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BIODIVERSITY MAPPING OF SHOLA FORESTS THROUGH REMOTE SENSING AND GIS TECHNIQUES

P. Vijayakumaran Nair

Kerala Forest Research Institute
Peechi - 680 653

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Final Report

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Research Project No. KFRI 314/99

P.Vijayakumaran Nair

Research Fellow: T.S. Baburaj

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Project Proposal

1	Code	KFRI 314/99
2	Title	Biodiversity mapping of Shola Forests through remote sensing and GIS techniques
3	Principal Investigator	P. Vijayakumaran Nair
	Research Fellow	T.S. Baburaj
4	Objectives	1. To prepare an atlas of the shola forests of the state at 1:50,000 scale. 2. To determine the extent of individual sholas, and to characterise the vegetation in the sholas. 3. To examine the fragmentation status and to overlay available information on species diversity and richness.
5	Outline of research programme	Maps of appropriate scale will be digitized and incorporated into the GIS. Details such as administrative boundaries, vegetation, soils, topography, etc. will be overlaid. Remotely sensed data from satellites in appropriate bands and scales will be procured, processed and information transferred to the GIS. The Forest Information System Unit of the KFRI possesses sufficient expertise and equipment to process the satellite images, Survey of India topo sheets and field visits. From this, area statistics of individual sholas will be worked out. Available species diversity information will be processed and biodiversity maps generated.
6	Date of commencement	January, 1999
7	Date of completion	December, 2000
8	Funding agency	Kerala Forest Department (Shola Forests)

Contents

Abstract

Grassland-evergreen forest combination can be seen almost throughout Kerala between altitudes of 1000 and 2690 m. Because of the fact that evergreen forest contrasts well with surrounding grasslands, satellite images show sholas clearly. Often sholas can be further differentiated from the images. In the present study multispectral images of 22 m resolution taken by IRS 1C satellite in February 1997 were used. Relevant parts of image were extracted, resampled with respect to 1:50,000 scale Survey of India topo sheets and subjected to supervised or unsupervised classification.

In the present study sholas are grouped into five regions namely Wayanad, Nilgiris, Anamalais, Periyar and Ashambu hills. The sholas in these regions are spatially mapped and characteristics examined. In general, one cannot describe the sholas as having a fixed species composition. Altitudinal factors, underlying soil and hydrological parameters seem to play an important role in species composition. Even though one can see gradations in tree composition with respect to altitude in particular locality, different localities are not comparable because of altitudinal difference. Another important consideration is that of patch size. Individual shola patches are of 0.1 to 1 ha in area. There are also sholas of larger extent and those in continuation with evergreen forest of lower altitude.

Among the four locations studied in detail, girth distribution shows that smaller trees are most predominant, frequency of larger tree decreasing. This pattern is not as clear in the case of tree height, because tree height is more dependent upon elevation and hence not comparable among different locations. An examination of genus wise distribution of trees shows that three genera have 5 or more species, one genera 4 species, three genera 3 species, nine genera 2 each and 36 genera one species alone. It can be seen that only one tree belonging to the species, *Cinnamom wightii*, is common to all the locations. A total of 82 birds were sighted during the field trips to the four areas. Of all seen, six species of birds are common to all the sites. These are common birds such as jungle myna, crow pheasant, jungle crow, large pied wagtail, red whiskered bulbul and white eye. Another 14 birds were common to three sites. Twenty one species were present in two locations. Forty one birds were restricted to one site.

Earlier trend was to describe the vegetation in an ecosystem in terms of composition and structure. Several authors have recently shown that tree composition is highly dependent upon microhabitat and a variety of other factors. Different parts of same habitat can be notably different. Sholas of the Western Ghats in this respect are more static and one would expect more homogeneity. But the structural data from the study indicate that there is much variation in the shola composition even within the same locality.

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Introduction

The shola forest may be described as high elevation, stunted and evergreen association commonly occupying the higher hills of South India. Two distinct types of vegetation can be noticed, evergreen forests extending from low altitude and evergreen forests seen as patches in the middle of grasslands. According to Champion and Seth (1968) the shola forests fall under the type Southern wet (montane) temperate forest (group 10 A). According to Ranganathan (1938) shola patches occur as a rule at the heads of streams in the folds of converging slopes, in wrinkles, hollows and depressions caused by landslips on the slopes of hills. The vegetation of the shola-grassland ecosystem is of special interest to ecologists in that two distinct plant communities, evergreen shola forest and grassland, which usually mutually hostile, co-exist on the plateau in close juxtaposition and apparent equilibrium.

Low elevation grasslands are usually considered result of repeated fire. One would normally expect climax evergreen forest on the hilltops; the high altitude shola-grassland combination is a unique feature. Combination of adequate soil moisture and shallow soil is believed to contribute to the formation of stunted tree patches. Gupta, (1962a) referring to shola forests of Palni hills state that, though it is convenient to speak of sholas as an ecological unit, the composition, size, height and growth of the forests vary according to altitude, aspect, situation and biotic factors. One can often see stretches of evergreen forest extending into high altitude areas along course of streams. The sholas of South India are notable in another context also, that of occurrence of species of *Rhododendron, Strobilanthes* and Nilgiri tahr, relatives of which are found on hilltops in the Himalayas. Birds such as black and orange flycatcher are specific to the sholas.

The vegetation map prepared by the French Institute shows spatial distribution of sholas. In this, shola forests are mapped as montane evergreen forest. *Strobilanthes* is the major undergrowth in the sholas. Most of the shola regions come under protected areas. Forest fire is a major threat to the sholas. There have been some instances of raising of plantations in shola areas.

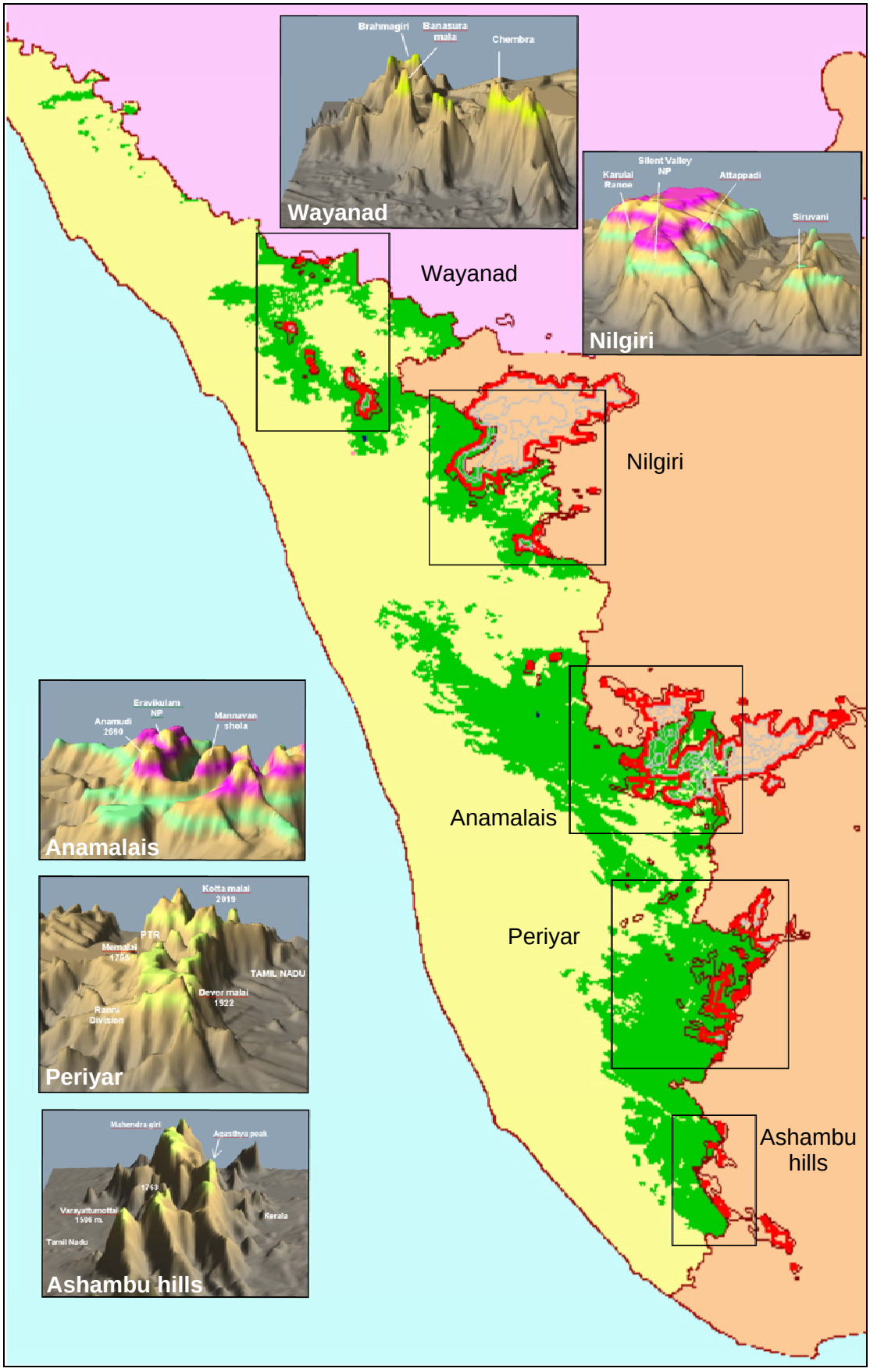


Fig 1. Map of Kerala showing forests and contour lines of 1200,1500 (red).

Remote sensing, so far used mainly for vegetation mapping, has recently been successfully used in combination with Geographical Information System (GIS) techniques in mapping biodiversity and habitat fragmentation, characterising landscape elements and monitoring habitat changes. Satellite imageries such as those from IRS IC have sufficient spectral and ground resolution for this purpose. Various indices such as Normalized Difference Vegetation Index (NDVI) can be connected to vegetation biomass, vigour, photosynthetic activity and leaf area index and are potentially useful for characterising different types of plant associations.

In recent years, in addition to maps depicting physiognomy of our country, need for maps depicting biognomy or biodiversity profiles has been stressed. This will be essential for allocation of resources for conservation activities. Genetic conservation maps, species conservation maps, species richness maps or hotspot maps for a wide variety of plants and animals have already been prepared by researchers. It has also been shown that species distribution pattern of dalbergias, dipterocarps, orchids, endangered plants, ants and birds largely correspond to the traditionally known major areas of biodiversity, namely the Western Ghats and Eastern Himalayas. But in the case of specific taxa, different protected areas may have to be chosen to conserve specific group. The concept of higher taxon richness has also been recently used for mapping biodiversity.

Literature review

Limited information on the floristic elements of the region is found in the working plans of forest divisions. Much floristic information on the vegetation is found in earlier floristic works like Wight (1853) *Icones Plantarum Indiae Orientalis*, Hooker's (1872-97) Flora of British India, Gamble and Fisher's (1915-1936) Flora of Presidency of Madras and other regional and local floras. Perhaps the first monographic floristic account on the high altitude forests was that of Fyson's (1915-1921) Flora of the Nilgiri and Pulney Hill-tops. The flora and vegetation of the high altitude forests of the Nilgiris and Pulneys and Kodaikkanal in Tamil Nadu are relatively well studied in comparison with that of Kerala. A comparable floristic account of the high altitude forests of Kerala is due to the pioneering studies of Shetty and Vivekananthan (1968) and Sebastine and Vivekananthan (1971).

Blasco (1971) made a phyto-geographic analysis of grassland forest continuum along the Hill-tops of the Western Ghats. Recently Swarupanandan *et al*. (1998) studied the

vegetation, its distribution and status in detail. Karunakaran (1997) studied in detail the floristic structure and ecological significance of both grassland and shola forest of Eravikulam National Park. Babu (1997) conducted the vegetation mapping and analysis of Eravikulam National Park using remote sensing. Menon *et al.* (1997) also studied high altitude shola and grassland, vegetation analysis and mapping of Eravikulam National Park using remote sensing. Nair (1988) conducted a study on the conservation potential of natural forests of southern Western Ghats where status of shola forests was emphasized. Aiyar (1932) has given a detailed account of sholas of Palghat division.

A coordinated research programme on the ecology of shola forests is being conducted, of which this study is a part.

Materials and Methods

Shola is a closed evergreen forest, where the trees are short-boled, well branched and often straggling. The height of the trees is low, rarely exceeding 16 – 20 m. Crowns are very dense and rounded and consist of coriaceous leaves which tend to have varying degrees of red colour when young. Branches of the trees are covered with mosses, ferns and other epiphytes; woody climbers are also common. The shola forests are mostly distributed on the rolling downs of hills occupying the sheltered folds in the hills at the heads of the streams on the converging slopes of hills where there is good drainage and sufficient moisture.

Study area

Based on forest continuity and altitude, the shola forests of Kerala could be grouped into five regions. Wayanad region is the northern most, followed by the Nilgiris, Anamalais, Cardamom hills and Ashambu hills.

1. Wayanad region

This is the northern most region in Kerala that contains high altitude evergreen forest. A series of hills around the Wayanad plateau rise more than 1500 m above mean sea level (MSL).

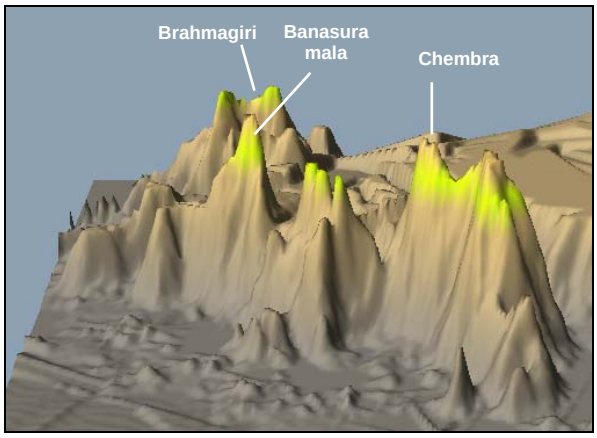


Fig 2. Computer generated 3D view of forests of Wayanad region. The region of 1500 m elevation is coloured green.

In the Brahmagiri region, there are sholas above the Thirunelly temple area. The sholas and grasslands continue into Karnataka. Five sample plots of 15 x 10 m size were laid out to document the tree composition. Sholas from Chembra hills in the Meppady range were also studied intensively through sample plots. There is stunted evergreen forest and grasslands above 1000 m MSL.

2. Nilgiri region

The Nilgiri region extends upto 2000 m in elevation. Shola forests are found in small patches in many areas. The western edge along the Kerala forest boundary has fairly extensive undisturbed high elevation forest. Sispara pass located at the junction of the Kunda and Korakunda hills on the edge of Silent Valley forest also is one of the richest known areas for high elevation flora in the Southern Western Ghats. Four sample plots were taken in this region for enumeration of trees.

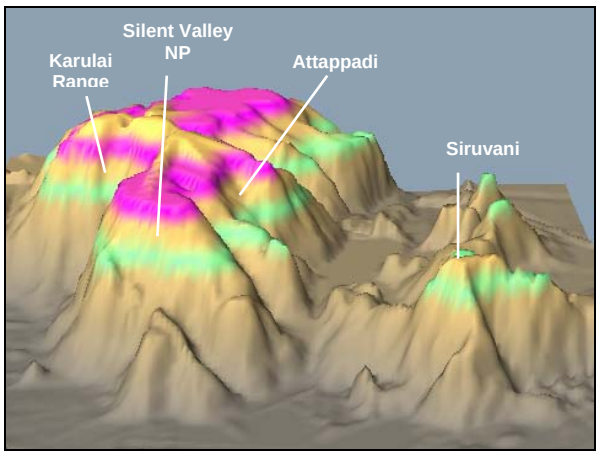


Fig 3. Computer generated 3D view of Silent Valley and Siruvani hills. The region of 1500 m is coloured green. Violet colour denotes 2000 m.

Most of the forests in this tract come under the Nilgiri Biosphere Reserve. This region is drained by the tributaries of Chaliyar. These forests are exceptionally rich in biological diversity and endemic forms. There is another tract of high elevation forest extending along the Siruvani - Eleval - Palamala - Karimala hills.

3. Anamalai region

The Anamalai region, located below the Palghat gap contains extensive ridges and undulating hills. This is a wide stretch of forest extending from Parambikulam, Eravikulam and Puyamkutty areas. Anamudi is the highest peak in Southern Western Ghats. Eravikulam National Park is situated around this. Several studies have been carried out in the Mannavan shola region falling under this tract. The Anamudi RF is a biologically rich area sheltered on

all sides by rocky cliffs. This region contains many relict plants such as *Rhododendron* and animals such as Nilgiri Tahr.

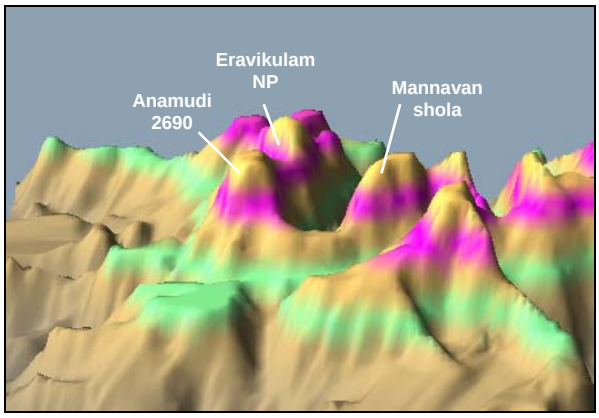


Fig. 4. Computer generated 3D view of Anamalai region. The region of 1500 m is coloured green, violet indicates 2000 m region.

The main high altitude vegetation type of the region is the grassland and sholas. Sholas are generally confined to sheltered valleys, hollows and depressions. There is much discontinuity in forest in this tract due to tea and cardamom plantations. Two sample plots have been laid out for enumerating tree composition in the Eravikulam National Park area.

