

Plant diversity of sacred groves and its comparative account with surrounding denuded hills from Bhore region of Western Ghats

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Abstract

Sacred groves in western Maharashtra are patches of forest preserved on religious ground. Only these preserved forest patches remain undamaged whereas the surrounding areas have scanty or eroded vegetation. Many studies show that the floristic surveys of sacred groves were carried out without emphasizing the comparative account with surrounding vegetation. In the present investigation we selected four sacred groves *i.e.* Somjaichi Rai, Maulidevichi Rai, Nivgunjaichi Rai, and Umberjaichi Rai; and focussed on comparative study between the floristic composition of sacred groves and its surrounding areas. These sacred groves look like a single isolated patch of forest; whereas the surrounding area supports very scanty trees and shrubs. The selected sacred groves depict such situation. Plant diversity in each sacred grove was very unique than its surrounding open areas. Some common species in all sacred groves are *Acacia concinna* DC, *Bridelia retusa* (L.) Spreng, *Cassia fistula* L., *Mangifera indica* L., *Erythrina varigeta* L., *Meyna laxiflora* Robyns, *Syzygium cumini* (L.) Skeels and *Terminalia chebula* Retz. Some rarely occurring plants were *Entada rheedei* Spreng, *Zingiber cerneum* Dalz and *Zingiber neesatum* (Grah.) Raman. We compared between these sacred groves and its surrounding areas at taxa level.

INTRODUCTION

Sacred groves are relics of the forests that once covered a large part of Western Ghats of Maharashtra. In view of the unique role played by sacred groves in preserving the natural resources, Gadgil and Vartak (1973,1981) are pioneer research worker in Maharashtra state and recorded 11 sacred groves from Bhore Taluka. A detail study were under taken in hilly regions of western Maharashtra under a project 'Floristic studies of sacred groves in Western Maharashtra' at Maharashtra Association for the Cultivation of Science (Renamed as

Agharkar Research Institute, Pune- 411 004) since 1983-86 funded by Department of Environment and Forest, Government of India under a leadership of Late Dr. V.D. Vartak. They reported total 228 sacred groves, out of which 177 were actually visited. Total 2,926 plant specimens collected within sacred groves from districts like Thane, Raigad, Ratnagiri, Sindhudurg, Ahmadnagar, Nasik, Pune, Satara, Sangli and Kolhapur (Anonymuce, 1986). Nipunage *et al.* (1993) reported seven sacred groves from Sinhadgad hills for floristic composition. Navalaichi rai has a special feature of pure stand

of *Miliusa tomentosa* (Roxb.) J. Sincl. and recorded 31 trees with natural regeneration. Deshmukh (1999) documented more than 4000 sacred groves from Maharashtra state and submitted report to Forest Department of Maharashtra State. He classified sacred groves according to climatic zones. Kulkarni and Shindikar (2005) made plant diversity evaluation of Shirikai sacred grove situated at village Shirkoli, Taluka Bhor and recorded 1499 individuals belong to 54 families, 106 genera and 116 species. Post monsoon floral diversity of Shirikai sacred grove was found to be significant. Kulkarni *et al.* (2015) have worked on tree species assessment at Lohgad and Visapur Fort – a part of Western Ghats documenting 194 tree species belonging to 134 genus and 48 families. From the results it is concluded that, Lohgad-Visapur forts region is highly diverse but under the anthropogenic threats due to various developmental projects. Bhor region was surveyed for Dhup rahat sacred groves by Kulkarni and Nipunage (2009). The name Dhup Rahat means magnificent trees of *Canarium strictum* Roxb. and other tree species like *Terminalia bellirica* Roxb., *Syzygium cumini* (L.) Skeels, *Holigarna grahamii* (Wt.) Kurz. are prominent in the grove. Quantitative floristic composition was determined by studying ten quadrats, each with an area of ten square meters chosen at random. Percentage, frequency and occurrence were documented. Further work on natural heritage conservation of sacred groves from Bhor region was carried out by Kulkarni *et al.* (2010). In this survey 8 sacred groves were visited and recorded dominant tree species, shrubs, climbers and natural regeneration within sacred groves. Major floristic composition was made inside sacred grove which was unique habitat of plant diversity. Surrounding area of sacred grove was denuded or partly covered with few trees, shrubs, herbs and grasses. Present attempt has been made on four sacred groves focused on plants diversity inside as well as outside the sacred groves.

