

Assessment of Herbaceous Floral Diversity of selected Sacred groves of Kottayam district, Kerala, India

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Abstract

An exploratory survey of different sacred groves of Kottayam District (9.5888° N to 76.5341° E) of Kerala was carried out during the period 2017-2019. The groves which were selected for study include Kurinji Bhagavathi Kavau, Illapozhuthu Bhagavathi Kavau, Koovakkal Sastha Kavau, Panachikadu Devi temple and Nagampoozhimana Kavau. Over all plant composition leads to 326 species coming under 268 genera and 89 families, representing 6 vulnerable and 31 endemic. This study covers herbaceous flora of angiosperms and pteridophytes. The vegetation profile of the Sacred groves in Kottayam district consists of 127 herbs, 88 trees, 74 shrubs and 37 climbers. Taxonomic analysis of herbaceous flora shows 103 angiosperms of 78 families and 24 pteridophytes of 11 families. The dominant families of herbaceous members are Acanthaceae, Asteraceae and Poaceae (8 species each) followed by Araceae with 7 species, Euphorbiaceae, Scrophlariaceae and Pteridaceae (6 species each). Moist deciduous forest members (20%) are dominant in the sacred groves and is followed by Wetland species (18%). Deciduous, Evergreen and Semi evergreen forests species (16%) followed by Wasteland component (12%), Grassland species (7%), Riparian species (6%) and Cultivated species (3%). Maximum herbaceous diversity is present in Nagampoozhimana Kavau (94 species of 41 families) and minimum diversity is present in Koovakkalmala Sastha Kavau (16 species belonging to 10 families).

Key words: Sacred groves, Herbs, Angiosperms, Pteridophytes, Diversity, Endemism, Phytosociology, Kottayam.

1. INTRODUCTION

Sacred groves are locally known as Kavau mean by consortium of trees seen throughout Kerala from coastal areas to the Ghats and are having different cultural practices and belief systems. The area of Sacred groves varies from few trees to several hectares. In Kerala, the Sacred groves are mostly distributed along the plains of northern and southern regions of Kerala and are comparatively well studied [1-4]. These landscapes are commonly community based remnants of biological diversity and protected on the basis of their religious beliefs, extremely rich in floral and faunal components. These patches of untouched forest with rich diversity, which have been protected by the local people for centuries for their cultural and religious beliefs [5]. Sacred groves are natural museums of living giant trees, treasure house of rare, endemic and endangered species, dispensary of medicinal plants, recreation center for urban life, garden for botanists, gene bank of economic species, paradise for nature lovers and laboratory for environmentalists [6]. About 364 important Sacred groves in Kerala with floristic wealth of over 722 species are identified [1]. It is estimated that around 500 ha of area is under Sacred groves in Kerala and the total number of groves reported is around 2000.

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Sacred groves often protect watersheds, and help in soil and water conservation. The thick root mat in the ground may help to prevent soil erosion. These virgin forests with the most favorable microclimate have an important role in the conservation of biodiversity and act as the last shelters of many endemic and ret species. Conservation of traditional knowledge about Sacred groves is another critical area that require lot of attention for preventing its narrowing. Being a biotype in a rural landscape, this sanctum performs a critical role in the maintenance of ecological and hydrological balance of an area, and also help to compensate for carbon emissions of polluting industries and thereby offers economic and ecological benefits to the communities [3]. Various studies were also contributed the information on the floristic wealth of Sacred groves of Kerala [7-13].

The sacred groves in central Kerala, especially in Kottayam district is poorly explored. Earlier studies on the religious important plants of some sacred groves in Kottayam district were done [14]. In the present study the vegetation analysis of selected sacred groves from three geographical zones of Kottayam districts viz., low land, mid land and high land are included. In central Kerala, Kavu or groves are of two types; Sarpakavu or Durgakavu which are close to the human settlements, especially for the Paradevathas of families and second type of groves are Sasthakavu which are far away from settlements and commonly on hill ranges.

The main objectives of the study include the analysis of the floristic composition, documentation of the herbaceous flora in the Sacred groves based on relevant classification [15-17] and to analyze the species diversity, phytosociology based on quadrat method.