4. Periyar region

This is another tract of mountains rising more than 1500 m in parts. Unlike the ones described so far, these are mostly dense forest and there is hardly any grassland in the shola region.

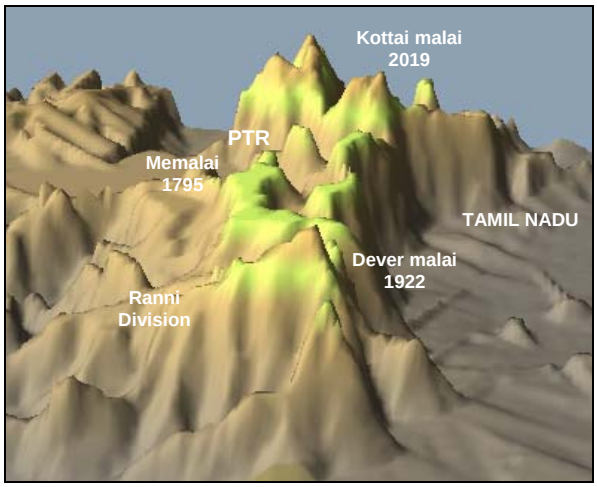


Fig. 5. Computer generated 3D view of Periyar region. The region of 1500 m is coloured green.

There is a chain of hills all along the eastern border of Periyar Tiger Reserve along the Tamil Nadu boundary. Altitude range from 1500 to 2000 m. Dever malai falling under the Ranni division on the State border is another hillock rising to 1922 m. Other peaks on the Chokkampatty region of Periyar Tiger Reserve rise to more than 1800 m. Memalai inside Periyar Tiger Reserve rises to 1795 m.

5. Ashambu hills

This is a composite range of hills with a main range descending steeply both on the western and eastern sides. There is hardly any shola forest in this region in areas above 1000 m. Combination of grassland and stunted forest is seen. The plains on the eastern side in Tamil Nadu are of about 100 m elevation; there are few small hillocks on the Kerala side.

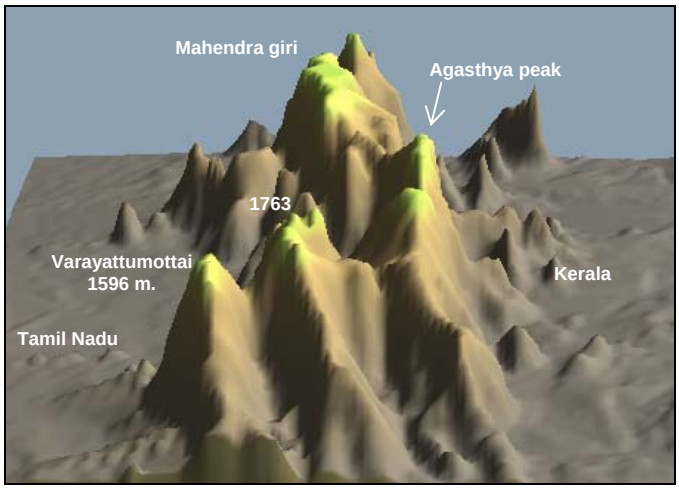


Fig. 6. Computer generated 3D view of Agasthyamalai region. The region of 1500 m is coloured green. The view is from North to south. (View is from north).

The southern most peak Mahendragiri falling in Tamil Nadu is not covered in this study. The Neyyar Wildlife Sanctuary and Peppara Wildlife Sanctuary are located within this region. The forests of Agasthya peak is at an elevation of 1869 m. Chemunji hills beside this are also above 1500 m. There are few isolated hills rising sharply to 1500 m.

There is a hill by name Karimalaikadakal rising to 1763 m in the Kulathupuzha range on the state boundary. Varayattumottai at an elevation of 1596 m in the Shenduruny Wildlife Sanctuary is also notable**.**

Methods

Multispectral satellite images of 23 m spatial resolution were digitally classified to demarcate shola region. Supervised classification was done with proper ground checking. Tree composition was estimated from sample plots. Bird checklists were prepared based on field observation. Forest above altitude of 1500 was examined. Methods employed for describing shola forest include mapping techniques, plotting contours, generation of 3D views, enumeration of trees from sample plots and plotting results and identification of sholas.

Mapping techniques

Several contour maps were prepared in connection with this project. Contours from Survey of India map at 1:1,000,000 scale were digitised and converted to Digital Elevation Model (DEM) by interpolating contours. For this purpose, a custom program written by the author (Nair, 2000) and interpolation module from Idrisi were used (Eastman, 1997). A freeware program 3DEM (Horne, 1999) was used for generating the 3D views. In addition to this, contours from Survey of India maps at 1: 50,000 were digitised at 100 m intervals and used for illustration of specific shola regions. Vector plotting has mainly been done using Mapinfo GIS software.

Identification of sholas

Multispectral satellite images from IRS 1C of 23 m resolution taken in 1997 were used for identification of shola forests. Relevant regions were extracted and resampled with respect to 1: 50,000 scale Survey of India topo sheets. RGB composites of the areas were prepared. Classification was carried out using supervised and unsupervised classification techniques. Contour lines and forest boundaries are overlaid on the RGB composite for interpretation.

Sample plots

Sample plots were laid out in four localities namely Brahmagiris, Chembra hills, Silent Valley and Eravikulam. Plots of 15 x 10 m were marked on the forest and corners and points at 5 m interval along plot boundary marked on ground and serially numbered. From each tree inside the quadrat, measurements were taken to two of the nearest boundary points. Identity, girth and approximate height of the trees were noted down. The crown of the trees was also marked by measuring distance from bole to crown corners on ground along eight directions using magnetic compass and tapes. From this the plot structure could be reconstructed and various parameters analysed. For this, a computer program was written. In the program the plot boundary points were marked on screen. Tree positions were fixed at position of minimum error, which satisfies distances to boundary points. Crown position was marked using the formula

$$x = d.\cos\theta \quad \text{and} \quad y = d.\sin\theta.$$

Where d is the distance from the bole to the crown periphery and θ is the angle along which distance is measured, x and y are coordinates in relation to the tree bole.

Standard parameters employed in structural analysis of vegetation such as density, frequency, basal area, relative density, relative frequency, relative basal area, IVI, Shannon Index and Simpson Index were computed using standard formulas (Misra, 1968).

Identification of plants and animals

Herbarium specimens of plants were made for confirming identity. Shrubs and herbs were also enumerated wherever possible. Birds were observed and identity noted down. Few insect samples were also collected.

$$\text{Density} = \frac{\text{Total number of individuals of a given species} * 100 * 100}{\text{Area sampled (size and number of quadrates)}}$$

$$\text{Frequency} = \frac{\text{Number of occurrence of each species} * 100}{\text{Total number of quadrates}}$$

$$\text{Basal area} = \text{GBH} * \text{GBH} * 0.08$$

$$\text{Basal area / ha} = \frac{\text{Total basal of each species} * 100 * 100}{\text{Area sampled (size and number of quadrates)}}$$

$$\text{Relative density} = \frac{\text{Individual density} * 100}{\text{Total density}}$$

$$\text{Relative frequency} = \frac{\text{Individual frequency} * 100}{\text{Total frequency}}$$

$$\text{Relative basal area} = \frac{\text{Individual basal area} * 100}{\text{Total basal area}}$$

$$\text{IVI} = \text{Relative density} + \text{Relative frequency} + \text{Relative basal area}$$

$$\text{Shanons Index (H)} = -\sum [(n_i / N) \log_2 (n_i / N)]$$

$$\text{Simpson Index (C)} \quad \sum (n_i / N)^2$$

Where H = Shannon index of species diversity, n_i= number of individuals of species I, N

Results

As described under study area, the high elevation areas (above 1500 m) in Kerala forests could be described under five regions. The Wayanad and Nilgiri regions are situated north of the Palghat gap. The sholas of Chembra region in Wayanad and Sispara region in the Nilgiris have been studied in detail. Anamalais, Periyar and Ashambu hills are located south of the Palghat gap, among which Anamalai region has large stretch of shola forests. Detailed studies have been carried out in the Eravikulam National Park. Shola forests in these areas are described serially.

1. Wayanad region

There is forest-grassland type of vegetation above 1000 m in Kottiyoor range and Aralam Wildlife Sanctuary. These cannot be considered as sholas. The forests go beyond 1500 m in the border areas of Begur range and the evergreen vegetation at this altitude can be considered as shola. Two hilly regions, Mylladi mala and the other at Banasuramala go beyond 1500 m and harbour evergreen vegetation. Chembra - Vellarimala region contains shola forest. Chembra region was studied in detail.

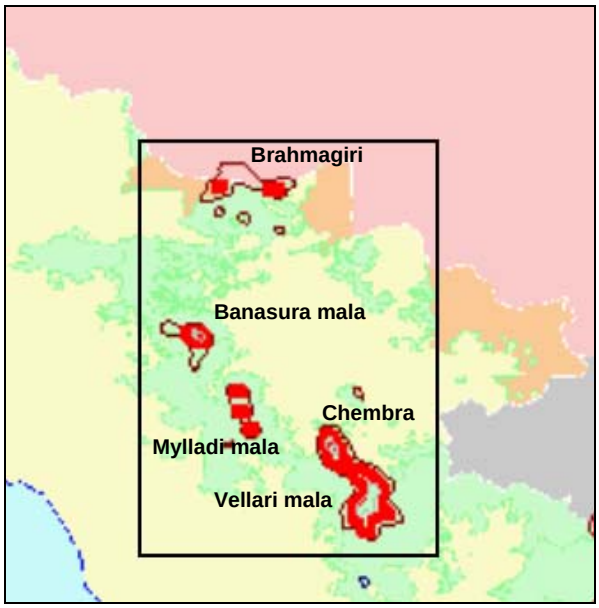


Fig 7. Forests of the Wayanad region. The 1500 m contour is shown in red. Green is reserved forest, orange is protected area.

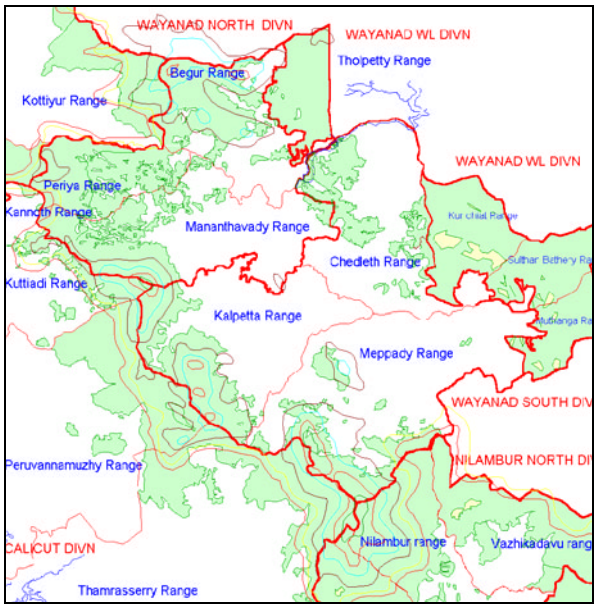


Fig 8. Forest of Wayanad region showing contours and administrative boundaries.

Brahmagiri sholas

The Brahmagiri region is in the Begur range of Wayanad North Division (Fig 9). In the Thirunelly region two hillocks rise above 1500 m. These regions contain shola forest and grasslands. Evergreen forest from lower elevation extends to the hilltops. The grasslands and shola continue on the other side of the state boundary also. There are small and large patches of sholas.

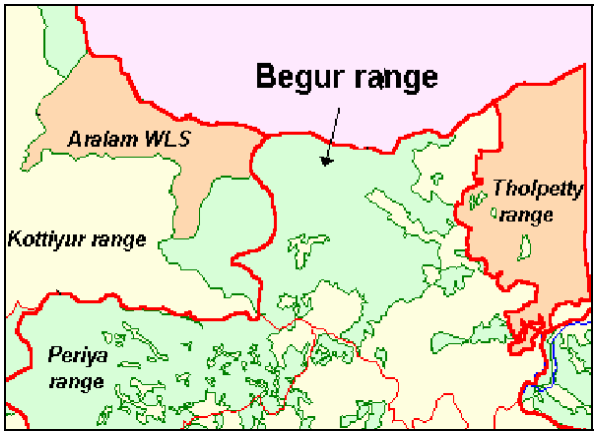


Fig 9. Location map of Begur and adjacent areas.

Fig 10. View of shola of Brahmagiri area

Only few shola patches are seen in the Kerala part and sholas continue on the Karnataka side. The vegetation of the region includes southern tropical wet evergreen forest, southern subtropical broad-leaved hill forest interspersed with stretches of grassland. The Brahmagiri shola is considered as a low level shola. Thirunelli river originates from shola regions of the Brahmagiri hills.

Figure 11 shows a computer generated 3D image of the study area. The main ridge and the shola forests in the valleys are clearly visible. The Thirunelli temple is located in the valley between the two hills. Pakshipathalam is an interesting area coming under the Brahmagiri region with caves made of numerous gigantic spherical rocks. These caves go down between tiers of rocks. Since there are large number of birds residing inside the caves, this place in known as Pakshipathalam. Beyond Pakshipathalam isolated grasslands and patches of sholas are found. About one km away from Paskhipathalam, is another place called Ambalappara which is also a rocky area with grasslands, sholas and evergreen forests.

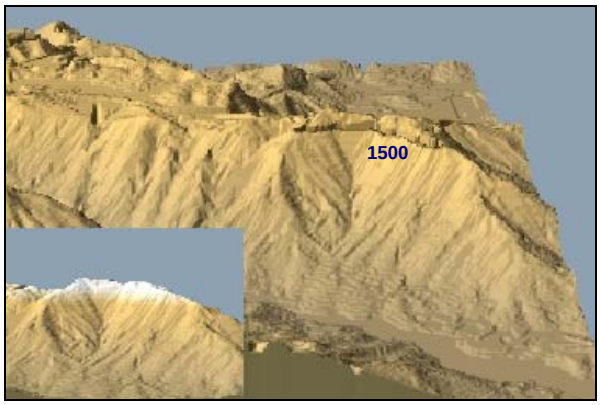


Fig 11. 3D view of the Brahmagiri hills. Inset shows the 1500 m region in white colour.

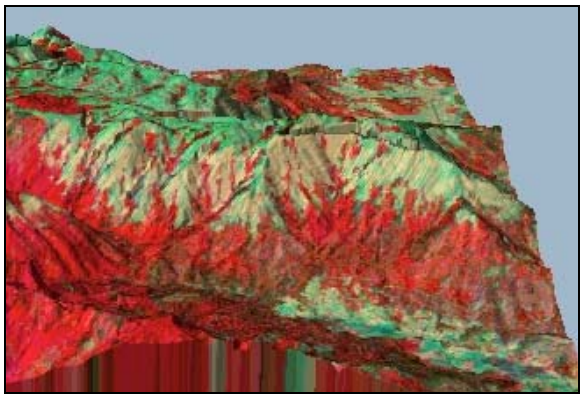


Fig 12. RGB composite draped over 3D view. Red is evergreen forest, Yellow and green savannah.

An area between 75^{o} 57' and 76 ^{o} 1.25' E, and, 11^{o} 54' and 11^{o} 56.75' N was examined in more detail. There is a stretch of grassland in this area. The Red Green Blue (RGB) composite satellite image for the same area is also given. The lower reaches have deciduous forest with bamboo.

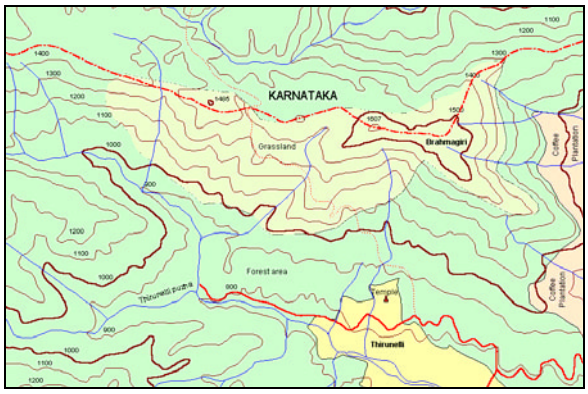


Fig 13. Enlarged map of Brahmagiri shola region

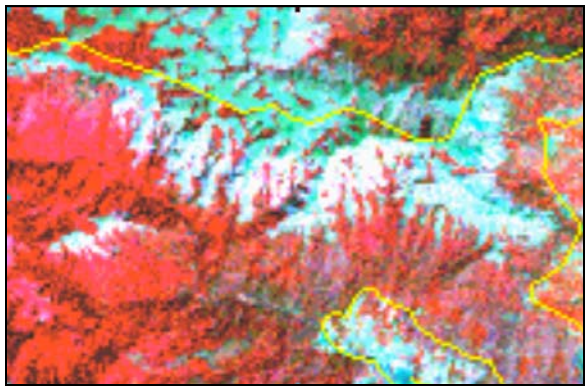


Fig 14. RGB composite of Brahmagiri shola region

Figure 13 shows the study area in detail. There is a stretch of grassland above 1000 m. The grasslands continue right up to the hilltop with elevation above 1500 m.

Sample plots

Five sample plots of 15 x 10 m were taken in the shola forest areas. Out of these, three plots were below 1500 m (located at 1300, 1400 and 1450 m), and the rest above 1500 m (1500, 1550 m). Of the five plots taken, four were in shola patches situated in the middle of grasslands. Status of trees in these plots is analysed. Total number of trees in the plot varied from 11 to 19 trees. In general, plots at lower elevation had higher girth and height. Even though some parts of Brahmagiri sholas have reed bamboo and few rattan species , none of them fell inside the sample plots.