MATERIALS AND METHODS

Study area:

Bhor Taluka is located in hilly and remote Western Ghat region covering an area about 892.0 Sq. Km. The Bhor town is located 55 Km south of Pune City and between 18° 45' N latitude and 73° 15' E longitude. Elevation of Bhor from mean Sea level is 591.43 meters. The chief rivers flowing through the taluka are Nira, Velvendi, Gunjawani and Shivganga that flow from west to east. Three major dams have

been constructed namely Bhatghar, Nira-Devghar and Gunjawani for irrigation purpose. We have selected four sacred groves (Fig.1) *i.e.* Somjaichi Rai sacred grove at Nandghur village has 5 hectare area, Moulidevichi Rai sacred grove at Varvand village is having 2.0 hectare area, Nivgunjaichi Rai sacred grove at Nivgun village is having 1 hectare area, and Umberjaichi Rai sacred grove at village Parhar is having 0.4 hectare area.

Vegetation:

Types of vegetation occurring in the different parts of Bhor are governed mainly by the rainfall and altitude. As per Champion and Seth (1968) this area includes tropical semi-evergreen, moist deciduous, dry mixed deciduous and scrub types of vegetation. The forest is classified into reserved forest (3818.444 ha), protected forest (9.984 ha) acquired private forest (1719.31 ha) and compensatory afforested land (35.10 ha) (Anonymous, 2003-2004). In recent years tree resources in forest/sacred groves or university campus are potential environmental sources of carbon sequestration (Suryawanshi *et al.*, 2014).

The GPS approach:

The study area is Bhor region and the sites of selected sacred groves were mapped with GPS for precise and accurate plotting and descriptive GIS maps of sacred groves were prepared. The Global Positioning System (GPS) was used to estimate land areas as well as making border by walking along the boundary of study areas. GPS was used extensively in all research stages and all map digitization was done based on GPS points recorded in the plots of the study areas. The method was based on a single unit, handheld GPS (GARMIN Make), which gives an accuracy of ± 10 m.

GIS application:

The application of GIS comes from a database management system that is designed to store and manipulate data (Lillesand *et al.*, 2004). Apart from its application for remote sensing data, GIS also offers the possibility of integrating further analysis of other types of information including data on soil types and population of a certain area in terms of different types of projects (Ostwald, 2002). In the present study GIS was used as a complimentary technique along with field measurements to obtain more accurate and precise calculation and interpretation.

RESULTS AND DISCUSSION

The plant diversity in the four sacred groves have been documented in the different seasons throughout the study duration and recorded in the tabular form as follows (Table-1)

