29	0.75
Unidentified-5	--	--	--	--	257	4.98
Unidentified-6	--	--	--	--	200	2.29



Table 2. Occurrence of mature trees (gbh > 30.1 cm) of different species in different quadrats (10 m x 10 m ) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola, Kerala. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
	53	54	67	73	75	88	94	98	99	
<i>Acronychia pedunculata</i>	53 (1)	54 (2)	67 (3)	73 (1)	75 (1)	88 (1)	94 (1)	98 (1)	99 (1)	
<i>Actinodaphne bourdillonii</i>	6 (1)	13 (1)	17 (1)	33 (3)	49 (1)	50 (1)	51 (1)	67 (1)	73 (1)	77 (1)
	85 (1)	96 (2)								
<i>Aglaia elaeagnoidea</i>	40 (1)	73 (1)								
<i>Alseodaphne semecarpifolia</i>	54 (1)	59 (1)	60 (1)	78 (1)	79 (1)	81 (1)	99 (1)			
<i>Beilschmiedia wightii</i>	2 (2)	7 (1)	10 (2)	13 (2)	14 (1)	15 (1)	20 (1)	25 (1)	26 (1)	34 (1)
	35 (1)	36 (1)	37 (1)	39 (2)	44 (1)	45 (1)	46 (2)	50 (1)	53 (1)	54 (1)
	56 (1)	57 (2)	58 (1)	59 (2)	60 (1)	65 (1)	70 (2)	76 (1)	85 (2)	90 (1)
	91 (2)	92 (1)								
<i>Bhesa indica</i>	3 (1)	21 (1)	23 (1)	33 (1)	35 (1)	42 (1)	a4 (1)			
<i>Canthium dicocum</i>	7 (1)	58 (1)								
<i>Celtis philippensis</i>	11 (1)	45 (1)								
<i>Chionanthus ramiflorus</i>	8 (1)	9 (1)	10 (5)	11 (2)	13 (1)	26 (1)	27 (1)	28 (1)	29 (2)	33 (1)
	36 (1)	39 (1)	45 (1)	48 (2)	50 (1)	51 (1)	52 (1)	53 (1)	55 (1)	58 (1)
	61 (1)	63 (2)	66 (2)	67 (1)	70 (1)	85 (1)	90 (1)	91 (1)	92 (1)	95 (1)
	98 (1)	100 (1)								
<i>Cinnamomum</i> sp. 1	76 (1)									
<i>Cinnamomum</i> sp. 2	77 (1)									
<i>Cinnamomum</i> sp. 3	66 (1)									
<i>Cinnamomum sulphuratum</i>	5 (1)	10 (1)	16 (1)	18 (1)	28 (1)	46 (1)	48 (1)	57 (1)	90 (1)	95 (1)
<i>Clerodendrum viscosum</i>	34 (1)									
<i>Cryptocarya</i> sp.	39 (1)	66 (1)								
<i>Cryptocarya lawsonii</i>	5 (1)	17 (1)	22 (1)	25 (2)	34 (1)	36 (1)	39 (1)	50 (1)	58 (1)	67 (1)
	78 (1)	83 (1)	87 (1)	91 (1)						
<i>Cyathea nilgiriensis</i>	28 (1)	29 (3)	92 (1)	93 (3)						

—cont'd—

Table 2 (cont'd). Occurrence of mature trees (gbh > 30.1 cm) of different species in different quadrats (10 m x 10 m) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola, Kerala. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
<i>Elaeocarpus serratus</i>	41 (1)									
<i>Eugenia</i> sp.	36 (1)									
<i>Eurya nitida</i>	31 (1)	93 (1)								
<i>Glochidion neilgherrense</i>	8 (1)	29 (1)	34 (1)	35 (1)	51 (1)					
<i>Gomphandra coriacea</i>	1 (1)	4 (2)	5 (1)	6 (1)	7 (1)	8 (2)	9 (1)	10 (1)	11 (1)	12 (1)
	13 (2)	14 (1)	18 (1)	19 (3)	21 (2)	22 (1)	25 (2)	28 (4)	31 (1)	33 (3)
	34 (1)	35 (2)	39 (1)	40 (3)	41 (1)	43 (1)	45 (1)	47 (1)	54 (1)	55 (1)
	56 (1)	57 (1)	58 (1)	59 (1)	62 (2)	63 (1)	66 (1)	69 (2)	74 (1)	76 (1)
	77 (2)	80 (2)	83 (1)	84 (2)	89 (1)	90 (1)	95 (1)	99 (1)		
<i>Hydnocarpus alpina</i>	1 (2)	2 (1)	3 (1)	4 (1)	6 (1)	7 (2)	8 (2)	13 (1)	14 (3)	15 (2)
	16 (2)	17 (1)	18 (2)	19 (3)	20 (4)	21 (3)	22 (1)	23 (2)	24 (1)	25 (1)
	27 (1)	28 (3)	33 (3)	35 (1)	36 (1)	37 (2)	38 (1)	39 (1)	40 (2)	41 (1)
	42 (4)	43 (1)	47 (1)	51 (1)	52 (1)	53 (3)	55 (1)	56 (1)	58 (1)	61 (2)
	62 (1)	63 (1)	65 (1)	66 (1)	68 (3)	69 (1)	72 (1)	73 (1)	74 (1)	75 (3)
	76 (4)	77 (2)	78 (1)	79 (1)	80 (1)	81 (2)	82 (4)	83 (2)	84 (6)	85 (2)
	86 (2)	87 (2)	88 (1)	92 (1)	94 (1)	95 (1)	97 (2)	98 (1)	99 (1)	0 (1)
<i>Isonandm stocksii</i>	1 (2)	5 (1)	7 (4)	8 (1)	9 (1)	14 (1)	16 (1)	17 (1)	18 (5)	19 (2)
	20 (2)	21 (3)	22 (1)	24 (1)	27 (1)	28 (1)	32 (1)	35 (1)	36 (1)	40 (3)
	41 (1)	43 (2)	44 (2)	48 (1)	49 (1)	50 (1)	51 (1)	53 (2)	54 (2)	56 (1)
	58 (2)	59 (1)	60 (1)	61 (2)	68 (1)	69 (1)	74 (1)	75 (1)	77 (1)	79 (1)
	83 (1)	84 (1)	88 (1)	92 (1)	93 (1)	97 (1)	99 (1)			
<i>Litsea floribunda</i>	10 (1)									
<i>Litsea ligustrina</i>	30 (1)									
<i>Mallotus tetracoccus</i>	88 (1)									

-cont'd-

Table 2 (cont'd). Occurrence of mature trees (gbh > 30.1 cm) of different species in different quadrats (10 m x 10 m ) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola, Kerala. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
	7	9	10	15	25	26	27	28	32	33
<i>Mastixia arborea</i>	7 (1)	9 (1)	10 (1)	15 (1)	25 (1)	26 (1)	27 (2)	28 (2)	32 (1)	33 (1)
	34 (1)	35 (1)	36 (1)	40 (1)	46 (2)	48 (1)	49 (3)	50 (1)	52 (2)	53 (4)
	55 (1)	58 (2)	63 (2)	64 (1)	65 (1)	67 (2)	68 (1)	69 (2)	72 (1)	74 (2)
	76 (1)	79 (1)	80 (1)	81 (2)	82 (1)	83 (2)	86 (1)	87 (1)	88 (3)	91 (2)
	94 (1)									
<i>Neolitsea scrobiculata</i>	65 (1)									
<i>Persea macrantha</i>	4 (1)	5 (1)	15 (1)	25 (1)	26 (1)	34 (1)	38 (1)	51 (1)	54 (1)	57 (1)
<i>Phoebe lanceolata</i>	9 (1)	84 (1)	92 (1)							
<i>Photinia integrifolia</i>	36 (1)	84 (1)								
<i>Prunus ceylanica</i>	28 (1)									
<i>Randia</i> sp.	92 (1)	93 (1)								
<i>Saprosma foetens</i>	9 (1)	10 (1)	21 (1)	26 (1)	31 (1)	35 (1)	36 (1)	37 (1)	42 (1)	44 (2)
	50 (1)	56 (1)	80 (1)	91 (2)						
<i>Schefflera racemosa</i>	45 (1)									
<i>Syzygium cumini</i>	56 (1)									
<i>Syzygium densiflorum</i>	18 (1)	25 (1)	35 (1)	58 (1)	79 (1)	81 (1)	82 (1)	92 (1)	97 (1)	100 (1)
<i>Syzygium gardneri</i>	77 (1)	91 (1)	94 (1)							
<i>Temstroemia japonica</i>	14 (1)	15 (1)	23 (1)	24 (1)	36 (1)	40 (1)	64 (1)			
<i>Turpinia nepalensis</i>	5 (1)	13 (1)	15 (1)							
Unidentified-1	10 (1)	28 (1)	46 (1)	64 (1)						
Unidentified-2	73 (1)	74 (1)	77 (1)							
Unidentified-3	34 (1)									

Table 3. Occurrence of saplings (gbh 10.1 cm to 30.0 cm) of different species in different quadrats (10m x 10 m) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola, Kerala. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
<i>Acronychia pedunculata</i>	66 (1)									
<i>Actinodaphne bourdillonii</i>	1 (2)	2 (2)	7 (1)	8 (4)	9 (2)	11 (1)	12 (1)	13 (1)	26 (1)	28 (3)
<i>Aglaia elaeagnoidea</i>	32 (1)	35 (1)	36 (2)	69 (1)						
<i>Ardisia rhomboidea</i>	2 (2)	3 (2)	4 (1)	5 (5)	6 (2)	7 (1)	8 (3)	9 (3)	10 (2)	15 (1)
<i>Beilschmiedia wightii</i>	17 (1)	26 (4)	27 (1)	31 (2)	34 (1)	36 (2)	63 (1)	91 (1)	97 (1)	
<i>Chassalia curviflora</i>	8 (1)	10 (2)								
<i>Chionanthus ramiflorus</i>	20 (1)	22 (1)	24 (1)	25 (1)						
<i>Cinnamomum sp.3</i>	1 (1)	2 (2)	7 (1)	12 (2)	18 (2)	23 (2)	26 (1)	27 (1)	28 (2)	33 (3)
<i>Cinnamomum sulphuratum</i>	34 (1)	37 (1)	63 (2)	94 (3)	97 (1)					
<i>Cryptocarya sp.</i>	33 (1)									
<i>Cryptocarya lawsonii</i>	9 (2)	10 (2)	29 (1)	94 (1)						
<i>Cyathea crinata</i>	10 (1)	28 (1)								
<i>Elaeocarpus tuberculatus</i>	8 (1)	12 (1)	13 (2)	28 (1)	33 (1)	63 (1)				
<i>Eugenia sp.</i>	12 (1)	33 (2)								
<i>Eurya nitida</i>	30 (1)									
<i>Glochidion nilgiriense</i>	12 (1)									
<i>Gomphandra coriacea</i>	7 (1)	63 (1)								
<i>Gomphandra sp.</i>	12 (1)	28 (1)								
<i>Hydnocarpus alpina</i>	5 (1)	29 (1)								
<i>Ilex denticulata</i>	8 (2)	15 (1)	16 (1)							
<i>Isonandra stocksii</i>	1 (1)	2 (1)	7 (1)	10 (2)	20 (2)	23 (1)	24 (1)	25 (1)	26 (1)	27 (1)
<i>Litsea floribunda</i>	28 (1)	33 (1)	36 (2)	66 (2)	94 (1)	97 (2)				

-cont'd-

Table 3 (cont'd). Occurrence of saplings (gbh 10.1-30.0 cm) of different species in quadrats (10 m x 10 m) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
	1	2	3	4	5	6	7	8	9	10
<i>Lasianthus acuminatus</i>	1 (1)	2 (6)	3 (4)	4 (2)	5 (1)	6 (2)	7 (3)	8 (3)	9 (2)	10 (3)
	11 (1)	12 (1)	13 (1)	14 (2)	15 (1)	16 (2)	17 (3)	18 (3)	19 (1)	20 (3)
	21 (1)	22 (2)	23 (9)	25 (9)	26 (3)	27 (4)	28 (4)	30 (3)	31 (1)	33 (1)
	34 (3)	36 (3)	37 (6)	38 (3)	39 (4)	40 (2)	43 (6)	63 (2)	66 (2)	69 (2)
	91 (10)	94 (3)	97 (2)	100 (5)						
<i>Litsea</i> sp. 1	8 (1)	13 (3)								
<i>Litsea</i> sp.2	28 (1)									
<i>Mastixia arborea</i>	1 (1)	2 (4)	3 (2)	7 (2)	8 (6)	10 (2)	11 (1)	12 (1)	13 (2)	14 (1)
	15 (3)	16 (1)	18 (2)	19 (1)	21 (1)	22 (4)	23 (5)	25 (1)	26 (2)	28 (5)
	29 (1)	30 (1)	33 (4)	34 (5)	37 (1)	38 (1)	43 (1)	63 (2)	66 (3)	91 (2)
	94 (2)	100 (4)								
<i>Microtropis ramiflora</i>	2 (1)	66 (1)	69 (1)	100 (2)						
<i>Neolitsea zeylanica</i>	9 (1)	12 (1)								
<i>Persea macrantha</i>	66 (1)									
<i>Phoebe lanceolata</i>	9 (1)	26 (1)	32 (1)	33 (1)	34 (1)	36 (1)	69 (1)	94 (1)		
<i>Photinia</i> sp.	8 (1)	10 (3)								
<i>Polygala arillata</i>	30 (1)									
<i>Prunus ceylanica</i>	63 (1)									
<i>Psychotria</i> sp.	63 (1)									
<i>Rauvolfia densiflora</i>	94 (1)									
<i>Saprosma foetens</i>	7 (1)	14 (1)	23 (1)	24 (1)	28 (1)	31 (1)	34 (1)	37 (1)	42 (1)	43 (1)
	66 (1)									
<i>Schefflera racemosa</i>	18 (1)									
<i>Symplocos pendula</i>	91 (1)									
<i>Syzygium densiflorum</i>	94 (1)									
<i>Syzygium tamilnadensis</i>	8 (1)	27 (2)	28 (1)							
<i>Turpinia nepalensis</i>	28 (1)	35 (1)								
<i>Vaccinium leschenaultii</i>	100 (1)									

Table 4. Occurrence of tree seedlings (girth <10.0 cm, height < 1 m) of different species in different quadrats (5 m x 5 m) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola, Kerala. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
	63	66	97							
<i>Acronychia pedunculata</i>	63 (1)	66 (1)	97 (2)							
<i>Actinodaphne bourdillonii</i>	1 (5)	10 (5)	33 (1)	37 (2)	39 (5)	63 (4)	66 (2)	94 (1)	97 (2)	
<i>Alseodaphne semecarpifolia</i>	7 (3)	10 (1)	33 (2)	37 (2)	100 (1)					
<i>Ardisia rhomboidea</i>	4 (2)	7 (11)	10 (3)	33 (1)	37 (4)	39 (3)	63 (1)	66 (1)	91 (4)	97 (6)
	100 (13)									
<i>Beilschmiedia wightii</i>	1 (3)	4 (1)	7 (13)	10 (1)	33 (12)	37 (7)	39 (6)	63 (4)	66 (3)	69 (9)
	91 (2)	94 (11)	97 (9)	100 (3)						
<i>Bhesa indica</i>	1 (1)	4 (3)	39 (4)							
<i>Chionanthus ramiflorus</i>	1 (14)	4 (1)	7 (5)	33 (4)	37 (8)	39 (3)	63 (11)	66 (4)	91 (4)	94 (5)
	97 (8)	100 (19)								
<i>Cinnamomum sp. 4</i>	1 (1)	10 (1)	39 (1)	91 (1)						
<i>Clerodendrum viscosum</i>	69 (10)									
<i>Elaeocarpus recurvatus</i>	91 (1)									
<i>Eurya nitida</i>	66 (1)									
<i>Glochidion sp.</i>	10 (1)	33 (2)	39 (1)	63 (1)	69 (2)					
<i>Gomphandra conacea</i>	1 (1)	94 (1)								
<i>Hydnocarpus alpina</i>	1 (8)	7 (5)	10 (1)	33 (4)	37 (2)	39 (2)	63 (3)	66 (1)	69 (1)	91 (4)
	97 (8)	100 (5)								
<i>Ilex sp.</i>	1 (1)									
<i>Isonandra stocksii</i>	33 (1)	91 (2)	94 (1)	97 (1)	100 (2)					
<i>Lasianthus acuminatus</i>	1 (37)	4 (10)	7 (18)	10 (5)	33 (4)	37 (3)	39 (16)	63 (7)	66 (3)	69 (9)
	91 (9)	94 (3)	97 (27)	100 (11)						

----cont'd----

Table 4 (cont'd). Occurrence of tree seedlings (girth <10.0 cm, height < 1 m) of different species in different quadrats (5 m x 5 m) laid out in the 1-ha permanent plot established in the Shola forest at Mannavan shola, Kerala. Values in parentheses are number of individuals in the given quadrat.

Species	Quadrat number									
<i>Litsea ligustrina</i>	37 (1)									
<i>Litsea</i> sp.3	1 (1)									
<i>Litsea wightiana</i>	69 (1)									
<i>Mastixia arborea</i>	7 (19)	37 (1)	39 (5)	63 (1)	97 (2)					
<i>Murraya paniculata</i>	1 (1)	69 (1)								
<i>Neolitsea scrobiculata</i>	33 (1)	37 (2)	66 (1)							
<i>Neolitsea zeylanica</i>	1 (4)	10 (2)	33 (1)	69 (3)	91 (5)	97 (2)				
<i>Olea dioica</i>	7 (1)									
<i>Persea macrantha</i>	1 (3)	4 (1)	7 (2)	10 (4)	33 (1)	37 (1)	39 (2)	63 (1)	69 (4)	91 (1)
	94 (1)									
<i>Phoebe lanceolata</i>	1 (1)	10 (6)	66 (1)	91 (1)						
<i>Rapanea</i> sp.	10 (1)									
<i>Saprosma foetens</i>	10 (1)	39 (1)	63 (2)	69 (1)	91 (1)	97 (1)				
<i>Symplocos cochinchinensis</i>	97 (1)									
<i>Symplocos</i> sp.	1 (2)	33 (6)	37 (1)	63 (1)	94 (1)	97 (2)				
<i>Syzygium densiflora</i>	1 (1)	4 (1)	10 (1)	33 (2)	66 (2)	94 (1)				
<i>Turpinia nepalensis</i>	91 (1)									
Unidentified-4	91 (1)									
Unidentified-5	1 (2)	4 (1)	7 (1)	37 (1)	66 (3)	97 (1)				
Unidentified-6	39 (6)	91 (1)								

About 10% mature trees, 7% of saplings and 0.3% of seedlings are damaged but live (Table 5). Location and tag number of these damaged trees are given in Table 6 to facilitate to verify their status in the next census.