2. MATERIALS AND METHODS

2.1 Study area

Different extents of Sacred groves of Kottayam district are selected for the study. Five Sacred groves from three taluks of Kottayam are identified and assessed for its biodiversity. The location of each sacred grove is marked with Garmin 72 GPS. These groves are distributed in various geographical zones of Kottayam district, viz, low land, mid land and high land. There are two low land and mid land groves and one high land grove selected for the study. (Figure 1. & Table 1.)

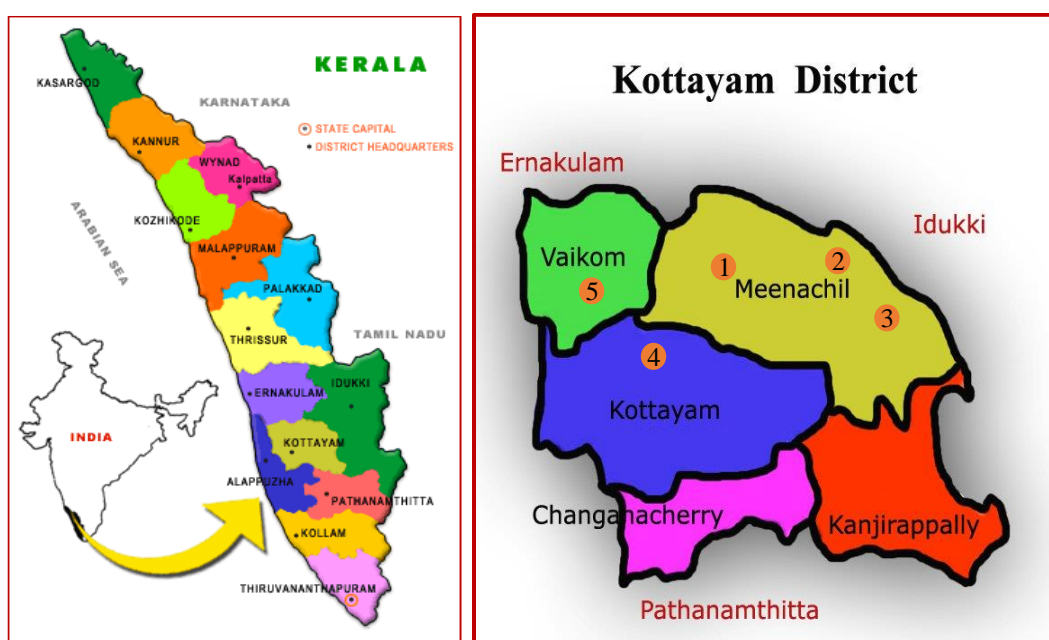


Figure 1. Location of Sacred groves in Kottayam district, Kerala, India

Table 1. Selected Sacred groves and Dieties

Sl. No.	Sacred groves	Taluk	Area in Ha.	Latitude/ Longitude	Geographical Zone	Deity
1.	KurinjiKavu, Ramapuram	Meenachil	2	9.7962 ⁰ N 76.6904 ⁰ E	High land	Vanadurga, Naga
2.	Illapozhuthu Kavu, Chakkambuzha	Meenachil	1.80	9.7676 ⁰ N 76.6557 ⁰ E	Mid land	Bhagavathi, Naga
3.	Thoovakkalmala Kavu, Valavoor	Meenachil	1	9.7453 ⁰ N 76.7442 ⁰ E	Mid land	Sasthavu, Yekshi
4.	Panachikkadu temple Chingavanam	Kottayam	1.45	9.5380 ⁰ N 76.5525 ⁰ E	Low land	Saraswathi, Yekshi, Naga
5.	Nagampoozhimana Kavu, Vaikom	Vaikom	1.6	9.7490 ⁰ N 76.3941 ⁰ E	Low land	Naga, Yekshi

2.2 Methodology

The study was conducted during 2017-2019, and the plant specimens are identified with the help of available floras and literature [18-21]. Ecological and morphological observations are done from the fields during site visits and the detailed morphological characters were observed under Leica MZ 7.5 Stereo microscope.