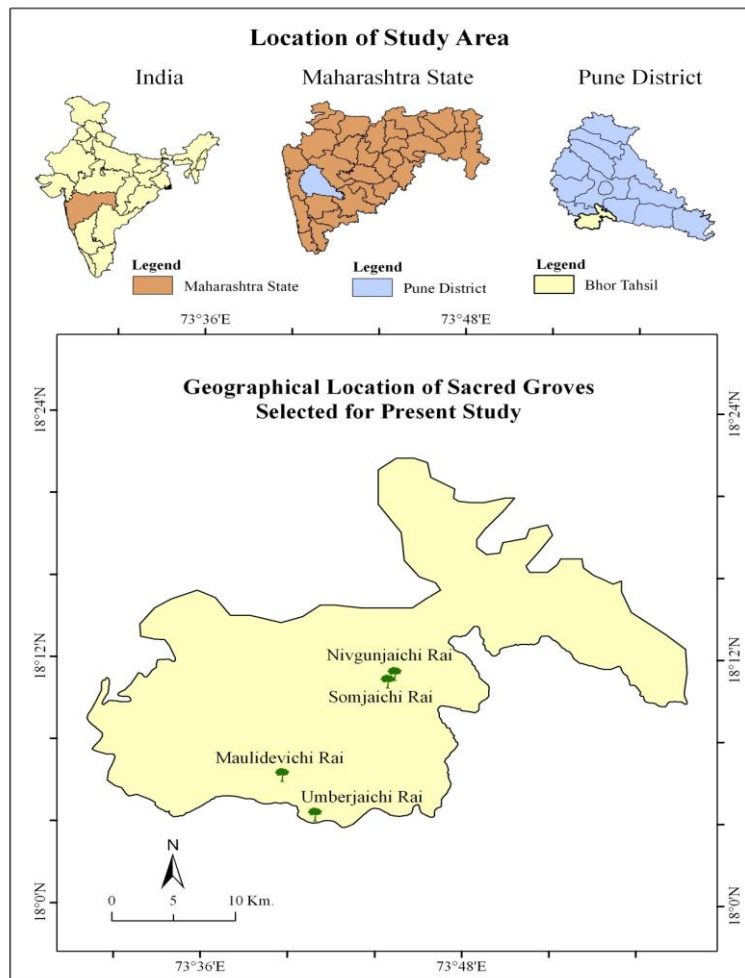


Fig.1: Study area map.

Table-1: Plant diversity in the selected sacred groves.

Sr. No.	Plant species	Sacred Groves							
		Somjaichi Rai		Maulidevichi Rai		Nivgunjaichi Rai		Umberjaichi Rai	
		In	Out	In	Out	In	Out	In	Out
1	<i>Acacia catechu</i> (L.f.) Wild			√					
2	<i>Acacia concinna</i> DC	√	√		√	√	√	√	√
3	<i>Acacia leucophloea</i> (Roxb.) Willd.	√	√						
4	<i>Acacia pennata</i> (L.) Willd.	√							
5	<i>Achyranthes aspera</i> L.	√				√			
6	<i>Actinodaphne angustifolia</i> Nees			√					
7	<i>Ageratum conyzoides</i> L.	√				√			
8	<i>Albizia procera</i> (Roxb.) Benth.	√							
9	<i>Allophylus cobbe</i> (L.) Raeusch	√		√					
10	<i>Argyrea sericea</i> Dalz.& Gibs					√		√	
11	<i>Arthraxon lanceolatus</i> (Roxb.) Hochst.	√				√			√
12	<i>Artocarpus heterophyllus</i> Lam.			√					
13	<i>Arundinella spicata</i> Dalz.	√					√		√
14	<i>Asystasia dalzelliana</i> Sant.			√		√			
15	<i>Atlantia racemose</i> Wt.	√							
16	<i>Biophytum sensitivum</i> (L.) DC.	√							
17	<i>Bombax ceiba</i> L	√		√	√				
18	<i>Breynia retusa</i> (Dennst.) Alst.			√					
19	<i>Bridelia retusa</i> (L.) Spreng	√		√	√	√	√	√	√

