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Woody species diversity of four sacred groves in the Pondicherry region of South India

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Abstract. Plant wealth and diversity of four sacred groves – two anthropogenic stands and two natural forest patches – along the southeast coast of India adjoining Pondicherry was studied. A total of 111 species, belonging to 103 genera in 53 families, were recorded from the four sites, which together measure 15.6 ha. The number of woody species (girth at breast height (gbh) ≤20 cm) was 20 each in Keezbuvanagiri (KBG) and Kilialamman (KLM) grove, followed by 13 in Periyakattupalayam (PKP) and 15 in Periyamudaliar chavadi (PMC). Based on the important value index (IVI), PMC grove is an association of *Aglaia elaeagnoidea*, *Borassus flabellifer* and *Pterospermum suberifolium*. A two-layered forest structure resembling tropical dry evergreen forest (TDEF) was found there. Stratification was obscured in the KBG grove, as the scrub species were abundant, indicating a scrub woodland formation. PKP and KLM were characterised by the abundance of a few species. The presence of a stout liana of *Secamone emetica* (gbh 35 cm), the robustness of *Cretaeva magna* (gbh 220 cm), *Syzigium cumini* (gbh 207.45 cm), *P. suberifolium* (gbh 128.7 cm) and *Tamarindus indica* (gbh 250 cm), and survival of evergreen species like *A. elaeagnoidea* and *Pamburus missionis* is botanically significant; *Polyalthia suberosa* is a rare taxon found only within the groves. The persistence of the groves until the present time is a testimony to the sacred grove status enjoyed by them.

Introduction

Sacred groves are patches of natural vegetation dedicated to local deities and protected by religious tenets and cultural traditions; they may also be anthropogenic tree stands raised in honour of heroes and warriors and maintained by the local community with religious fervour. The importance of sacred groves in conserving the local biodiversity has been acknowledged only recently, though this practice has been long back hailed by the British Forester Dietrich Brandis as an example of 'vernacular conservation' (Brandis and Grant 1868). Since the tropical forests have impressive species diversity contained in diverse formation types (Condit et al. 1996), attention has been diverted to the sacred groves of the tropical tracts in the recent past.

A systematic survey of the sacred groves of India in 1997 has recorded the existence of thousands of such groves along the plains and hills of the Indian subcontinent and confirmed their floristic richness confined within islets of diverse habitats (Ramakrishnan et al. 1998). Their plant wealth and conservation potential

were impressive enough to acknowledge them as 'mini biosphere reserves' (Gadgil and Vartak 1975). However, the surveys were largely limited to enumeration of plants only, neglecting quantitative analyses which are essential for evolving strategies for their conservation.

Despite the impetus to the sacred grove initiative in India, information on their distribution and plant wealth in the plains of the Tamilnadu–Pondicherry belt has been scanty. Meher-Homji (1986) reported the protection conferred by a termite mound protecting a forest patch at Puthupet near Pondicherry. The biodiversity and forest structure of eight sacred groves in this region have been reported recently (Visalakshi 1995; King 1997; Parthasarathy and Karthikeyan 1997; Parthasarathy and Sethi 1997; Ramanujam and Kadamban 2001). As part of a continuing research programme on the sacred groves of Pondicherry and its environs, as many as 80 groves have been enumerated and their status has been assessed on the basis of their appearance and composition (Kadamban et al. 2000). We studied the patterns of belief system and stand structure in four groves – one memorial grove, two anthropogenic stands and a formal grove, with the objective of understanding the linkage between culture and conservation. This paper describes the floristic richness and vegetation analysis of these groves and highlights their botanical significance.

Study area and sacred groves

The Coromandal coast of South India along the Bay of Bengal extends from Ramanathapuram in South Tamil Nadu to Visakapattinam in Andhra Pradesh State. This belt harbours several patches of dry evergreen forest vegetation (Champion 1936; Meher-Homji 1974), some of which are maintained as sacred groves (Parthasarathy and Karthikeyan 1997). The present study area is a tract of ca. 110×40 km^2 in which the Udaiyarappan grove of Keezbuvanagiri village (KBG), Kilialamman grove of Periyakumatti village (KLM), Pazhayachotrappan grove of Periyakattupalayam village (PKP), and Karikattu Aiyanar grove of Periya Mudaliyar Chavadi village (PMC) are situated. They lie on the east-coast highway connecting Pondicherry and Chidambaram in Tamil Nadu State.