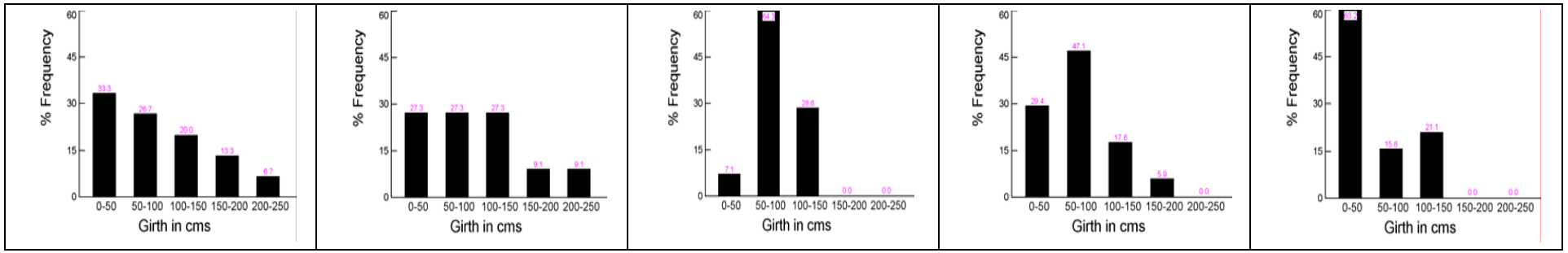
The plot taken at the lowest elevation (plot 3) was situated inside a small patch of shola of about 0.5 ha. This patch had very little undergrowth and regeneration. This patch was susceptible to fire also. It contained some *Strobilanthus* as undergrowth. *Litsea ligustrina* is the most common tree followed by *Cinnamomum sulphuratum*, *Elaeocarpus serratus* and *Scolopia crenata*. The plot taken at 1400 m (plot 4) was situated on a large patch of steep shola forest on the other side of the hills. This had the least number of trees. This plot had some amount of regeneration and undergrowth. *Aphanomixis ploystachia, Meliosma simplicifolia* and *Persea macrantha* were the most frequent trees. The plot at 1450 m (plot 1) was located in a small patch of shola of about 0.5 ha near Pakshipathalam. The trees were comparatively shorter in this plot; undergrowth and regeneration were also less. *Coffea cracifolia* was the most frequent species. This was followed by *Casearia coriacea* and *Litsea bourdillonii*. The plot taken at 1500 m (plot 2) was situated on a small patch of shola of about 0.5 ha. There was good regeneration and undergrowth in this plot. This is situated more or less at the hill top. *Symplocos spicata* was the most frequent tree here. This was followed by *Heritiera papilio.* The plot taken at 1550 m (plot 5) was also taken in a small patch of shola of about 0.25 ha. This plot had two large trees and a large number of small trees. There was small amount of undergrowth. *Coffea cracifolia* was the most abundant. This was followed by *Meliosma simplicifolia*, *Glochidion ellipticum* and *Eurya nitida*.

Table 1. Summary vegetation plot characteristics

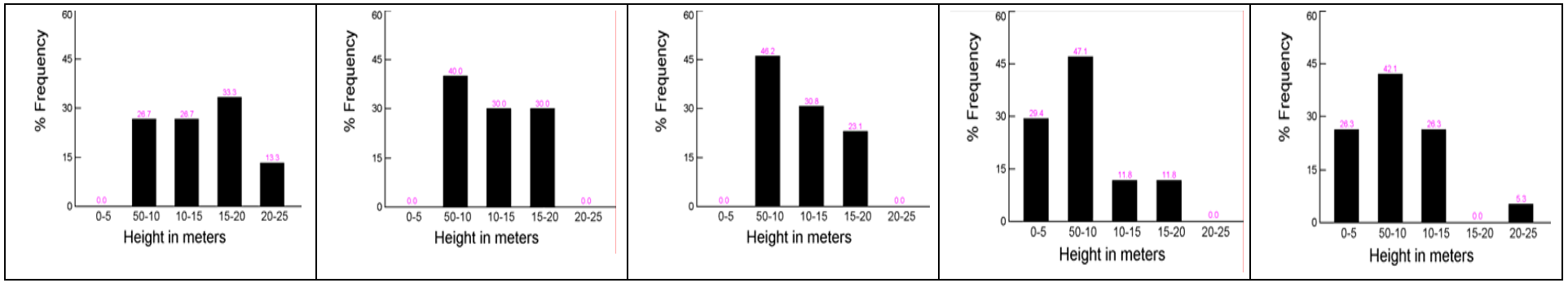
Plot	Altitude	No. of trees	Avg. GBH	Avg. height	Diversity	Avg. IVI
Plot 3	1300	15	92.07	16.67	2.2111	19.99
Plot 4	1400	11	96.36	15.91	2.0198	27.27
Plot 1	1450	14	90.71	15.00	2.2056	21.42
Plot 2	1500	15	74.33	11.00	2.3035	20.00
Plot 5	1550	19	64.26	10.79	1.7673	15.79

In Brahmagiri, none of the species was present in all the plots. *Casearia coriacea, Casearia ovata* and *Coffea cracifolia* were present in three plots. When overall composition was considered, *Coffea cracifolia* was the most frequent tree (14.8 %). Among the plots in Brahmagiri, all the plots contained trees up to 20 m in height. Canopy cover was more or less similar. When all the five plots were considered, the girth distribution in 5 category of 0.5 m increment was 35.1, 35.1, 21.6, 5.4 and 2.7 % respectively. They belonged to mostly low girth class (<100 cm). When higher taxa distribution was considered, genus *Elaeocarpus* had three species, and several other genera two species each.

Girth distribution



Height Distribution



Plot 3	Plot 4	Plot 1	Plot 2	Plot 5
1300 m	1400 m	1450 m	1500 m	1550m

Fig 15. Girth and height details in the sample plots at Brahmagiri

Individual wise *Coffea cracifolia* was the most frequent (10 individuals) this was followed by *Casaeria coriacea, Meliosma simplicifolia, Glochidion elliypticum, Litsea ligustrina and Scolopia crenata*. There were four species with three individuals each. There were three species under the genus *Elaeocarpus.* Five genera had two species each (Table 2).

Table 2. Frequency of species under different genera of trees at Brahmagiri

Genus	No. of species
Elaeocarpus	3
Canthium	2
Casaeria	2
Syzygium	2
Cinnamomum	2
Symplocos	2

There was one genera with three species of trees in it. Six genera had two species under them. Fourteen genera had only one species in it. Regarding number of individuals in species, two species had more than five individuals. Thirteen species had only one individual. There was no tree species common to all the five plots. Four trees were common to three plots, six species common to two plots and nineteen species restricted to one plot.

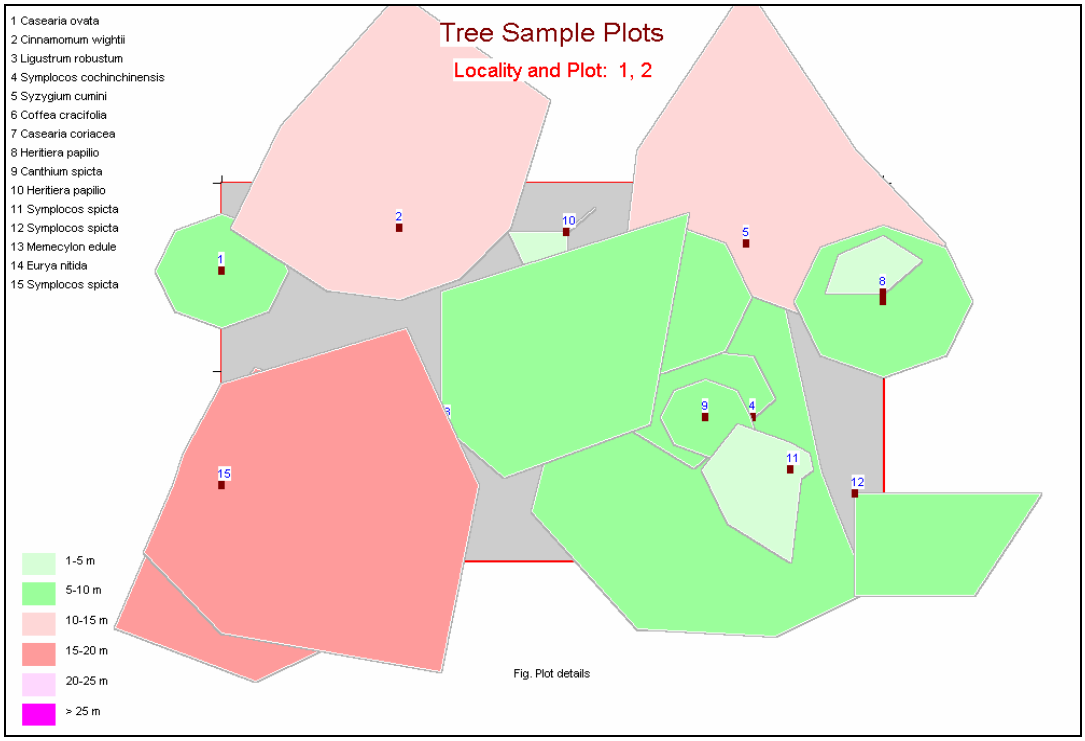


Fig 16. Plot of tree canopy. Tree locations and canopy corners in eight directions are plotted.

Table 3. Brahmagiri plots, species comparison

Species	1	2	3	4	5	Total	Common to
Antidesma menasu	-	-	1	-	-	1	1
Aphanamixis polystachya	-	-	-	2	-	2	1
Canthium dicoccum	-	-	1	-	-	1	1
Canthium spicta	-	1	-	-	-	1	1
Casearia coriacea	2	1	-	-	1	4	3
Casearia ovata	1	1	-	-	1	3	3
Cinnamomum sulphuratum	1	-	2	-	-	3	2
Cinnamomum wightii	-	1	-	-	-	1	1
Coffea cracifolia	3	1	-	-	6	10	3
Elaeocarpus glandulosa	1	-	-	-	-	1	1
Elaeocarpus serratus	-	-	2	-	-	2	1
Elaeocarpus tectorius	-	-	-	1	-	1	1
Eurya nitida	-	1	-	-	2	3	2
Evodia lunu ankenda	1	-	-	-	-	1	1
Flacourtia montana	-	-	-	1	-	1	1
Glochidion ellipticum	-	-	1	-	3	4	2
Heritiera papilio	-	2	-	-	-	2	1
Ligustrum robustum	1	1	-	-	-	2	2
Litsea bourdillonii	2	-	-	-	-	2	1
Litsea ligustrina	1	-	3	-	-	4	2
Meliosma simplicifolia	-	-	-	2	5	7	2
Memecylon edule	-	1	-	-	-	1	1
Neolitsea zeylanica	-	-	1	-	-	1	1
Persea macrantha	-	-	-	2	-	2	1
Scolopia crenata	-	-	2	1	1	4	3
Symplocos cochinchinensis	-	1	-	-	-	1	1
Symplocos spicata	-	3	-	-	-	3	1
Syzygium cumini	-	1	-	-	-	1	1
Syzygium sp. 1	-	-	1	-	-	1	1
Unidentified 2	1	-	-	-	-	1	1
Unidentified 5	-	-	-	1	-	1	1
Unidentified 7	-	-	1	1	-	2	2
				Total:		74	

List of birds in Brahamagiri area

A total of 41 species of birds were identified from Brahmagiri area. Number of birds falling under different genera was examined. One genus *Dicrurus* (drongos) had three species, seven genera had two species each and 24 genera had one speices. It was found that none of the genus had more than two species.

Table 4. List of bird species sighted at Brahmagiri

Sl.No	Common name	Scientific name
1	Red whiskered bulbul	*Pycnonotus jocosus*
2	Pariah kite	*Milvus migrans*
3	House crow	*Corvus splendens*
4	Jungle babbler	*Turdoides striatus*
5	Blue rock pigeon	*Columba livia*
6	Black drongo	*Dicrurus adsimilis*
7	Crow pheasant	*Centropus sinensis*
8	Grey wagtail	*Motacilla caspica*
9	Large pied wagtail	*Motacilla maderaspatensis*
10	Jungle myna	*Acridotheres fuscus*
11	Grey jungle fowl	*Gallus sonneratii*
12	Small green bee eater	*Merops orientalis*
13	Red jungle fowl	*Gallus gallus*
14	Purple sunbird	*Nectarina asiatica*
15	House swift	*Apus affinis*
16	Rose ringed parakeet	*Psittacula karameri*
17	Golden backed woodpecker	*Dinopium benghalensis*
18	White bellied drongo	*Dicrurus caerulescens*
19	Scarlet minivet	*Pericrocotus flammeus*
20	Paradise fly catcher	*Terpsiphone paradisi*
21	Common quail	*Coturnix coturnix*
22	Racket tailed drongo	*Dicrurus paradiseus*
23	Jungle crow	*Corvus macrorhynchos*
24	Emerald dove	*Chalcophaps indica*
25	Scimitar babbler	*Pomatorhinus schisticeps*
26	Large green barbet	*Megalaima zeylanica*
27	Common babbler	*Turdoides caudatus*
28	White eye	*Zosterops palpebrosa*
29	Black winged kite	*Elanus caeruleus*
30	White throated ground thrush	*Zoothera citriana*
31	Purple rumped sunbird	*Nectarinia zeylonica*
32	Black bulbul	*Hypsipetes indicus*
33	Common grey hornbill	*Tockus birostris*
34	Cattle egret	*Bubulcus ibis*
35	Red rumped swallow	*Hirundo daurica*
36	Golden oriole	*Oriolus oriolus*
37	Blue headed rock thrush	*Monticola cinclorhynchus*
38	Malabar whistling thrush	*Myiophonus horsfieldii*

Sl.No	Common name	Scientific name
39	Blue tailed bee eater	*Merops philippinus*
40	Black headed yellow bulbul	*Pycnonotus melanicterus*
41	Rufous backed shrike	*Lanius schach*

Sholas of Banasuramala

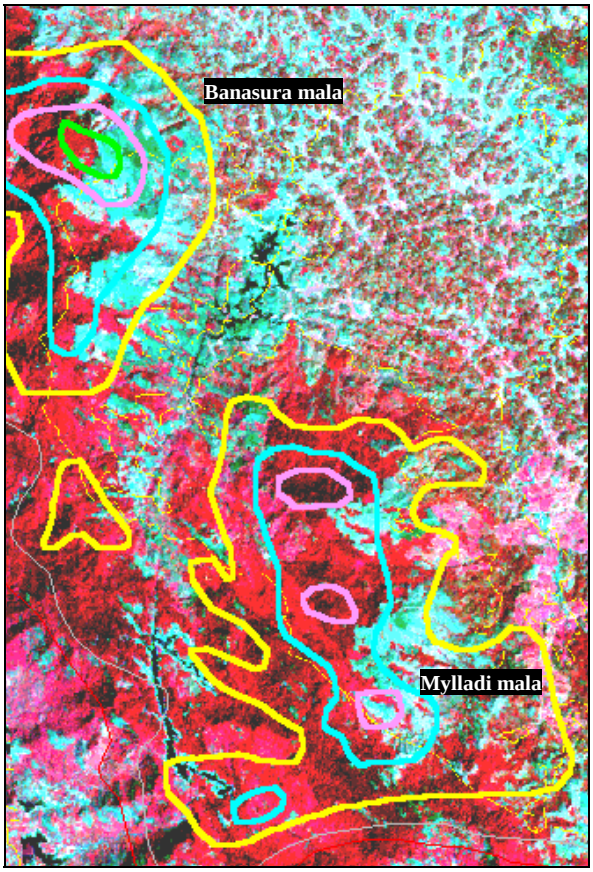


Fig 17. RGB composite of forest of Banasuramala, Yellow is 900, light blue is 1200, violet is 1500 and light green is 1800

Banasuramala and the associated shola fall in the border of Kalpetta, Mananthavadi and Kuttiady ranges. In other words the shola falls in the area of Wayanad North and Kozhikode divisions. The peak hill of this region has an elevation of about 2050 m. Here the vegetation covers Southern subtropical broad-leaved hill forest, Southern montane temperate forest and extended grasslands. This region may be considered as a high level shola. Next to it is the Thondarmudi mala and Maylladi mala falling in Kalpetta range of Wayanad South Division. High altitude areas of this region occur in the border of Kalpetta and Peruvannamuzhy ranges. The maximum elevation of this region is 1800 m.

Sholas of Chembra hill

The shola forest of Chembra hills comes under Meppadi range of Wayanad South Division. Forests of Chembra hill is distributed as a continuous stretch from lower evergreen forest to the upper Southern montane subtropical forests. The forest extends up to an elevation of 1800 m. The vegetation of the region includes grassland, Southern tropical wet evergreen forest and Southern subtropical broad leaved hill forest. These sholas extend to parts of Thamarasseri Range also. Towards the peak, a gradual decrease in height of the trees was observed. Vegetation of this tract was analysed through sample plots taken.

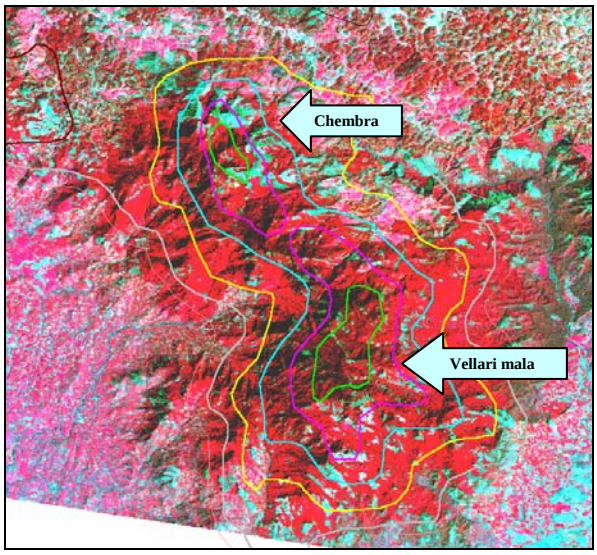


Fig 18. RGB composite of Chembra-Vellarimala region, overlaid with contours of 1200, 1500 and 1800m.