The girth class distribution of trees showed a negative exponential pattern. This is another indication to the undisturbed nature of the forest stand. However, based on the analysis of patterns of girth distribution of individual species three groups of species can be recognised (Table 7). Group 1 comprises species with a negative exponential distribution and capable of attaining large girths. such as *Chionanthus ramiflorus*, *Hydnocarpus alpina*, *Isonandra stocksii* and *Mastixia arborea*. Species of group 2 also show a negative exponential girth distribution pattern. They are species of the understorey with small girth classes such as *Lasianthus acuminatus*, *Ardisia rhomboidea*, *Saprosma foetens* and *Turpinia nepalensis*. The distribution pattern in group 3 species is characterised by a large number of individuals of medium and small girth classes. *Cryptocarya lawsonii*, *Phoebe lanceolata*, *Gomphandra coriacea* and *Glochidion nilgirensis* are examples to this group. It may also be noted here that while 18 % species represented in all three phases (seedling, sapling and mature trees) indicating better recruitment, 30% species do not have representation in seedling stage showing poor regeneration (Table 5). In Mannavan shola, Lauraceae is the most dominant family recording about 21% of the total IVI.



Table 5. Basic statistics of mature trees (>30.1 cm gbh). saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth <10.0 cm height <1 m) population in the permanent plot established in the Shola forest at Mannavan shola Kerala

	Phases		
	Mature trees	Saplings	Seedlings
Families represented	21	24	18
Species represented	44	42	36
Total number of individuals (ha <sup>-1</sup> )	566	818	18260
Total basal area (m <sup>2</sup> ha <sup>-1</sup> )	52.4	2.13	—
Species diversity index (H)	3.997	3.533	3.784
Species dominance value (C)	0.0995	0.1608	0.1178
Ramakrishnan Index of Stand Quality (RISQ)	1.178	1.155	1.224
Number of live but damaged trees (ha <sup>-1</sup> )	55	58	56

**Table 6. List of damaged but live trees recorded in the permanent plot established in the Shola forest at Mannavan shola, Kerala. Location (quadrat number) and tag number of trees are given.**

Species	Mature trees*	Saplings**	Seedlings***
<i>Acronychia pedunculata</i>	Q54:330 <sup>2</sup> Q99:568 <sup>5</sup>	---	---
<i>Actinodaphne bourdillonii</i>	Q6:22 <sup>2</sup>	Q28:2719 <sup>2</sup>	---
<i>Aglaia elaeagnoidea</i>	Q73:425 <sup>1</sup> Q73:425 <sup>8</sup>	---	---
<i>Alseodaphne semecarpifolia</i>	Q99:564 <sup>2</sup>		
<i>Ardisia rhomboidea</i>	---	Q31:2811 Q31:2814 <sup>2</sup> Q6:1498 <sup>6</sup>	
<i>Beilschmiedia wightii</i>	Q7:24 <sup>4</sup>		
<i>Canthium dicoccum</i>	Q7:28 <sup>2</sup>	---	---
<i>Chionanthus ramiflorus</i>	Q53:325 <sup>1</sup> Q8:37 <sup>4</sup> Q11:61 <sup>7</sup>	---	---
<i>Clerodendrum viscosum</i>	---	---	Q69:3648
<i>Cryptocarya lawsonii</i>	Q25:145 <sup>1</sup> Q25:145 <sup>8</sup>		
<i>Cyathea nilgiriensis</i>	Q93:544 <sup>1</sup> Q93:545 <sup>1</sup> Q93:546 <sup>1</sup>		
<i>Glochidion neilgherrense</i>	Q8:41 <sup>1</sup>	Q12:1733 <sup>8</sup>	---
<i>Gomohandra coriacea</i>	Q33:197 <sup>2</sup> Q62:374 <sup>2</sup> Q80:464 <sup>2</sup> Q83:481 <sup>2</sup> Q99:566 <sup>2</sup> Q41:255 <sup>3</sup> Q45:277 <sup>7</sup> Q62:374 <sup>8</sup>	Q29:2744 <sup>1</sup>	---

---cont'd---

\*; gbh >30.1 cm; \*\*, gbh 10.1 cm to 30.0 cm, \*\*\*, girth <10.0 cm and height <1 m

<sup>1</sup>: Fallen, <sup>2</sup>: Tip broken, <sup>3</sup>: Tip cut, <sup>4</sup>: Branches dried, <sup>5</sup>: Heart wood broken,

<sup>6</sup>: Bole infected, <sup>7</sup>: Fungal attack, <sup>8</sup>: Sprouted. <sup>9</sup>: Tip dried

<sup>10</sup>: Bark eaten by wild animals.

Table 6 (cont'd). List of damaged but live trees recorded in the permanent plot established in the Shola forest at Mannavan shola, Kerala. Location (quadrat number) and tag number of trees are given.

Species	Mature trees*	Saplings**	Seedlings***
Hydnocarpus alpina	Q52:311 <sup>1</sup> Q42:258 <sup>2</sup> Q47:284 <sup>2</sup> Q74:431 <sup>2</sup> Q76:444 <sup>2</sup> Q78:456 <sup>2</sup> Q82:473 <sup>2</sup> Q82:474 <sup>2</sup> Q83:484 <sup>2</sup> Q83:485 <sup>2</sup> Q84:496 <sup>2</sup> Q61:372 <sup>7</sup> Q74:431 <sup>7</sup> Q82:474 <sup>7</sup> Q83:484 <sup>7</sup> Q83:485 <sup>7</sup>	Q66:1051 <sup>2</sup> Q36:866 <sup>3</sup>	
Isonandra stocksii	Q43:267 <sup>2</sup> Q77:450 <sup>2</sup> Q18:96 <sup>4</sup> Q19:112 <sup>4</sup> Q21:123 <sup>8</sup>	---	---
Lasianthus acuminatus		Q6:1513 <sup>1</sup> Q17:1974 <sup>1</sup> Q4:621 <sup>2</sup> Q12:1754 <sup>2</sup> Q23:2450 <sup>2</sup> Q23:2455 <sup>2</sup> Q30:2759 <sup>2</sup> Q30:2765 <sup>2</sup> Q40:3079 <sup>2</sup> Q43:3192 <sup>2</sup> Q25:2529 <sup>3</sup> 238:2982 <sup>3</sup>	---
Mastixia arborea	Q40:263 <sup>1</sup> Q94:548 <sup>2</sup> Q81:468 <sup>2</sup> Q88:518 <sup>2</sup> Q94:548 <sup>8</sup>	228:2685 <sup>2</sup> 228:2688 <sup>2</sup> 37:638 <sup>9</sup> 234:2855 <sup>3</sup> 234:2858 <sup>10</sup>	---

-cont'd-

\*, gbh >30.1 cm; \*\*, gbh 10.1 cm to 30.0 cm, \*\*\*, girth <10.0 cm and height <1 m.

<sup>1</sup>: Fallen, <sup>2</sup>: Tip broken, <sup>3</sup>: Tip cut, <sup>4</sup>: Branches dried, <sup>5</sup>: Heart wood broken,  
<sup>6</sup>: Bole infected, <sup>7</sup>: Fungal attack, <sup>8</sup>: Sprouted. <sup>9</sup>: Tip dried <sup>10</sup>: Bark eaten by wild animals.

Table 6 (cont'd). List of damaged but live trees recorded in the permanent plot established in the Shola forest at Mannavan shola, Kerala. Location (quadrat number) and tag number of trees are given.

Species	Mature trees <sup>*</sup>	Saplings <sup>**</sup>	Seedlings <sup>***</sup>
<i>Microtropis ramiflora</i>	----	Q100:1306 <sup>2</sup> Q100:1308 <sup>2</sup>	----
<i>Fersea macrocartha</i>	Q38:234 <sup>1</sup> Q57:348 <sup>7</sup>	----	----
<i>Phoebe lanceolata</i>	----	Q34:2853 <sup>3</sup>	----
<i>Prunus ceylanica</i>	Q28:172 <sup>1</sup>	Q63:960 <sup>8</sup>	----
<i>Saprosma foetens</i>	Q80:465 <sup>2</sup>	----	----
<i>Syzygium cumini</i>	Q56:343 <sup>1</sup>	----	----
<i>Syzygium densiflorum</i>	Q79:458 <sup>2</sup>	----	----
<i>Syzygium gardneri</i>	Q91:531 <sup>1</sup> Q94:547 <sup>7</sup>	----	----
<i>Turpinia nepalensis</i>	Q13:71 <sup>2</sup>	----	----
Unidentified -2	Q77:448 <sup>2</sup>	----	----
Unidentified-6	----	----	Q91:3663 <sup>2</sup>

\* , gbh >30.1 cm; \*\*, gbh 10.1 cm to 30.0 cm , \*\*\*, girth <10.0 cm and height <1 m.

<sup>1</sup>: Fallen, <sup>2</sup>: Tip broken, <sup>3</sup>: Tip cut, <sup>4</sup>: Branches dried, <sup>5</sup>: Heartwood broken,  
<sup>6</sup>: Bole infected, : Fungal attack, : Sprouted. : Tip dried : Bark eaten by wild animals.

Table 7. Girth class distribution of trees in the permanent plot established in the Shola forest at Mannavan shola, Kerala.

Species	Size class category*							
	A	B	C	D	E	F	G	H
	Number of individuals ha <sup>-1</sup>							
<i>Acronychia pedunculata</i>	114	2	6	5	2	--	--	--
<i>Actinodaphne bourdillonii</i>	771	44	4	1	3	3	1	3
<i>Aglaiia elaeagnoidea</i>	--	2	1	--	--	1	--	--
<i>Alseodaphne semecarpifolia</i>	257	--	2	--	2	3	1	--
<i>Ardisia rhomboidea</i>	1400	72	--	--	--	--	--	--
<i>Beilschmiedia wightii</i>	2400	6	9	11	10	9	3	--
<i>Bhesa indica</i>	229	--	--	3	3	1	--	--
<i>Canthium dicoccum</i>	--	--	--	--	2	--	--	--
<i>Celtis philippensis</i>	--	--	2	--	--	--	--	--
<i>Chassalia curviflora</i>	--	8	--	--	--	--	--	--
<i>Chionanthus ramiflorus</i>	2457	50	9	9	6	7	6	4
<i>Cinnamomum</i> sp.1	--	--	1	--	--	--	--	--
<i>Cinnamomum</i> sp.2	--	--	1	--	1	--	--	--
<i>Cinnamomum</i> sp.3	--	2	--	--	--	--	--	--
<i>Cinnamomum</i> sp.4	114	--	--	--	--	--	--	--
<i>Cinnamomum sulphuratum</i>	--	12	1	3	1	2	2	1
<i>Clerodendrum viscosum</i>	286	--	1	--	--	--	--	--
<i>Cryptocarya</i> sp.	--	4	--	--	--	1	--	--
<i>Cryptocarya lawsonii</i>	--	14	4	5	2	5	--	--
<i>Cyathea crinita</i>	--	6	--	--	--	--	--	--
<i>Cyathea nilgiriensis</i>	--	--	8	--	--	--	--	--
<i>Elaeocarpus recurvatus</i>	29	--	--	--	--	--	--	--
<i>Elaeocarpus serratus</i>	--	--	--	--	--	--	--	1
<i>Elaeocarpus tuberculatus</i>	--	2	--	--	--	--	--	--
<i>Eugenia</i> sp.	--	2	--	--	--	--	--	1
<i>Eurya nitida</i>	29	4	1	--	1	--	--	--
<i>Glochidion neilgherrense</i>	--	4	3	2	--	--	--	--
<i>Glochidion</i> sp.	200	--	--	--	--	--	--	--
<i>Gomphandra coriacea</i>	57	4	48	18	1	--	--	--
<i>Gomphandra</i> sp.	--	8	--	--	--	--	--	--
<i>Hydnocarpus alpina</i>	1257	42	35	34	28	15	7	2
<i>Ilex denticulata</i>	--	4	--	--	--	--	--	--
<i>Ilex</i> sp.	29	--	--	--	--	--	--	--
<i>Isonandra stocksii</i>	200	6	8	19	12	16	6	6
<i>Lasianthus acuminatus</i>	4628	270	--	--	--	--	--	--
<i>Litsea floribunda</i>	--	2	1	--	--	--	--	--
<i>Litsea ligustrina</i>	29	--	--	--	--	1	--	--

---cont'd---

\*, Size classes: A- Seedlings (girth < 10.0 cm, height < 1 m), B- Saplings (gbh 10.1 to 30.0 cm), C to H- Mature trees, gbh 30.1-60.0, 60.1-90.0, 90.1 - 120.0, 120.1 - 150.0, 150.1-180.0 and > 180.1 cm respectively.

Table 7(cont'd). Girth class distribution of trees in the permanent plot established in the Shola forest at Mannavan shola, Kerala.

Species	Size class category <sup>*</sup>							
	A	B	C	D	E	F	G	H
	Number of individuals ha <sup>-1</sup>							
<i>Litsea</i> sp.1	--	8	--	--	--	--	--	--
<i>Litsea</i> sp.2	--	2	--	--	--	--	--	--
<i>Litsea</i> sp.3	29	--	--	--	--	--	--	--
<i>Litsea wightiana</i>	29	--	--	--	--	--	--	--
<i>Mallotus tetracoccus</i>	--	--	--	--	--	1	--	--
<i>Mastixia arborea</i>	800	148	49	6	3	1	1	--
<i>Microtropis ramiflora</i>	--	10	--	--	--	--	--	--
<i>Murraya paniculata</i>	57	--	--	--	--	--	--	--
<i>Neolitsea scrobiculata</i>	114	--	--	1	--	--	--	--
<i>Neolitsea zeylanica</i>	486	4	--	--	--	--	--	--
<i>Olea dioica</i>	29	--	--	--	--	--	--	--
<i>Persea macrantha</i>	600	2	--	1	--	4	3	2
<i>Phoebe lanceolata</i>	257	16	3	--	--	--	--	--
<i>Photinia</i> sp.	--	8	--	--	--	--	--	--
<i>Photinia integrifolia</i>	--	--	1	1	--	--	--	--
<i>Polygala arillata</i>	--	2	--	--	--	--	--	--
<i>Prunus ceylanica</i>	--	2	--	1	--	--	--	--
<i>Psychotria</i> sp.	--	2	--	--	--	--	--	--
<i>Randia</i> sp.	--	--	--	--	1	1	--	--
<i>Rapanea</i> sp.	29	--	--	--	--	--	--	--
<i>Rauvolfia densiflora</i>	--	2	--	--	--	--	--	--
<i>Saprosma foetens</i>	200	22	11	5	--	--	--	--
<i>Schefflera racemosa</i>	--	2	1	--	--	--	--	--
<i>Symplocos cochinchinensis</i>	29	--	--	--	--	--	--	--
<i>Symplocos pendula</i>	--	2	--	--	--	--	--	--
<i>Symplocos</i> sp.	371	--	--	--	--	--	--	--
<i>Syzygium cumini</i>	--	--	--	1	--	--	--	--
<i>Syzygium densiflorum</i>	229	2	--	1	1	--	2	6
<i>Syzygium gardneri</i>	--	--	1	--	1	--	--	1
<i>Syzygium tamilnadensis</i>	--	8	--	--	--	--	--	--
<i>Ternstroemia japonica</i>	--	--	--	--	--	3	3	1
<i>Turpinia nepalensis</i>	29	4	5	--	1	--	--	--
<i>Vaccinium leschenaultii</i>	--	2	--	--	--	--	--	--
Unidentified-1	--	--	3	--	--	1	--	--
Unidentified -2	--	--	--	1	--	1	--	1
Unidentified-3	--	--	1	--	--	--	--	--
Unidentified-4	29	--	--	--	--	--	--	--
Unidentified-5	257	--	--	--	--	--	--	--
Unidentified-6	200	--	--	--	--	--	--	--

\*, Size classes: A- Seedlings (girth < 10.0 cm, height <1 m), B- Saplings (gbh 10.1 cm to 30.0 cm), C to H- Mature trees, gbh 30.1-60.0, 60.1-90.0, 90.1 - 120.0, 120.1 -150.0, 150.1-180.0 and > 180.1 cm respectively.

### 3.1.2. Wet evergreen forest plot in Pothumala

*Palaquium ellipticum*, *Cullenia exarillata*, *Mesua ferrea* and *Drypetes wightii* are the dominant species in the mature tree phase in the permanent plot established in the wet evergreen forest at Pothumala. These four dominant species constituted about 56% of the mature tree population. About 29% of the tree species are represented by individual mature tree (Table 8). In the case of sapling population *Ardisia pauciflora*, *Syzygium laetum*, *Meiogyne pannosa* and *Aglaia tomentosa* are the dominant species. All these four are species of the understorey with small girth class. Contribution of emergent species like *Palaquium ellipticum*, *Cullenia exarillata* and *Mesua ferrea* to the total IVI of sapling population is only about 10%. *Dimocarpus longan*, *Litsea stocksii*, *Meiogyne pannosa* and *Litsea mysorensis* showed higher values for IVI in seedling population.

The distribution pattern of mature trees, saplings and seedlings in quadrats laid out in the permanent plot is represented in Table 9, 10 and 11. These Tables will help in recensuses and also to understand the dynamics of trees in the forest. In order to facilitate easy identification of species in the plot representative individuals with their locations (quadrat number) and tag number are given in Appendix 2.

The *Cullenia exarillata* - *Mesua ferrea*- *Palaquium ellipticum* type is the most important among the medium elevation forest types in the Western Ghats, both in area and quality (Pascal, 1988). Forests of this type located in Attappadi, Silent Valley and Pothumala (Nelliampathy) have been studied by Pascal (1988), Singh et al. (1981) and Chandrashekara and Ramakrishnan (1994) respectively. Number of tree species recorded per hectare through these studies was 32, 37 and 30 respectively from Attappadi, Silent valley and Pothumala forest. When compared to these three forest patches, therefore, the permanent plot established at Pothumala with 55 tree species is richer in terms of species number (Table 12).

In a temporary plot studied in the same forest (Pothumala), the stem density recorded for mature trees, saplings and seedlings was 496, 900 and 20,500 respectively (Chandrashekara and Ramakrishnan, 1994). Thus the permanent plot is characterised by having comparatively higher stem density for mature trees and sapling phases and significantly lower seedling density.

Table 8. Density (individuals ha<sup>-1</sup>) and importance value index (IVI) of mature trees (gbh > 30.1 cm), saplings (gbh 10.1 cm to 30.0 cm) and tree seedlings (girth < 10.0 cm, height < 1 m) in the permanent plot established in a wet evergreen forest at Pothumala, Kerala.