Sr. No.	Plant species	Sacred Groves							
		Somjaichi Rai		Maulidevichi Rai		Nivgunjaichi Rai		Umberjaichi Rai	
		In	Out	In	Out	In	Out	In	Out
20	<i>Canavalia gladiata</i> (Jacq.) DC.					√			
21	<i>Careya arborea</i> Roxb.			√				√	
22	<i>Carissa congesta</i> Wt.	√	√	√	√	√	√	√	√
23	<i>Casearia graveolens</i> Dalz.					√		√	
24	<i>Cassia fistula</i> L	√	√	√	√	√	√	√	
25	<i>Catunaregam spinosa</i> (Thunb.) Tirveng.	√	√	√		√		√	√
26	<i>Cayratia trifolia</i> (L.) Domin.	√						√	
27	<i>Celosia argentea</i> L.					√			
28	<i>Cissampelos pererira</i> L.	√				√			
29	<i>Cissus pallida</i> (t. & Arn.) Steud.	√		√					
30	<i>Clematis gauriana</i> Roxb.ex DC.							√	
31	<i>Cocculus hirsutus</i> (L.) Theob.	√							
32	<i>Colebrookea oppositifolia</i> J.E. Smith.					√			
33	<i>Commelina forsskalaei</i> Vahl.	√							
34	<i>Cordia dichotoma</i> Forst. f.	√							
35	<i>Cryptolepis buchananii</i> R.Br.ex R.& S			√					
36	<i>Curcuma inodora</i> Blatt.					√			
37	<i>Cyclea peltata</i> (Lam.) Hook.f.Thoms.			√					
38	<i>Cynarospermum asperrimum</i> (Nees) Volesen.	√							
39	<i>Cyperus corymbosus</i> Rottb.					√			
40	<i>Dalbergia horrida</i> (Dennst.) Mabb.					√			
41	<i>Dalbergia lanceolaria</i> L.f.	√							
42	<i>Dalbergia volubilis</i> Roxb	√							
43	<i>Dendrocalamus strictus</i> (Roxb.) Nees	√	√	√	√	√	√		
44	<i>Derris scandens</i> (Roxb.) Benth.	√							
45	<i>Dioscorea alata</i> L.			√					
46	<i>Dioscorea pentaphylla</i> L.	√		√		√			
47	<i>Diospyros montana</i> Roxb.			√				√	
48	<i>Diploclisia glaucascens</i> Blume.	√							
49	<i>Elephantopus scaber</i> L.			√					
50	<i>Embelia basaal</i> (R. & S.) DC.	√				√			
51	<i>Emilia sochifolia</i> (L.) DC.	√							
53	<i>Entada rheedei</i> Spreng.			√					
54	<i>Eragrostis unioloides</i> (Retx) Nees ex Steud.	√					√		
55	<i>Erythrina stricta</i> Roxb.			√					
56	<i>Erythrina suberosa</i> Roxb.			√					
57	<i>Erythrina varigeta</i> L.	√	√	√	√	√	√	√	
58	<i>Eucalyptus globulus</i> Lab.			√					
59	<i>Exacum pumilum</i> Griseb.					√			
60	<i>Ficus amplissima</i> J.F. Smith.	√				√			
61	<i>Ficus microcarpa</i> L.F.			√					
62	<i>Ficus recemosa</i> L	√	√			√		√	√
63	<i>Firmiana colorata</i> (Roxb.) R.Br.			√					
64	<i>Flacourtia latifolia</i> (Hook.f.Thoms.) Cooke							√	
65	<i>Flacurtia indica</i> (Burm.f.) Merr.					√			
66	<i>Flemingia strobilifera</i> (L.) Ait. & Ait.f.	√				√			
67	<i>Geissaspis cristata</i> Wt. & Arn.					√			
68	<i>Girardinia diversifolia</i> (Link.) Friss.					√			
69	<i>Glochidion ellipticum</i> Wt.			√					
70	<i>Gloriosa superba</i> L.	√							
71	<i>Glyphochloa divergens</i> (Hack.) Clayton.	√					√		√
72	<i>Gnidia glauca</i> (Fresen) Gilg	√							
73	<i>Grewia tiliifolia</i> Vahl.							√	
74	<i>Gynura bicolor</i> (Roxb. ex Willd.) DC.					√			
75	<i>Hemidesmus indicus</i> (L.) R. Br.	√							
76	<i>Heterophragma quadriloculare</i> (Roxb.) K.Schum.					√			