Herbarium were prepared by standard methods [22] and verified with the help of herbariums at Kerala Forest Research Institute (KFRI), Peechi and Calicut University (CALI). IUCN categories used to evaluate and arrange the taxa into RET species [23]. Voucher specimens of species collected from Sacred groves were deposited in the Herbarium, St. Teresa's College (Autonomous), Ernakulam. The nomenclature and citations followed as per IPNI [24].

For Phytosociological studies, quantitative data for Frequency, Relative frequency (RF), Density, Relative density (RD) and Diversity indices were calculated according to the standard methods [25-28]. For the sampling of herbaceous species, each study area are divided into approximately four equal quadrats to calculate Density (D) and Relative density (RD), while Frequency (F) and Relative frequency (RF) were analyzed after dividing each study area into eight equal quadrats. All these parameters are calculated for the selected species, which shows presence in more than two slots. Diversity of flora was assessed through Shannon-Weiner diversity index (H') and the analysis was conducted for two consecutive years to cover maximum species representation.

3. RESULT AND DISCUSSION

The herbaceous flora of Sacred groves of Kottayam district revealed that, there are 103 angiosperms in 78 families and 24 pteridophytes belongs to 11 families. Nagampoozhimana Kavu have the highest number of herbaceous species (108), followed by Illapozhuthu Kavu (56), Panachikadu Devi temple (40), Kurinji Kavu (35) and Koovakkalmala Sastha Kavu (28). The dominant families of herbaceous angiosperm members are Acanthaceae, Asteraceae and Poaceae (8 species each) followed by Araceae with 7 species and Euphorbiaceae and Scrophulariaceae (6 species each), Cyperaceae,

Rubiaceae and Zingiberaceae (6 species each), Amaranthaceae and Apiaceae (4 species each), Commelinaceae and Fabaceae (3 species each), Malvaceae with 2 species and remaining families comprising single species (Figure 2.). Dominant genera in the selected sites are *Curcuma*, *Justicia*, *Lindernia* with 3 species and *Limnophylla*, *Phyllanthus*, *Saccharum* and *Spermacoce* with 2 species.

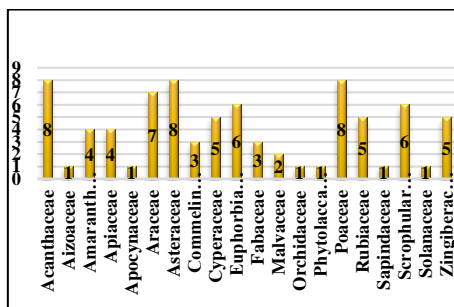


Figure 2. Dominant families of herbaceous angiosperms from Sacred groves of Kottayam district

Floristics of pteridophytes from the groves revealed that, Pteridaceae is the dominant family with 6 species, followed by Selaginellaceae and Polypodiaceae with 4 species both and Adiantaceae with 3 species (Figure 3.). The dominant genera is *Selaginella* (4 spp.), *Adiantum* and *Pteris* (3spp.).

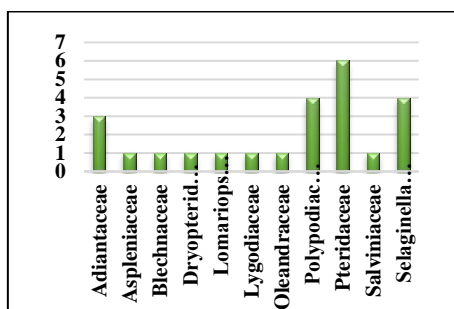


Figure. 3 Dominant families of herbaceous Pteridophytes from Sacred groves of Kottayam district

The habitat diversity and natural distribution of identified herbaceous flora (both angiosperms and pteridophytes) indicated that, moist deciduous forest members (20%) are dominated in the Sacred groves and is followed by wetland species (18%). Deciduous, evergreen and semi evergreen forests species (16%) followed by wasteland components (12%), grassland species (7%), riparian species (6%), cultivated species (3%) (Figure 4.).