Species	Mature trees		Saplings		Seedlings	
	Density ha <sup>-1</sup>	IVI	Density ha <sup>-1</sup>	IVI	Density ha <sup>-1</sup>	IVI
<i>Actinodaphne bourdillonii</i>	-	-	2	0.7	-	--
<i>Actinodaphne tadulingamii</i>	1	0.4	2	0.6	86	4.2
<i>Aglaia tomentosa</i>	13	5.7	74	23.3	57	2.8
<i>Agrostistachys borneensis</i>	40	14.7	20	5.8	-	--
<i>Antidesma menasu</i>	2	1.1	2	0.9	-	--
<i>Ardisia pauciflora</i>	4	1.8	206	54.6	28	1.4
<i>Artocarpus heterophyllus</i>	8	4.0	2	0.7	57	1.9
<i>Artocarpus hirsutus</i>	-	-	2	0.6	-	--
<i>Beilschmiedia sp.</i>	-	-	2	0.6	-	--
<i>Canarium strictum</i>	1	0.6	-	-	-	--
<i>Canthium sp.</i>	3	1.7	-	-	-	--
<i>Cassine sp.</i>	1	0.5	-	-	-	--
<i>Chionanthus sp.</i>	3	2.4	-	-	-	--
<i>Cinnamomum malabatum</i>	-	-	-	-	28	1.4
<i>Cryptocarya bourdillonii</i>	2	1.0	-	-	-	--
<i>Cullenia exarillata</i>	48	37.9	24	8.7	114	5.6
<i>Dimocarpus longan</i>	20	12.3	32	10.3	1542	36.9
<i>Diospyros assimilis</i>	1	0.5	-	-	-	--
<i>Drypetes wightii</i>	78	31.0	60	19.7	285	10.3
<i>Fahrenheitia zeylanica</i>	5	2.4	4	1.4	-	--
<i>Ficus sp.</i>	1	0.5	-	-	-	--
<i>Garcinia gummi-gutta</i>	7	3.4	4	1.6	-	--
<i>Gomphandra sp.</i>	8	4.0	2	1.6	-	--
<i>Heritiera papilio</i>	12	8.8	2	0.9	428	11.8
<i>Holigama ferruginea</i>	9	7.7	-	-	-	--
<i>Isonandra lanceolata</i>	7	3.2	14	4.1	-	--
<i>Lasianthus sp.</i>	-	-	4	1.2	-	--
<i>Leea indica</i>	-	-	10	3.0	29	1.4
<i>Litsea stocksii</i>	10	4.6	32	11.0	742	23.4
<i>Litsea laevigata</i>	-	-	12	3.7	114	3.7
<i>Litsea mysorensis</i>	-	-	56	16.5	371	16.3
<i>Litsea sp1.</i>	1	0.5	-	-	-	-
<i>Litsea Sp.2.</i>	6	3.2	42	13.9	285	11.2
<i>Litsea floribunda</i>	4	1.8	2	0.8	142	5.1
<i>Macaranga peltata</i>	1	0.5	-	-	-	--
<i>Mallotus sp.</i>	-	-	2	0.8	-	--
<i>Mastixia arborea</i>	1	0.4	-	-	-	--
<i>Meiogyne pannosa</i>	20	8.5	78	25.6	599	17.4
<i>Memecylon sp.</i>	-	-	6	2.0	114	4.7



Table 8 (cont'd). Density (individuals ha<sup>-1</sup>) and importance value index (IVI) of mature trees (gbh >30.1 cm), saplings (10.1 cm to 30.0 cm) and tree seedlings (girth < 10.0 cm, height <1 m) in the permanent plot established in a wet evergreen forest at Pothumala, Kerala.

Species	Mature trees		Saplings		Seedlings	
	Density ha-1	IVI	Density ha-1	IVI	Density ha-1	IVI
<i>Mesua ferrea</i>	51	35.9	14	4.7	114	4.7
<i>Myristica dactyloides</i>	9	5.4	10	3.4	85	4.2
<i>Neolitsea</i> sp.	-	-	-	-	57	2.8
<i>Nothopegia beddomei</i>	1	0.4	-	-	29	1.4
<i>Palaquium ellipticum</i>	128	77.9	50	15.6	29	1.4
<i>Phoebe lanceolata</i>	1	0.4	4	1.2	29	1.4
<i>Psychotria</i> sp.	-	-	8	2.8	229	9.3
<i>Polyalthia coffeoides</i>	2	1.0	4	1.6	-	-
<i>Syzygium gardneri</i>	4	1.8	-	-	-	-
<i>Syzygium laetum</i>	27	11.3	166	49.4	143	5.1
<i>Villebrunea integrifolia</i>	-	-	2	1.1	-	-
Unidentified - P1	1	0.4	4	1.3	-	-
Unidentified-P2	1	0.4	2	0.7	-	-
Unidentified-P3	-	-	-	-	58	2.8
Unidentified-P4	-	-	-	-	115	6.4
Unidentified-P5	-	-	10	3.6	29	1.4

Table 9. Mature trees (gbh >30.1 cm) distribution in quadrats (10 m x 10 m) laid out in the permanent plot established in a wet evergreen forest at Pothumala. Values in parantheses are number of individuals in the given quadrat

Species	Quadrat number and number of individuals									
<i>Actinodaphne tadulingamii</i>	44 (1)									
<i>Aglaiatomentosa</i>	9 (1)	13 (1)	15 (1)	22 (1)	31 (1)	55 (1)	71 (1)	91 (1)	94 (2)	96 (1)
	97 (1)	98 (1)								
<i>Agrostistachys meeboldii</i>	31 (1)	46 (1)	47 (2)	48 (4)	49 (2)	51 (3)	53 (3)	54 (2)	56 (1)	66 (1)
	67 (1)	68 (1)	70 (3)	72 (1)	73 (4)	80 (1)	84 (1)	85 (1)	86 (2)	87 (1)
	96 (1)	97 (2)	99 (1)							
<i>Antidesma menasu</i>	80 (1)	87 (1)								
<i>Ardisia pauciflora</i>	40 (1)	46 (1)	52 (1)	68 (1)						
<i>Artocarpus heterophyllus</i>	14 (1)	31 (1)	35 (1)	43 (1)	49 (2)	85 (1)	86 (1)			
<i>Canarium strictum</i>	70 (1)									
<i>Canthium sp.</i>	16 (1)	35 (1)	70 (1)							
<i>Cassine sp.</i>	7 (1)									
<i>Chionanthus sp.</i>	39 (1)	43 (1)	74 (1)							
<i>Cryptocarya bourdillonii</i>	9 (1)	34 (1)								
<i>Cullenia exarillata</i>	13 (1)	16 (2)	17 (1)	18 (1)	21 (3)	23 (1)	24 (1)	25 (1)	27 (3)	28 (3)
	30 (1)	34 (1)	35 (2)	36 (1)	39 (1)	41 (1)	42 (1)	43 (1)	45 (1)	48 (2)
	51 (1)	52 (1)	55 (2)	58 (1)	65 (1)	69 (1)	70 (1)	73 (2)	78 (1)	83 (2)
	84 (1)	96 (1)	97 (2)	99 (1)	100 (2)					
<i>Dimocarpus longan</i>	6 (1)	20 (1)	23 (1)	35 (1)	37 (1)	40 (1)	55 (1)	59 (1)	68 (1)	74 (1)
	81 (1)	82 (1)	85 (1)	89 (1)	90 (1)	91 (2)	93 (1)	94 (2)		
<i>Diospyros assimilis</i>	8 (1)									

--cont'd--

Table 9 (cont'd). Mature trees (gbh >30.1 cm) distribution in quadrats (10 m x 10 m) laid out in the permanent plot established in a wet evergreen forest at Pothumala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat number and number of individuals									
	4	6	7	11	12	13	14	15	17	18
<i>Drypetes wightii</i>	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(1)	(1)	(1)
	19	21	22	24	25	28	29	30	31	32
	(1)	(2)	(2)	(2)	(3)	(1)	(1)	(1)	(1)	(2)
	33	34	35	36	37	39	41	42	44	46
	(1)	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(2)
	50	51	52	54	56	58	59	61	66	67
(1)	(1)	(1)	(2)	(1)	(2)	(4)	(1)	(2)	(2)	
	69	72	73	74	75	82	85	86	87	88
	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	90	91	94	95	98	100				
	(4)	(1)	(2)	(1)	(1)	(2)				
<i>Fahrenheitia zeylanica</i>	72	92	94	95	96					
	(1)	(1)	(1)	(1)	(1)					
<i>Ficus sp.</i>	61									
	(1)									
<i>Garcinia gummi-gutta</i>	3	19	21	27	76	78	99			
	(1)	(1)	(1)	(1)	(1)	(1)	(1)			
<i>Gomphandra sp.</i>	44	50	55	71	82	94	95	100		
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)		
<i>Heritiera papilio</i>	1	2	3	9	13	19	21	22	23	25
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	36	57								
	(1)	(1)								
<i>Holigarna ferruginea</i>	4	7	18	25	33	37	40	41	83	
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
<i>Isonandra lanceolata</i>	9	11	13	23	34	36	70			
	(1)	(1)	(1)	(1)	(1)	(1)	(1)			
<i>Litsea sp.1</i>	67									
	(1)									
<i>Litsea Sp.2.</i>	2	18	19	22	92					
	(1)	(1)	(1)	(2)	(1)					
<i>Litsea floribunda</i>	5	9	12	15						
	(1)	(1)	(1)	(1)						
<i>Litsea stocksii</i>	8	16	19	23	33	41	46	48	52	73
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
<i>Macaranga peltata</i>	47									
	(1)									
<i>Mastixia arborea</i>	23									
	(1)									
<i>Meiogyne pannosa</i>	1	2	3	20	24	26	27	40	41	61
	(1)	(1)	(1)	(3)	(1)	(1)	(1)	(1)	(1)	(1)
	63	71	75	76	78	84	92	94		
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)		

--cont'd--

Table 9 (cont'd). Mature trees (gbh >30.1 cm) distribution in quadrats (10 m x 10 m) laid out in the permanent plot established in a wet evergreen forest at Pothumala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat number and number of individuals									
	4 (1)	5 (1)	8 (1)	9 (2)	11 (1)	12 (3)	14 (1)	19 (1)	24 (1)	26 (1)
<i>Mesua ferrea</i>	30 (1)	32 (2)	34 (1)	36 (2)	43 (1)	46 (1)	49 (1)	50 (1)	54 (1)	56 (1)
	58 (1)	59 (1)	60 (3)	62 (1)	63 (1)	66 (2)	67 (1)	69 (1)	71 (1)	72 (1)
	73 (1)	75 (1)	76 (1)	77 (1)	79 (1)	82 (1)	83 (1)	90 (1)	91 (1)	95 (1)
	96 (1)	99 (1)	100 (1)							
<i>Myristica dactyloides</i>	11 (1)	21 (1)	36 (1)	41 (1)	45 (1)	53 (1)	59 (1)	83 (1)	96 (1)	
<i>Nothopegia beddomei</i>	76 (1)									
<i>Palaquium ellipticum</i>	1 (1)	2 (4)	4 (1)	6 (1)	7 (3)	8 (2)	9 (1)	11 (1)	12 (2)	13 (1)
	15 (1)	16 (4)	17 (1)	21 (1)	24 (2)	25 (1)	26 (4)	27 (1)	28 (1)	29 (1)
	30 (3)	31 (1)	32 (5)	33 (1)	35 (2)	36 (1)	37 (4)	38 (4)	39 (2)	40 (1)
	41 (1)	42 (3)	43 (2)	44 (2)	45 (3)	46 (1)	47 (1)	49 (4)	51 (1)	52 (3)
	53 (1)	54 (2)	55 (1)	56 (1)	60 (1)	64 (2)	65 (1)	66 (2)	67 (1)	68 (1)
	69 (1)	72 (2)	74 (1)	75 (1)	76 (2)	77 (2)	78 (1)	79 (1)	80 (1)	81 (2)
	83 (3)	84 (2)	85 (2)	86 (1)	87 (3)	89 (2)	94 (1)	96 (1)	97 (1)	98 (2)
	99 (3)	100 (1)								
<i>Phoebe lanceolata</i>	74 (1)									
<i>Polyalthia coffeoides</i>	7 (1)	81 (1)								
<i>Syzygium gardneri</i>	36 (1)	40 (1)	45 (2)							
<i>Syzygium laetum</i>	2 (1)	7 (1)	8 (1)	9 (1)	10 (2)	11 (2)	13 (1)	15 (1)	17 (1)	21 (1)
	25 (1)	29 (2)	33 (1)	34 (1)	36 (1)	38 (1)	39 (1)	51 (1)	54 (1)	55 (1)
	60 (1)	69 (1)	76 (1)	90 (1)						
Unidentified - P1	95 (1)									
Unidentified - P2	69 (1)									

Table 10. Saplings (gbh 10.1cm to 30.0 cm) distribution in quadrats (10 m x 10 m ) laid out in the permanent plot established in a wet evergreen forest at Pothumala, Kerala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat numbers and number of individuals									
<i>Actinodaphne bourdillonii</i>	41 (1)									
<i>Actinodaphne tadulingamii</i>	33 (1)									
<i>Aglaia tormentosa</i>	1 (1)	10 (1)	16 (1)	18 (1)	20 (1)	23 (1)	36 (1)	41 (2)	51 (2)	57 (4)
	63 (2)	64 (1)	69 (2)	73 (1)	76 (1)	81 (1)	85 (3)	87 (2)	89 (5)	91 (1)
	93 (2)	94 (3)	97 (1)	100 (1)						
<i>Agrostistachys meeboldii</i>	32 (1)	51 (2)	89 (3)	94 (3)	97 (1)					
<i>Antidesma menasu</i>	20 (1)									
<i>Ardisia pauciflora</i>	1 (3)	2 (2)	4 (4)	6 (3)	7 (1)	10 (1)	12 (1)	14 (2)	16 (4)	18 (1)
	20 (2)	21 (8)	23 (1)	26 (3)	28 (6)	30 (1)	32 (2)	33 (4)	35 (6)	36 (6)
	39 (4)	45 (3)	47 (4)	50 (1)	51 (2)	57 (4)	60 (2)	64 (1)	69 (1)	71 (1)
	73 (2)	76 (1)	79 (3)	81 (1)	83 (1)	85 (3)	87 (2)	89 (1)	91 (1)	94 (1)
	97 (2)	100 (1)								
<i>Artocarpus heterophyllus</i>	79 (1)									
<i>Artocarpus hirsutus</i>	1 (1)									
<i>Beilschmiedia sp.</i>	94 (1)									
<i>Cullenia exarillata</i>	7 (2)	14 (1)	21 (1)	35 (1)	38 (1)	57 (1)	60 (1)	81 (1)	89 (2)	91 (1)
<i>Dimocarpus longan</i>	16 (1)	24 (1)	33 (1)	45 (1)	47 (2)	54 (1)	66 (1)	71 (1)	87 (3)	89 (1)
	93 (2)	94 (1)								
<i>Drypetes wightii</i>	1 (1)	7 (4)	12 (1)	16 (1)	32 (4)	35 (1)	38 (1)	57 (1)	71 (1)	73 (1)
	76 (1)	79 (1)	81 (2)	85 (2)	87 (2)	89 (3)	91 (2)	94 (1)		
<i>Fahrenheitia zeylanica</i>	81 (1)	94 (1)								
<i>Garcinia gummi-gutta</i>	23 (1)	51 (1)								
<i>Gomphandra sp.</i>	10 (1)									

--cont'd-

Table 10 (cont'd). Saplings (gbh 10.1cm to 30.0 cm) distribution in quadrats (10 m x 10 m ) laid out in the permanent plot established in a wet evergreen forest at Pothumala, Kerala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat numbers and number of individuals									
<i>Heritiera papilio</i>	2 (1)									
<i>Isonandra lanceolata</i>	7 (2)	36 (2)	41 (1)	66 (1)	97 (1)					
<i>Lasianthus sp.</i>	57 (1)	94 (1)								
<i>Leea indica</i>	39 (1)	41 (1)	64 (1)	87 (1)	93 (1)					
<i>Litsea sp.2.</i>	1 (2)	4 (1)	6 (1)	7 (1)	16 (1)	18 (1)	23 (2)	35 (1)	39 (2)	43 (1)
	50 (1)	57 (1)	63 (1)	66 (1)	69 (2)	83 (1)	94 (1)			
<i>Litsea floribunda</i>	36 (1)									
<i>Litsea laevigata</i>	24 (1)	35 (1)	45 (1)	57 (2)	87 (1)					
<i>Litsea mysorensis</i>	14 (1)	21 (1)	23 (1)	26 (1)	28 (1)	30 (2)	38 (2)	45 (1)	51 (1)	57 (4)
	60 (1)	71 (1)	73 (3)	81 (1)	83 (1)	85 (2)	87 (3)	89 (1)		
<i>Litsea stocksii</i>	7 (1)	14 (1)	23 (1)	36 (1)	39 (2)	41 (1)	64 (2)	66 (2)	71 (1)	79 (1)
	83 (1)	94 (1)	97 (1)							
<i>Mallotus sp.</i>	100 (1)									
<i>Meiogyne pannosa</i>	2 (2)	6 (2)	7 (1)	10 (1)	16 (2)	18 (2)	20 (1)	21 (2)	28 (1)	30 (1)
	33 (1)	39 (1)	41 (2)	47 (1)	51 (1)	60 (4)	63 (1)	64 (1)	71 (1)	73 (1)
	79 (1)	87 (2)	91 (1)	94 (1)	97 (4)	100 (1)				
<i>Memecylon sp.</i>	2 (1)	6 (1)	26 (1)							
<i>Mesua ferrea</i>	18 (1)	21 (1)	23 (1)	38 (1)	39 (1)	57 (2)				
<i>Myristica dactyloides</i>	23 (1)	41 (2)	57 (1)	64 (1)						

--cont'd--

Table 10 (cont'd). Saplings (gbh 10.1cm to 30.0 cm) distribution in quadrats (10 m x 10 m ) laid out in the permanent plot established in a wet evergreen forest at Pothumala, Kerala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat number and number of individuals									
	4	16	21	30	35	36	43	51	60	63
<i>Palaquium ellipticum</i>	(3)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	66	73	79	83	87	91	94			
	(1)	(2)	(2)	(3)	(3)	(1)	(1)			
<i>Phoebe lanceolata</i>	35	64								
	(1)	(1)								
<i>Polyalthia coffeoides</i>	85	94								
	(1)	(1)								
<i>Psychotria sp.</i>	23	24	43	45						
	(1)	(1)	(1)	(1)						
<i>Syzygium laetum</i>	1	2	4	6	7	10	12	14	16	18
	(1)	(1)	(1)	(1)	(2)	(1)	(3)	(2)	(1)	(3)
	21	23	26	28	32	33	35	36	38	39
	(1)	(4)	(2)	(2)	(3)	(2)	(3)	(1)	(2)	(1)
	41	43	45	47	50	51	57	60	64	66
(1)	(3)	(1)	(1)	(4)	(1)	(2)	(3)	(1)	(2)	
	69	71	73	76	79	81	83	85	87	91
	(4)	(1)	(2)	(1)	(1)	(2)	(2)	(5)	(3)	(3)
	93	94	97							
	(1)	(1)	(1)							
<i>Villebrunea integrifolia</i>	93									
	(1)									
Unidentified- P1	81									
	(2)									
Unidentified -P2	89									
	(1)									
Unidentified- P3	41	54	73	87						
	(1)	(2)	(1)	(1)						

Table 11. Tree seedlings (girth 40.1 cm. height <1 m) distribution in quadrats (5 m x 5 m) laid out in the permanent plot established in a wet evergreen forest at Pothumala, Kerala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat numbers and number of individuals									
<i>Actinodaphne tadulingamii</i>	33 (1)	39 (1)	97 (1)							
<i>Aglaia tomentosa</i>	63 (1)	94 (1)								
<i>Ardisia pauciflora</i>	39 (1)									
<i>Artocarpus heterophyllus</i>	7 (2)									
<i>Cinnamomum malabattrum</i>	100 (1)									
<i>Cullenia exarillata</i>	10 (1)	66 (1)	69 (1)	94 (1)						
<i>Dimocarpus longan</i>	1 (9)	4 (4)	7 (6)	10 (14)	33 (2)	36 (6)	39 (3)	63 (2)	66 (1)	94 (3)
	97 (1)	100 (3)								
<i>Drypetes wightii</i>	4 (2)	7 (1)	10 (1)	36 (2)	66 (2)	91 (2)				
<i>Heritiera papilio</i>	1 (7)	4 (2)	10 (2)	39 (1)	63 (3)					
<i>Leea indica</i>	63 (1)									
<i>Litsea Sp.2.</i>	1 (1)	4 (2)	7 (1)	33 (2)	36 (1)	39 (2)	94 (1)			
<i>Litsea floribunda</i>	63 (1)	66 (1)	69 (3)							
<i>Litsea laevigata</i>	4 (3)	33 (1)								
<i>Litsea mysorensis</i>	1 (1)	4 (1)	7 (1)	10 (1)	36 (1)	39 (1)	63 (2)	69 (2)	91 (1)	97 (1)
	100 (1)									
<i>Litsea stocksii</i>	1 (2)	7 (2)	10 (2)	33 (2)	36 (3)	39 (1)	63 (3)	66 (3)	69 (1)	91 (2)
	94 (4)	97 (2)								
<i>Meiogyne pannosa</i>	4 (4)	7 (4)	10 (1)	33 (3)	39 (1)	91 (5)	94 (1)	100 (2)		
<i>Memecylon sp</i>	1 (2)	91 (1)	97							
<i>Mesua ferrea</i>	66 (1)	69 (1)	97 (2)							
<i>Mynstica dactyloides</i>	39 (1)	63 (1)	97 (1)							



Table 11 (cont'd). Tree seedlings (girth <10.1 cm, height <1 m) distribution in quadrats (5 m x 5 m) laid out in the permanent plot established in a wet evergreen forest at Pothumala, Kerala. Values in parantheses are number of individuals in the given quadrat.