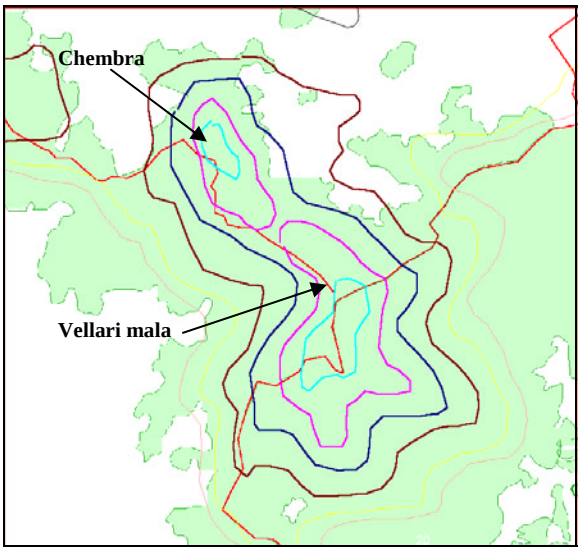


Fig 19. Location of Chembra hills and Meppadi range. Chembra part is at the northern end.

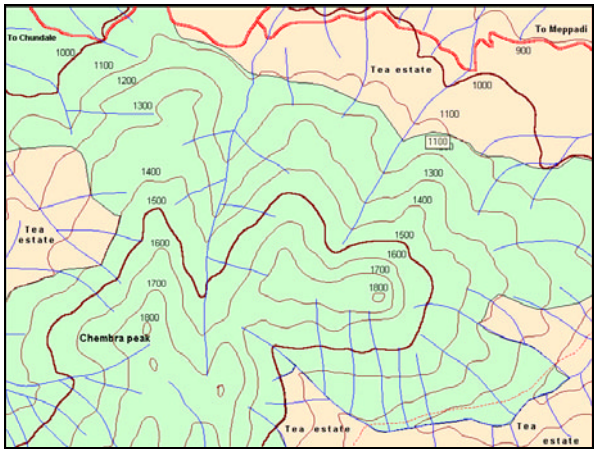


Fig 20. Detailed map of Chembra hills showing forest, contour and streams.

Fig 21. Grass lands and shola forests of the Chembra region.

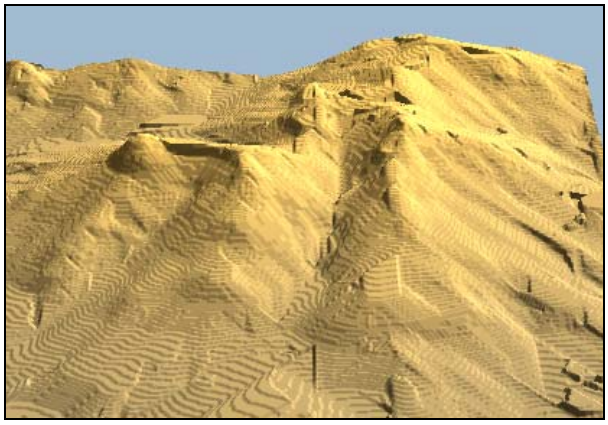


Fig 22. Computer generated 3D view of the Chembra hills. Two hills and a valley can be seen.

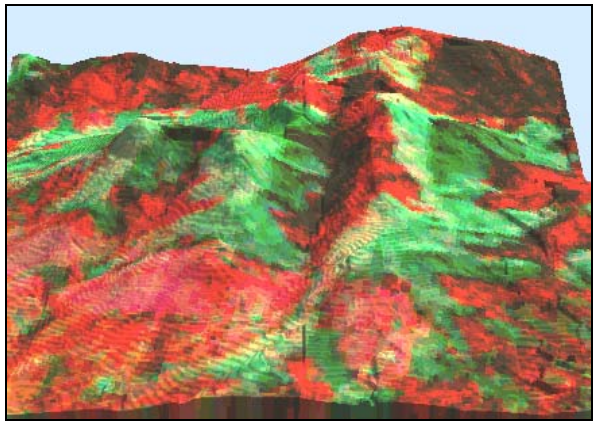


Fig 23. RGB draped over 3D view. Red is ever green forest, yellow and green are grassland savannah.

Sample plots

Three sample plots were taken in the Chembra area. The first plot at 1400 m was located in a small patch of shola of about 0.25 ha. *Casearia coriacea,Cinnamomum wightii, Memecylon edule* were the most common trees. Of the three plots this had the least frequency of trees. GBH and height of tree were also least in the plot. This could be due to periodic fire and other disturbances, being situated near a popular picnic spot. The second plot was taken at 1450 m inside a large patch of shola forest. *Myristica dactyloides* was the most common tree followed by *Agrostistachys indica, Coffea cracifolia* and *Syzygium montanum*. Frequency, girth and height wise, this plot was of medium nature. The third plot was taken at 1500 m in the same patch as above. *Myristica dactyloides* was the most frequent tree. This was followed by *Dillenia bracteata, Ardisia pauciflora, Cassine paniculata and Myristica beddomei*. This plot was the best in terms of tree species frequency, girth and height among all the plots.

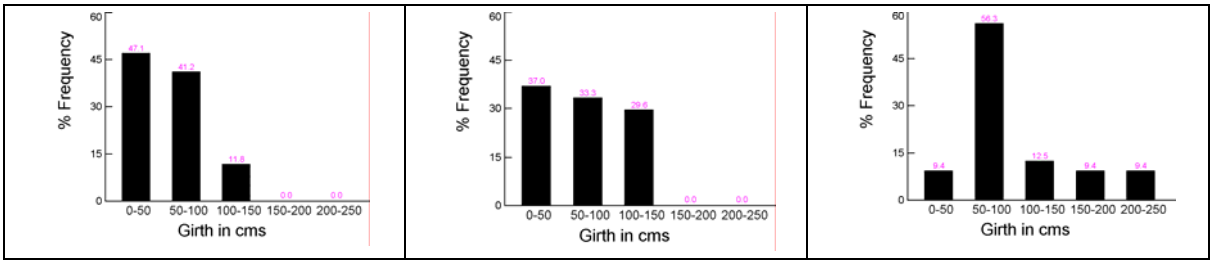
At Chembra, when all the plots were considered, *Myristica dactyloides* was the most common species, followed by *Cinnamomum wightii*.

Larger trees were confined to the plot at 1500 m.

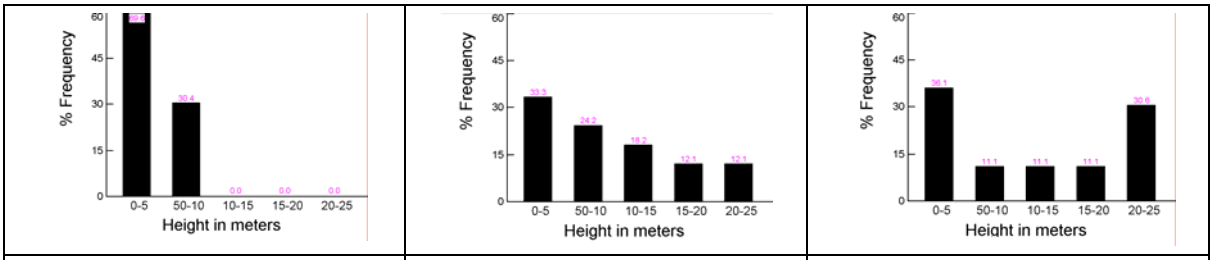
Table 5. Frequency of species under different genus of tree at Chembra

Plot	Altitude	Freq	Avg. GBH	Avg. Height	Diversity	Avg. IVI
Plot 1	1400	17	53.12	7.06	2.4762	17.64
Plot 2	1450	25	86.84	17.80	2.5988	11.99
Plot 3	1500	29	103.93	22.41	2.7576	10.34

Girth distribution



Height Distribution



Plot 1 1400 m	Plot 2 1450 m	Plot 3 1500 m

Fig 24. Girth and height details in the sample plots at Chembra

Three species of trees were present in all the plots, there was much similarity between plots in the large shola patch. Twelve species were common to two plots. Considering species richness of trees, there were two genera with three species under them, two genera with two species under them, and 18 genera with only one species. Three species were common to all the plots.

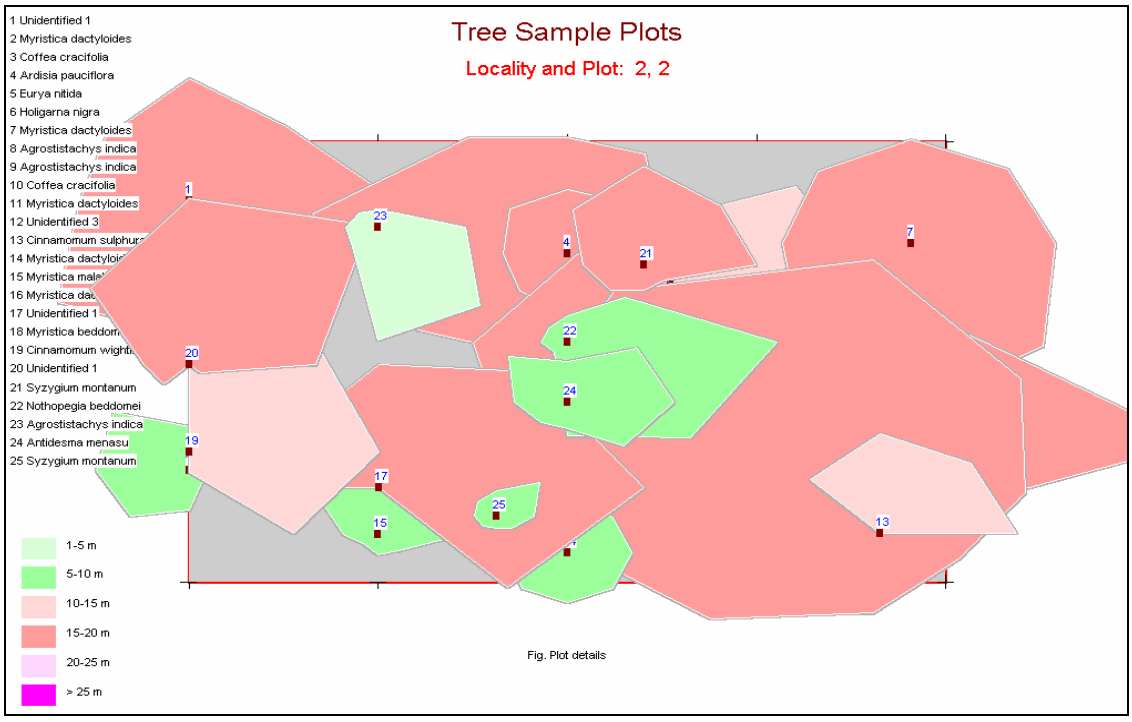


Fig 25. Plot of tree canopy. Tree location and canopy is eight directions are plotted.

Table 6. Chembra plots, species comparison

Species	1	2	3	4	5	Total	Common to
Agrostistachys indica	-	3	-	-	-	3	1
Antidesma menasu	1	1	-	-	-	2	2
Ardisia pauciflora	-	1	2	-	-	3	2
Casearia coriacea	2	-	-	-	-	2	1
Cassine paniculata	-	-	2	-	-	2	1
Cinnamomum sulphuratum	1	1	1	-	-	3	3
Cinnamomum wightii	2	1	1	-	-	4	3
Clerodendrum viscosum	1	-	-	-	-	1	1
Coffea cracifolia	-	2	-	-	-	2	1
Croton reticulatus	1	-	-	-	-	1	1
Dillenia bracteata	-	-	3	-	-	3	1
Euonymus indicus	-	-	1	-	-	1	1
Eurya nitida	1	1	1	-	-	3	3
Goniothlamus wightii	-	-	1	-	-	1	1
Holigarna nigra	-	1	1	-	-	2	2
Litsea bourdillonii	1	-	-	-	-	1	1
Litsea ligustrina	1	-	-	-	-	1	1
Litsea wightiana	1	-	1	-	-	2	2
Memecylon edule	2	-	-	-	-	2	1
Memecylon sp.	-	-	1	-	-	1	1
Myristica beddomei	-	1	2	-	-	3	2
Myristica dactyloides	-	5	4	-	-	9	2
Myristica malabarica	-	1	-	-	-	1	1
Nothopegia beddomei	1	1	-	-	-	2	2
Persea macrantha	-	-	1	-	-	1	1
Rapanea wightiana	1	-	-	-	-	1	1
Scolopia crenata	1	-	-	-	-	1	1
Syzygium montanum	-	2	-	-	-	2	1
Unidentified 1	-	3	2	-	-	5	2
Unidentified 2	-	-	2	-	-	2	1
Unidentified 3	-	1	2	-	-	3	2
Unidentified 4	-	-	1	-	-	1	1
					Total:	71	

List of birds in Meppadi area

Sixty three birds were identified from Chembra region. Considering higher taxa richness, genus *Dicrurus* had three species under it. Many of the other genera had two species each.

Table 7. List of birds species sighted at Chembra region

Sl.No	Common name	Species name
1	Pariah kite	*Milvus migrans*
2	Spotted munia	*Lonchura punctulata*
3	Pied bushchat	*Saxicola caprata*
4	Red whiskered bulbul	*Pycnonotus jocosus*
5	House crow	*Corvus splendens*
6	Jungle babbler	*Turdoides striatus*
7	Blue rock pigeon	*Columba livia*
8	Common sand grouse	*Pterocles exustus*
9	Black drongo	*Dicrurus adsimilis*
10	Crow pheasant	*Centropus sinensis*
11	Grey wagtail	*Motacilla caspica*
12	Large pied wagtail	*Motacilla maderaspatensis*
13	Common myna	*Acridotheres tristis*
14	Grey jungle fowl	*Gallus sonneratii*
15	Small green bee eater	*Merops orientalis*
16	Red jungle fowl	*Gallus gallus*
17	Thickbilled flower pecker	*Dicaeum agile*
18	Jungle myna	*Acridotheres fuscus*
19	Purple sunbird	*Nectarinia asiatica*
20	House swift	*Apus affinis*
21	Rose ringed parakeet	*Pisittacula karameri*
22	Green munia	*Estrilda Formosa*
23	Golden backed wood pecker	*Dinopium benghalensis*
24	Blossom headed parakeet	*Psittacula cyanocephala*
25	Rufous bellied babbler	*Dumetia hyperythra*
26	Gold mantled chloropsis	*Chloropsis cochinchinensis*
27	Yellow eyed babbler	*Chrysomma sinense*

Sl.No	Common name	Species name
28	Pigmy woodpecker	*Picoides nanus*
29	White bellied drongo	*Dicrurus caerulescens*
30	Scarlet minivet	*Pericrocotus flammeus*
31	Paradise fly catcher	*Terpsiphone paradisi*
32	Black bird	*Turdus merula*
33	Magpie robin	*Copsychus saularis*
34	Common quail	*Coturnix coturnix*
35	Racket tailed drongo	*Dicrurus paradiseus*
36	Jungle crow	*Crovus macrorhynchos*
37	Emerald dove	*Chalcophaps indica*
38	Pond heron	*Ardeola grayii*
39	Shikra	*Accipiter badius*
40	Scimitar babbler	*Pomatorhinus schisticeps*
41	Large green barbet	*Megalaima zeylanica*
42	Common babbler	*Turdoides caudatus*
43	Indian robin	*Saxicoloides fulicata*
44	Indian wren warbler	*Prinia subflava*
45	Streaked fantail warbler	*Cisticola juncidis*
46	White eye	*Zosterops palpebrosa*
47	Velvetfronted nuthatch	*Sitta frontalis*
48	Little cormorant	*Phalacrocorax niger*
49	Black winged kite	*Elanus caeruleus*
50	Black headed oriole	*Oriolus xanthornus*
51	Pale harrier	*Circus macrourus*
52	White throated ground thrush	*Zoothera citriana*
53	Purple rumped sunbird	*Nectarinia zeylanica*
54	Black bulbul	*Hypsipetes indicus*
55	Common grey hornbill	*Tockus birostris*
56	Blue throated barbet	*Megalaima asiatica*
57	Cattle egret	*Bubulcus ibis*
58	Red rumped swallow	*Hirundo daurica*
59	Verditter flycatcher	*Muscicapa thalassina*
60	Bronzed drongo	*Dicrurus aeneus*
61	Blue headed rock thrush	*Monticola cinclorhynchus*
62	Gold fronted chloropsis	*Chloropsis aurifrons*

Sholas of Vellarimala region

Vellarimalai, Kurathimala and the associated region are inaccessible with irregularly distributed rocky mountains and hills. Here the altitude extends beyond 2200 m. This is a large area falling in Meppadi, Nilambur, Thamarasserry and Edavanna ranges of three divisions namely Wayanad South, Kozhikode and Nilambur North. Vellarimala is a rocky area with very stunted vegetation between the grasslands. The forest type of this region extends from Southern subtropical broad leaved hill forest to Southern montane wet temperate forest mixed with stretches of grassland.

2. Nilgiri region

A continuous stretch of forest covers the areas of Karulai, Kalikavu and Attappadi ranges and the Silent Valley National Park. A region between 76^{o} 22' and 76^{o} 43' E, and, 11^{o} 5' and 11^{o} 25' N was examined altitude wise. The areas extend to an elevation upto 2000 m or more. The areas fall in Nilambur South and Mannarkad Forest Divisions and Silent Valley National Park. Isolated shola patches and sholas extending from evergreen forest were seen. The vegetation type varied from Southern subtropical broad leaved hill forest to Southern montane temperate forest mixed with stretches of grassland. The sholas of these regions are considered as high level sholas. Kottapuzha river originates from the high altitude areas of Silent Valley and Kalikavu forests. Kuntipuzha and Karimpuzha originate from different parts of Silent valley.