Sr. No.	Plant species	Sacred Groves							
		Somjaichi Rai		Maulidevichi Rai		Nivgunjaichi Rai		Umberjaichi Rai	
		In	Out	In	Out	In	Out	In	Out
77	<i>Heteropogon contortus</i> (L.) P.Beauv. ex R.& S.								√
78	<i>Hiptage benghalensis</i> (L.) Kurz.	√							
79	<i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex G.Don.							√	
80	<i>Hoya wightii</i> Hook.f.					√			
81	<i>Ischaemum rugosum</i> Salisb.						√		
82	<i>Isodon lophanthoides</i> (Buch.-Ham.ex D.Don.) H. Hara.	√							
83	<i>Ixora brachiata</i> Roxb.			√				√	√
84	<i>Jasminium malbaricum</i> Wt.							√	
85	<i>Justicia glauca</i> Rottl.	√							
86	<i>Kyllinga tenuifolia</i> Steud.	√							
87	<i>Lagerstroemia microcarpa</i> Wt.	√						√	√
88	<i>Lantana camara</i> L.					√		√	
89	<i>Ligustrum perrottetii</i> DC.			√					
90	<i>Lucas indica</i> (L.) R.Br. ex Vatke.					√		√	
91	<i>Lucas stelligera</i> Wall. Ex Benth.	√							
92	<i>Maesa indica</i> (Roxb.) DC.	√							
93	<i>Mallotus philippensis</i> (Lam.) Muell.-Arg.	√							
94	<i>Mangifera indica</i> L	√	√	√	√	√	√		√
95	<i>Memecylon umbellatum</i> Burm.f	√	√	√	√			√	√
96	<i>Meyna laxiflora</i> Robyns.	√	√	√		√	√	√	
97	<i>Mucuna pruriens</i> (L) DC.					√			
98	<i>Nothapodytes nimmoniana</i> (Grah.) Mabb.	√				√			
99	<i>Oberonia recurva</i> Lindl.					√			
100	<i>Olea dioica</i> Roxb.	√		√					
101	<i>Oplismenus burmannii</i> (Retz.) P. Beauv.	√					√		√
102	<i>Osyris quadripartita</i> Salz. ex Decne.	√		√					
103	<i>Oxalis corniculata</i> L.	√							
104	<i>Paspalidium flavidum</i> (Retz.) A. Camus	√					√		
105	<i>Paspalum canarae</i> (Steud.) Veldk.						√		
106	<i>Pavetta crassicaulis</i> Bremek.	√						√	
107	<i>Peltophorum petrocarpum</i> (DC.) Baker ex. Heyne			√					
108	<i>Peristrophe paniculata</i> (Forssk.) Brummit.					√			
109	<i>Pimpinella adscendens</i> Dalz.					√			
110	<i>Pimpinella wallichiana</i> (Miq.ex Hohen.) Gandhi	√							
111	<i>Pogostemon purpurascens</i> Dalz.			√					
112	<i>Pongamia pinnata</i> (L.) Pierre.	√	√						
113	<i>Remusatia vivipara</i> (Roxb.) Schott & Endl.					√			
114	<i>Sauromatum venosum</i> (Ait.) Schott.	√							
115	<i>Securinega lucopyrus</i> (Willd.) Muell.-Arg.	√							
116	<i>Senecio bombayensis</i> Balakr.	√				√		√	
117	<i>Sida rhombifolia</i> L.	√		√					
118	<i>Smilax zeylanica</i> L.	√		√		√			
119	<i>Smithia bigemina</i> Dalz.					√			
120	<i>Solanum anguivi</i> Lam.	√				√			
121	<i>Spodiopogon rhizophorus</i> (Steud.) Pilger.					√			
122	<i>Sporobolus indicus</i> (L.) R.Br.					√			
123	<i>Stereospermum chelenoides</i> (Lf.) DC.	√				√		√	
124	<i>Syzygium cumini</i> (L.) Skeels.	√	√	√	√	√	√	√	√
125	<i>Tectona grandis</i> L.f.			√					
126	<i>Terminalia alata</i> Heyne.ex. Roth			√	√			√	√
127	<i>Terminalia bellirica</i> (Gaertn.) Roxb	√	√	√		√	√	√	
128	<i>Terminalia chebula</i> Retz	√	√	√	√	√	√	√	
129	<i>Terminalia elliptica</i> Will.			√				√	

Sr. No.	Plant species	Sacred Groves									
		Somjaichi Rai		Maulidevichi Rai		Nivgunjaichi Rai		Umberjaichi Rai			
		In	Out	In	Out	In	Out	In	Out		
130	<i>Terminalia paniculata</i> Roth.			√							
131	<i>Themeda tremula</i> (Nees ex Steud.) Hack.										√
132	<i>Themeda tremula</i> (Nees ex Steud.) Hack.					√					
133	<i>Tinospora sinensis</i> (Lour.) Merr.	√									
134	<i>Tragia hispida</i> Willd.	√									
135	<i>Trichosanthes tricuspidata</i> Lour.					√					
136	<i>Triumfetta rhomboidea</i> Jacq.			√		√					
137	<i>Triumfetta ventandra</i> A.Rich.	√									
138	<i>Tylophora indica</i> (Burm.f.) Merr.	√		√						√	
139	<i>Urena lobata</i> L.	√									
140	<i>Vernonia anthelmintica</i> (L.) Willd.	√				√					
141	<i>Vernonia cinerea</i> (L.) Less.	√									
142	<i>Vigna dalzelliana</i> O.Ktze.) Verdc.			√							
143	<i>Vigna vexillata</i> (L.) A. Rich.			√							
144	<i>Vitex negundo</i> L.			√							
145	<i>Wrightia tinctoria</i> R.Br.										√
146	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	√		√							√
147	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.										√
148	<i>Zingiber cernuum</i> Dalz.	√		√							
149	<i>Zingiber neesenum</i> (Grah.) Ramam.			√							
150	<i>Ziziphus rugosa</i> Lamk	√									
151	<i>Ziziphus xylopyra</i> (Retz.) Willd,										√