Species	Quadrat number and number of individuals									
<i>Neolitsea</i> sp.	10 (1)	33 (1)								
<i>Nothopegia beddomei</i>	36 (1)									
<i>Palaquium ellipticum</i>	10 (1)									
<i>Phoebe lanceolata</i>	97 (1)									
<i>Psychotria</i> sp.	33 (1)	39 (1)	63 (1)	91 (1)	97 (2)	100 (2)				
<i>Syzygium laetum</i>	33 (2)	39 (2)	94 (1)							
Unidentified P3	7 (2)									
Unidentified P4	39 (1)	66 (1)	97 (1)							
Unidentified- P5	10 (1)									

Tree species diversity was high for sapling phase followed by mature trees and seedlings phases (Table 12). Compared to the species diversity recorded for mature trees (gbh more than 30.1 cm) in tropical rainforest of Barro Colorado Island (4.8; Knight, 1975) and in Kakachi. Kalakkad, India (4.87 : Ganesh et.al., 1996), in Silent valley, Kerala (4.89; Singh et.al., 1981) and Pothumala, Kerala, (4.0; Chandrashekara and Ramakrishnan, 1994) that recorded for the permanent plot established at Pothumala was much lower. The value obtained for the concentration of dominance for mature tree layer (0.1069) in the present study is higher than those recorded for the similar type of forests in Silent valley (0.06; Singh et.al., 1981), Attappadi (0.90; Pascal, 1988), Pothumala (0.086; Chandrashekara and Ramakrishnan, 1994). This may indicate the higher contribution of dominant species to the total IVI values. The RISQ values obtained for tree seedlings (1.473), saplings (1.597) and mature trees (1.164) indicated that the site selected is a natural stand without major disturbance.

A detailed comparison of girth class distribution of all species in the plot indicated that the dominant species are represented in all girth classes (Table 13). Most of the trees represented only in the lower girth classes are of either mid canopy (15-25 m height) or understorey (4-15 m height) species. However, some of the species capable of growing as top canopy trees are disproportionately represented. Similar type of observation has also made at Kade. Ghana (Swaine and Hall, 1988), and Pothumala, Kerala (Chandrashekara and Ramakrishnan, 1992). Whether the species showed disproportionate presentation do typically show poorer regeneration on a wider scale wherever they occur needs to be studied.

About 5% mature trees, 3% saplings and 0.5 % seedlings showed the sign of damage but are live (Table 12). Location and tag number of these damaged trees are given in Table 14 to facilitate to verify their status in the next census.

Table 12. Basic statistics of mature trees ( $\geq 30.1$  cm gbh), saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth  $< 10.0$  cm height  $< 1$  m) population in the permanent plot established in the wet evergreen forest at Pothumala, Kerala.

	Tree phases		
	Mature trees	Saplings	Seedlings
Families represented	20	18	17
Species represented	37	34	25
Total number of individuals ( $\text{ha}^{-1}$ )	542	972	5942
Total basal area ( $\text{m}^2 \text{ha}^{-1}$ )	49.8	2.94	—
Species diversity index (H)	3.953	4.138	3.939
Species dominance value (C)	0.1069	0.0968	0.1110
Ramakrishnan Index of Stand Quality (RISQ)	1.164	1.597	1.473
Number of live but damaged trees ( $\text{ha}^{-1}$ )	27	26	28

Table 13. Size class distribution of trees in the permanent plot established in a wet evergreen forest at Pothumala, Kerala.

Species	Girth classes <sup>*</sup>							
	A	B	C	D	E	F	G	H
	Number of individuals ha <sup>-1</sup>							
<i>Actinodaphne bourdillonii</i>	-	2	-	-	-	-	-	-
<i>Actinodaphne tadulingamii</i>	86	2	1	-	-	-	-	-
<i>Aglaia tomentosa</i>	57	74	13	-	-	-	-	-
<i>Agrostistachys borneensis</i>	-	20	35	5	-	-	-	-
<i>Antidesma menasu</i>	-	2	1	-	1	-	-	-
<i>Ardisia pauciflora</i>	29	206	4	-	-	-	-	-
<i>Artocarpus heterophyllus</i>	57	2	6	-	-	1	1	-
<i>Artocarpus hirsutus</i>	-	2	-	-	-	-	-	-
<i>Beilschmiedia</i> sp.	-	2	-	-	-	-	-	-
<i>Canarium strictum</i>	-	-	-	-	1	-	-	-
<i>Canthium</i> sp.	-	-	1	1	1	-	-	-
<i>Cassine</i> sp.	-	-	-	1	-	-	-	-
<i>Chionanthus</i> sp.	-	-	1	-	-	1	-	1
<i>Cinnamomum malabatum</i>	29	-	-	-	-	-	-	-
<i>Cryptocarya bourdillonii</i>	-	-	-	2	-	-	-	-
<i>Cullenia exarillata</i>	115	24	16	8	3	-	8	13
<i>Dimocarpus longan</i>	1542	32	7	6	2	1	1	3
<i>Diospyros assimilis</i>	-	-	1	-	-	-	-	-
<i>Drypetes wightii</i>	286	60	71	7	-	-	-	-
<i>Fahrenheitia zeylanica</i>	-	4	3	2	-	-	-	-
<i>Ficus</i> sp.	-	-	1	-	-	-	-	-
<i>Garcinia gummi-gutta</i>	-	4	4	2	1	-	-	-
<i>Gomphandra</i> sp.	-	2	6	2	-	-	-	-
<i>Heritiera papilio</i>	428	2	2	2	2	1	4	1
<i>Holigarna ferruginea</i>	-	-	3	1	-	-	1	4
<i>Isonandra lanceolata</i>	-	14	7	-	-	-	-	-
<i>Lasianthus</i> sp.	-	4	-	-	-	-	-	-
<i>Leea indica</i>	29	10	-	-	-	-	-	-
<i>Litsea stocksii</i>	742	32	10	-	-	-	-	-
<i>Litsea laevigata</i>	114	12	-	-	-	-	-	-
<i>Litsea mysorensis</i>	371	56	-	-	-	-	-	-
<i>Litsea</i> sp.1	-	-	1	-	-	-	-	-
<i>Litsea</i> sp.2.	285	42	2	2	1	1	-	-
<i>Litsea floribunda</i>	142	2	4	-	-	-	-	-
<i>Macaranga peltata</i>	-	-	-	1	-	-	-	-
<i>Mallotus</i> sp.	-	2	-	-	-	-	-	-
<i>Mastixia arborea</i>	-	-	1	-	-	-	-	-

-cont'd-

\*; Size classes: A- Seedlings (girth < 10.0 cm, height < 1 m), B- Saplings (gbh 10.1 cm to 30.0 cm), C to H- Mature trees, gbh 30.1-60.0, 60.1-90.0, 90.1 - 120.0, 120.1 - 150.0, 150.1-180.0 and > 180.1 cm respectively.

Table 13 (cont'd). Size class distribution of trees in the permanent plot established in a evergreen forest at Pothumala, Kerala.

Species	Girth classes*							
	A	B	C	D	E	F	G	H
	Number of individuals ha <sup>-1</sup>							
<i>Meiogyne pannosa</i>	599	78	20	-	-	-	-	-
<i>Memecylon</i> sp.	114	6	-	-	-	-	-	-
<i>Mesua ferrea</i>	114	14	7	11	9	8	9	7
<i>Myristica dactyloides</i>	85	10	3	2	-	3	1	-
<i>Neolitsea</i> sp.	57	-	-	-	-	-	-	-
<i>Nothopegia beddomei</i>	29	-	1	-	-	-	-	-
<i>Palaquium ellipticum</i>	29	50	48	17	15	10	16	22
<i>Psychotria</i> sp.	229	8	-	-	-	-	-	-
<i>Polyalthia coffeoides</i>	-	4	2	-	-	-	-	-
<i>Syzygium gardneri</i>	-	-	3	-	1	-	-	-
<i>Syzygium laetum</i>	143	166	27	-	-	-	-	-
<i>Villebrunea integrifolia</i>	-	2	-	-	-	-	-	-
Unidentified - P1	-	4	1	-	-	-	-	-
Unidentified - P2	-	2	1	-	-	-	-	-
Unidentified - P3	58	-	-	-	-	-	-	-
Unidentified- .P4	115	-	-	-	-	-	-	-
Unidentified- P5	29	10	-	-	-	-	-	-

\*, Size classes: A- Seedlings (girth < 10.0 cm, height < 1 m), B- Saplings (gbh 10.1 cm to 30.0 cm), C to H- Mature trees, gbh 30.1-60.0,60.1-90.0, 90.1 - 120.0, 120.1-150.0, 150.1-180.0and >180.1 cm respectively.

Table 14. List of damaged but live trees recorded in the permanent plot established in the wet evergreen forest at Pothumala, Kerala. Location (quadrat number) and tag number of trees are given.

Species	Mature trees	Saplings	Seedlings
<i>Ardisia pauciflora</i>	---	Q91:723 <sup>1</sup> Q36:629 <sup>7</sup> Q39:650 <sup>7</sup>	---
<i>Aglaia tomentosa</i>	---	Q57:918 <sup>2</sup> Q69:697 <sup>7</sup>	---
<i>Agrostistachys borneensis</i>	Q47:277 <sup>5</sup> Q53:314 <sup>6</sup> Q53:315 <sup>6</sup> Q54:320 <sup>6</sup> Q84:456 <sup>6</sup> Q85:466 <sup>6</sup> Q97:523 <sup>6</sup> Q97:524 <sup>6</sup>	Q51:1122 <sup>4</sup> Q51:1126 <sup>4</sup>	---
<i>Beilschmiedia</i> sps	---	Q94:739 <sup>9</sup>	---
<i>Chionanthus</i> sps	Q43:253 <sup>5</sup>	---	---
<i>Cullenia exarillata</i>	Q21:110 <sup>5</sup> Q84:457 <sup>5</sup>	---	---
<i>Dimmarpus longan</i>	Q40:236 <sup>5</sup>	---	---
<i>Drypetes wightii</i>	Q61:354 <sup>1</sup> Q7:28 <sup>5</sup>	---	Q36:1248 <sup>3</sup>
<i>Ficus</i> sp.	Q61:353 <sup>2</sup>	---	---
<i>Gomphandra</i> sp.	Q95:509 <sup>5</sup>	---	---
<i>Heritiera papilio</i>	Q9:46 <sup>5</sup>	---	---
<i>Isonandra lanceolata</i>	Q9:41 <sup>5</sup>	---	---
<i>Litsea mysorensis</i>	---	Q26:997 <sup>2</sup>	---
<i>Litsea</i> sp- 2	---	Q24:937 <sup>3</sup>	---
<i>Litsea stocksii</i>	---	Q66:673 <sup>6</sup>	---
<i>Meiogyne pannosa</i>	Q20:101 <sup>8</sup> Q20:102 <sup>8</sup> Q20:103 <sup>8</sup>	---	---
<i>Palaquium ellipticum</i>	Q44:256 <sup>2</sup> Q49:289 <sup>2</sup> Q24:128 <sup>5</sup>	Q60:822 <sup>3</sup>	---
<i>Polyalthia coffeoides</i>	Q7:31 <sup>5</sup>	---	---
<i>Syzygium gardneri</i>	Q45:262 <sup>2</sup>	---	---
<i>Syzygium laetum</i>	Q15:78 <sup>5</sup>	Q18:864 <sup>3</sup>	---

\*, gbh >30.1 cm; \*\*, gbh 10.1 cm to 30.0 cm, \*\*\*, girth <10.0 cm and height <1 m.

<sup>1</sup>: fallen, <sup>2</sup>: Tip broken, <sup>3</sup>:Tip cut, <sup>4</sup>:Wounded, <sup>5</sup>:Heart wood broken, <sup>6</sup>:Bark eaten by wild animals, <sup>7</sup>:Bark infected, <sup>8</sup>:Insect attack, <sup>9</sup>:Fungal attack.

### 3.1.3. Moist deciduous forest plot in Channakkad

In the moist deciduous forest plot, mature tree population is dominated by *Xylia xylocarpa*. *Grewia tiliifolia*, *Dillenia pentagyna* with 62% contribution to the total number of trees censused in the plot (Table 15). *Miliusa tomentosa*, *Grewia tiliifolia*, *Terminalia paniculata* and *Stereospermum* sp. are dominant among sapling population. In the case of seedling population, *Xylia xylocarpa* is dominant followed by *Stereospermum* sp. *Grewia tiliifolia* and *Sterculia guttata*. Out of 37 tree species recorded only six species including *Grewia tiliifolia* and *Xylia xylocarpa* represented in all three phases i.e. seedling, saplings and mature phases, while the remaining species represented in only one or two phases. All trees recorded in the quadrats studied are listed (Tables 16,17 and 18) with quadrat number and number of individuals in a given quadrat to assist in locating each of them during recensus. Appendix 3 provides quadrat number and tag number of some representative individuals of each species to help in identification in the field.

The permanent plot at Channakkad with 98 mature trees ha<sup>-1</sup> (Table 19), represented mainly by deciduous species, is poorer in terms of stem density when compared to the moist deciduous forest of Devadana, Chikmagalore District in the Western Ghat region (344 trees ha<sup>-1</sup>; Swamy. 1988). Girth class analysis of all tree species in the permanent plot also showed that about 83% of species are represented in one or two phases primarily indicate poor recruitment of individuals from lower girth class to higher ones (Table 20). Further, trees with gbh >120.1 cm are more than those of gbh ranging from 30.1-120.0 cm. The poor representation of trees especially those falling under middle size class may be attributed to illicit felling of such trees by the forest dwellers and residents of near by areas.

About 5 % mature trees and 4.8 % saplings showed the sign of damage but are alive (Table 19). Location and tag number of these damaged trees are given Table 21 to facilitate to verify their status in the next census.

Table 15. Density (number of individuals ha<sup>-1</sup>) and importance value index (IVI) of mature trees (gbh > 30.1 cm), saplings (gbh 10.1cm to 30.0 cm) and tree seedlings (girth 40.0 cm, height <1 m) in the permanent plot established in a moist deciduous forest at Channakkad, Kerala.

Species	Mature trees		Saplings		Seedlings	
	Density	IVI	Density	IVI	Density	IVI
<i>Albizia lebbek</i>	-	-	1	3.7	8	0.8
<i>Albizia odoratissima</i>	1	4.7	-	-	-	-
<i>Albizia procera</i>	-	-	1	2.8	-	-
<i>Albizia</i> sp.	-	-	-	-	48	4.1
<i>Bauhinia</i> sp.	-	-	1	2.2	-	-
<i>Bombax ceiba</i>	4	9.5	1	2.1	32	3.1
<i>Bridelia airy-shawii</i>	2	6.5	1	4.3	-	-
<i>Cassia fistula</i>	-	-	-	-	8	0.8
<i>Cycas circinalis</i>	3	7.1	-	-	-	-
<i>Dalbergia latifolia</i>	1	2.8	4	9.2	96	8.2
<i>Dalbergia sissooides</i>	-	-	1	2.6	-	-
<i>Dillenia pentagyna</i>	11	33.8	-	-	-	-
<i>Ehretia canarensis</i>	-	-	-	-	120	11.4
<i>Ficus</i> sp.	2	4.8	-	-	-	-
<i>Gmelina arborea</i>	-	-	1	2.1	-	-
<i>Grewia tiliifolia</i>	17	51.0	22	47.6	272	19.1
<i>Haldinia cordifolia</i>	1	4.8	-	-	-	-
<i>Hymenodictyon excelsum</i>	-	-	1	2.9	-	-
<i>Lagerstroemea microcarpa</i>	5	18.3	-	-	64	4.6
<i>Lannea coromandelica</i>	4	8.8	1	2.3	-	-
<i>Mallotus</i> sp.	-	-	-	-	24	2.3
<i>Miliusa tomentosa</i>	-	-	34	73.5	176	13.4
<i>Radermachera xylocarpa</i>	-	-	1	3.1	-	-
<i>Sapindus laurifolia</i>	-	-	-	-	40	2.8
<i>Schleichera oleosa</i>	1	5.4	2	4.5	104	7.5
<i>Spondias pinnata</i>	-	-	1	2.5	-	-
<i>Sterculia guttata</i>	2	6.9	-	-	168	14.1
<i>Sterculia urens</i>	-	-	-	-	16	1.5
<i>Stereospermum colais</i>	-	-	14	38.9	312	23.9
<i>Streblus asper</i>	-	-	-	-	8	0.8
<i>Strychnos nux-vomica</i>	-	-	6	13.2	136	9.5
<i>Terminalia bellirica</i>	2	10.7	-	-	16	1.5
<i>Terminalia paniculata</i>	3	13.0	17	49.4	104	8
<i>Tetrameles nudiflora</i>	3	15.3	-	-	-	-
<i>Wrightia tinctoria</i>	2	4.8	-	-	-	-
<i>Xylia xylocarpa</i>	33	89.2	16	33.1	1160	62.8
Unidentified- C1	1	2.6	-	-	-	-



Table 16. Distribution of mature trees (gbh >30.1) in quadrats (10 x 10 m) laid out in the permanent plot established in a moist deciduous forest at Channakkad. Number of individuals in the given quadrat is given in parentheses.