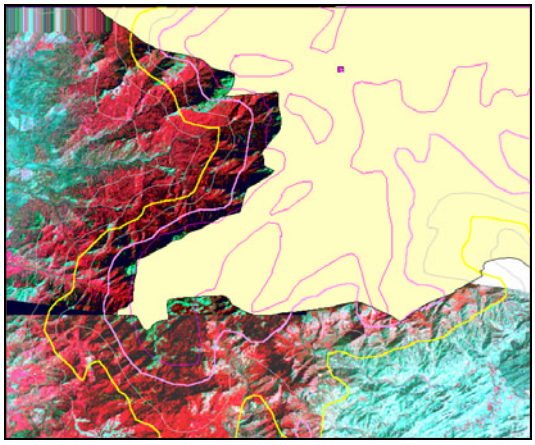


Fig 26. RGB composite of Silent Valley area. Yellow is 1200 and violet is 1800 m contour.

Fig27. View of sholas of Sispara region, of the Silent Valley National Park.

Sample plots

Four sample plots were laid out in the Sispara region of Silent Valley National Park. In this region, isolated shola forests are at about 1900 m height. Below this is evergreen forest. The plot at 1950 m (plot 3) was at Sispara. The plot was located in a small patch of about 0.25 ha. Among the plots, this plot had the maximum average height for trees. *Syzigium arnotianum* and *Syzigium calophyllifolium* were the most frequent trees. There were followed by *Daphniphyllum nilgherrense* and *Microtropis ramiflora*. The plot had moderate undergrowth and regeneration.

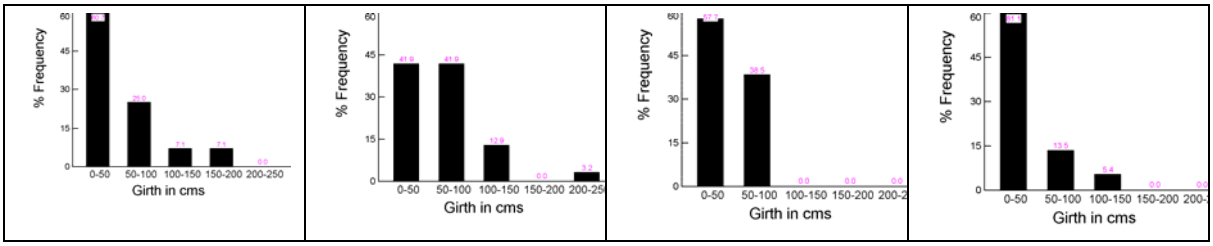
Plot 4 was at 2000 m and was situated at Mukkalimudi, on the crestline. The shola patch was about one ha in extent. Undergrowth consisted mainly of *Strobilanthus*. *Cinnamomum wightii* was the most frequent tree. Plot 1 was at 2200 m elevation. The plot was located in a steep shola of about 0.5 ha. The shola had good undergrowth and

regeneration. Trees were comparatively short and low in frequency. Most frequent trees were *Cinnamomum* sp and *Eurya nitida*. An examination of the girth and height distribution among different sample plots showed decrease of size of trees with altitude. The plot at 2300 m (plot 2) was located in a small shola of about one ha situated near Anginda. The plot did not have much undergrowth and regeneration. This plot had the maximum number of trees, but their girth was the lowest among the plots. When all the plots were considered together, *Rapania wightiana* was found common to all the plots. Several trees were common to three plots.

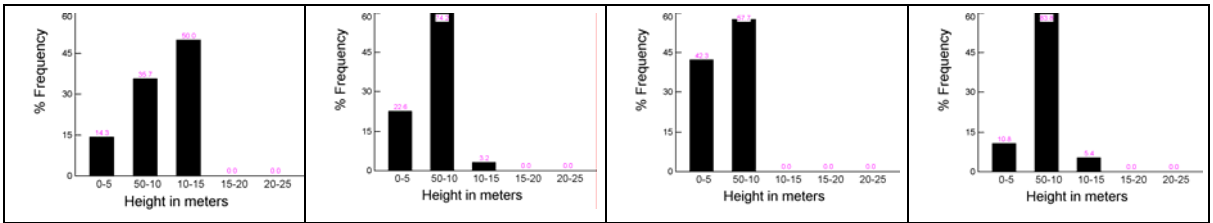
Table 8. Summary vegetation plot characteristics

Plot	Altitude	No. of trees	Avg. GBH	Avg. height	Diversity	Avg. IVI
Plot 3	1950	26	57.19	12.31	2.4915	11.53
Plot 4	2000	29	70.24	9.31	2.9190	10.34
Plot 1	2200	21	64.05	8.33	2.5325	14.28
Plot 2	2300	35	47.00	10.00	2.5656	8.57

Girth distribution



Height Distribution



Plot 3 1950 m	Plot 4 2000 m	Plot 1 2200 m	Plot 2 2300 m

Fig 28. Girth and height details of trees in sample plots

Regarding higher taxa richness of trees, two genera had four species under them, one genera had one species, five genera two species and 13 genera with only one species. One tree was common to all the plots.

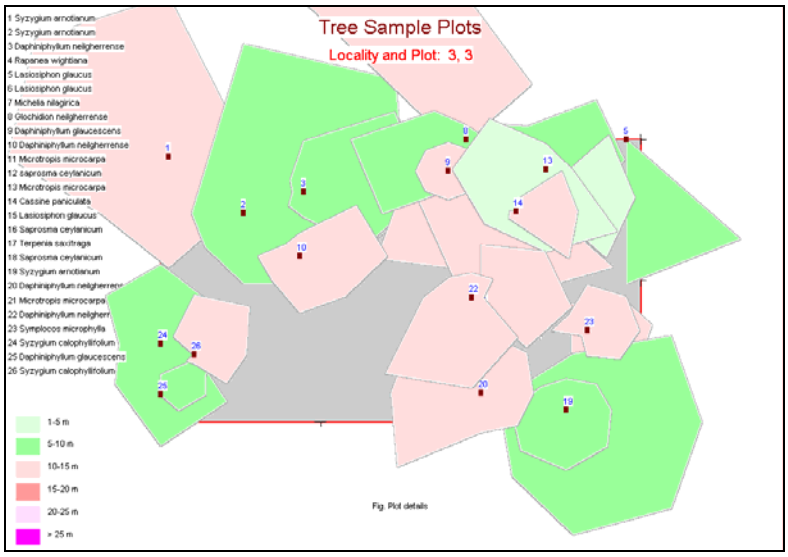


Fig 29. Plot of tree canopy. Tree locations and canopy corners in eight directions are plotted.

Fig 30. The lion-tailed macaque, in Silent valley region.

Table 9. Silent Valley plots, species comparison

Species	1	2	3	4	5	Total	Common to
Cassine paniculata	-	-	1	-	-	1	1
Cinnamomum macrocarpum	3	-	-	3	-	6	2
Cinnamomum perrottetii	3	1	-	2	-	6	3
Cinnamomum wightiana	1	-	-	-	-	1	1
Cinnamomum wightii	-	-	-	3	-	3	1
Daphniphyllum glaucescens	-	-	2	-	-	2	1
Daphniphyllum neilgherrense	-	2	4	1	-	7	3
Eurya nitida	3	1	-	-	-	4	2
Glochidion neilgherrense	-	-	1	-	-	1	1
Gomphandra coriacea	-	-	-	2	-	2	1
Ilex gardneriana	1	-	-	1	-	2	2
Ilex wightiana	-	2	-	-	-	2	1
Isonandra candolleana	-	-	-	2	-	2	1
Ixora notoniana	-	-	-	1	-	1	1
Lasiosiphon glaucus	-	-	3	1	-	4	2
Ligustrum perrottetii	-	1	-	-	-	1	1
Litsea oleides	-	-	-	1	-	1	1
Litsea wightiana	1	-	-	-	-	1	1
Mastixia arborrea	-	-	-	1	-	1	1
Michelia nilagirica	-	-	1	-	-	1	1
Microtropis microcarpa	-	2	3	-	-	5	2
Microtropis ovalifolia	-	4	-	-	-	4	1
Microtropis ramiflora	2	3	-	2	-	7	3
Prunus zeylanica	1	1	-	2	-	4	3

Rapanea wighitiana	-	1	-	-	-	1	1
Rapanea wightiana	1	1	1	1	-	4	4
Saprosma ceylanicum	-	-	2	1	-	3	2
saprosma ceylanicum	-	-	1	-	-	1	1
Symplocos anamallayana	1	2	-	-	-	3	2
Symplocos microphylla	-	1	1	1	-	3	3
Symplocos pendula	-	-	-	1	-	1	1
Symplocos spicata	-	-	-	1	-	1	1
Syzygium arnotianum	1	4	3	-	-	8	3
Syzygium calophyllifolium	2	4	2	-	-	8	3
Syzygium sp. 2	-	3	-	-	-	3	1
Ternstroemia japonica	-	-	-	2	-	2	1
Terpenia saxifraga	1	-	1	-	-	2	2
Unidentified 1	-	1	-	-	-	1	1
					Total:	110	

List of birds in Silent Valley area

Twenty two birds could be identified from the shola region. Considering the species richness of higher taxa the genera *Dicrurus* (drongo) and *Acridotheres* (mynas) had two species each.

Table 10. List of birds in Silent Valley area

Sl.No	Common name	Scientific name
1	Common myna	*Acridotheres tristis*
2	Emerald dove	*Chalcophaps indica*
3	Gold fronted chloropsis	*Chloropsis aurifrons*
4	Jungle crow	*Corvus macrorhynchos*
5	Redvented bulbul	*Pycnonotus cafer*
6	White eye	*Zosterops palpebrosa*
7	Jungle myna	*Acridotheres fuscus*
8	Golden backed woodpecker	*Dinopium benghalensis*
9	Black drongo	*Dicrurus adsimilis*
10	Grey jungle fowl	*Gallus sonneratii*
11	Racket tailed drongo	*Dicrurus paradiseus*
12	Redwhiskered bulbul	*Pycnonotus joscosus*
13	Velvetfronted nuthatch	*Sitta frontalis*
14	Large pied wagtail	*Motacilla maderaspatensis*
15	Crow pheasant	*Centropus silensis*
16	Scarlet minivet	*Pericrocotus flammeus*
17	Tickell’s flower pecker	*Dicaeum erythrorhynchos*
18	Grey wagtail	*Motacilla capsica*
19	Crimson breasted barbet	*Megalaima haemcephala*
20	Common hawk-cuckoo	*Cuculus varius*
21	Thickbilled flower pecker	*Dicaeum agile*
22	White breasted kingfisher	*Halcyon smyrnensis*

Sholas of Palghat region

Fig. 31. A grass hopper collected from Siruvani region. Photo: Stephen Sequiera.

In Olavakkode, Walayar and Agali ranges, there are a few little patches of shola forests. These forest patches also extend into Tamil Nadu region. This area falls in two divisions, namely Palakkad and Mannarkad. Elevation of these areas reaches up to 1600 m. This is a very small area with few isolated hills, covered with grasslands and few patches of Southern wet tropical evergreen and Southern subtropical broad-leaved hill forests. This region can be considered to have low level shola.

Sholas of Nelliampathy region

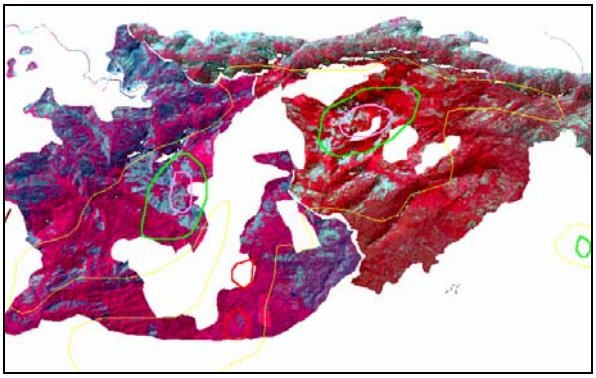


Fig 32. RGB composite of Nelliampathy, Kollengode region

South of Palghat gap, in Nelliampathy range of Nemmara Forest Division, there are isolated shola patches in the Padagiri hills. The elevation of this region is about 1600 m. In the same division, there is another shola coming under Kumblakkode region of Kollengode range; here also the elevation goes just above 1500 m. Here the vegetation type is Southern tropical wet evergreen forest and Southern subtropical broad-leaved hill forest.

3. Anamalai region

Anamalai region contains stretches of shola forests. There is a high altitude area covering the forests of Marayur, Munnar and Devikulam ranges and few areas of Chinnar, Anakulam and Mankulam ranges and the Eravikulam National Park. The forests of this region fall in Munnar division, Mankulam special division and Eravikulam National Park. In Eravikulam National Park, shola forests are seen as isolated patches interspersed with stretches of grasslands. Elevation of the region goes up to 2600 m. The vegetation of the region is a mixture of grassland and Southern montane temperate forest. The forest tracts extend into Tamil Nadu as a continuation.

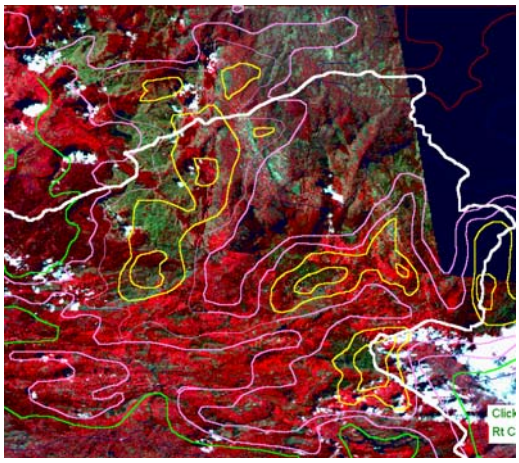


Fig 33. RGB composite of Anamalai region overlaid with contour. Violet line is 1500 m contour and yellow line is 2000 m contour.

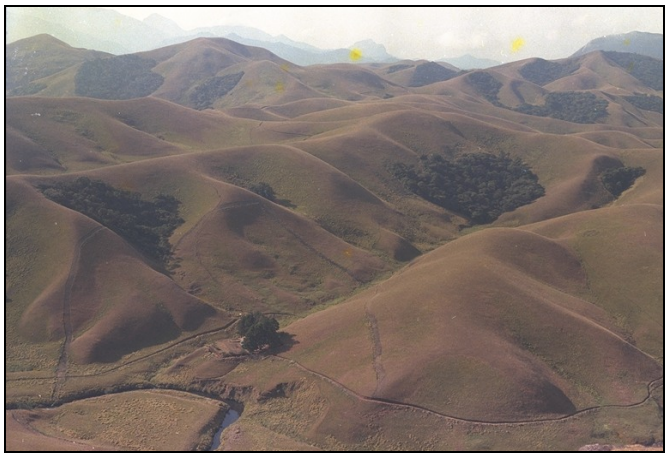


Fig 34. View of shola forests and grasslands. Eravikulam National Park.

Vegetation of Eravikulam National Park consists of sholas and grasslands. The vegetation is mapped using unsupervised classification of IRS IC image (Fig 37& 38.)

Fig 35. Nilgiri tahr, grassland at Eravilulam

Fig 36. Shola forest of Eravikulam contain several types of epiphytes

Sample plots

Two sample plots were taken in Eravikulam National Park. The plot (plot 2) taken at 2050 m elevation was situated above the tea estates. The shola patch was a large one of about 100 ha. The trees were of medium height; undergrowth consisted mainly of *Strobilanthus*. Among the trees, *Glochidion* sp. had the maximum frequency. The plot at 2200 m (plot 1) was laid out enroute to Anamudi. The patch was about one ha in extent and *Strobilanthus* was the main undergrowth. There were few woody climbers belonging to the genus *Derris* among and the trees, *Saprosma* sp. had the maximum frequency.

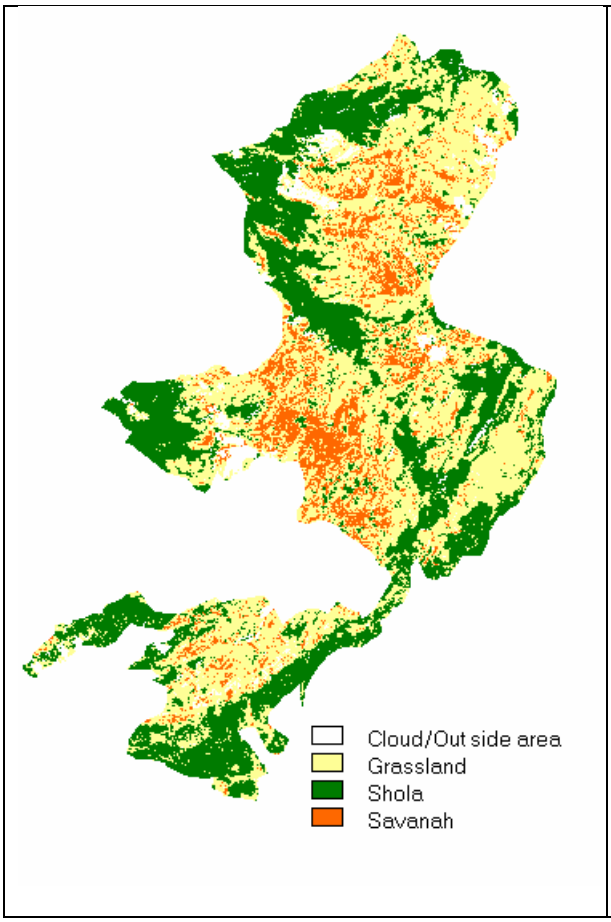


Fig 37. Vegetation of the Eravikulam National Park, unsupervised classification

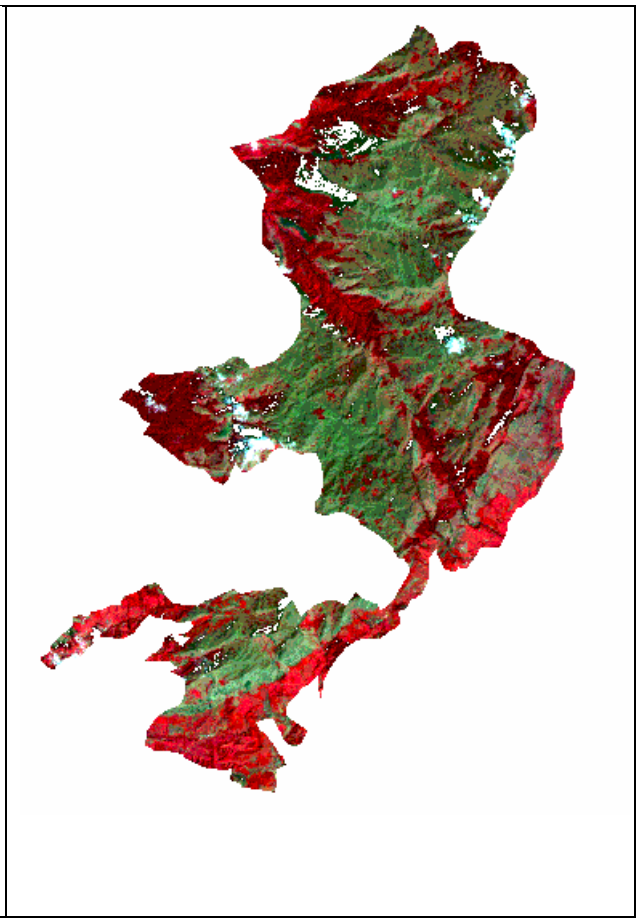


Fig 38. RGB Composite of the Eravikulam National Park, IRS IC image, 1997.

