CHAPTER 2

MATERIALS AND METHODS

The study of Phytosociology and Plant Diversity of the Attappady Hills were conducted during 2008-2014. The study consists of following:

2.1. Literature Survey

An extensive survey of literature was done as to update available information in the field of study and to interpret and analyze the data collected from the area. The details were collected from different sources are libraries of institutions, universities, and information retrieval systems. Electronic sources like Internet and INFO-NET facilities were also utilized. The literature retrieval system of Biodiversity heritage library of New York Botanic Garden (http://www.biodiversitylibrary.org), The Plant list (http://www.theplantlist.org), International Plant Name Index (http://www.ipni.org) and Botanical literature from the Missouri Botanical Garden Library (http://botanicus.org) were also utilized.

2.2. Herbaria Reference

During the present study, herbaria and types deposited in CAL, CALI, CMPR, E, FRC, K, KFRI, MH, SKC and TBGT were examined.

2.3. Floristic survey and Specimen collection

For vegetation analysis, initially available data on the vegetation types were gathered and a vegetation map of the area was prepared. Based on this, exhaustive and intensive field trips and camping were conducted for the survey and plant collection in Attappady hills during 2008-2014. Most of the natural forests of Attappady were so remote and reachable on foot. Several field trips, each ranging from 3 to 12 days were conducted to various parts of Attappady during different seasons. During each trips focused for both Phytosociology analysis and plant collection were. Assistance of tribal and local peoples were also utilized for the field trips.

2.3.1. Phytosociological Survey

Quadrats of different size and number were established in various vegetation types for the Phytosociological analysis of Attappady hills. Size and number of the quadrate was determined by Species Area Curve method (Shailaja & Sudha, 2001).
While laying the quadrate, representation of the forest types and also variation in their altitudinal distribution were also considered. Structural data were collected from sample quadrate of 20 m x 20 m size laid in different forest types. Each quadrate was then systematically surveyed by identifying and all trees with girth at breast height (gbh) greater than and equal to 30 cm were taken and for analysis. Tree girth measurements were made as per Poffenberger et al., (1992). Trees with multiple stems (clonal population) near the ground were counted as single individual. The data obtained were recorded to find out Density, Abundance, Relative Frequency, Relative Density, Percentage Frequency, Basal area, Importance value Index and Relative Importance. Value Index by using standard formula. In addition to this, various diversity indices like Simpson’s Index (Simpson, 1949), Shannon-Wiener's Index (Shannon, 1963) were also worked.

Of the studied area protected by AHADS, a minimum of five year old stand alone were considered for survey. Geographic location of each quadrate was noticed with the aid of a GPS (Garmin 76 cSx).

2.3.2. Plant collection

Repeated collections in the same locality were made to get all essential parts of the plant and all seasonal plants especially annuals. A total of 3800 collections were made. Usually four specimens of each species were collected to study the range of variations. Photographs of plants, inflorescence, flowers, fruits, etc. were taken by digital camera (Canon SX 100). All the field observations such as habit, habitat, presence of buttressed stem, colour and nature of bark (inside and outside), colour of latex and other exudates; odour and morphology of leaves, flower and fruits etc. were noted in the field book. Local name, uses were later collected from tribal people. In case of parasites and epiphytes details of the host plants were also recorded. Reproductive structures such as flowers, fruits etc. were preserved in Poly Vinyl Chloride (PVC) bottles with Formalin-Acetic acid-Alcohol (FAA) for further studies and preparation of illustration.

2.4. Herbarium Preparation

Plant materials of proper size with relevant parts were collected from the field and sealed in polyethylene covers after treating with formaldehyde. Herbaria were prepared following wet method (De Vogel, 1987; Bridson & Forman, 1998). The dried specimens were mounted on standard handmade sheets (28 × 42 cm) and labeled properly with standard labels (14.5 × 11 cm), after including all the relevant
information. The specimens were poisoned with mercuric chloride and deposited in CMPR.

2.5. Descriptions and Illustrations

The interesting materials collected were brought to laboratory for detailed study of micro characters. Photographs of floral parts were also taken. Observations were made using a dissecting microscope MOTIC. Photomicrographs of essential parts were taken using Nikon and Canon still camera. Illustrations of smaller parts were made with the help of wild stereo microscope attached with camera lucida. Illustrations were drawn on Gateway stereo microscope using Micro tip pen (ROTRING Variant) equipped with 0.1 mm.

2.6. Identification

The specimens were identified by using Floras, Monographs, publications, etc. and identity of the taxon was confirmed with type materials deposited at E, K, CAL, MH, and protologue. The expertise from Royal Botanic Garden, Edinburgh was also utilized.