Species	Quadrat number and number of individuals									
<i>Albizia odoratissima</i>	21 (1)									
<i>Bombax ceiba</i>	10 (1)	73 (1)	85 (1)	93 (1)						
<i>Bridelia airy-shawii</i>	28 (1)	83 (1)								
<i>Cycas circinalis</i>	37 (1)	69 (1)	87 (1)							
<i>Dalbergia latifolia</i>	13 (1)									
<i>Dillenia pentagyna</i>	1 (1)	23 (1)	25 (1)	60 (1)	63 (1)	64 (1)	66 (1)	67 (1)	78 (1)	84 (1)
	89 (1)									
<i>Ficus sp.</i>	19 (1)	60 (1)								
<i>Grewia tiliifolia</i>	3 (1)	6 (1)	10 (1)	11 (1)	13 (1)	16 (1)	30 (2)	32 (1)	34 (1)	58 (1)
	61 (1)	75 (1)	85 (1)	87 (1)	88 (1)	95 (1)				
<i>Haldina cordifolia</i>	72 (1)									
<i>Lagerstromea microcarpa</i>	12 (1)	19 (1)	27 (1)	39 (1)	96 (1)					
<i>Lannea coromandelica</i>	75 (2)	86 (1)	87 (1)							
<i>Schleichera oleosa</i>	49 (1)									
<i>Sterculia guttata</i>	2 (1)	45 (1)								
<i>Terminalia bellirica</i>	69 (1)	82 (1)								
<i>Terminalia paniculata</i>	25 (1)	37 (1)	58 (1)							
<i>Tetrameles nudiflora</i>	17 (1)	22 (1)	77 (1)							
<i>Wrightia tinctoria</i>	42 (1)	66 (1)								
<i>Xylocarpus xylocarpa</i>	4 (2)	5 (1)	9 (1)	14 (2)	19 (1)	20 (1)	22 (1)	23 (1)	24 (1)	28 (1)
	39 (1)	42 (1)	48 (1)	51 (1)	54 (1)	58 (1)	65 (1)	66 (1)	67 (1)	70 (1)
	73 (1)	77 (1)	78 (1)	90 (1)	91 (1)	92 (2)	95 (1)	96 (1)	97 (1)	100 (1)
<i>Unidentified -C1</i>	40 (1)									

Table 17. Distribution of saplings (gbh 10.1 cm -30.0 cm) in quadrats (10 x 10 m) laid out in the permanent plot established in a moist deciduous forest at Channakkad. Number of individuals in the given quadrat is given in parentheses.

Species	Quadrat number and number of individuals									
<i>Albizia lebbek</i>	21 (1)									
<i>Albizia procera</i>	79 (1)									
<i>Bauhinia</i> sp.	69 (1)									
<i>Bombax ceiba</i>	90 (1)									
<i>Bridelia airy-shawii</i>	94 (1)									
<i>Dalbergia latifolia</i>	46 (1)	70 (1)	89 (1)	100 (1)						
<i>Dalbergia sissoides</i>	5 (1)									
<i>Gmelina arborea</i>	56 (1)									
<i>Grewia filiifolia</i>	5 (1)	15 (1)	38 (1)	39 (2)	41 (1)	42 (2)	43 (1)	44 (3)	57 (1)	59 (1)
	77 (3)	82 (1)	83 (1)	98 (1)	100 (2)					
<i>Hymenodictyon excelsum</i>	59 (1)									
<i>Lanea coromandelica</i>	77 (1)									
<i>Milium tomentosum</i>	2 (2)	3 (1)	4 (1)	9 (1)	11 (2)	13 (1)	14 (1)	15 (1)	16 (1)	21 (1)
	24 (1)	25 (2)	26 (4)	30 (1)	31 (1)	45 (1)	50 (1)	53 (2)	56 (1)	58 (1)
	61 (1)	68 (1)	76 (1)	79 (1)	85 (1)	88 (1)	94 (1)			
<i>Radermachera xylocarpa</i>	86 (1)									
<i>Schleichera oleosa</i>	27 (1)	60 (1)								
<i>Spondias pinnata</i>	91 (1)									
<i>Stereospermum colais</i>	5 (1)	8 (1)	10 (1)	14 (1)	16 (1)	21 (1)	26 (1)	38 (1)	40 (1)	43 (1)
	44 (1)	46 (1)	66 (1)	75 (1)						
<i>Strychnos nux-vomica</i>	37 (1)	40 (1)	42 (1)	59 (1)	90 (2)					
<i>Terminalia paniculata</i>	10 (2)	12 (1)	28 (1)	29 (2)	31 (1)	41 (1)	60 (1)	61 (1)	67 (1)	68 (1)
	73 (1)	77 (1)	87 (1)	88 (1)	95 (1)					
<i>Xylia xylocarpa</i>	7 (1)	8 (2)	9 (3)	12 (1)	29 (2)	30 (1)	39 (1)	44 (1)	72 (1)	73 (2)

Table 18. Distribution of seedlings (girth < 10.1 cm, height 1.0m) in quadrats (5 m x 5m) laid out in the permanent plot established in a moist deciduous forest at Channakad. Number of individuals in the given quadrat is given in parentheses.

Species	Quadrat number and number of individuals									
<i>Albizia lebeck</i>	26 (1)									
<i>Albizia</i> sps	30 (2)	31 (1)	33 (1)	36 (1)	45 (1)					
<i>Bombax ceiba</i>	11 (1)	16 (1)	36 (1)	47 (1)						
<i>Cassia fistula</i>	10 (1)									
<i>Dalbergia latifolia</i>	5 (1)	7 (1)	25 (1)	27 (2)	30 (1)	31 (2)	42 (1)	43 (1)	46 (1)	48 (1)
<i>Ehretia canarensis</i>	2 (1)	4 (1)	6 (1)	10 (1)	14 (1)	17 (1)	19 (1)	20 (1)	23 (1)	24 (1)
	25 (1)	29 (1)	31 (1)	34 (1)	41 (1)					
<i>Grewia tiliifolia</i>	1 (1)	8 (2)	9 (1)	15 (1)	16 (1)	20 (1)	21 (2)	22 (1)	27 (3)	28 (6)
	30 (4)	33 (1)	34 (1)	35 (2)	36 (1)	39 (1)	40 (2)	42 (1)	46 (1)	49 (1)
<i>Lagerstromea microcarpa</i>	3 (1)	18 (1)	22 (1)	28 (2)	35 (3)					
<i>Mallotus</i> sp.	23 (1)	25 (1)	44 (1)							
<i>Milium tomentosa</i>	1 (1)	2 (3)	3 (1)	7 (1)	9 (3)	10 (1)	12 (1)	13 (2)	19 (1)	20 (1)
	23 (1)	27 (1)	31 (1)	35 (2)	50 (2)					
<i>Sapindus laurifolia</i>	9 (1)	13 (1)	32 (3)							
<i>Schleichera oleosa</i>	7 (1)	16 (1)	23 (2)	29 (1)	32 (2)	39 (3)	44 (2)	48 (1)		
<i>Sterculia guttata</i>	1 (3)	3 (1)	7 (1)	8 (1)	9 (1)	11 (1)	13 (1)	14 (2)	18 (1)	19 (1)
	21 (1)	25 (1)	29 (1)	32 (1)	35 (1)	42 (2)	45 (1)			
<i>Sterculia urens</i>	27 (1)	28 (1)								
<i>Stereospermum colais</i>	1 (3)	3 (2)	4 (1)	7 (1)	10 (3)	11 (1)	12 (1)	14 (1)	16 (1)	19 (1)
	20 (1)	21 (1)	24 (2)	27 (1)	28 (1)	29 (1)	30 (4)	31 (2)	33 (1)	34 (3)
	37 (1)	38 (1)	39 (1)	42 (1)	45 (1)	48 (1)	50 (1)			

--cont'd --

Table 18 (cont'd). Distribution of seedlings (girth < 10.1 cm , height 1.0 m) in quadrats (5 x 5 m) laid out in the permanent plot established in a moist deciduous forest at Channakkad. Number of individuals in the given quadrat is given in parentheses.

Species	Quadrat number and number of individuals									
<i>Streblus asper</i>	38 (1)									
<i>Strychnos nux-vomica</i>	9 (1)	22 (2)	24 (1)	25 (1)	28 (1)	31 (2)	32 (5)	34 (1)	36 (2)	42 (1)
<i>Terminalia bellirica</i>	2 (1)	25 (1)								
<i>Terminalia paniculata</i>	5 (1)	7 (1)	26 (1)	28 (1)	32 (1)	36 (1)	42 (4)	46 (2)	48 (1)	
<i>Xylocarpus xylocarpa</i>	1 (2)	2 (5)	3 (1)	4 (3)	5 (2)	6 (2)	7 (8)	8 (1)	10 (3)	11 (1)
	12 (2)	14 (1)	15 (3)	16 (4)	17 (7)	19 (4)	20 (1)	21 (4)	22 (2)	23 (4)
	24 (2)	25 (5)	26 (4)	27 (6)	28 (3)	29 (1)	30 (3)	31 (4)	32 (4)	33 (2)
	34 (1)	35 (1)	36 (3)	37 (4)	38 (5)	39 (2)	40 (3)	41 (2)	42 (2)	43 (3)
	44 (1)	45 (9)	46 (1)	47 (6)	48 (5)	49 (1)	50 (2)			

Table 19. Basic statistics of mature tree (gbh >30.1 cm), saplings (gbh 10.1- 30.0 cm) and seedlings (girth <10.0cm. height <1.0 m) population in the permanent plot established in a moist deciduous forest at Channakkad , Kerala.

	Tree phases		
	Mature trees	Saplings	Seedlings
Families represented	15	12	13
Species represented	18	19	20
Total number of individuals (ha <sup>-1</sup> )	98	126	2912
Total basal area (m <sup>2</sup> ha <sup>-1</sup> )	28.30	0.22	—
Species diversity index (H)	3.289	3.147	3.1614
Species dominance value (C)	0.1673	0.1548	0.1946
Number of live but damaged trees (ha-1)	6	6	nil

Table 20. Girth class distribution of trees in the permanent plot established in a moist deciduous forest at Channakkad, Kerala.

Species	Girth classes*							
	A	B	C	D	E	F	G	H
	Number of individuals ha <sup>-1</sup>							
<i>Albizia lebbbeck</i>	8	1	-	-	-	-	-	-
<i>Albizia odoratissima</i>	-	-	-	-	-	-	-	1
<i>Albizia procera</i>	-	1	-	-	-	-	-	-
<i>Albizia sp.</i>	48	-	-	-	-	-	-	-
<i>Bauhinia sp.</i>	-	1	-	-	-	-	-	-
<i>Bombax ceiba</i>	32	1	2	2	-	-	-	-
<i>Bridelia airy-shawii</i>	-	1	-	-	-	-	1	1
<i>Cassia fistula</i>	8	-	-	-	-	-	-	-
<i>Cycas circinalis</i>	-	-	2	1	-	-	-	-
<i>Dalbergia latifolia</i>	96	4	-	-	-	1	-	-
<i>Dalbergia sissoides</i>	-	1	-	-	-	-	-	-
<i>Dillenia pentagyna</i>	-	-	-	-	-	3	3	5
<i>Ehretia canarensis</i>	120	-	-	-	-	-	-	-
<i>Ficus sp.</i>	-	-	1	1	-	-	-	-
<i>Gmelina arborea</i>	-	1	-	-	-	-	-	-
<i>Grewia tiliifolia</i>	272	22	-	-	-	4	6	7
<i>Haldina cordifolia</i>	-	-	-	-	-	-	-	1
<i>Hymenodictyon excelsum</i>	-	1	-	-	-	-	-	-
<i>Lagerstroemea microcarpa</i>	64	-	-	-	-	-	3	2
<i>Lannea coromandelica</i>	-	1	3	-	-	-	1	-
<i>Mallotus sp.</i>	24	-	-	-	-	-	-	-
<i>Miliusa tomentosa</i>	176	34	-	-	-	-	-	-
<i>Radermachera xylocarpa</i>	-	1	-	-	-	-	-	-
<i>Sapindus laurifolia</i>	40	-	-	-	-	-	-	-
<i>Schleichera oleosa</i>	104	2	-	-	-	-	-	1
<i>Spondias pinnata</i>	-	1	-	-	-	-	-	-
<i>Sterculia guttata</i>	168	-	-	-	-	1	-	1
<i>Sterculia urens</i>	16	-	-	-	-	-	-	-
<i>Stereospermum colais</i>	312	14	-	-	-	-	-	-
<i>Streblus asper</i>	8	-	-	-	-	-	-	-
<i>Strychnos nux-vomica</i>	136	6	-	-	-	-	-	-
<i>Terminalia bellirica</i>	16	-	-	-	-	-	-	2
<i>Terminalia paniculata</i>	104	17	-	-	-	1	-	2
<i>Tetrameles nudiflora</i>	-	-	-	-	-	-	-	3
<i>Wrightia tinctoria</i>	-	-	1	-	1	-	-	-
<i>Xylia xylocarpa</i>	1160	16	1	1	-	11	11	9
Unidentified - C1	-	-	-	-	1	-	-	-

\*, Girth classes: A- seedlings (girth <10.0 cm, height <1.0.m), B- Saplings (gbh 10.0cm to 30.0 cm), C to H - mature trees, 30.1cm - 60.0 cm, 60.1 cm- 90.0cm, 90.1cm - 120.0 cm, 120.1 cm -150.0 cm, 150.1 cm - 180.0 cm, and > 180.1 cm.

Table 21. List of damaged but live mature trees (gbh >30.1 cm), saplings (gbh 10.1 cm- 30.0 cm) and seedlings (girth <10.0 cm, height 1 m) in the permanent plot established in a moist deciduous forest at Channakkad, Kerala. Quadrat number and tag number are given.

Species	Mature trees	Saplings	Seedlings
<i>Cycas circinalis</i>	Q37:39 <sup>3</sup> Q69:64 <sup>3</sup>	—	
<i>Grewia tiliifolia</i>	Q11:11 <sup>1</sup>	—	—
<i>Milusa tomentosa</i>	—	Q2:100 <sup>1</sup> Q45:1258 <sup>1</sup> Q15:1071 <sup>2</sup> Q24:1109 <sup>5</sup>	—
<i>Strychnos nux-vomica</i>	—	Q90:1629 <sup>1</sup>	—
<i>Wrightia tinctoria</i>	Q66:60 <sup>4</sup>	—	—
<i>Xylia xylocarpa</i>	Q98 <sup>1</sup>	Q9:1029 <sup>1</sup>	—

<sup>1</sup> Tip broken, <sup>2</sup> Tip dried, <sup>3</sup> Foliage harvested, <sup>4</sup> Heart wood broken, <sup>5</sup> Fungal attack,

<sup>6</sup> Sprouted.

### 3.14. Dry deciduous forest plot at Chinnar Wildlife Sanctuary

The dry deciduous forest plot established in the Chinnar Wildlife Sanctuary can be described as *Chloroxylum swietenia*-*Anogeissus latifolia*-*Strychnos potatorum* type as these three species contributed about 77% of the stem density and with total IVI of 214.17 in the mature tree phase (Table 22). *Chloroxylum swietenia* and *Strychnos potatorum* are also dominant species in sapling and seedling stages. However, *Ixora arborea*, a smaller sized species, is the most dominant in seedling population with IVI of 69.8.

Out of 41 species recorded only six species showed representation in all three phases namely seedlings, saplings and mature trees (Table 23), while about 60% of the species represented in only one stage. Except the dominant species like *Chloroxylum swietenia*, *Ixora arborea* and *Strychnos potatorum*, most of the species did not show a negative exponential distribution with a clear preponderance of stem of small girth classes. About 30 species showed poor regeneration as indicated by the absence of their seedlings. Species diversity index value was more for saplings than for mature trees or seedlings. This indicates the resource partitioning among several species in the sapling population and by only two or three species in seedling and mature phases (Table 24).

All trees censused are listed (Tables 25, 26, and 27). This will assist in locating each stem of a given species during recensus. In the Appendix 4 provided the quadrat number and tag number of some representative individuals of each species to make species identification in the field easier. Table 28 gives the list of damaged but live trees with their location in the plot, tag number and type of damage. Fate of these damaged but live trees could be verified in the next census.



Table 22. Density (individuals ha<sup>-1</sup> ) and importance value index (IVI) mature trees (gbh> 30.1 cm), saplings (gbh 10.1 cm - 30.0 cm) and seedlings (girth < 10.0 cm, height < 1m) in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala.

Species	Mature trees		Saplings		Seedlings	
	Density	IVI	Density	IVI	Density	IVI
<i>Acacia ferruginea</i>	2	2.1	-	-	-	-
<i>Albizia amara</i>	4	8.1	53	40.8	40	14.9
<i>Albizia lebbek</i>	-	-	1	0.8	-	-
<i>Anogeissus latifolia</i>	52	52.8	20	20.7	-	-
<i>Bauhinia racemosa</i>	4	4.3	3	2.4	-	-
<i>Canthium dicoccum</i>	-	-	1	0.8	-	-
<i>Carissa carandas</i>	-	-	1	0.8	-	-
<i>Celtis cinnamomea</i>	1	0.9	-	-	16	5.9
<i>Chloroxylon swietenia</i>	139	121.6	100	68.0	168	48.7
<i>Commiphora berryi</i>	-	-	1	0.9	-	-
<i>Commiphora caudata</i>	3	3.1	-	-	8	3.0
<i>Cordia rothii</i>	-	-	2	1.9	-	-
<i>Dalbergia lanceolria</i>	-	-	6	5.3	16	5.9
<i>Dalbergia paniculata</i>	12	11.2	2	1.6	-	-
<i>Dichrostachys cinerea</i>	-	-	-	-	8	3.0
<i>Diospyros ovalifolia</i>	-	-	-	-	16	5.9
<i>Diospyros cordifolia</i>	-	-	3	2.4	-	-
<i>Diospyros ebenum</i>	-	-	1	0.9	-	-
<i>Diospyros melanoxylon</i>	-	-	1	0.8	-	-
<i>Dolichandrone arcuata</i>	4	4.5	1	0.8	-	-
<i>Ehretia ovalifolia</i>	-	-	2	1.6	-	-
<i>Ficus benghalensis</i>	2	5.6	-	-	-	-
<i>Ficus sp.</i>	2	3.9	-	-	-	-
<i>Givotia rottleriformis</i>	4	7.8	-	-	-	-
<i>Grewia daimine</i>	-	-	3	2.4	-	-
<i>Grewia tiliifolia</i>	1	0.9	2	2.2	-	-
<i>Gyrocarpus asiatica</i>	1	0.9	-	-	-	-
<i>Ixora arborea</i>	7	6.8	10	11.2	248	69.8
<i>Lanea coromandelica</i>	6	5.5	-	-	-	-
<i>Pavetta indica</i>	1	0.9	13	16.1	32	11.9
<i>Phyllanthus emblica</i>	1	1.1	-	-	-	-
<i>Premna tomentosa</i>	4	3.9	23	30.7	-	-
<i>Pterocarpus marsupium</i>	5	5.8	-	-	-	-
<i>Pterolobium hexapetalum</i>	-	-	1	1.2	-	-
<i>Santalum album</i>	-	-	-	-	16	5.9
<i>Securinega leucopyrus</i>	-	-	2	1.5	-	-
<i>Strychnos nux-vomica</i>	-	-	4	2.9	-	-
<i>Strychnos potatorum</i>	39	39.7	100	67.4	56	20.8
<i>Tectona grandis</i>	4	6.0	1	0.9	-	-
<i>Wrightia tinctoria</i>	2	2.5	7	5.2	16	4.2
<i>Ziziphus oenoplia</i>	-	-	10	7.9	-	-

Table 23. Girth class distribution of trees in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala