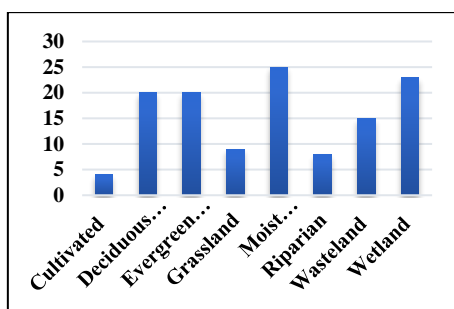


Figure.4 Composition of habitat types of herbaceous angiosperms in Sacred groves of Kottayam district

The pteridophyte species composition shows habitat specificity for their adaptation and survival within the common distribution pattern. In the present in the study area they are included in 3 types of habitats: Terrestrial (15 species), Lithophytes (8 species) and Hydrophytes (3 species) (Figure 5.).

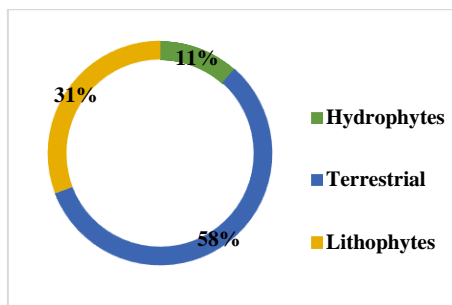


Figure 5. Habitat diversity of Pteridophytic flora in Sacred groves of Kottayam district

The native range and worldwide distribution of herbaceous species found in the Sacred groves shows that; Pan tropical elements (39) and Indo- Malesia & African elements (26) are dominated and followed by Asia to Africa (21), Peninsular Indian/Sri Lankan (20), South to South East Asia (13), Indian Elements and South East to Australia (10), Endemic species (6). There are 4 endemic angiosperms and 2 pteridophytes. In which Peninsular Indian (2), South Indian (2) Western Ghats endemic (1) and South Western Ghats (1) (Table 2.).

Table 2. Native range and worldwide distribution of species found in the Sacred groves of Kottayam district.

Sl. No.	Distribution	Number of Species
1.	Asia to Africa	21
2.	Endemic to Penisular India	3
3.	Endemic to Western Ghats	3
4.	Indian Elements	10
5.	Indo- Malesia & Africa	26
6.	Pantropical / Paleotropical	39
7.	Peninsular Indian / Sri Lankan	20
8.	South East to Australia	10
9.	South to South East Asia	13

3.1 Vegetation profile

The vegetation profile of the Sacred groves in Kottayam district consists of 127 herbs, 88 trees, 74 shrubs and 37 climbers (Figure 6.). However herbaceous species in the study area has relatively high species number comparing to shrubs, climbers and epiphytes, the canopy dominated by most of the wild trees that indicate the rich forest among the surrounding ecosystem in the past. But the herbaceous ground layer protect the soil from erosion, contributes litter accumulation and improves the microclimate of the region that favors these groves to become suitable for many endemic species. Among the herbaceous

members, about 75 species (59%) have medicinal values in different treatment systems and is effectively utilized by traditional healers in the nearby areas.

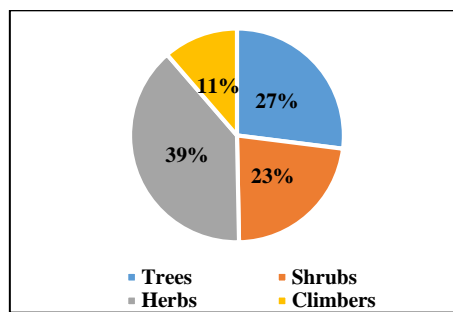


Figure 6. Life form analysis in selected Sacred groves of Kottayam district

3.2 Phytosociology

The most frequent herbs observed among the sites are *Peperomia pellucida* (113), followed by *Scoparia dulcis* (94), *Curcuma neilgherrensis* (81), *Achyranthus aspera* (77), *Centella asiatica* (61). This frequency distribution indicates the disturbed nature of the sites, where weeds and cultivated species dominated. The distribution density of herbs indicated that *Peperomia pellucida* has highest (5.65), followed by *Scoparia dulcis* (4.7), *Curcuma neilgherrensis* (4.05), *Achyranthes aspera* (3.85) and *Weddelia chinensis* (3.2). It is evident from the relative density (RD-4.7) and relative frequency (RF-80%) data that, *Scoparia dulcis* contribute the highest percent in the ground cover of herbaceous species (Table 3.).

