CHAPTER IV

METHODOLOGY

This study envisages the estimation of floral wealth of the sacred groves in Kerala, understanding the vegetation from a holistic point of view and ascertaining their regeneration status. Since the objectives are quite varied, it is important to describe the various methodologies of this study.

SURVEY OF GROVES

First hand information about the existence of sacred groves was gathered from personal contacts with village and temple authorities, Environmental Action Groups and various social organisations. With these background information, thorough field surveys were carried out to know their exact location, extent, presiding deity, etc. Whenever any sacred grove was visited the neighbouring people and temple worshippers were interviewed to confirm the above facts and also to elicit information about the presence of other groves in the vicinity. The extent of each grove was ascertained by discussion with local people and later confirmed with temple records. They were subsequently located on the Survey of India toposheets. Groves less than 200 m$^2$ were not considered for detailed investigations.

FLORAL ANALYSIS

To understand the flora, each grove was visited during different seasons. Plants were identified with the publications of Beddome (1868-74), Hooker (1872-97), Bourdillon (1908), Gamble (1915-35), Sreekumar and Nair (1991) and Renuka (1992) and by using field keys devised by Balasubramanyan et al. (1985) and Pascal and Ramesh (1987). Different regional floras detailed in review of literature were also consulted. The identification was further confirmed with the herbaria at Kerala Forest Research Institute, Peechi; French Institute, Pondicherry and Botanical Survey of India, Coimbatore. Based on the floristic data gathered, the status of rare, endemic, endangered or threatened taxa was ascertained with the help of Jain and Sastry (1980), Nayar and Sastry, (1987, 1988 and 1990) and Karunakaran (1991).
Detailed information on the medicinal plants was gathered by critically going through the works of Kirtikar and Basu (1935), Chopra et al. (1956 and 1969), Jaln (1968 and 1991), Nadkarni (1976), Satyavathi et al. (1976), Banerji (1980), Vagbhata (1982) Namblar et al. (1985), and Sivarajan and Balachandran (1994). Wealth of India, publications brought out by C.S.I.R. (1948-1976) were consulted to know the species of economic importance. Along with these phytogeography of each taxon was ascertained by referring to Hooker (1872-97) and Blasco (1971). Raunkaier's Biological spectrum was worked out, based on Ellenberg and Mueller-Dombois (1967).

**TYPOLOGY OF GROVES**

To understand the influence of floristic community in grouping the groves, correspondence analysis was performed using ADE (Chessel and Dole, 1992). The correspondence analysis is a nonlinear multivariate descriptive statistical method that represents the row and column variables of categorical data matrix in low dimensional space. It is an analysis of FCA, which is more appropriate to discrete data represented in two way contingency tables. Correspondence analysis is a graphical technique which simultaneously projects the row and column effects (groves and species respectively). It is amenable for interpreting the species preference in different ecological conditions of groves (Greenacre, 1984). Since the total number of species was very large (722), it was not possible to use all the species for analysis with the memory of accessible computers. Hence only tree species were considered. All groves which contained more than five species and all trees which were present in more than five groves were considered for this analysis. Thus a data matrix containing 356 groves and 124 species was used for analysis. The analysis was carried out in 3 steps. In the first step, three clusters had separated out. These outliers were removed and the resulting data subjected to another step of analysis. The outliers in this step were also removed (6 clusters) and subjected to third step of analysis. The objective in repeating this exercise was to understand the composition of the central group and to bring them all under different clusters based on their floristic composition.

The clusters thus obtained were named after the species that had common distribution within the groves in that cluster. These clusters were brought under different groups based on the percentage of evergreen and deciduous trees present in them. While calculating this, weightage was given for the number of groves in which each species was present. Phytogeographic elements, Raunkaier's Life Forms and number of economically important species were worked for each association and for each group in the same manner as described earlier.
To analyse the plant diversity of evergreen group, groves larger than four hectares in extent were selected for phytosociological studies. Coastal group did not have large groves; In total 11 groves were selected - eight from lowlying evergreens and three *Myristica* Swamp. Among the *Myristica* Swamps, there were 4 groves exceeding 4 ha in size, but local customs and regulations in an area were so rigid that I could not get permission to investigate that grove (Thavidissery Kavu, Cannanore District). Plots of 50 x 50 m were laid out at random in all the 11 groves and each plot was further subdivided into 10 x 10 m quadrats. Height and girth at breast height (GBH) of all trees above 10 cms. were recorded. Phytosociological parameters like relative density, relative frequency, relative basal area and Importance Value Index for each species were calculated following the methods of *Curtis and McIntosh, (1950), Misra and Puri (1954), Misra (1969), Muller Dombols and Ellenberg (1974)* and *Werger (1974a and b)*. Definitions for various terminologies employed are given below:

- **Density (D)**: \[
\frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}
\]
- **Relative Density (RD)**: \[
\frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100
\]
- **Abundance (Ab)**: \[
\frac{\text{Total number of individuals}}{\text{Number of quadrats of occurrence}}
\]
- **Relative abundance (RA)**: \[
\frac{\text{Number of quadrats of occurrence}}{\text{Total number of quadrats studied}} \times 100
\]
- **Frequency**: \[
\frac{\text{Number of quadrats of occurrence of a species}}{\text{Total number of quadrats studied}}
\]
- **Relative frequency (RF)**: \[
\frac{\text{Number of occurrence of the species}}{\text{Number of occurrence of all species}} \times 100
\]
- **Basal Area**: It is an index of dominance. In general, higher the basal area greater the dominance. The total basal area is the sum of individual basal areas of all trees calculated from the GBH of each tree.
Relative Basal Area (RBA) = \frac{\text{Basal area of the species x 100}}{\text{Basal area of all species}}

Importance Value Index (IVI) of a species

It is computed by adding the figures of Relative frequency, Relative Density and Relative Basal Area for that species. It gives the total picture or the sociological structure of a species in a community.

IVI for family was worked out by adding the IVI of different species of that family.

Diversity indices

For studying the species richness and diversity Simpson's (1949) and Shannon-Wiener's (1963) indices were used which is calculated using the formulae.

Simpson's Index \( D = 1 - \sum_{i=1}^{S} \left( \frac{n_i}{N} \right)^2 \)

where

\( n_i = \text{number of individuals of each species} \)
\( N = \text{Total number of individuals in the plot} \)
\( S = \text{Total number of species in the plot} \)

Simpson's Index expressed in this form may be interpreted in terms of probability. e.g., \( D = 0.95 \) means that for 100 pairs of trees taken at random, 5 will be of the same species and 95 will be of different species.

Shannon-Wiener's index \( H^1 = 3.219 \left( \log_{10} N - \frac{1}{N} \sum_{i=1}^{S} n_i \log_{10} n_i \right) \)

where the symbols used are same as above. Shannon - Wiener's index (\( H' \)) depends on tree abundance and their distribution among the species. The index is maximum when the species have same number of individuals and minimum when the individuals are maximally concentrated in one species.

Basal area for the plot is multiplied by four to get the basal area per hectare. Similarly, number of trees per hectare is four times the number of trees in the plot.
BIOMASS

Since complete harvesting of the sample area was not possible, biovolume has been used as an index of biomass. Biovolume was calculated, using the formula, \( V = D^2H \), (Where, \( D \) = Trunk diameter at breast height and \( H \) = Height of the tree). The formula \( D^2H \) applicable to cylindrical objects, introduces a systematic error when used for tree trunks, as the boles are progressively narrower towards the apex. It is assumed that space around the progressively narrow portion of the trunk within the imaginary cylinder based on diameter of the tree at breast height, represent the biovolume of branches and foliage. Volume thus calculated for individual trees are added to get the biovolume for the plot, which is extrapolated for one hectare. So, the term biomass had been used, based on this biovolume.

GIRTH CLASS DISTRIBUTION

Trees in each plot had been grouped into 25cm girth classes and histogram showing their frequency in different girth classes had been prepared.

REGENERATION

Regeneration studies were conducted in all the eleven selected groves. Two regeneration plots of 5 x 5 m were selected at random in each of the 10 x 50 m strip of the plot laid out for phytosociological studies. Thus ten regeneration plots were laid out in each of the 50 x 50 m plot. All tree species less than 10 cm GBH were enumerated and classified according to height as follows :

- Category 1 - < 20 cm in height
- Category 2 - 21 to 40 cm in height
- Category 3 - 41 to 100 cm in height
- Category 4 - > 100 cm in height, but < 10 cm in GBH

The data collected was analysed to assess the regeneration status of tree species in the groves.