Species	Girth classes*							
	A	B	C	D	E	F	G	H
	Number of individuals ha <sup>-1</sup>							
<i>Acacia ferruginea</i>	-	-	1	1	-	-	-	-
<i>Albizia amara</i>	40	53	1	1	1	-	-	1
<i>Albizia lebbeck</i>	-	1	-	-	-	-	-	-
<i>Anogeissus latifolia</i>	-	20	20	22	9	-	1	-
<i>Bauhinia racemosa</i>	-	3	3	-	1	-	-	-
<i>Canthium dicoccum</i>	-	1	-	-	-	-	-	-
<i>Carissa carandas</i>	-	1	-	-	-	-	-	-
<i>Celtis cinnamomea</i>	16	-	1	-	-	-	-	-
<i>Chloroxylon swietenia</i>	168	100	63	51	19	5	1	-
<i>Commiphora berryi</i>	-	1	-	-	-	-	-	-
<i>Commiphora caudata</i>	8	-	2	1	-	-	-	-
<i>Cordia rothii</i>	-	2	-	-	-	-	-	-
<i>Dalbergia lanceolaria</i>	16	6	-	-	-	-	-	-
<i>Dalbergia paniculata</i>	-	2	9	3	-	-	-	-
<i>Dichrostachys cinerea</i>	8	-	-	-	-	-	-	-
<i>Diospyros ovalifolia</i>	16	-	-	-	-	-	-	-
<i>Diospyros cordifolia</i>	-	3	-	-	-	-	-	-
<i>Diospyros ebenum</i>	-	1	-	-	-	-	-	-
<i>Diospyros melanoxylon</i>	-	1	-	-	-	-	-	-
<i>Dolichandrone arcuata</i>	-	1	2	1	1	-	-	-
<i>Ehretia ovalifolia</i>	-	2	-	-	-	-	-	-
<i>Ficus benghalensis</i>	-	-	-	-	-	1	-	1
<i>Ficus sp.</i>	-	-	-	-	-	2	-	-
<i>Givotia rottleriformis</i>	-	-	-	-	2	1	-	1
<i>Grewia daimi</i>	-	3	-	-	-	-	-	-
<i>Grewia tiliifolia</i>	-	2	1	-	-	-	-	-
<i>Gyrocarpus asiatica</i>	-	-	1	-	-	-	-	-
<i>Ixora arborea</i>	248	10	5	2	-	-	-	-
<i>Lannea coromandelica</i>	-	-	4	2	-	-	-	-
<i>Pavetta indica</i>	32	13	1	-	-	-	-	-
<i>Phyllanthus emblica</i>	-	-	1	-	-	-	-	-
<i>Premna tomentosa</i>	-	23	4	-	-	-	-	-
<i>Pterocarpus marsupium</i>	-	-	2	1	2	-	-	-
<i>Pterolobium hexapetalum</i>	-	1	-	-	-	-	-	-
<i>Santalum album</i>	16	-	-	-	-	-	-	-
<i>Securimega leucopyrus</i>	-	2	-	-	-	-	-	-
<i>Strychnos nux-vomica</i>	-	4	-	-	-	-	-	-
<i>Strychnos potatorum</i>	56	100	27	6	5	1	-	-
<i>Tectona grandis</i>	-	1	1	-	2	1	-	-
<i>Wrightia tinctoria</i>	16	7	-	2	-	-	-	-
<i>Ziziphus oenoplia</i>	-	10	1	-	-	-	-	-

\*, Size classes: A- Seedlings (girth 40.0cm, height <1.0 m ); B- Saplings (gbh 10.1 cm to 30.0 cm); C to H- Mature trees , 30.1- 60.0, 60.1 -90.0, 90.1- 120.0, 120.1-150.0, 150.1- 180.0 and >180.0cm respectively.

Table 24. Basic statistics of mature tree (gbh >30.1 cm), saplings (gbh 10.1- 30.0 cm) and seedlings (girth <10.0 cm, height <1.0 m) population in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Keraia.

	Tree phases		
	Mature trees	Saplings	Seedlings
Families represented	14	12	9
Species represented	23	28	12
Total number of individuals (ha <sup>-1</sup> )	300	374	640
Total basal area (m <sup>2</sup> ha <sup>-1</sup> )	11.84	2.13	—
Species diversity index (H)	2.753	3.198	2.633
Species dominance value (C)	0.2656	0.1730	0.2366
Number of live but damaged trees (ha-1)	12	nil	nil

Table 25. Mature trees (gbh >30.1 cm) distribution in quadrats (10m x 10 m) laid out in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala. Values in parentheses are number of individuals.

Species	Quadrat number and number of individuals									
	31	94								
<i>Acacia ferruginea</i>	(1)	(1)								
<i>Albizia amara</i>	(1)	(1)	(1)	(1)						
<i>Anogeissus latifolia</i>	(2)	(1)	(1)	(1)	(1)	(2)	(1)	(2)	(1)	(4)
	(1)	(1)	(2)	(3)	(2)	(1)	(1)	(1)	(1)	(2)
	(2)	(1)	(2)	(1)	(1)	(2)	(1)	(1)	(1)	(1)
	(2)	(1)	(1)	(1)	(1)	(1)	(1)			
<i>Bauhinia racemosa</i>	(1)	(1)	(1)	(1)						
<i>Celtis cinnamomea</i>	(1)									
<i>Chloroxylon swietenia</i>	(1)	(1)	(2)	(2)	(1)	(1)	(2)	(3)	(1)	(1)
	(2)	(2)	(3)	(3)	(3)	(1)	(5)	(1)	(1)	(2)
	(2)	(3)	(2)	(2)	(1)	(3)	(1)	(1)	(1)	(1)
	(3)	(1)	(1)	(1)	(2)	(2)	(1)	(2)	(2)	(4)
	(3)	(4)	(5)	(2)	(1)	(1)	(3)	(3)	(1)	(3)
	(1)	(4)	(2)	(3)	(3)	(2)	(1)	(1)	(2)	(3)
	(1)	(1)	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(2)
	(2)	(1)	(2)							
<i>Commiphora caudata</i>	(1)	(1)								
<i>Dalbergia paniculata</i>	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	(1)									
<i>Dolichandrone arcuata</i>	(1)	(1)	(1)	(1)						

Table 25 (cont'd). Mature trees (gbh >30.1 cm) distribution in quadrats (10m x 10 m) laid out in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala. Values in parentheses are number of individuals.

Species	Quadrat number and number of individuals									
	6	58								
<i>Ficus benghalensis</i>	6 (1)	58 (1)								
<i>Ficus sp.</i>	9 (1)	10 (1)								
<i>Givotia rottleniformis</i>	42 (1)	83 (1)	87 (1)	88 (1)						
<i>Grewia tiliifolia</i>	38 (1)									
<i>Gyrocarpus asiatica</i>	3 (1)									
<i>Ixora arborea</i>	1 (1)	27 (1)	43 (1)	49 (1)	51 (1)	59 (1)	64 (1)			
<i>Lanea coromandelica</i>	10 (1)	14 (1)	16 (2)	20 (1)	26 (1)	34 (1)				
<i>Pavetta indica</i>	6 (1)									
<i>Phyllanthus emblica</i>	37 (1)									
<i>Premna tomentosa</i>	17 (1)	38 (1)	50 (1)	75 (1)						
<i>Pterocarpus marsupium</i>	18 (1)	37 (1)	56 (1)	83 (1)	88 (1)					
<i>Strychnos potatorum</i>	1 (1)	2 (1)	9 (1)	10 (1)	15 (1)	17 (1)	19 (1)	21 (1)	24 (1)	28 (1)
	32 (1)	34 (1)	36 (1)	38 (1)	40 (1)	41 (1)	43 (1)	44 (2)	46 (1)	55 (1)
	57 (1)	58 (1)	60 (1)	61 (1)	62 (1)	63 (1)	65 (1)	67 (1)	68 (1)	69 (1)
	70 (1)	76 (1)	82 (2)	85 (1)	87 (2)	89 (1)	96 (1)			
<i>Tectona grandis</i>	17 (1)	36 (1)	38 (1)	82 (1)						
<i>Wrightia tinctoria</i>	10 (1)	49 (1)								

Table 26. Saplings (gbh 10.1 cm to 30.0 cm ) distribution in quadrats (10m x 10 m) laid out in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala. Values in parentheses are number of individuals.

Species	Quadrat number and number of individuals									
	1	2	16	18	19	20	21	22	23	24
<i>Albizia amara</i>	(3)	(1)	(1)	(2)	(3)	(2)	(2)	(4)	(3)	(1)
	28	29	30	31	36	37	38	39	43	44
	(1)	(1)	(1)	(2)	(1)	(1)	(2)	(1)	(1)	(1)
	45	46	48	49	51	52	53	64	69	70
	(2)	(2)	(1)	(1)	(3)	(1)	(1)	(1)	(1)	(3)
<i>Albizia lebbbeck</i>	71	73	97							
	(1)	(1)	(1)							
<i>Anogeissus latifolia</i>	13									
	(1)									
	1	35	45	46	50	75	81	83	86	88
<i>Bauhinia raemosa</i>	(1)	(1)	(1)	(1)	(2)	(1)	(1)	(1)	(1)	(1)
	89	90	91	92	100					
<i>Canthium dicoccum</i>	(1)	(1)	(1)	(3)	(3)					
	37	76	84							
<i>Carissa carandas</i>	(1)	(1)	(1)							
	43									
<i>Chloroxylon swietenia</i>	(1)									
	18									
	(1)									
	2	7	10	14	15	16	18	21	22	23
	(1)	(1)	(1)	(2)	(4)	(2)	(1)	(1)	(2)	(3)
	25	26	27	28	30	31	32	33	34	35
(1)	(2)	(2)	(1)	(1)	(3)	(3)	(3)	(1)	(1)	
<i>Commiphora berryi</i>	38	40	41	43	44	48	49	50	51	52
	(1)	(2)	(1)	(1)	(2)	(4)	(6)	(4)	(5)	(8)
	53	54	55	58	59	65	66	67	69	70
	(1)	(2)	(1)	(3)	(2)	(1)	(2)	(2)	(1)	(2)
<i>Cordia rothii</i>	71	73	75	78	84	87	95			
	(1)	(1)	(1)	(5)	(2)	(1)	(2)			
<i>Dalbergia lanceolaria</i>	9									
<i>Dalbergia paniculata</i>	(1)									
	59									
<i>Diospyros cordifolia</i>	(1)									
	23	37	55	61	64					
<i>Diospyros ebenum</i>	(1)	(1)	(2)	(1)	(1)					
	66	97								
<i>Diospyros ebenum</i>	(1)	(1)								
	45	49	59							
<i>Diospyros ebenum</i>	(1)	(1)	(1)							
	66									
<i>Diospyros ebenum</i>	(1)									

Table 26 (cont'd). Saplings (gbh 10.1 to 30.0 cm) distribution in quadrats (10m x 10 m) laid out in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala. Values in parentheses are number of individuals.

Species	Quadrat number and number of individuals									
<i>Diospyros melanoxylon</i>	57 (1)									
<i>Dolichandrone arcuata</i>	54 (1)									
<i>Ehretia ovalifolia</i>	21 (1)	52 (1)								
<i>Grewia daimine</i>	30 (1)	51 (1)	86 (1)							
<i>Grewia tiliifolia</i>	1 (1)	15 (1)								
<i>Ixora arborea</i>	1 (1)	21 (1)	22 (1)	45 (1)	63 (1)	87 (1)	90 (3)	93 (1)		
<i>Pavetta indica</i>	5 (1)	15 (1)	22 (1)	42 (1)	43 (1)	44 (2)	51 (1)	52 (1)	58 (1)	59 (1)
	75 (1)	76 (1)								
<i>Premna tomentosa</i>	2 (1)	3 (1)	19 (1)	22 (1)	24 (1)	29 (1)	41 (1)	43 (1)	49 (1)	56 (1)
	57 (1)	58 (2)	59 (1)	62 (1)	69 (1)	70 (1)	74 (1)	77 (1)	79 (2)	91 (1)
	92 (1)									
<i>Pterolobium hexapetalum</i>	14 (1)									
<i>Securimea leucopyrus</i>	31 (1)	49 (1)								
<i>Strychnos nux-vomica</i>	33 (3)	39 (1)								
<i>Strychnos potatorum</i>	6 (1)	9 (1)	12 (2)	15 (2)	17 (8)	22 (1)	23 (3)	24 (1)	25 (3)	26 (4)
	27 (1)	28 (2)	32 (1)	34 (1)	35 (4)	38 (2)	42 (2)	44 (1)	45 (10)	47 (1)
	49 (1)	52 (1)	54 (3)	56 (5)	60 (1)	63 (1)	64 (2)	65 (4)	66 (7)	67 (1)
	68 (2)	71 (1)	74 (1)	75 (4)	76 (3)	78 (1)	84 (2)	87 (2)	91 (2)	94 (4)
	95 (1)									
<i>Tectona grandis</i>	17 (1)									
<i>Wrightia tinctoria</i>	6 (1)	9 (1)	10 (2)	31 (3)						
<i>Ziziphus oenopia</i>	8 (1)	19 (1)	23 (1)	30 (1)	40 (1)	42 (1)	43 (1)	45 (1)	59 (1)	65 (1)

Table 27. Seedlings (girth < 10.0 cm , height <1.0 m ) distribution in quadrats (5 mx5 m) laid out in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala. Values in parentheses are number of individuals.

Species	Quadrat Number and number of individuals									
<i>Albizia amara</i>	1 (1)	3 (1)	43 (1)	47 (1)	87 (1)					
<i>Celtis cinnamomea</i>	1 (1)	59 (1)								
<i>Chloroxylon swietenia</i>	1 (1)	3 (1)	5 (1)	29 (1)	31 (1)	41 (1)	43 (2)	49 (2)	53 (1)	59 (6)
	61 (2)	65 (1)	83 (1)							
<i>Commiphora caudata</i>	59 (1)									
<i>Dalbergia lanceolaria</i>	3 (1)	81 (1)								
<i>Dichrostachys cinerea</i>	49 (1)									
<i>Diospyros ovalifolia</i>	41 (1)	93 (1)								
<i>Ixora arborea</i>	1 (1)	3 (1)	13 (1)	23 (1)	27 (2)	31 (2)	33 (1)	41 (1)	43 (1)	45 (1)
	53 (1)	57 (1)	59 (4)	61 (2)	63 (1)	65 (6)	71 (3)	75 (1)		
<i>Pavetta indica</i>	1 (1)	31 (1)	33 (1)	41 (1)						
<i>Santalum album</i>	7 (1)	87 (1)								
<i>Strychnos potatorum</i>	3 (1)	23 (1)	37 (1)	45 (1)	59 (1)	61 (1)	87 (1)			
<i>Wrightia tinctoria</i>	31 (2)									



Table 28. List of damaged but live trees recorded in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala. Location (quadrat number) and tag number of trees are given.

Species	Mature trees <sup>*</sup>	Saplings <sup>**</sup>	Seedlings <sup>***</sup>
<i>Anogeissus latifolia</i>	Q43:142 <sup>3</sup> Q49:164 <sup>4</sup>	---	---
<i>Bauhinia racemosa</i>	Q5:14 <sup>3</sup>	---	---
<i>Chloroxylon swietenia</i>	Q40:128 <sup>3</sup> Q24: 87 <sup>5</sup> Q23:82 <sup>6</sup> Q23:78 <sup>8</sup>	---	---
<i>Ficus bengalensis</i>	Q6:17 <sup>4</sup>	---	---
<i>Lanea coromandelica</i>	Q34:109 <sup>1</sup>	---	---
<i>Phyllanthus emblica</i>	Q37:120 <sup>3</sup>	---	---
<i>Strychnos potatorum</i>	Q32:104 <sup>2</sup> Q21:72 <sup>7</sup>	---	---

<sup>\*</sup>, Gbh>30.1 cm, <sup>\*\*</sup>, Gbh10.1 cm to 30.0cm, <sup>\*\*\*</sup>, Girth <10.0 cm, height <1.0 m.

<sup>1</sup>: Tip broken, <sup>2</sup>: Tip dried, <sup>3</sup>: Tip cut, <sup>4</sup>: Branches dried, <sup>5</sup>: Bark infected, <sup>6</sup>: Insect attack, <sup>7</sup>: Fungal attack, <sup>8</sup>: Sprouted.

### **3.2. Comparison of permanent sample plots for vegetation structure and tree species diversity**

In terms of number of tree species per hectare, shola forest has the highest density (76 species) followed by evergreen forest (41), dry deciduous forest (41) and moist deciduous forest (37). Even the stem density of mature trees, and seedlings also showed the same trend. However, sapling density was more in evergreen forest than in shola forest plot. This could be attributed for two reasons. The first reason is the dominance of understorey species in the girth class ranging from 10.1 cm to 30.0 cm in evergreen forest. It may be noticed that late secondary successional species are well represented in the sapling population in evergreen forest plot. This is an indication of a natural disturbance occurred in the evergreen forest patch leading to the regeneration of late secondary species in the recent past. These species are now attained sapling phase thus contributed to the higher sapling density in the plot. The shola and wet evergreen forest patches are undisturbed as also indicated by their RISQ values (Tables 5 and 12).

The dry deciduous forest plot is not being subjected to the anthropogenic disturbance after the establishment of the Sanctuary. Yet the poor regeneration of majority of the species are recorded from the plot. The causes for such a general failure of regeneration of trees in the plot need to be investigated. It may be mentioned here that unlike dry deciduous forest, the moist deciduous forest plot showed better regeneration of trees as noticed by the better representation of majority of species in the seedling phase. However, in the moist deciduous forest, the recruitment of stems from lower girth class to higher girth classes was significantly low. This could be attributed to the anthropogenic disturbance continuously faced by this forest patch.

Among four plots, shola and wet evergreen forest plots are species rich and comparable to many tropical wet evergreen forests. Lowest species diversity values recorded for dry deciduous forest is an indication of the dominance of one or two species in the tree community. Even the number of species endemic to the Western Ghat region is more in the shola (14 species; see Appendix 1) and in the wet evergreen forest (13 species; see Appendix 2) plots. Almost all species in the moist

deciduous forest and dry deciduous forest plots are widely distributed in the Indian sub-continent.

#### **4.0. CONCLUSIONS**

As discussed earlier, the permanent plots established in shola and wet evergreen forests are undisturbed patches. These plots can be used as benchmark plots for studies on the impact of natural and man-made disturbances on species and community composition and various ecological functions. These plots also could be monitored for further inventory of biodiversity covering various groups of plants and animals. Since the location of trees in the permanent plots is marked, further studies on these trees could be oriented to cover their phenological, autecological and dynamic properties.

As moist deciduous forests in the Western Ghats are subjected to intensive human-induced changes than any other forest types, the plot established at Channakkad is typical of moist deciduous forest of the region. Long-term monitoring of the plot would provide an opportunity for understanding the succession pattern in this forest type. Information on species composition change and ecosystem recovery process during succession recorded from this plot could be used in attempts of rehabilitation of moist deciduous forests of the region. One characteristic feature recorded in the plot established in the dry deciduous forest patch was that the absence of or poor regeneration of tree species. Therefore, the plot is suitable to monitor the reasons for the lack of tree species regeneration and to identify strategies to trigger the regeneration processes.