2.7. Nomenclature and Citations

Citations of all taxa published were obtained from Index Kewensis and IPNI. The database of the International Plant Names Index (IPNI) (http://www.ipni.org) and ‘The Plantlist’, a database of Royal Botanic Garden, Kew, (http://apps.kew.org) were also utilized. Abbreviations of the periodicals were mainly according to those given in *Botanico Periodicum Huntianum* (B-P-H) (Lawrence et al., 1968). Authors of plant names were based on Brummitt & Powell (1992), and Mabberly (2005) and acronyms of herbaria were used according to Index Herbariorum (Thiers, 2011). For nomenclature clarifications ICN for Algae, Fungi and Plants (Melbourne Code) (McNeill et al., 2012) was used.

2.8. IUCN status

The RET status of new species/rediscoveries and other interesting plant species has been evaluated against IUCN Red List Categories and Criteria and IUCN standards and Petitions Subcommittee (2012). The status tentatively based on the knowledge from the field visits and herbaria reference.
2.9. Phytosociological Analysis

2.9.1. Structural Analysis

The numerical data obtained were analysed to find out Density (De.), Abundance (AB), Relative frequency (RF), Relative density (RD), Percentage Frequency (% F), Basal area (BA), Relative basal area (RBA) and Importance value index (IVI) as methods suggested by Phillips, 1959.

1. Density = \textbf{No. of individuals/} Total No. of quadrats studied

2. Relative density = No. of individuals of the species x 100/ No. of individuals of all species

3. Abundance = Total no. of individuals of a sp. in all quadrats/Total no. of quadrats in which the species occur

4. Percentage frequency = No. of quadrats of occurrence x 100 /Total no. of quadrats studied.

5. Relative frequency = No. of occurrence of a Species/No. of occurrence of all species

6. Basal area = \( \frac{G^2}{4\pi} \) (G = Girth at breast height)

7. Relative basal area = Basal area for the species x 100 /Basal areas of all species

8. Importance Value Index = Relative density + Relative frequency + Relative basal area

9. Relative Importance Value Index = Importance value index /3

2.9.2. Plant Diversity Indexes

Diversity indices like Simpson's index and Shannon-Wiener's function were found out using the following formula:

1. Simpson's index, (D) (Simpson, 1949)

\[ \lambda = \frac{\sum (n_i)(n_i-1)}{N(N-1)} \]

This index is also a measure of the dominance.
2. Modified Simpson's index: $\frac{\lambda}{1}$

3. Shannon-Wiener's index ($H'$) (Shannon, 1963)

   a) $H' = 3.3219 \left( \log \frac{N}{\sum n_i \log n_i} \right)$

   b) $H_{\text{max}} = 3.3219 \log_{10} S$

   $H_{\text{max}}$ is the maximum dispersion taking into account the number of species present in the plot.

   Where, $N$-Total number of all individuals of all the species.

   $n_i$-No. of individuals of a species.

   $S$-Total no. of species

   3.3219 is the conversion factor from log$_2$ to log$_{10}$.

2.10. Plan of presentation of data

2.10.1. Phytosociology of Attappady

   In the Phytosociology part the results are arranged as per each forest area surveyed. Each sampling area starts with the vegetation type as per the classification of Champion and Seth (1968) followed by the total number of individuals and species in the sampling area. The general information like, presence of litter in soil, soil humus, average slope, soil erosion are mentioned. Anthropogenic effects like lopping, cut stumps, collection of litter, soil removal, grazing and weeds are also mentioned. Presence of water bodies and wild life occurrence were given for the better knowledge of the forest. For each area the highest species having Density, Abundance, Relative Frequency, Relative Density, Percentage Frequency, Relative Basal area and Importance value Index are detailed and above details of each tree species in that area given in tables. The Simpson's Index and Shannon-Wiener's Index are given for knowing the diversity of sampling area and the same was compared with other sampling areas.

2.10.2. Flora of Attappady

   For general format of flora, the format proposed by Radford et al., (1974) was followed. The families were arranged according to the classification of Bentham and Hooker (1862-1883) with necessary alterations, based on split up of various families as proposed by Brummit & Powell (1992) and Venter (2001). An artificial diagnostic key is
provided for the identification of genus and species. Dichotomous parallel keys are provided for the identification. Keys for identification of genera under each family and that for the species under each genus are given in respective places. The taxa below family level under each family were arranged in alphabetic sequence. The keys for identification of intraspecific taxa are given after the description of the respective species. Illustrations and photographs are provided for some of the rare and endemic species.

The species under each genus are also arranged in alphabetic order. The correct name of the species is written in bold Roman letters followed by the author citation and full reference of the original publication. Basionym (if any), important synonyms and citation of the names included in important Indian floras including regional floras are also given. Synonyms relevant to Indian Flora only were given and are written in italics. All the relevant monographs and revision works were also cited. The detailed description of each species was given after the nomenclature citations. The description of the species is in the following sequence: habit, branchlets, leaves, inflorescence, flower, calyx, corolla, stamens, ovary, fruit and seed. The local names, geographical distribution, habitat and abundance in the study, flowering and fruiting followed by name of the collector followed by collection number and name of the locality are given. Traditional and common uses, IUCN status and notes are also are given after the herbarium details.

Cultivated or other ornamental plants seen in the district were named at the end of respective families.