Table 11. Summary vegetation plot characteristics

Plot	Altitude	No. of trees	Avg. GBH	Avg. height	Diversity	Avg. IVI
Plot 2	2050	21	70.00	13.33	2.6895	14.28
Plot 1	2200	20	111.65	12.00	2.3457	14.99

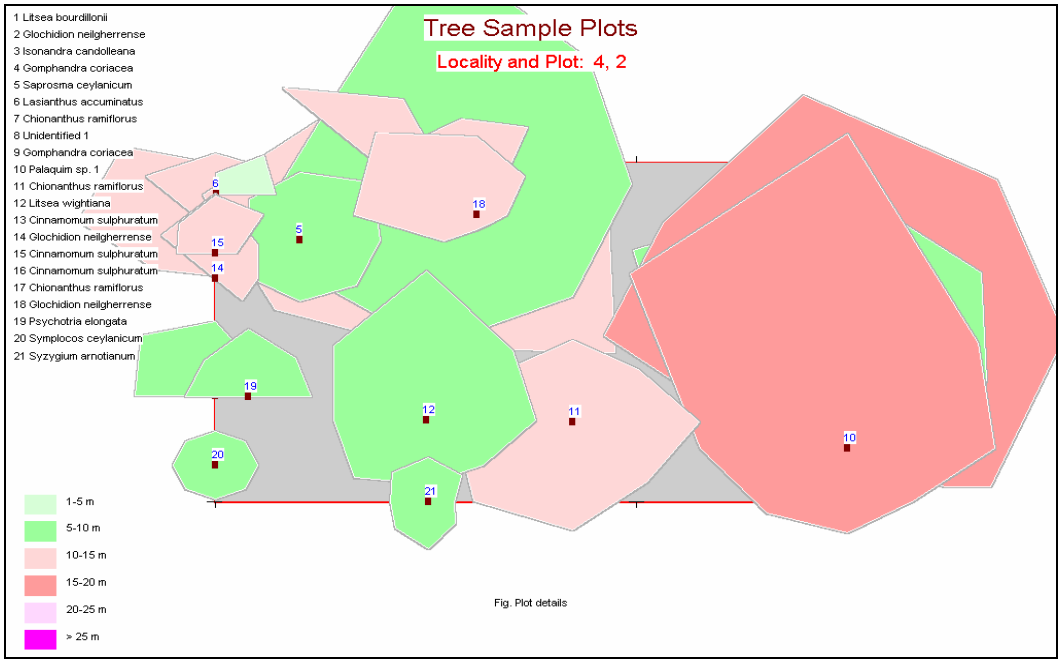
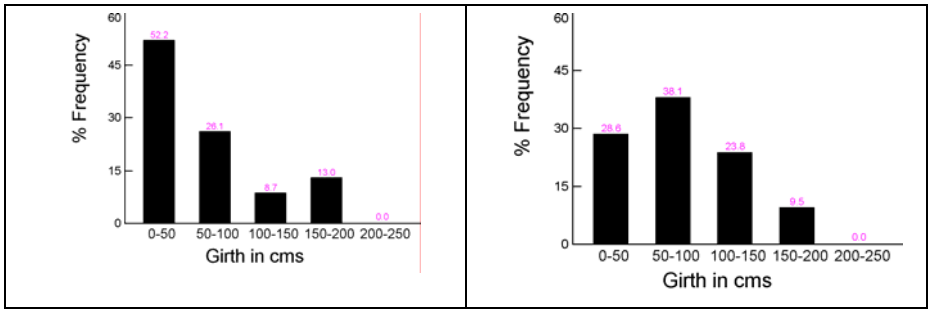


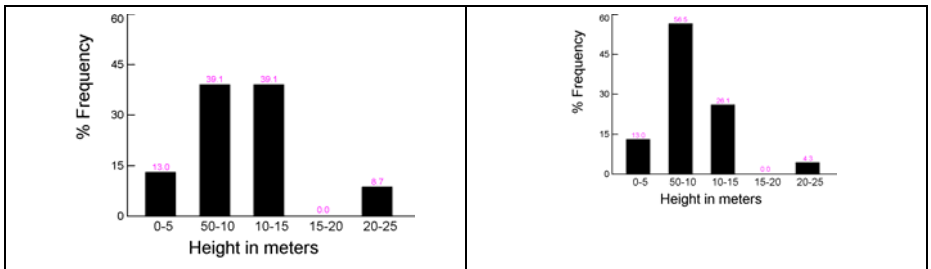
Fig 39. Plot of tree canopy. Tree location and canopy corners in eight direction are plotted.

Plots 1 and 2 were similar in having a total of 20 and 21 trees respectively. Trees in the sample plot at higher elevation were better in terms of girth and height distribution. Since there were only two plots, further comparisons are not attempted.

Girth distribution



Height distribution



Plot 2 2050 m	Plot 1 2200 m

Fig. 40. Girth and height details of tree in sample plots

In plot 2 at 2050 m *Chinanthus* and *Glochidion* were the common trees. *Saprosma ceylanicum* was the most common tree. It is a woody shrub. This was followed by *Cinnamomum sulphuratum*. There were two species under *Cinnamomum* and *Litsea* each.

Table 12. Eravikulam National Park plots, species comparison

Species	1	2	3	4	5	Total	Common to
Chionanthus ramiflorus	-	3	-	-	-	3	1
Cinnamomum sulphuratum	1	3	-	-	-	4	2
Cinnamomum wightii	2	-	-	-	-	2	1
Glochidion neilgherrense	-	3	-	-	-	3	1
Gomphandra coriacea	-	2	-	-	-	2	1
Ilex gardneriana	2	-	-	-	-	2	1
Isonandra candolleana	2	1	-	-	-	3	2
Lasianthus accuminatus	-	1	-	-	-	1	1
Litsea bourdillonii	-	1	-	-	-	1	1
Litsea wightiana	-	1	-	-	-	1	1
Microtropis ramiflora	3	-	-	-	-	3	1
Neolitsea scrobiculata	1	-	-	-	-	1	1
Palaquim sp. 1	-	1	-	-	-	1	1
Pavetta breviflora	1	-	-	-	-	1	1
Psychotria elongata	-	1	-	-	-	1	1
Saprosma ceylanicum	7	1	-	-	-	8	2
Symplocos ceylanicum	-	1	-	-	-	1	1
Syzygium arnotianum	1	1	-	-	-	2	2
Unidentified 1	-	1	-	-	-	1	1
					Total:	41	

Several trees were common to both the plots. This indicates a high degree of similarity between the plots.

List of birds in Eravikulam National Park area

A total of 28 species of birds could be identified during field trips. Genus such as *Hirundo*, *Pycnonotus*, *Motocilla* and *Muscicapa* had two species each.

Table 13. List of birds at Eravikulam National Park area

Sl.No	Common name	Scientific name
1	Nilgiri laughing thrush	*Garrulax cachinnans*
2	Nilgiri house swallow	*Hirundo tahitica*
3	Scimitar babbler	*Pomatorhinus schisticeps*
4	Pied bush chat	*Saxicola caprata*
5	White bellied fly catcher	*Muscicapa parva*
6	White eye	*Zosterops palpebrosa*
7	Red jungle fowl	*Gallus gallus*
8	Red whiskered bulbul	*Pycnonotus joscosus*
9	Red vented bulbul	*Pycnonotus cafer*
10	Grey patridge	*Francolinus pondicerianus*
11	Large green barbet	*Megalaima zeylanica*
12	Velvetfronted nuthatch	*Sitta frontalis*
13	Nilgiri pipit	*Anthus nilghiriensis*
14	Black bird	*Turdus merula*
15	Red rumped swallow	*Hirundo daurica*
16	Jungle myna	*Acridotheres fuscus*
17	Jungle crow	*Corvus macrorhyuchos*
18	Pied wagtail	*Motocilla maderaspatensis*
19	Crow pheasant	*Centropus sinensis*
20	Pariah kite	*Miluvs migrans*
21	Rufous backed shrike	*Lanius schach*
22	Small minivet	*Pericrocotus cinnamomeus*
23	Malabar whistling thrush	*Myiophonus horsfieldii*
24	Grey wagtail	*Motocilla caspica*
25	Black and orange flycatcher	*Muscicapa nigrorufa*
26	Tickell's flower pecker	*Dicaeum erythrorhynchos*
27	Purple rumped sunbird	*Nectarinia zeylanica*
28	Grey headed flycatcher	*Culicicapa ceylonensis*

Nilgiri Tahr is an endangered ungulate found in the shola regions. Eravikulam National Park is the prime habitat for this species.

4. Periyar region

In Thekkady region, evergreen forest from lower elevation extends up to the hills of high altitude. There is a large continuous patch at the border of Thekkay and Goodrickal range. Along the north-eastern and eastern boundary of Thekkady range, on Tamil Nadu border, a few shola patches are seen. The maximum elevation of this region is about 1800 m. Another shola patch is seen on the border of Goodrickal and Kanayar ranges covering the area of Ranni forest division. This patch also extends to Tamil Nadu region. Here too the maximum elevation is up to 1800 m. Southern tropical wet evergreen and Southern subtropical broad-leaved hill forest types with grasslands are seen along this region.

5. Ashambu hills

In the Southern part, shola areas are distributed as three isolated patches. Shola patches are seen at the border of Shenduruny Wildlife Sanctuary, Kulathupuzha range and Tamil Nadu region. The next patch is seen in the border of Peppara Wildlife Sanctuary and Paruthipally range, but major part of it is in Tamil Nadu region. A third patch is seen on the border of Neyyar Wildlife Sanctuary and Tamil Nadu region, in the Agasthyamala region. The vegetation of the region consists of Southern tropical wet evergreen and Southern subtropical broad-leaved hill forests in close combination with grasslands. The maximum altitude of this region was around 1900 m.

Discussion and Conclusion

In general, one cannot describe the sholas as having a fixed tree composition. Altitudinal factors, underlying soil and hydrological parameters seem to play an important role in species composition. Even though one can see gradations in tree composition with respect to altitude in particular locality, different localities are not comparable because of altitudinal difference (Table 14). Another important consideration is shola forest size. Individual shola patches are of 0.1 to 1 ha in area. There are also sholas of larger extent and those in continuation with evergreen forest of lower altitude. The case of rhododendron, a tree typical of high altitude montane forest is notable. Rhododendron is found both in the Sispara region and Eravikulam area. Since it occurs as isolated trees in grasslands, and the plots were taken in wooded forest the species has not been found in the sample plots.

Among the four locations studied in detail, trees with smaller girth were most predominant, frequency of larger trees decreasing. This pattern is not clear in the case of tree height, as height is more dependant on elevation and hence not comparable among different locations (Fig 41 & 42). An examination of genus wise distribution of trees shows that two genera have 6 species, one genera 5 species, two genera 4 species, five genera 3 species, eight genera 2 species each and 30 genera one species alone. It can be seen from table 15 that only *Cinnamom wightii* and *C. sulphuratum* are common to all locations.

Girth and height comparison in different locations

Table 14. Comparison of tree frequency, average GBH and height among the four localities studied

Location	No. of trees	Avg. GBH	Avg. height	Diversity	Avg. IVI
Brahmagiri	74	81.72	13.58	3.2636	4.05
Chembra	71	85.75	17.11	3.4639	4.22
Silent valley	111	58.68	10.05	3.4171	2.70
Eravikulam	41	90.32	12.68	3.0456	7.31

Girth distribution

Earlier trend was to describe the vegetation of a certain type in terms of composition and structure. Several authors have recently shown that tree composition is highly dependent upon microhabitat and a variety of other factors. Different parts of same habitat will be notably different and to cover these variations, sample plots of huge size will be required. In fact, in many parts of the world, vegetation is subjected to drastic and unpredictable factors such as cyclone, fire, earthquakes, etc. These create various levels of succession in forest, and this is the main theme of focus in such regions. Sholas of Western Ghats in this respect are more static and one would expect more homogeneity. But the structural data from the study indicate that there is much variation in the species composition of the trees in sholas even in the same locality.

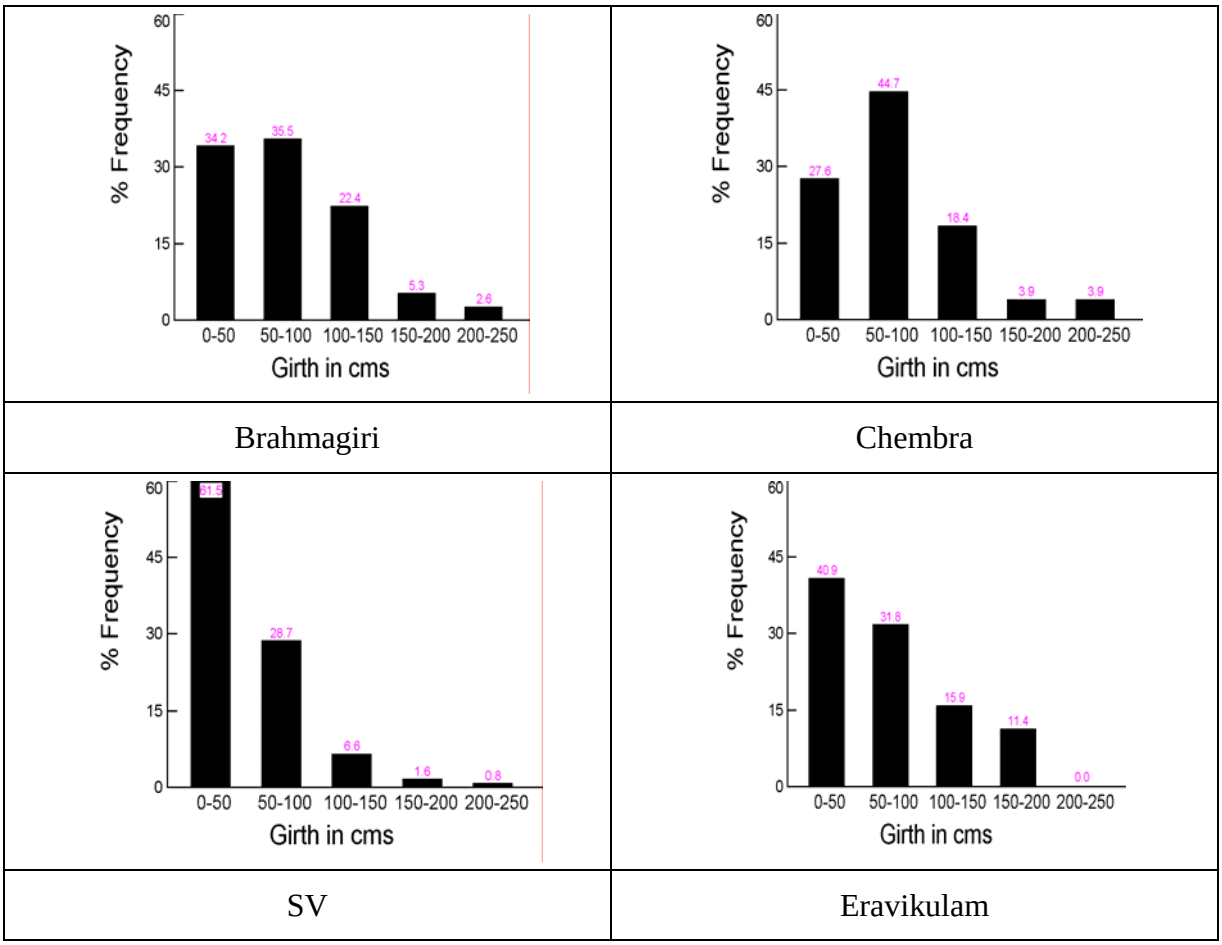


Fig. 41. Girth details of trees in the location studied.