## 6.0. REFERENCES

- Balasubramanyan, K. (1987). **Impact of Selection Felling in a Forest Ecosystem in Kerala**. KFRI Research Report No. S3. Kerala Forest Research Institute, Peechi, Kerala.
- Chandrasekaran, C. (1960). **Forest Types of Kerala State**. Special paper submitted for diploma in Forestry. New Forest, Dehra Dun, India.
- Chandrashekara, U.M. (1998). Ramakrishnan Index of Stand Quality (RISQ): An indicator for the level of Forest Disturbance. In: **Proceedings of the Tenth Kerala Science Congress** (ed. A.D. Damodaran), State Committee on Science, Technology and Environment, Trivandrum: 398-400.
- Chandrashekara, U.M. and Ramakrishnan, PS (1994). Vegetation and gap dynamics of a tropical wet evergreen forest in the western Ghats of Kerala, India. **Journal of Tropical Ecology**, 10: 337-354.
- Chandrashekara, U.M. and Sankar, S. (1998). Tribals and conservation: Chinnar Snactuary, India. In: **Communities and Conservation: Natural Resource Management in South and Central Asia**, (eds. Ashish Kothari, Neema Pathak, R.V. Anuradha and Bansuri Taneja), Sage Publications, New Delhi:467-480.
- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (1991). **The Conservation Atlas of Tropical Rainforests: Asia and the Pacific**. Macmillan, London.
- FAO/UNEP (1981). **Tropical Forest Resources Assessment Project**. Forest Resources of Tropical Asia. Vol. 3, FAO, Rome.
- Gamble, J.S. (1915-1935). **Flora of Madras Presidency**. 3 volumes. Adalard and Son Ltd. London,
- Ganesh, T., Ganesan. R., Soubadra Devy, M., Davidar. P. and Bawa, K.S. (1996). Assessment of plant biodiversity at a mid elevation evergreen forest of Kalakkad-Mundanthurai Tiger Reserve, Western Ghats, India. **Current Science**, 71 :379-392.

- Hubbell, S.P. and Foster, R. (1986). Commonness and rarity in a neotropical forest: Implications for tropical tree conservation. In: (ed. M.Soule), **Conservation Biology, the Science of Scarcity and Diversity**. Sinauer Associates, Sunderland, Massachusetts: 205-234.
- Kallarackal, J. and Somen. C.K. (1997). Weather data of Peechi-1996. **Evergreen**, 38:6-7.
- Knight, D.H. (1975). A phytosociological analysis of species rich tropical forest on Barro Colorado Island, Panama. **Ecological Monograph**, 45:259-284.
- Margalef, R. (1968). **Perspective in Ecological Theory**. University of Chicago Press, Chicago.
- Misra, R. (1968). **Ecology Work Book**. Oxford and IBH Publications, New Delhi
- Myers, N. (1988). Tropical forests and their species: Going, going ...? In: (ed. E.O. Wilson) **Biodiversity**. National Academy Press, Washington, DC: 28-35.
- Pascal, J. P. (1988). **Wet Evergreen Forests of the Western Ghats of India: ecology, structure, floristic composition and succession**. French Institute of Pondicherry, Pondicherry, India.
- Rai, S.N. (1979). **Gap Regeneration in Wet Evergreen Forest of Karnataka**. Karnataka Forest Department Research Paper, KFD-2.
- Rai, S.N. and Proctor. J. (1986). Ecological studies on four rainforests in Karnataka, India. 1. Environment, structure, floristics and biomass. **Journal of Ecology**, 74:439-454.
- Simpson, E.H. (1949). Measurement of diversity. **Nature (London)**, 163:688

Singh, J.S., Singh, S.P., Saxena, A.K. and Rawat, Y.S.(1981). **The Silent Valley forest ecosystem and possible impact of proposed hydroelectric project.** Reports on the Silent Valley Study. Ecology Research Circle, Kumaun University, Nainital.

Swamy, H.R. (1988). **Study of Organic Productivity, Nutrient cycling and Small Watershed Hydrology in Natural Forests and in Monoculture Plantations in Chikmagalore District, Kamataka.** Final Report submitted to Department of Environment and Forests, Govt. Of India. (Mimeo).

Swaine, M.D. and Hall, JAB. (1988). The mosaic theory of forest regeneration and the determination of forest composition in Ghana. **Journal of Tropical Ecology**, 4: 253-269.

Appendix 1. Examples of labelled mature trees, saplings and seedlings of different species in the permanent plot established in the Shola forest at Mannavan shola, Kerala. Quadrat number and tag number is given.

Species	Phases		
	Mature trees	Saplings	Seedlings
<i>Acronychia pedunculata</i> (L.) Miq. (Rutaceae)	Q8:34, Q53:314, Q54:330, Q67:396	Q66:1045	Q63:3558, Q66:3599 Q97:3754, Q97:3775
<i>Actinodaphne bourdillonii</i> Gamble * (Lauraceae)	Q6:22, Q13:70, Q17:93, Q33:192	Q1:605, Q2:1334, Q7:650, Q8:1579	Q1:3211, Q1:3228 Q1:3231, Q1:3266
<i>Aglaiia elaeagnoidea</i> (Juss.) Benth. (Meliaceae)	Q40:240, Q73:425	Q33:798	-
<i>Alseodaphne semecarpifolia</i> Nees (Lauraceae)	Q54:331, Q59:360 Q60:368, Q78:455	-	Q7:3341, Q7:3344, Q10:3393, Q10:3425
<i>Ardisia rhomboidea</i> Wt. * (Myrsinaceae)	-	Q2:1370, Q2:1374 Q3:1410, Q4:623	Q4:3288, Q4:3293, Q7:3307, Q7:3313
<i>Beilschmiedia wightii</i> (Nees) Benth. * (Lauraceae)	Q2:6, Q2:7, Q7:24, Q10:49	Q8:1561, 10:748, Q10:750	Q1:3229, Q1:3258, Q4:3302, Q7:3316
<i>Bhesa indica</i> (Bedd.) Ding Hou (Celastraceae)	Q3:10, Q21:125, Q23:138, Q33:194	-	Q1:3227, Q4:3289, Q4:3295, Q39:3523
<i>Canthium dicoccum</i> (Gaertn.) Merr. (Rubiaceae)	Q7:28, Q58:353	-	-
<i>Celtis philippensis</i> Blanco var. <i>Wightii</i> (Planch.) Soep. (Ulmaceae)	Q11:62, Q45:276	-	-
<i>Chassalia curviflora</i> Thw. (Rubiaceae)	-	Q2:2180, Q22:2325 Q24:2504, Q25:2534	-
<i>Chionanthus Ramiflorus</i> Roxb. (Oleaceae)	Q8:37, Q9:47, Q10:48, Q10:52	Q1:582, Q2:1383, Q2:1385, Q7:662	Q1:3201, Q1:3203, Q1:3205, Q1:3213
<i>Cinnamomum</i> sp.1 (Lauraceae)	Q76:437	-	-
<i>Cinnamomum</i> sp.2 (Lauraceae)	Q77:451	-	-
<i>Cinnamomum</i> sp.3 (Lauraceae)	Q66:393	Q33:836	-
<i>Cinnamomum</i> sp.4 (Lauraceae)	-	-	Q1:3276, Q10:3387, Q39:3512, Q91:3676
<i>Cinnamomum sulphuratum</i> Nees * (Lauraceae)	Q5:17, Q10:59, Q18:100, Q28:167	Q9:1684, Q9:1694, Q10:729, Q10:741	-

--cont'd--

Endemic to the Western Ghats. India.



Appendix 1 (cont'd). Examples of labelled mature trees, sapling and seedlings of different species in the permanent plot established in the Shola forest at Mannavan shola, Kerala. Quadrat number and tag number is given.

Species	Phases		
	Mature tree	Saplings	Seedlings
<i>Clerodendrum viscosum</i> Vent. (Verbenaceae)	Q34:205	-	Q69:3612, Q69:3613, Q69:3618, Q69:3621
<i>Cryptocarya</i> sp. (Lauraceae)	Q39:237,	Q10:776, Q28:270	-
<i>Cryptocarya lawsonii</i> Gamble (Lauraceae)	Q5:15, Q17:94, Q22:132, Q25:145	Q8:1603, Q12:1736 Q13:1797, Q13:1798	-
<i>Cyathea crinita</i> (Hk.) (Cyathaceae)	-	Q12:1758, Q33:824, Q33:825	-
<i>Cyathea nilgiriensis</i> Holtum * (Cyathaceae)	Q28:174, Q29:177 Q29:178, Q29:182	-	-
<i>Elaeocarpus recurvatus</i> Comer * (Elaeocarpaceae)	-	-	Q91:3656
<i>Elaeocarpus serratus</i> L. (Elaeocarpaceae)	Q41:253	-	-
<i>Elaeocarpus tuberculatus</i> Roxb. (Elaeocarpaceae)	-	Q30:2761	-
<i>Eugenia</i> sp. (Myrtaceae)	Q36:228	Q12:1750	-
<i>Eurya nitida</i> Korthals (Temstroemiaceae)	Q31:186, Q93:543	Q7:652, Q63:996	Q66:3602
<i>Glochidion neilgherrense</i> Wt. * (Euphorbiaceae)	Q8:41, Q29:176, Q34:208, Q35:209	Q12:1733, Q28:2739	-
<i>Glochidion</i> sp. (Euphorbiaceae)	-	-	Q10:3403, Q33:3426, Q33:3457, Q39:3522
<i>Gomphandra coriacea</i> Wt. (Icacinaceae)	Q1:4, Q4:12, Q4:14, Q5:19	Q5:1466, Q29:2744	Q1:3267, Q94:3708
<i>Gomphandra</i> sp. (Icacinaceae)	-	Q8:1578, Q8:1656 Q15:1901, Q16:1917	-
<i>Hydnocarpus alpina</i> Wt. (Flacourtiaceae)	Q1:3, Q1:5, Q2:8, Q3:9	Q1:606, Q2:1312, Q7:642, Q10:734	Q1:3202, Q1:3207, Q1:3209, Q1:3210
<i>Ilex denticulata</i> Wall. (Aquifoliaceae)	-	Q13:1767, Q29:2748	-
<i>Ilex</i> sp. (Aquifoliaceae)	-	-	Q1:3239
<i>Isonandra stocksii</i> Cl. * (Sapotaceae)	Q1:1, Q1:2, Q5:18, Q7:26	Q11:1722, Q31:2792 Q33:802	Q33:3450, Q91:3653, Q91:3661, Q94:3699

--cont'd--

\*, Endemic to the Western Ghats, India.

Appendix 1 (cont'd). Examples of labelled mature trees, saplings and seedlings of different species in the permanent plot established in the Shola forest at Mannavan shola, Kerala. Quadrat number and tag number is given.

Species	Phases		
	Mature trees	Saplings	Seedlings
<i>Lasianthus acuminatus</i> Wt. * (Rubiaceae)	-	Q1:595,Q2:1322, Q2:1332,Q2:1339	Q1:3206,Q1:3208, Q1:3214,Q1:3217
<i>Litsea floribunda</i> (Bl.)Gamble (Lauraceae)	Q10:57	Q10:727	-
<i>Litsea ligustrina</i> (Nees) Hk.f. * (Lauraceae)	Q30:183	-	Q37:3472
<i>Litsea</i> sp.1 (Lauraceae)	-	Q8:1582,Q13:1777, Q13:1785,Q13:1786	-
<i>Litsea</i> sp.2 (Lauraceae)	-	Q28:2709	-
<i>Litsea</i> sp.3 (Lauraceae)	-	-	Q1:3204
<i>Litsea wightiana</i> (Nees) Hk.f. * (Lauraceae)	-	-	Q69:3616
<i>Mallotus tetracoccus</i> (Roxb.) Kurz (Euphorbiaceae)	Q88:514	-	-
<i>Mastixia arborea</i> (Wt.)Bedd. (Cornaceae)	Q7:31, Q9:46 Q10:55,Q15:83	Q1:599, Q2:1314, Q2:1323,Q2:1373	Q7:3311, Q7:3318, Q7:3320,Q7:3322
<i>Microtropis ramiflora</i> Wt. * (Celastraceae)	-	Q2:1363, Q66:1082 Q69:1088,Q100:1306	-
<i>Murraya paniculata</i> (L.) Jack. (Rutaceae)	-	-	Q1:3221,Q69:3633
<i>Neolitsea scrobiculata</i> (Meissn.) Gamble * (Lauraceae)	Q65:387	-	Q33:3448, 37:3462, Q37:3463,Q66:3590
<i>Neolitsea zeylanica</i> (Nees) Merr. (Lauraceae)	-	Q9:1671, Q12:1741	Q1:3223, Q1:3248, Q1:3250,Q1:3277
<i>Olea dioica</i> Roxb. (Oleaceae)	-	-	Q7:3380
<i>Persea macrantha</i> (Nees) Kosterm. (Lauraceae)	Q4:11, Q5:20, Q15:87,Q25:143	Q66:1066	Q1:3254, Q1:3260, Q1:3279, Q4:3290
<i>Phoebe lanceolata</i> Nees (Lauraceae)	Q9:43, Q84:493, Q92:533	Q9:1668, Q26:2563, Q32:2828,Q33:787	Q1:3253, Q10:3388 Q10:3391, Q10:3394
<i>Photinia</i> sp. (Rosaceae)	-	Q8:1542,Q10:743, Q10:769,Q10:771	-
<i>Photinia integrifolia</i> Lindl. Var. <i>sublanceolata</i> Miq. (Rosaceae)	Q36:227, Q84:491	-	-
<i>Polygala anillata</i> Ham. (Polygalaceae)	-	Q30:2769	-
<i>Prunus ceylanica</i> (Wt.)Miq. (Rosaceae)	Q28:172,	Q63:960	-

---cont'd---

Endemic to the Western Ghats, India

Appendix 1 (cont'd). Examples of labelled mature trees, saplings and seedlings of different species in the permanent plot established in the Shola forest at Mannavanshola, Kerala. Quadrat number and tag number are given.

Species	Phases		
	Mature trees	Saplings	Seedlings
<i>Psychotria</i> sp. (Rubiaceae)	-	Q63:990	-
<i>Randia</i> sp. (Rubiaceae)	Q92:537, Q93:541	-	-
<i>Rapanea</i> sp. (Myrsinaceae)	-	-	Q10:3407
<i>Rauvolfia densiflora</i> Benth. (Apocynaceae)	-	Q94:1158	-
<i>Saprosma foetens</i> (Wt.) K.Schum. (Rubiaceae)	Q9:44, Q10:58 Q21:122, Q26:152	Q7:698, Q14:1832, Q23:2458, Q24:2509	Q10:3396, Q63:3557, Q63:3581, Q69:3632
<i>Schefflera racemosa</i> (Wt.) Harms (Araliaceae)	Q45:275	Q18:2052	-
<i>Symplocos cochinchinensis</i> (Lour.) S. Moore ssp. <i>laurina</i> (Retz.) Nooteb. (Symplocaceae)	-	-	Q97:3773
<i>Symplocos pendula</i> Wt. (Symplocaceae)	-	Q91:1143	-
<i>Symplocos</i> sp. (Symplocaceae)	-	-	Q1:3220, Q1:3237, Q33:3422, Q33:3435
<i>Syzygium cumini</i> (L.) Skeels (Myrtaceae)	Q56:343	-	-
<i>Syzygium densiflorum</i> Wall.ex Wt.&Am * (Myrtaceae)	Q18:104, Q25:149 Q35:218, Q58:349	Q94:1157	Q1:3259, Q4:3294, Q10:3404, Q33:3420
<i>Syzygium taminadensis</i> Rathak & Chithra (Myrtaceae)	-	Q8:1663, Q27:2633 Q27:2647, Q28:2710	-
<i>Syzygium gardneri</i> Thw. (Myrtaceae)	Q77:453, Q91:531 Q94:547,	-	-
<i>Temstroemia japonica</i> (Thunb.) Thunb. (Temstroemiaceae)	Q14:80, Q15:82, Q23:137, 24:141	-	-
<i>Turpinia nepalensis</i> Wall. ex Wt. & Am. (Staphyleaceae)	Q5:16, Q13:71, Q15:84, Q29:179	Q28:2698, Q35:2925	Q91:3687
<i>Vaccinium leschenaultii</i> Wt. (Vacciniaceae)	-	Q100:1292	-
Unidentified -1	Q10:51, Q28:171 Q46:282, Q64:384	-	-
Unidentified-2	Q73:422, Q74:426 Q77:448	-	-
Unidentified-3	Q34:201	-	-
Unidentified-4	-	-	Q91:3681
Unidentified-5	-	-	Q1:3225, Q1:3243, Q4:3301, Q7:3326
Unidentified-6	-	-	Q39:3511, Q39:3530, Q39:3535, Q39:3536

Endemic to the Western Ghats, India.

Appendix 2. Examples of mature trees (gbh >30.1 cm), saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth < 10.0 cm, height < 1. cm) tagged in the wet evergreen forest in Pothumala. Quadrat number and tag number are given.

Species	Mature trees	Saplings	Seedlings
<i>Actinodaphne bourdillonii</i> Gamble *	-	Q41:817	-
(Lauraceae)			
<i>Actinodaphne tadulingamii</i> Gamble	Q44:258	Q33:604	Q33:1259, Q39:1234, Q97:1309
(Lauraceae)			
<i>Aglaia tomentosa</i> Teijsm & Binn. *	Q9:44, Q13:64, Q15:77, Q22:117	Q1:551, Q10:599, Q16:944, Q18:865	Q63:1286, Q94:745
(Meliaceae)			
<i>Agrostistachys borneensis</i> Becc.	Q31:169, Q46:270, Q47:275, Q47:277	Q32:1094, Q51:1122, Q89:1098, Q89:1099	-
(Euphorbiaceae)			
<i>Antidesma menasu</i> Miq. ex Tul. (Euphorbiaceae)	Q80:439, Q87:477	Q20:793	-
<i>Ardisia pauciflora</i> Heyne ex Wall.	Q40:233, Q46:272, Q52:309, Q68:378	Q1:546, Q1:548, Q1:555, Q2:857	Q39:648
(Myrsinaceae)			
<i>Artocarpus heterophyllus</i> Lamk. (Moraceae)	Q14:72, Q31:172, Q35:197, Q43:249	Q79:847	Q7:1166, Q7:1167
<i>Artocarpus hirsutus</i> Lam. *	-	Q1:550	-
(Moraceae)			
<i>Beilschmiedia</i> sp. (Lauraceae)	-	Q94:739	-
<i>Canarium strictum</i> Roxb. (Burseraceae)	Q70:387	-	-
<i>Canthium</i> sp. (Rubiaceae)	Q16:80, Q35:196, Q70:388	-	-
<i>Cassine</i> sp. (Celastraceae)	Q7:25	-	-
<i>Chionanthus</i> sp. (Oleaceae)	Q39:227, Q43:253, Q74:412,	-	-
<i>Cinnamomum malabatum</i> (Burm.f.) Bl. *	-	-	Q100:1296
(Lauraceae)			
<i>Cryptocarya bourdillonii</i> Gamble (Lauraceae)	Q9:43, Q34:193	-	-
<i>Cullenia exarillata</i> Robyns *	Q13:63, Q16:79, Q17:90, Q18:94	Q7:580, Q7:585, Q14:1016, Q21:808	Q66:1277, Q69:1272, Q94:1320, Q10:1143
(Bombacaceae)			
<i>Dimocarpus longan</i> Lour. (Sapindaceae)	Q6:21, Q20:104, Q23:124, Q35:198	Q16:946, Q24:938, Q33:605, Q45:955	Q1:1207, Q1:1208, Q1:1209, Q1:1210
<i>Diospyros assimilis</i> Bedd. *	Q8:33	-	-
(Sterculiaceae)			
<i>Drypetes wightii</i> (Hk.f.) Pax & Hoffm. *	Q4:16, Q6:22, Q7:28, Q11:49	Q1:547, Q7:586, Q7:587, Q7:590	Q4:1185, Q4:1192 Q7:1184, Q10:1160
(Euphorbiaceae)			

--cont'd--

\*. Endemic to the Western Ghats, India.