DISCUSSION

In recent years sacred groves became fragile due to several reasons. These sacred groves look like a single isolated patch of forest; whereas the surrounding area supports very scanty trees and shrubs. The selected sacred groves depict such situation. Plant diversity in each sacred grove was very unique than its surrounding open areas. Some common species in all sacred groves are *Acacia concinna* DC, *Bridelia retusa* (L.) Spreng, *Cassia fistula* L., *Mangifera indica* L., *Erythrina varigeta* L., *Meyna laxiflora* Robyns, *Syzygium cumini* (L.) Skeels and *Terminalia chebula* Retz. Some rarely

occurring plants were *Entada rheedii* Spreng, *Zingiber cerneum* Dalz and *Zingiber neesenum* (Grah.) Raman. The only exotic species *Peltophorum petrocarpum* (DC) Baker ex Heyne was reported in Maulidevichi rai. We compared between these sacred groves and its surrounding areas at taxa level; it showed difference in number of families, genera and species. Nivgunjaichi rai was having 34 families and only 17 in surroundings; Somjaichi rai 48 and 13; Maulidevichi rai 33 and 10; and Umberjaichi rai 29 and 16 respectively. The plant diversity at habit form level has also been documented in different seasons (Table-2).

Table-2: Diversity of species at habit-form level in selected sacred groves.

S.G. No	Species inside	Species out side	Trees inside	Trees outside	Shrub inside	Shrub out side	Herb inside	Herb out side	Climber inside	Climber out side	Culm
1	78	15	21	8	26	2	27	0	5	0	1
2	54	18	15	8	9	3	22	7	8	0	1
3	50	11	32	8	6	2	5	0	9	0	0
4	34	16	19	8	8	3	2	5	8	2	1

1:- Somjaichi rai; 2:- Nivgunjaichi rai; 3:- Maulidevichi rai; 4:- Umberjaichi rai

Dominant species in each sacred grove are as follows:

1 Somjaichi Rai: The dominant species recorded was *Terminalia bellirica* Roxb. followed by

Mangifera indica L., *Syzygium cumini* Skeels., *Pongamia pinnata* Pierre., *Ficus racemosa* L., *Lagerstroemia microcarpa* Wt., *Dalbergia leceolaria* L., *Dendrocalamus strictus* Nees.

2 Maulidevichi Rai: The dominant species recorded as *Dendrocalamus strictus* Nees followed by *Memecylon umbellatum* Burm f., *Mangifera indica* L. *Syzygium cumini* Skeels, *Artocarpus heterophyllus* Lam., *Terminalia chebula* Retz., *Terminalia alata* Heyne ex Roth.

3 Nivganjaichi Rai: The dominant species recorded as *Terminalia bellirica* Roxb. followed by *Ficus racemosa* L., *Mangifera indica* L., *Syzygium cumini* Skeels, *Ficus amplissima* J.E. Smith., *Dendrocalamus strictus* Nees., and *Terminalia chebula* Retz.

4 Umberjaichi Rai: The dominant species recorded as *Lagerstroemia microcarpa* Wt. followed by *Memecylon umbellatum* Burm f., *Terminalia chebula* Retz., *Terminalia bellirica*, Roxb., and *Terminalia alata* Heyne ex Roth.

Somjaichi rai was rich in species diversity (78 species) and Umberjaichi rai has only 34 species. Tree species are more in Maulidevichi rai 32 and minimum in Navunjaichi rai 15 trees. *Dendrocalamus strictus* (Roxb.) Nees. was only found in three sacred groves. In all the total number of plant species in four sacred groves was 151 plant species belonging to 54 trees, climbers 33, shrubs 12 and herbs 53. Sacred groves are known for its climax vegetation which is preserved since ancient time. These sacred groves are unique heritage sites and need urgent attention. Therefore the protection and conservation of habitat either in wild life sanctuary (Ben *et al.*, 2013) and sacred groves becomes a need for maintaining environmental balance. Sacred groves were studied for phytosociological aspect in Mahe, U.T. of Puducherry by Sasikala *et al.*, 2014.

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