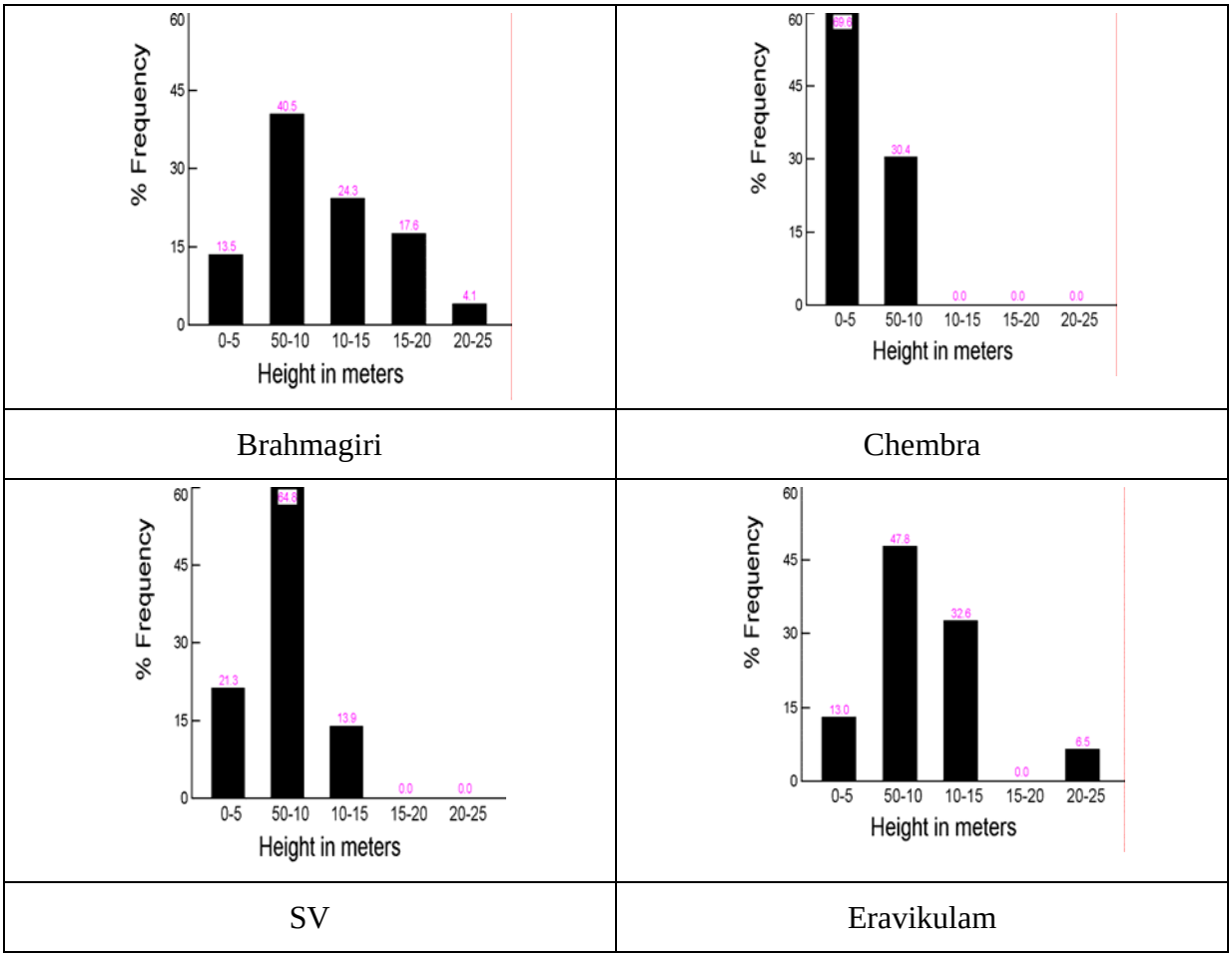


Fig. 42. Height details of trees in the location studied.

Birds sighted during the field trips to the four areas are listed in Table 16. It can be seen that six birds are common to all the sites. These are common birds such as jungle myna, crow pheasant, jungle crow, large pied wagtail, red whiskered bulbul and white eye. Another 14 birds were common to three sites. Twenty one species were present in two locations. Forty one birds were recorded from only one site.

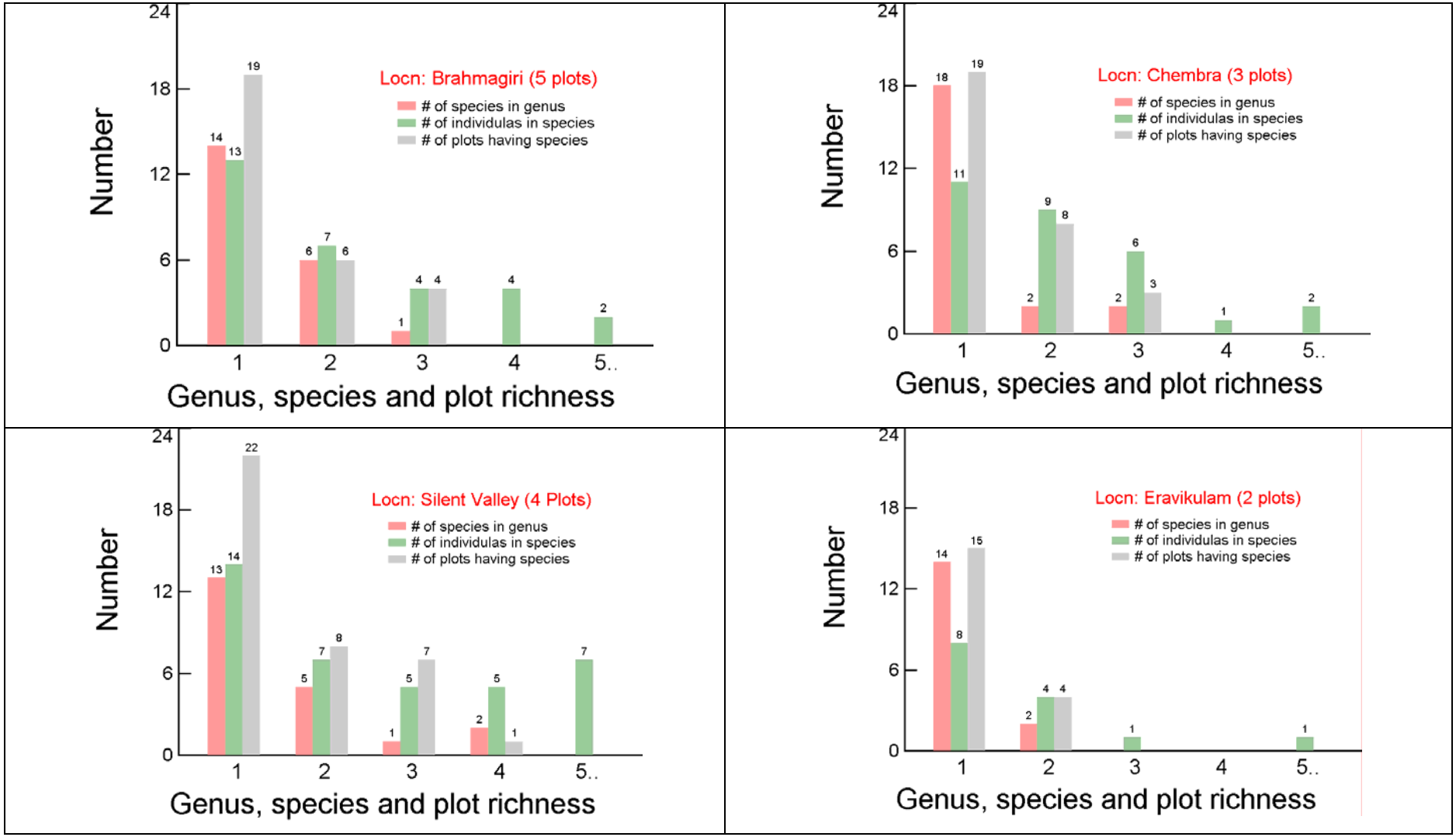


Fig. 43. Comparison of genus, species and plot richness in four study locations.

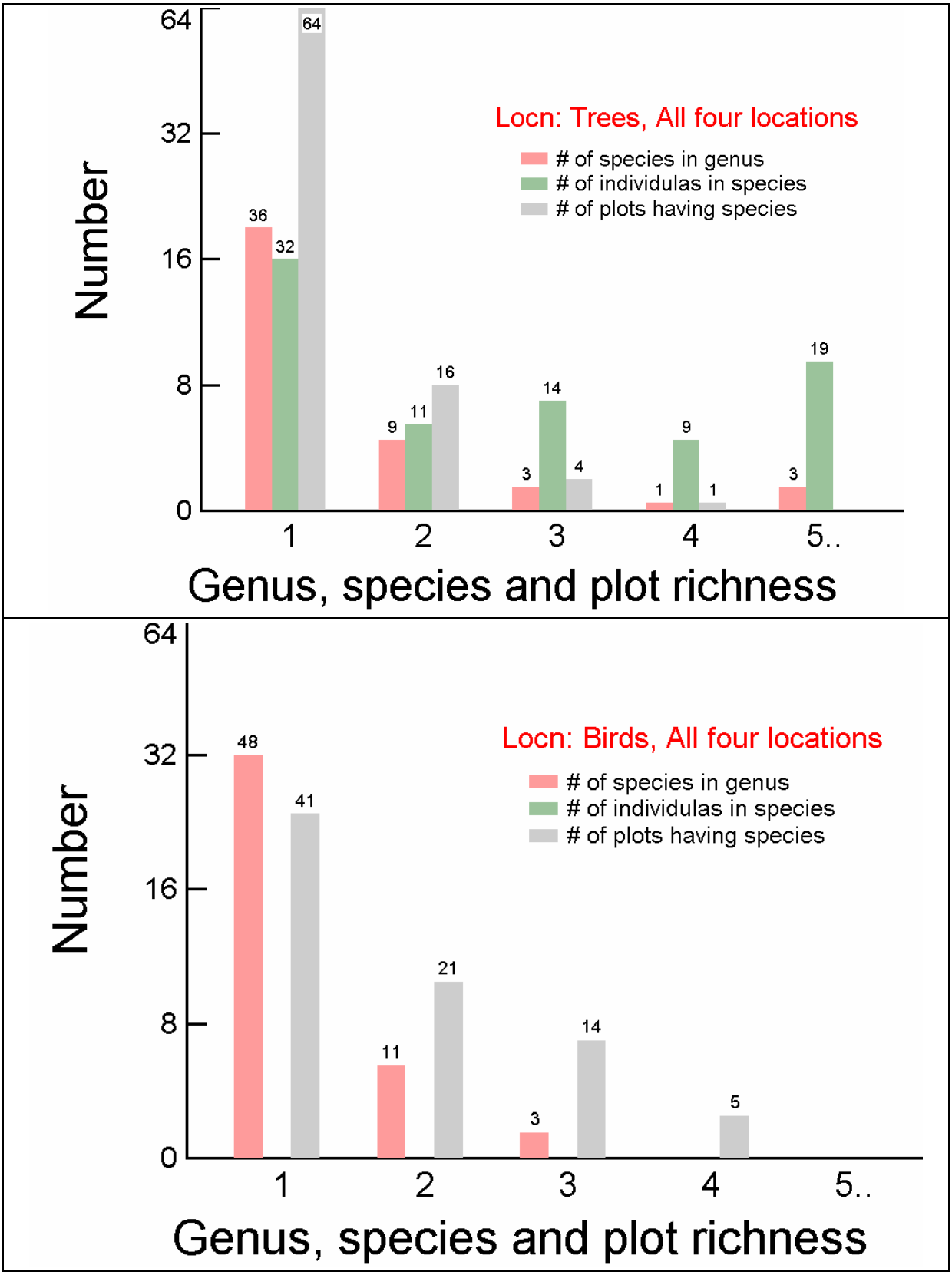


Fig. 44. Genus, species and plot richness for trees and birds.

Regarding diversity of higher taxa, Silent Valley had two genera with four species. Regarding genera with three species under them, Chembra had two such species and Brahmagiri and Silent Valley one each. In the case of genera with two species Brahmagiri had maximum, six genera. Silent Valley, Chembra and Eravikulam had two genus each in this category. Chembra had eighteen genera having only one species. Brahmagiri and Eravikulam had 14 genera in this category. Silent Valley had 13 such genera.

Regarding species richness, all four locations had species with more than five individuals. Silent Valley had seven, Brahmagiri and Chembra two, and Eravikulam one. Number of individuals under species wise Eravikulam was comparatively poor (Figs 43 & 44).

An examination of common presence of species across locations shows pattern similar to distribution in genus and species. Brahmagiri which had five plots did not have any common tree, whereas Silent Valley which had four plots had one common tree and Chembra which had three plots had three common trees.

Table 15. List of trees and sample plots in four locations

Species	1	2	3	4	5	Total	Common to
Agrostistachys indica	-	3	-	-	-	3	1
Antidesma menasu	1	2	-	-	-	3	2
Aphanamixis polystachya	2	-	-	-	-	2	1
Ardisia pauciflora	-	3	-	-	-	3	1
Canthium dicoccum	1	-	-	-	-	1	1
Canthium spicta	1	-	-	-	-	1	1
Casearia coriacea	4	2	-	-	-	6	2
Casearia ovata	3	-	-	-	-	3	1
Cassine paniculata	-	2	1	-	-	3	2
Chionanthus ramiflorus	-	-	-	3	-	3	1
Cinnamomum macrocarpum	-	-	6	-	-	6	1
Cinnamomum perrottetii	-	-	6	-	-	6	1
Cinnamomum sulphuratum	3	3	-	4	-	10	3
Cinnamomum wightiana	-	-	1	-	-	1	1
Cinnamomum wightii	1	4	3	2	-	10	4
Clerodendrum viscosum	-	1	-	-	-	1	1
Coffea cracifolia	10	2	-	-	-	12	2
Croton reticulatus	-	1	-	-	-	1	1
Daphiniphyllum glaucescens	-	-	2	-	-	2	1
Daphiniphyllum neilgherrense	-	-	7	-	-	7	1
Dillenia bracteata	-	3	-	-	-	3	1
Elaeocarpus glandulosa	1	-	-	-	-	1	1
Elaeocarpus serratus	2	-	-	-	-	2	1
Elaeocarpus tectorius	1	-	-	-	-	1	1
Euonymus indicus	-	1	-	-	-	1	1
Eurya nitida	3	3	4	-	-	10	3
Evodia lunu ankenda	1	-	-	-	-	1	1
Flacourtia montana	1	-	-	-	-	1	1
Glochidion ellipticum	4	-	-	-	-	4	1
Glochidion neilgherrense	-	-	1	3	-	4	2
Gomphandra coriacea	-	-	2	2	-	4	2
Goniothlamus wightii	-	1	-	-	-	1	1
Heritiera papilio	2	-	-	-	-	2	1
Holigarna nigra	-	2	-	-	-	2	1
Ilex gardneriana	-	-	2	2	-	4	2
Ilex wightiana	-	-	2	-	-	2	1
Isonandra candolleana	-	-	2	3	-	5	2
Ixora notoniana	-	-	1	-	-	1	1
Lasianthus accuminatus	-	-	-	1	-	1	1
Lasiosiphon glaucus	-	-	4	-	-	4	1
Ligustrum perrottetii	-	-	1	-	-	1	1
Ligustrum robustum	2	-	-	-	-	2	1
Litsea bourdillonii	2	1	-	1	-	4	3
Litsea ligustrina	4	1	-	-	-	5	2
Litsea oleides	-	-	1	-	-	1	1

Species	1	2	3	4	5	Total	Common to
Litsea wightiana	-	2	1	1	-	4	3
Mastixia arborrea	-	-	1	-	-	1	1
Meliosma simplicifolia	7	-	-	-	-	7	1
Memecylon edule	1	2	-	-	-	3	2
Memecylon sp.	-	1	-	-	-	1	1
Michelia nilagirica	-	-	1	-	-	1	1
Microtropis microcarpa	-	-	5	-	-	5	1
Microtropis ovalifolia	-	-	4	-	-	4	1
Microtropis ramiflora	-	-	7	3	-	10	2
Myristica beddomei	-	3	-	-	-	3	1
Myristica dactyloides	-	9	-	-	-	9	1
Myristica malabarica	-	1	-	-	-	1	1
Neolitsea scrobiculata	-	-	-	1	-	1	1
Neolitsea zeylanica	1	-	-	-	-	1	1
Nothopegia beddomei	-	2	-	-	-	2	1
Palaquim sp. 1	-	-	-	1	-	1	1
Pavetta breviflora	-	-	-	1	-	1	1
Persea macrantha	2	1	-	-	-	3	2
Prunus zeylanica	-	-	4	-	-	4	1
Psychotria elongata	-	-	-	1	-	1	1
Rapanea wighitiana	-	-	1	-	-	1	1
Rapanea wightiana	-	1	4	-	-	5	2
Saprosma ceylanicum	-	-	3	8	-	11	2
saprosma ceylanicum	-	-	1	-	-	1	1
Scolopia crenata	4	1	-	-	-	5	2
Symplocos anamallayana	-	-	3	-	-	3	1
Symplocos ceylanicum	-	-	-	1	-	1	1
Symplocos cochinchinensis	1	-	-	-	-	1	1
Symplocos microphylla	-	-	3	-	-	3	1
Symplocos pendula	-	-	1	-	-	1	1
Symplocos spicata	-	-	1	-	-	1	1
Symplocos spicta	3	-	-	-	-	3	1
Syzygium arnotianum	-	-	8	2	-	10	2
Syzygium calophyllifolium	-	-	8	-	-	8	1
Syzygium cumini	1	-	-	-	-	1	1
Syzygium montanum	-	2	-	-	-	2	1
Syzygium sp. 1	1	-	-	-	-	1	1
Syzygium sp. 2	-	-	3	-	-	3	1
Ternstroemia japonica	-	-	2	-	-	2	1
Terpenia saxifraga	-	-	2	-	-	2	1
Unidentified 1	-	5	1	1	-	7	3
Unidentified 2	1	2	-	-	-	3	2
Unidentified 3	-	3	-	-	-	3	1
Unidentified 4	-	1	-	-	-	1	1
Unidentified 5	1	-	-	-	-	1	1
Unidentified 7	2	-	-	-	-	2	1
					Total:	296	

Table 16 Comparison of birds observed in the four localities.