Table 3. Phytosociological parameters of herbaceous species from selected sacred groves of Kottayam district

Sl. No	Botanical name	Family	No. of plants	Density (4*5) (20)	R D (%)	Occurence in the sampling units	Frequency % (8*5)(40)	R F (%)
1	<i>Achyranthes aspera</i> L.	Amaranthaceae	77	3.85	5.20	29	72.5	5.53
2	<i>Adiantum latifolium</i> Lam.	Adiantaceae	42	2.1	2.83	11	27.5	2.09
3	<i>Adiantum lunulatum</i> Burm.	Adiantaceae	33	1.65	2.22	14	35	2.67
4	<i>Aerva lanata</i> (L.) Juss. ex Schult.	Amaranthaceae	27	1.35	1.82	7	17.5	1.33
5	<i>Biophytum reinwardtii</i> (Zucc.) Klotzsch.	Apiaceae	51	2.55	3.44	16	40	3.05
6	<i>Cardiospermum halicacabum</i> L.	Sapindaceae	9	0.45	0.60	5	12.5	0.95
7	<i>Catharanthus roseus</i> (L.) G. Don	Apocynaceae	11	0.55	0.74	4	10	0.76
8	<i>Centella asiatica</i> (L.) Urb.	Apiaceae	60	3	4.05	27	67.5	5.15
9	<i>Colocasia esculenta</i> (L.)Schott.	Araceae	31	1.55	2.09	12	30	2.29

10	<i>Curculigo orchioides</i> Gaertn.	Apiaceae	53	2.65	3.58	19	47.5	3.62
11	<i>Curcuma longa</i> L.	Zingiberaceae	37	1.85	2.5	11	27.5	2.09
12	<i>Curcuma neilgherrensis</i> Wight	Zingiberaceae	81	4.05	5.47	25	62.5	4.77
13	<i>Eclipta alba</i> var. <i>prostrata</i> (L.) Miq.	Asteraceae	14	0.7	0.94	6	15	1.14
14	<i>Emilia sonchifolia</i> DC.	Asteraceae	55	2.75	3.71	17	42.5	3.24
15	<i>Euphorbia hirta</i> L.	Euphorbiaceae	14	0.7	0.94	6	15	1.14
16	<i>Gloriosa superba</i> L.	Liliaceae	12	0.6	0.81	9	22.5	1.71
17	<i>Justicia procumbens</i> L.	Acanthaceae	20	1	1.35	7	17.5	1.33
18	<i>Laportea interrupta</i> (L.) Chew	Euphorbiaceae	21	1.05	1.41	13	32.5	2.48
19	<i>Leucas aspera</i> (Willd.) Link	Lamiaceae	26	1.3	1.75	16	40	3.05
20	<i>Ludwigia hyssopifolia</i> (G. Don) Exell	Onagraceae	28	1.4	1.89	10	25	1.90
21	<i>Mimosa pudica</i> L.	Mimosaceae	28	1.4	1.89	18	45	3.43
22	<i>Naragamia alata</i> Wight & Arn.	Meliaceae	32	1.6	2.16	12	30	2.29
23	<i>Nephrolepis cordifolia</i> (L.) C. Presl.	Oleandraceae	17	0.85	1.14	6	15	1.14
24	<i>Oldenlandia corymbosa</i> var. <i>corymbosa</i> L.	Rubiaceae	38	1.9	2.56	17	42.5	3.24
25	<i>Ophiorrhiza mungos</i> Wall.	Rubiaceae	18	0.9	1.21	5	12.5	0.95
26	<i>Parahemionitis cordata</i> (Roxb. ex. Hook. & Grev.)Fraser.-Jenk.	Pteridaceae	19	0.95	1.28	10	25	1.90
27	<i>Peperomia pellucida</i> (L.) Kunth.	Piperaceae	113	5.65	7.63	29	72.5	5.53
28	<i>Phyllanthus amarus</i> Schumach. & Thonn.	Euphorbiaceae	33	1.65	2.22	8	20	1.52
29	<i>Physalis angulate</i> L.	Solanaceae	13	0.65	0.87	5	12.5	0.95
30	<i>Pityrogramma calomelanos</i> (L.)Link	Pteridaceae	32	1.6	2.16	11	27.5	2.09
31	<i>Rauvolfia serpentina</i> Benth. ex Kurz	Apocynaceae	12	0.6	0.81	4	10	0.76
32	<i>Rivina humilis</i> L.	Phytolaccaceae	10	0.5	0.67	3	7.5	0.57
33	<i>Scoparia dulcis</i> L.	Scrophulariaceae	94	4.7	6.35	32	80	6.10