Appendix 2 (cont'd). Examples of mature trees (gbh >30.1 cm), saplings gbh 10.1 cm to 30.0 cm) and seedlings (girth <10.0 cm , height <1.0 m) tagged in the wet evergreen forest in Pothumala. Quadrat number and tag number are given.

Species	Mature trees	Saplings	Seedlings
<i>Ficus</i> sp. (Moraceae)	Q61:353	-	-
<i>Fahrenheitia zeylanica</i> (Thw.) Airy Shaw (Euphorbiaceae)	Q72:397, Q92:494, Q94:507, Q95:512	Q81:841, Q 94:728	-
<i>Garcinia gummi-gutta</i> (L.) Robs. (Clusiaceae)	Q3:13, Q19:100, Q21:106, Q27:150	Q23:880, Q51:1124	-
<i>Gomphandra</i> sp. (Icacinaceae)	Q44:259, Q50:296, Q55:330, Q71:393	Q10:602	-
<i>Heritiera papilio</i> Bedd. * (Sterculiaceae)	Q1:1, Q2:6, Q3:14, Q9:46	Q2:856	Q1:1203, Q1:1204, Q1:1206, Q1:1216
<i>Holigama ferruginea</i> March. * (Anacardiaceae)	Q4:15, Q7:27, Q18:93, Q25:139	-	-
<i>Isonandra lanceolata</i> W. (Sapotaceae)	Q9:41, Q11:54, Q13:66, Q23:123	Q7:581, Q7:593, Q36:626, Q36:627	-
<i>Lasianthus</i> sp. (Rubiaceae)	-	Q57:922, Q94:736	-
<i>Leea indica</i> (Burm.f.) Merr. (Leeaceae)	-	Q39:651, Q41:821, Q64:912, Q87:1033	Q63:671
<i>Litsea</i> sp1. (Lauraceae)	Q67:369	-	-
<i>Litsea</i> Sp.2. (Lauraceae)	Q2:7, Q18:92, Q19:98, Q22:119	Q1:544, Q1:554, Q4:570, Q7:584	Q4:1187, Q4:1189
<i>Litsea floribunda</i> (Bl.) Gamble (Lauraceae)	Q5:20, Q9:45, Q12:58, Q15:74	Q36:617	Q63:1283, Q66:1278, Q69:1268, Q68:1269
<i>Litsea laevigata</i> (Nees) Gamble (Lauraceae)	-	-	Q4:1197, Q33:1261, Q4:1186, Q4:1195
<i>Litsea mysorensis</i> Gamble * (Lauraceae)	-	Q14:1011, Q21:805, Q23:882, Q24:937	Q1:1212, Q1:1223, Q4:1196, Q7:1175,
<i>Litsea stocksii</i> Hk.f. (Lauraceae)	Q8:37, Q16:81, Q19:99, Q23:125	Q7:588, Q14:1015, Q23:877, Q36:631	Q1:1219, Q1:1220, Q7:1173, Q7:1180
<i>Macaranga peltata</i> (Roxb.) M.-A (Euphorbiaceae)	Q47:276	-	-
<i>Mallotus</i> sp. (Euphorbiaceae)	-	Q100:782	-
<i>Mastixia arborea</i> (Wt.) Bedd. (Comaceae)	Q23:126	-	-
<i>Meiogyne pannosa</i> (Dalz.) Baill * (Annonaceae)	Q1:3, Q2:8, Q3:12, Q20:101	Q2:859, Q2:861, Q6:1007, Q6:1008	Q4:1188, Q4:1193, Q4:1194, Q4:1199
<i>Memecylon</i> sp. (Melastomataceae)	-	Q2:860, Q6:1009, Q26:996	Q1:1205, Q1:1215, Q91:712, Q97:1306
<i>Mesua ferrea</i> L. (Clusiaceae)	Q4:18, Q5:19, Q8:36, Q9:40	Q18:866, Q21:809, Q23:874, Q39:647	Q66:1279, Q69:1270, Q97:1305, Q97:1313

-cont'd-

Endemic to the Western Ghats, India.

Appendix 2 (cont'd). Examples of mature trees (gbh >30.1 cm), saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth <10.0 cm, height <1.0 m) tagged in the wet evergreen forest in Pothurnala. Quadrat number and tag number are given

Species	Mature trees	Saplings	Seedlings
<b>Myristica dactyloides Gaertn.</b> (Myristicaceae)	Q11:52, Q21:108, Q36:207, Q41:238	Q23:881, Q 41:819 (Q41:320, Q64 :915	Q39:1235,,Q63:1287 , Q97:1301
<b>Nothopegia beddomei Gamble</b> (Anacardiaceae)	Q76:426		Q36:628
<b>Neolitsea sp.</b> (Lauraceae)			Q10:1154,Q33:1254
<b>Palaquium ellipticum (Dalz.)</b> Engl. (Sapotaceae)	Q1:2, Q2:4, Q2:5,Q2:9	Q4:565, Q4:567, Q4:572, Q16:943	Q10:1144
<b>Phoebe lanceolata Nees</b> (Lauraceae)	Q74:415	Q35:984,Q64:910	Q97:1310
<b>Polyalthia coffeoides Hk.f. &amp;</b> Thorns. (Annonaceae)	Q7:31, Q81:440	Q85:966, Q94:727	
<b>Psychotria sp.</b> (Rubiaceae)		Q23:873.  Q43:897, Q45: 953	Q33:1260. Q39:654, Q91:1331.Q97:1304
<b>Syzygium gardneri Thw.</b> (Myrtaceae)	Q36:206, Q40:234. Q45:260, Q45:262		
<b>Syzygium laetum (Ham.) Gandhi *</b> (Myrtaceae)	Q2:11, Q7:24, Q8:35, Q9:39	Q1:549. Q2:855, Q4:560. Q6:1002	Q33:1256, Q33:1263. Q39:1227. Q39:1228
<b>Villebrunea integrifolia Gaud.</b> (Urticaceae)		Q93:1057	
Unidentified - P1	Q95:508	Q81:838, Q81:843	-
Unidentified - P2	Q69:379	Q89:1108	-
Unidentified - P3	-	-	Q7:1178, Q7:1183
Unidentified -P4	-	-	Q39:1249. Q69:1266, Q66:689, Q97:1302
Unidentified -P5		Q41:814, Q54:102 Q54 1027, Q73: 1059	Q10:1147

\*, Endemic to the Western Ghats, India.

Appendix 3. Examples of mature trees (gbh >30.1 cm), saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth <10.0 cm, height < 1.0 m) labelled in the permanent plot established in the moist deciduous forest at Channakkad, Kerala. Quadrat number and lag number are given.

Species	Mature trees	Saplings	Seedlings
<i>Albizia lebbbeck</i> (L.) Willd. (Fabaceae)	-	Q21:1099	Q26:1854
<i>Albizia odoratissima</i> (L.f.) Benth. (Fabaceae)	Q21:23	-	-
<i>Albizia procera</i> (Roxb.) Benth. (Fabaceae)	-	Q79:1539	-
<i>Albizia</i> sp. (Fabaceae)	-	-	Q30:1904, Q30:1905, Q31:1913, Q33:1936
<i>Bauhinia</i> sp. (Fabaceae)	-	Q69:1458	-
<i>Bombax ceiba</i> L. (Bombacaceae)	Q10:10, Q73:69, Q85:80, Q93:92	Q90:1632,	Q11:1760, Q16:1784, Q36:1963, Q47:2232
<i>Bridelia airy-shawii</i> P.T.Li (Euphorbiaceae)	Q28:33, Q87:78	Q94:1658	-
<i>Cassia fistula</i> L. (Fabaceae)	-	-	Q10:1758
<i>Cycas circinalis</i> L. (Cycadaceae)	Q37:39, Q69:64 Q87:83	-	-
<i>Dalbergia latifolia</i> Roxb. (Fabaceae)	Q13:13	Q46:1274, Q70:1472 Q89:1625, Q100:1679	Q5:1722, Q7:1738 Q25:1852, Q27:1862
<i>Dalbergia sissoides</i> Grah. ex Wt. & Arn. (Fabaceae)	-	Q5:1020	-
<i>Dillenia pentagyna</i> Roxb. (Dilleniaceae)	Q1:1, (Q23:26, Q25:29, Q60:56		
<i>Ehretia canarensis</i> (Cl.) Gamble (Boraginaceae)			Q2:1699, Q4:1717, (Q6:1723, Q10:1752
<i>Ficus</i> sp. (Moraceae)	Q19:21, Q60:54		
<i>Gmelina arborea</i> Roxb. (Verbenaceae)		Q56:1345	
<i>Grewia tillifolia</i> Vahl (Tiliaceae)	Q3:3, Q6:7 Q10:9, Q11:11	Q5:1015, Q15:1072 Q36:1208, Q39:1214	Q1:1696, Q8:1741 Q8:1742, Q9:1745
<i>Haldina cordifolia</i> (Roxb.) Ridsd. (Rubiaceae)	Q72:67		
<i>Hymenodictyon orixense</i> (Roxb.) Mabber. (Rubiaceae)		Q59:1366	

Appendix 3 (cont'd). Examples of mature trees (gbh > 30.1 cm ), saplings ( gbh 10.1 cm to 30.0 cm) and seedlings (girth 40.0 cm , height <1.0 m) tagged in a permanent plot established in the moist deciduous forest at Channakkad, Kerala. Quadrat number and log number are given.

Speues	Mature trees	Saplings	Seedlings
Lagerstroemia microcarpa Wt * (Lythraceae)	Q12:12,Q19:19 Q27:31,Q39:41	-	Q23:1709,Q18:1798 Q22:1824,Q28:1877
Lannea coromandelica (Houtt.) Merr. (Anacardiaceae)	Q75:71,Q75:72 Q:66:82,Q87:84	Q77:1528	-
Mallotus sp. (Euphorbiaceae)			Q23:1831,Q25:1848 Q44:2211
Milusa tomentosa (Rox.) Sinclair (Annonaceae)		Q2:1002,Q2:1003 Q3:1005,Q4:1008	Q1:1690,Q2:1698 Q2:1701,Q2:1702
Radermachera xylocarpa (Roxb.) K. Schum (Bignoniaceae)		Q86:1601	
Sapindus laurifolia Vahl (Sapindaceae)			Q9:1744,Q13:1770 Q32:1931,Q32:1933
Schleichera oleosa (Lour.) Oken (Sapindaceae)	Q49:47	Q27:1137, Q60:1382	Q7:1727,Q16:1781 (223:1826,Q23:1830
Spondias pinnata (L.f.) Kurz (Anacardiaceae)		Q91:1638	
Sterculia guttata Roxb. (Sterculiaceae)	Q2:2.Q45:45		Q1:1692,Q1:1693 Q1:1694,Q3:1712
Sterculia urens Roxb. (Sterculiaceae)			Q27:1872,Q26:1875
Stereospermum colais (Buch - Ham. ex Dillw.) Mabber. (Bignoniaceae)		Q5:1017,Q8:1027 Q10:1038, Q14:1068	Q1:1688,Q1:1689 Q1:1691,Q3:1711
Strehlus asneri Lour (Moraceae)			Q38:1976
Strychnos nux-vomica L. (Loganiaceae)	-	Q37:1202, Q40:1218 Q42:1235, Q59:1863	Q9:1750,Q22:1822 Q22:1823,Q24:1836
Terminalia bellirica (Gaertn.) Presl (Combretaceae)	Q69:65,Q82:77	-	Q2:1707,Q25:1844
Terminalia paniculata Roth (Combretaceae)	Q25:30,Q37:38 Q58:50	Q10:1037, Q10:1041 Q12:1044. Q28:1141	Q5:1719,Q7:1736 Q26:1857.Q28:1883
Tetrameles nudiflora R. Br. Daliscaceae)	Q17:18,(122:25 Q77:74		
Wrightia tinctoria (Roxb.) R. Br. (Apocynaceae)	Q42:43,Q66:60		
Xylocarpus xylocarpa (Roxb.) Taub. (Fabaceae)	Q4:4,Q4:5 Q5:6,Q9:8	Q7:1021,Q8:1026 Q8:1028,Q9:1029	Q1:1695,Q1:1697 Q2:1700.Q2:1703
Unidentified- C1	Q40:42		

\*,Endemic to the Western Ghats. India



Appendix 4. Examples of mature trees (gbh >30.1 cm), saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth <10.0 cm, height < 1.0 m) labelled in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary, Kerala.

Species	Mature trees	Saplings	Seedlings
<i>Acacia ferruginea</i> DC. (Fabaceae)	Q31: 102, Q94: 291	-	-
<i>Albizia amara</i> (Roxb.) Biov. (Fabaceae)	Q33: 108, Q40: 129 Q52: 182, Q58: 196	Q1: 304, Q1: 305 Q1: 306, Q2: 397	Q1: 805, Q3: 809 Q43: 833, Q47: 838
<i>Albizia lebbbeck</i> (L.) Willd. (Fabaceae)	-	Q13: 415	-
<i>Anogeissus latifolia</i> (Roxb. ex DC.) Wall. ex. Guill. & Perr. (Combretaceae)	Q1: 4, Q1: 5 Q4: 12, Q5: 15	Q1: 303, Q35: 575 Q45: 622, Q46: 643	-
<i>Bauhinia racemosa</i> Lamk. (Fabaceae)	Q5: 14, Q23: 77 Q42: 136, Q86: 301	Q37: 579, Q76: 957 Q84: 974	-
<i>Canthium dicoccum</i> (Gaertn.) Merr. (Rubiaceae)	-	Q43: 606	-
<i>Carissa carandas</i> L. (Apocynaceae)	-	Q18: 448	-
<i>Celtis cinnamomea</i> Lindl. Ex Planch. (Ulmaceae)	Q6: 18	-	Q1: 803, Q59: 847
<i>Chloroxylon swietenia</i> DC. (Flindersiaceae)	Q1: 3, Q2: 7 Q3: 8, Q3: 9	Q2: 396, Q7: 307 Q10: 309, Q14: 420	Q1: 804, Q3: 808 Q5: 811, Q29: 818
<i>Commiphora berryi</i> (Arn.) Engl. (Burseraceae)	-	Q9: 409	-
<i>Commiphora caudata</i> (Wt. & Arn.) Engl. (Burseraceae)	Q9: 31, Q19: 64	-	Q59: 846
<i>Cordia rothii</i> Roem. & Schult. (Boraginaceae)	-	Q59: 766	-
<i>Dalbergia lanceolaria</i> L.f. (Fabaceae)	-	Q23: 501, Q37: 577 Q55: 733, Q55: 734	Q3: 810, Q81: 875
<i>Dalbergia paniculata</i> Roxb. (Fabaceae)	Q23: 80, Q23: 81 Q32: 107, Q37: 119	Q66: 337, Q97: 387	-
<i>Dichrostachys cinerea</i> (L.) Wt. & Arn. (Fabaceae)	-	-	Q49: 841
<i>Diospyros ovalifolia</i> Wt. (Ebenaceae)	-	-	Q41: 831, Q93: 880
<i>Diospyros cordifolia</i> Roxb. (Ebenaceae)	-	Q45: 630, Q49: 664 Q59: 764	-
<i>Diospyros ebenum</i> Koenig (Ebenaceae)	-	Q66: 334	-
<i>Diospyros melanoxylon</i> Roxb. (Ebenaceae)	-	Q57: 749	-
<i>Dolichandrone arcuata</i> Cl. * (Bignoniaceae)	Q46: 155, Q67: 228 Q68: 236, Q91: 286	Q54: 731	

---cont'd---

Endemic to the Western Ghats, India

Appendix 4 (cont'd). Examples of mature trees (gbh >30.1 cm), saplings (gbh 10.1 cm to 30.0 cm) and seedlings (girth <10.0 cm, height < 1.0 m) labelled in the permanent plot established in a dry deciduous forest at Chinnar Wildlife Sanctuary: Kerala.

Species	Mature trees	Saplings	Seedlings
<i>Ehretia ovalifolia</i> Wt. (Boraginaceae)	-	Q21:469, Q52:707	-
<i>Ficus benghalensis</i> L. (Moraceae)	Q6:17, Q58:198	-	-
<i>Ficus</i> sp. (Moraceae)	Q9:30, Q10:33	-	-
<i>Givotia rottleriformis</i> Griff. (Euphorbiaceae)	Q42: 138, Q83: 262 Q87:274, Q88:280	-	-
<i>Grewia daimine</i> Gaertn. (Tiliaceae)	-	Q30: 540, Q51: 692 Q86:984,	-
<i>Grewia tiliifolia</i> Vahl (Tiliaceae)	Q38:123	Q1:302, Q15:425	-
<i>Gyrocarpus asiatica</i> Willd. (Hernandiaceae)	Q3:10	-	-
<i>Ixora arborea</i> Roxb. ex J. E. Sm. (Rubiaceae)	Q1: 2, Q27: 92 Q43:141, Q49:160	Q1: 301, Q21: 466 Q22:475, Q45:628	Q1: 802, Q3: 806 Q13:813, Q23:815
<i>Lannea coromandelica</i> (Houtt.) Merr. (Anacardiaceae)	Q10: 32, Q14:41 Q16:49, Q16:50	-	-
<i>Pavetta indica</i> L. (Rubiaceae)	Q6: 20	Q5: 400, Q15:427 Q22:473, Q42:604	Q1: 801, Q31: 823 Q33:825, Q41:829
<i>Phyllanthus emblica</i> L. (Euphorbiaceae)	Q37:120	-	-
<i>Premna tomentosa</i> Willd. (Verbenaceae)	Q17: 56, Q38:124 Q50:166, Q75:253	Q2:398, Q3:399 Q19:459, 22:483	-
<i>Pterocarpus marsupium</i> Roxb. (Fabaceae)	Q18: 59, Q37:118 Q56:190, Q83:263	-	-
<i>Pterolobium hexapetalum</i> (Roth) Sant. & Wagh (Fabaceae)	-	Q14:416	-
<i>Santalum album</i> L. (Santalaceae)	-	-	Q7:812, Q87:878
<i>Securinega leucopyrus</i> (Willd.) M. - A. (Euphorbiaceae)	-	Q31:553, Q49:669	-
<i>Strychnos nux-vomica</i> L. (Loganiaceae)	-	Q33: 312, Q33:313 Q33:318, Q39:324	-
<i>Strychnos potatorum</i> L.f. (Loganiaceae)	Q1:1, Q2:6 Q9:29, Q10:34	Q6: 402, Q9:410 Q12:413, Q12:414	Q3: 807, Q23:814 Q37:827, Q45:836
<i>Tectona grandis</i> L.f. (Verbenaceae)	Q17:57, Q36:116 Q38:121, Q82:258	Q17:434	-
<i>Wrightia tinctoria</i> (Roxb.) R.Br. (Apocynaceae)	Q10:35, Q49:163	Q6:403, Q9:408 Q10:308, Q10:310	Q31:820, Q31:821
<i>Ziziphus oenoplia</i> Mill. (Rhamnaceae)	-	Q8: 406, Q19:458 Q23:495, Q30:549	-