Species	Brahmagiri	Chembra	Silent valley	Anamalai	Common
Accipiter badius		+			1
Acredotheres fuscus	+	+	+	+	4
Acridotheres tristis		+	+		2
Anthus nilghiriensis				+	2
Apus affinis	+	+			2
Ardeola grayii		+			1
Bubulcns ibis	+	+			2
Centropus silensis	+	+	+	+	4
Chalcophaps indica	+	+	+		3
Chloropsis aurifrons		+	+		2
Chloropsis cochinchinensis		+			1
Chlumba livia	+				1
Chrysomma sinense		+			1
Circus macrourus		+			1
Cisticola juncidis		+			1
Columba livia		+			1
Copsychus saularis		+			1
Corvus splendens	+	+			2
Corvus macrorhynchos	+	+	+	+	4
Coturnix coturnix	+	+			2
Cuculus varius			+		1
Culicicapa ceylonensis				+	1
Dicacum agile		+	+		2
Dicaeum erythrorhynchos			+		1
Dicaeus coucolour				+	1
Dicrurus adsimilis	+	+	+		3
Dicrurus caerulensis		+			1
Dicrurus paradiscus	+	+	+		3
Dinopium benghalensis	+	+	+		3
Dumetia hyperythra		+			1
Elanus cacruleus	+	+			2
Estrilda formosa		+			1
Francolinus pondiceerianus				+	1
Gallus gallus	+	+		+	3
Gallus soneratii	+	+	+		3
Garrulax cachinanaus				+	1
Halcyon smyrnensis			+		1
Hiriundo tahitica	+	+		+	3
Hypsipetes indicus	+				1
Lanius schach	+			+	2
Louchura punctulata		+			1

Species	Brahmagiri	Chembra	Silent valley	Anamalai	Common
Megalaima asialica		+			1
Malvus migraus		+			1
Megalaima haemcephala			+		1
Megalaima zeylanica	+	+		+	3
Merops orientalis	+	+			2
Merops philiipinus	+				1
Miluvs migrans	+			+	2
Monticata canclorhynehus	+	+			2
Motacilla caspica	+	+	+		3
Motacilla maderaspatensis	+	+	+	+	4
Muscicapa parva				+	1
Muscicapa rubeculoides				+	1
Muscicapa thlassina		+			1
Myiophonus horsfieldii	+			+	2
Nectarinia zeylanica	+	+		+	3
Nectarrana asialica	+	+			2
Oriolus oriolus	+				1
Oriolus xanthornus		+			1
Pericrocotus cinnamomeus				+	1
Pericrocotus flammens	+	+	+		3
Phalacrocorax niger		+			1
Picoides nannus		+			1
Pisittacula karameri		+			1
Pomatorhinus schisticeps	+	+		+	3
Prinia sub flava		+			1
Psittacula cyanocephala		+			1
Psittaenla karameri	+				1
Pterocles exustus		+			1
Pycnonotus jocosus	+	+	+	+	4
Pycnonotus melanicaterus	+				1
Pycnonotus cafer			+	+	3
Saxicola caprata		+		+	2
Saxicoloides fulicata		+			1
Sitta frontalis		+	+	+	3
Terpsiphone paradisi	+	+			2
Tockus birostris	+				1
Turdoided striatus	+	+			2
Turdoides candatus	+	+			2
Turdus merula		+		+	2
Zoothera citrina	+	+			2
Zosterops palpebrora	+	+	+	+	4

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Location : Brahmagiri **Plot no : 1** **Plot size: 15x10**

Sl.No.	Plant Name	GBH (cm)	Basal area (cm)	Height class (m)	Height CMP (m)
1	*Canthium sp. 2*	100	800.00	10-15	12.5
2	*Canthium sp. 2*	140	1568.00	15-20	17.5
3	*Canthium sp. 2*	65	338.00	5-10	7.5
4	*Casaeria sp. 1*	55	242.00	10-15	12.5
5	*Casaeria sp. 1*	55	242.00	5-10	7.5
6	*Casaeria sp. 2*	85	578.00	5-10	7.5
7	*Cinnamomum sp1*	140	1568.00	10-15	12.5
8	*Elaeocarpus glandulosa*	100	800.00	10-15	12.5
9	*Ligustrum sp1*	140	1568.00	15-20	17.5
10	*Litsea bordilonia*	55	242.00	5-10	7.5
11	*Litsea bordilonia*	55	242.00	5-10	7.5
12	*Neolitsea sp1*	80	512.00	5-10	7.5
13	*Unknown 1*	150	1800.00	25-30	27.5
14	*Unknown 2*	50	200.00	15-20	17.5
	Total	1270	10700.00		175
	Average	91	764		13

Location : Brahmagiri **Plot : 2** **Plot size : 15 x 10**

Sl.No.	Plant Name	GBH (cm)	Basal area (cm)	Height class (m)	Height CMP (m)
1	*Acronychia sp1*	115	1058.00	5-10	7.5
2	*Canthium sp. 2*	48	184.32	5-10	7.5
3	*Canthium sp. 2*	76	462.08	5-10	7.5
4	*Casaeria sp. 1*	52	216.32	5-10	7.5
5	*Casaeria sp. 2*	30	72.00	5-10	7.5
6	*Cinnamomum sp2*	90	648.00	10-15	12.5
7	*Eurya nitida*	136	1479.68	15-20	17.5
8	*Memecyon sp1*	80	512.00	5-10	7.5
9	*Symplocos cochinchinensis*	56	250.88	5-10	7.5
10	*Symplocos sp2*	33	87.12	0-5	2.5
11	*Symplocos sp2*	60	288.00	5-10	7.5
12	*Symplocos sp2*	174	2422.08	15-20	17.5
13	*Syzygium cumini*	100	800.00	10-15	12.5
14	*Unknown 4*	35	98.00	0-5	2.5
15	*Unknown 4*	30	72.00	0-5	2.5
	Total	1115	8650.48		127.5
	Average	74	576.70		8.50

Location : Brahmagiri **Plot : 3** **Plot size: 15 x 10**

Sl.No.	Plant Name	GBH (cm)	Basal area (cm)	Height class (m)	Height CMP (m)
1	*Antidesma menasu*	58	269.12	10-15	12.5
2	*Canthium dicoccum*	64	327.68	15-20	17.5
3	*Cinnamomum sp1*	48	184.32	5-10	7.5
4	*Cinnamomum sp1*	46	169.28	5-10	7.5
5	*Elaeocarpus serratus*	230	4232.00	15-20	17.5
6	*Elaeocarpus serratus*	165	2178.00	15-20	17.5
7	*Glochidion elypticum*	190	2888.00	10-15	12.5
8	*Neolitsea sp1*	46	169.28	5-10	7.5
9	*Neolitsea sp1*	80	512.00	10-15	12.5
10	*Neolitsea sp1*	43	147.92	5-10	7.5
11	*Neolitsea sp2*	102	832.32	15-20	17.5
12	*Scolopia creanata*	38	115.52	5-10	7.5
13	*Scolopia creanata*	51	208.08	10-15	12.5
14	*Syzygium sp2*	103	848.72	20-25	22.5
15	*Unknown 7*	117	1095.12	20-25	22.5
	Total	1381.00	14177.00		203.0
	Average	92.07	945.00		14.0

Location : Brahmagiri **Plot: 4** **Plot size : 15 x 10**

Sl.No.	Plant Name	GBH (cm)	Basal area (cm)	Height class (m)	Height CMP (m)
1	*Aphanomixis polystachia*	240	4608.00	15-20	17.5
2	*Aphanomixis polystachia*	66	348.48	10-15	12.5
3	*Elaeocarpus tectorius*	115	1058.00	10-15	12.5
4	*Flacourtia sp1*	33	87.12	5-10	7.5
5	*Persea macarantha*	51	208.08	10-15	12.5
6	*Persea macarantha*	24	46.08	5-10	7.5
7	*Scolopia creanata*	96	737.28	15-20	17.5
8	*Unknown 3*	107	915.92	5-10	7.5
9	*Unknown 3*	43	147.92	5-10	7.5
10	*Unknown 5*	133	1415.12	15-20	17.5
11	*Unknown 7*	152	1848.32	25-30	27.5
	Total	1060	11420.32		147.5
	Average	96	1038.21		13.0

Loation name : Brahmagiri **Plot no : 5** **Plot size : 15 x 10**

Sl.No.	Plant Name	GBH (cm)	Basal area (cm)	Height class (m)	Height CM (m)
1	*Canthium sp. 2*	49	192.08	5-10	7.5
2	*Canthium sp. 2*	31	76.88	10-15	12.5
3	*Canthium sp. 2*	43	147.92	5-10	7.5
4	*Canthium sp. 2*	23	42.32	0-5	2.5
5	*Canthium sp. 2*	35	98.00	5-10	7.5
6	*Canthium sp. 2*	33	87.12	5-10	7.5
7	*Casaeria sp. 2*	47	176.72	10-15	12.5
8	*Casaeria sp. 2*	30	72.00	10-15	12.5
9	*Eurya nitida*	59	278.48	5-10	7.5
10	*Eurya nitida*	35	98.00	5-10	7.5
11	*Glochidion elypticum*	137	1501.52	10-15	12.5
12	*Glochidion elypticum*	49	192.08	5-10	7.5
13	*Glochidion elypticum*	48	184.32	5-10	7.5
14	*Scolopia creanata*	150	1800.00	20-25	22.5
15	*Unknown 6*	38	115.52	5-10	7.5
16	*Unknown 6*	117	1095.12	10-15	12.5
17	*Unknown 6*	97	752.72	0-5	2.5
18	*Unknown 6*	145	1682.00	5-10	7.5
19	*Unkonwn 6*	55	242.00	5-10	7.5
	Total	1221	8834.80		172.5
	Average	64.26	465.00		9.0

Location :Bramagiri Plot : 1

PLNTNAME	NOIND	OCCUR	TPLT	AREA	GBH	BA	DENSITY	FREQNCY	BAHA	RDEN	RFRE	REBA	IVI	RIVI
Canthium sp. 2	3	1	1	150.00	305	7442.00	200.00	100.00	496133.33	21.43	10.00	45.37	76.80	25.60
Casaeria sp. 1	2	1	1	150.00	110	968.00	133.33	100.00	64533.33	14.29	10.00	5.90	30.19	10.06
Casaeria sp. 2	1	1	1	150.00	85	578.00	66.67	100.00	38533.33	7.14	10.00	3.52	20.66	6.89
Cinnamomum sp1	1	1	1	150.00	140	1568.00	66.67	100.00	104533.33	7.14	10.00	9.56	26.70	8.90
Elaeocarpus glandulosa	1	1	1	150.00	100	800.00	66.67	100.00	53333.33	7.14	10.00	4.88	22.02	7.34
Ligustrum sp1	1	1	1	150.00	140	1568.00	66.67	100.00	104533.33	7.14	10.00	9.56	26.70	8.90
Litsea bordilonia	2	1	1	150.00	110	968.00	133.33	100.00	64533.33	14.29	10.00	5.90	30.19	10.06
Neolitsea sp1	1	1	1	150.00	80	512.00	66.67	100.00	34133.33	7.14	10.00	3.12	20.26	6.75
Unknown 1	1	1	1	150.00	150	1800.00	66.67	100.00	120000.00	7.14	10.00	10.97	28.11	9.37
Unknown 2	1	1	1	150.00	50	200.00	66.67	100.00	13333.33	7.14	10.00	1.22	18.36	6.12
Total	14				1270	16404.00	933.35	1000.00	1093599.97	99.99	100.00	100.00	299.99	99.99

Location : Brahmagiri Plot 2

PLNTNAME	NOIND	OCCUR	TPLT	AREA	GBH	BA	DENSITY	FREQNCY	BAHA	RDEN	RFRE	REBA	IVI	RIVI
Acronychia sp1	1	1	1	150.00	115	1058.00	66.67	100.00	70533.33	6.67	9.09	8.60	24.36	8.12
Canthium sp. 2	2	1	1	150.00	124	1230.08	133.33	100.00	82005.33	13.33	9.09	9.99	32.41	10.80
Casaeria sp. 1	1	1	1	150.00	52	216.32	66.67	100.00	14421.33	6.67	9.09	1.76	17.52	5.84
Casaeria sp. 2	1	1	1	150.00	30	72.00	66.67	100.00	4800.00	6.67	9.09	0.58	16.34	5.45
Cinnamomum sp2	1	1	1	150.00	90	648.00	66.67	100.00	43200.00	6.67	9.09	5.26	21.02	7.01
Eurya nitida	1	1	1	150.00	136	1479.68	66.67	100.00	98645.33	6.67	9.09	12.02	27.78	9.26
Memecyon sp1	1	1	1	150.00	80	512.00	66.67	100.00	34133.33	6.67	9.09	4.16	19.92	6.64
Symplocos cochinchinensis	1	1	1	150.00	56	250.88	66.67	100.00	16725.33	6.67	9.09	2.04	17.80	5.93
Symplocos sp2	3	1	1	150.00	267	5703.12	200.00	100.00	380208.00	20.00	9.09	46.34	75.43	25.14
Syzygium cumini	1	1	1	150.00	100	800.00	66.67	100.00	53333.33	6.67	9.09	6.50	22.26	7.42
Unknown 4	2	1	1	150.00	65	338.00	133.33	100.00	22533.33	13.33	9.09	2.75	25.17	8.39
Total	15				1115	12308.08	1000.02	1100.00	820538.64	100.02	99.99	100.00	300.01	100.00

Location : Brahmagiri Plot 3

PLNTNAME	NOIND	OCCUR	TPLT	AREA	GBH	BA	DENSITY	FREQNCY	BAHA	RDEN	RFRE	REBA	IVI	RIVI
Antidesma menasu	1	1	1	150.00	58	269.12	66.67	100.00	17941.33	6.67	10.00	1.20	17.87	5.96
Canthium dicoccum	1	1	1	150.00	64	327.68	66.67	100.00	21845.33	6.67	10.00	1.46	18.13	6.04
Cinnamomum sp1	2	1	1	150.00	94	706.88	133.33	100.00	47125.33	13.33	10.00	3.16	26.49	8.83
Elaeocarpus serratus	2	1	1	150.00	395	12482.00	133.33	100.00	832133.33	13.33	10.00	55.80	79.13	26.38
Glochidion elypticum	1	1	1	150.00	190	2888.00	66.67	100.00	192533.33	6.67	10.00	12.91	29.58	9.86
Neolitsea sp1	3	1	1	150.00	169	2284.88	200.00	100.00	152325.33	20.00	10.00	10.21	40.21	13.40
Neolitsea sp2	1	1	1	150.00	102	832.32	66.67	100.00	55488.00	6.67	10.00	3.72	20.39	6.80
Scolopia creanata	2	1	1	150.00	89	633.68	133.33	100.00	42245.33	13.33	10.00	2.83	26.16	8.72
Syzygium sp2	1	1	1	150.00	103	848.72	66.67	100.00	56581.33	6.67	10.00	3.79	20.46	6.82
Unknown 7	1	1	1	150.00	117	1095.12	66.67	100.00	73008.00	6.67	10.00	4.90	21.57	7.19
Total	15				1381	22368.40	1000.01	1000.00	1491226.64	100.01	100.00	99.98	299.99	100.00

Locaiton : Brahmagiri Plot : 4

PLNTNAME	NOIND	OCCUR	TPLT	AREA	GBH	BA	DENSITY	FREQNCY	BAHA	RDEN	RFRE	REBA	IVI	RIVI
Aphanomixis polystachia	2	1	1	150.00	306	7490.88	133.33	100.00	499392.00	18.18	12.50	50.32	81.00	27.00
Elaeocarpus tectorius	1	1	1	150.00	115	1058.00	66.67	100.00	70533.33	9.09	12.50	7.11	28.70	9.57
Flacourtia sp1	1	1	1	150.00	33	87.12	66.67	100.00	5808.00	9.09	12.50	0.59	22.18	7.39
Persea macarantha	2	1	1	150.00	75	450.00	133.33	100.00	30000.00	18.18	12.50	3.02	33.70	11.23
Scolopia creanata	1	1	1	150.00	96	737.28	66.67	100.00	49152.00	9.09	12.50	4.95	26.54	8.85
Unknown 3	2	1	1	150.00	150	1800.00	133.33	100.00	120000.00	18.18	12.50	12.09	42.77	14.26
Unknown 5	1	1	1	150.00	133	1415.12	66.67	100.00	94341.33	9.09	12.50	9.51	31.10	10.37
Unknown 7	1	1	1	150.00	152	1848.32	66.67	100.00	123221.33	9.09	12.50	12.42	34.01	11.34
Total	11				1060	14886.72	733.34	800.00	992447.99	99.99	100.00	100.01	300.00	100.01

Location : Brahmagiri **Plot : 5**

PLNTNAME	NOIND	OCCUR	TPLT	AREA	GBH	BA	DENSITY	FREQNCY	BAHA	RDEN	RFRE	REBA	IVI	RIVI
Canthium sp. 2	6	1	1	150.00	214	3663.68	400.00	100.00	244245.33	31.58	14.29	15.34	61.21	20.40
Casaeria sp. 2	2	1	1	150.00	77	474.32	133.33	100.00	31621.33	10.53	14.29	1.99	26.81	8.94
Eurya nitida	2	1	1	150.00	94	706.88	133.33	100.00	47125.33	10.53	14.29	2.96	27.78	9.26
Glochidion elypticum	3	1	1	150.00	234	4380.48	200.00	100.00	292032.00	15.79	14.29	18.35	48.43	16.14
Scolopia creanata	1	1	1	150.00	150	1800.00	66.67	100.00	120000.00	5.26	14.29	7.54	27.09	9.03
Unknown 6	4	1	1	150.00	397	12608.72	266.67	100.00	840581.33	21.05	14.29	52.81	88.15	29.38
Unkonwn 6	1	1	1	150.00	55	242.00	66.67	100.00	16133.33	5.26	14.29	1.01	20.56	6.85
Total	19				1221	23876.08	1266.67	700.00	1591738.65	100.00	100.03	100.00	300.03	100.00