34	<i>Selaginella ciliaris</i> (Retz.) Spring	Selaginellaceae	16	0.8	1.08	7	17.5	1.33
35	<i>Selaginella delicatula</i> Alston	Selaginellaceae	24	1.2	1.62	8	20	1.52
36	<i>Sida alnifolia</i> L.	Malvaceae	26	1.3	1.75	11	27.5	2.09
37	<i>Solanum viarum</i> Dunal	Solanaceae	14	0.7	0.94	9	22.5	1.71
38	<i>Spermacoce latifolia</i> Aubl.	Rubiaceae	39	1.95	2.63	7	17.5	1.33
39	<i>Spilanthes ciliata</i> Kunth	Asteraceae	16	0.8	1.08	3	7.5	0.57
40	<i>Tragia involucrata</i> L.	Euphorbiaceae	40	2	2.70	16	40	3.05
41	<i>Vernonia cinerea</i> (L.) Less.	Asteraceae	50	2.5	3.37	19	47.5	3.62
42	<i>Vigna adenantha</i> (G. Mey.) Marechal et al.	Fabaceae	24	1.2	1.62	9	22.5	1.71
43	<i>Weddellia chinensis</i> Merr.	Asteraceae	64	3.2	4.32	10	25	1.90
44	<i>Zingiber zerumbet</i> (L.) Sm.	Zingiberaceae	6	0.3	0.40	1	2.5	0.19
	TOTAL species = 44 Genus = 41		1480			524		

The distribution frequency range of herbaceous species in Sacred groves of Kottayam district indicates 11.36 % herbs in the groves are coming under fairly good and moderate frequency range while rest of the 38.63% of species are in the mostly poor and poor frequency range (Table 4.).

Table 4. Distribution frequency range of herbaceous species

Frequency Range	5 Sacred Groves from Kottayam District	
	No. of herbs species	% of species
1-20% (Poor)	17	38.63
21-40% (Mostly poor)	17	38.63
41-60% (Moderate)	5	11.36
61-80% (Fairly good)	5	11.36
81-100% (Good)	0	0

3.3 Diversity indices

The Shannon Weiner diversity Index (H') of the study area is 3.6. This indicates the species are distributed uniformly and shows high diversity without dominant species.

4. CONCLUSION

The Sacred groves selected for the present study has wide range of diversity of herbaceous flora with 103 angiosperms in 78 families and 24 pteridophytes belonging to 11 families. The dominant families of herbaceous members are in Acanthaceae, Asteraceae and Poaceae. Of the 127 herbaceous species 4 angiosperm herbs and 2 pteridophytic species are endemic. This region is to be conserved and protected for its plants and animal diversity. The dominance of light demanding Acanthaceae and

Asteraceae members in the groves indicate that the mini forest floor is well exposed to sunlight through the canopy gaps. Sacred groves in the low land region shows high herbaceous diversity, while groves in the mid land and high land regions shows less diversity. Size of the grove is an important factor may affect the floristic diversity also. There are 59.12% of the herbaceous flora were medicinally valuable and used in traditional treatment systems. Further studies are required for the enumeration of lower forms like algae, fungi and bryophytes. Anthropogenic activities in and around the groves leads to the disturbance of such natural habitats. Immediate conservation measures should be taken to protect these species and its remaining repositories from the extinction.

CONFLICT OF INTEREST STATEMENT

We declare that we have no conflict of interest.

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