KBG, measuring 1.0 ha, is a memorial grove commemorating the supreme sacrifice of Udaiyarappan, the Chieftain of an erstwhile Zamin. A monolithic granite carved image of Udayappan along with his consort lies in the open constituting the sanctum sanctorum. According to the villagers, the cemetery is part of a natural forest patch which has been suffering from human impacts of different kinds. KLM (1.0 ha) and PKP (0.4 ha) are anthropogenic stands of select species, called 'Thoppu' in local dialect. KLM is dedicated to Kili Aal Amman, a female deity, though a shrine for Aiyanar, the village guardian deity, also occurs nearby. Aiyanar is the presiding deity in PKP. A larger grove covering 3.16 ha exists at PMC, which is dedicated to Aiyanar but has a complex of shrines with images of several minor deities. All the groves are associated with regular worship patterns and annual festivals. Taboos and restrictions: axing of wood and collection of fallen trees and branches are banned. Public access is limited to ritualistic occasions and ceremonies only. However, the restrictions are not binding to the low-caste people, who, under

Table 1. Floristic composition of the groves.

Habit/Taxon	KBG	KLM	PKP	PMC
Herbs	13	9	9	9
Shrubs	13	8	9	7
Climbers	9	8	9	4
Liana	2	1	1	–
Parasite	–	–	–	1
Trees	18	19	12	15
Total species	55	45	40	36
Genera	53	43	38	36
Families	31	33	25	27

KBG – Keezhbuvanagiri; KLM – Kilialamman; PKP – Periya Kattupalayam; PMC – Periya Mudaliar Chavadi.

the guise of poverty, cut and remove the trees stealthily. The villagers are not honest either; 80% of the grove has been cleared for the brick-kiln industry at KBG, ca. 20% at PKP for threshing yard and 35% for auctioned cultivation at PMC. Folklores eulogising the might of Gods are narrated by the villagers who acknowledge the erosion of the belief system over the ages (Praveen Kumar Cyril 1999).

Methods

Floristic survey

Floristic composition of each grove was analysed during field visits spreaded over different seasons. Flowering twigs were collected and identified taxonomically using the publications of Gamble and Fischer (1915–1935), Henry et al. (1989) and Mathew (1981, 1982, 1991, 1993). Plots (20×20 m^2) were laid randomly in each grove excluding the temple structures. As the temples had been raised on cleared land, plots were always laid at a distance of 5 m from them. Similarly, to avoid 'edge effects' distorting the data, peripheral areas, 3 m from the margin along the boundary or access trail were excluded from the analysis except for one or two plots per site.

Phytosociology

Following Murphy and Lugo (1986), trees and lianas measuring $\geq$20 cm girth at breast height (gbh) were enumerated and the phytosociological parameters, viz. density, basal area (BA), and biovolume (BV) were determined as per Cottam and Curtis (1956). For calculating the BA of multi-stemmed trees, the girth of each stem was measured individually and added up. Species importance value (SIV) was computed by adding the figures of relative density, relative frequency and relative BA for that species, as it gives the relative contribution of species to the stand structure.

Table 2. Comparative analysis of woody taxa of the sacred groves.

Parameter	Sacred grove sites										
	ORN	OLM	PTP	TMK	KKM	SMP	KBG	KLM	PKP	PMC	MRF
No. of woody species	30	21	51	38	42	28	20	20	13	15	65
No. of genera	28	19	46	35	37	24	19	18	12	15	54
No. of families	22	14	30	26	26	16	16	16	10	13	36
Girth class (cm)	≥20	≥20	≥10	≥10	≥10	≥30	≥20	≥20	≥20	≥20	≥20
Density	1070	953	1130	674	1367	–	80	140	160	101	280
Basal area (m^2 ha^{-1})	25.55	4.31	36.8	29.5	23.75	21.54	–	–	–	–	11.14

Source: Oorani (ORN) – Ramanujam and Kadamban (2001); Olagapuram (OLM) – Ramanujam and Kadamban (2001); Puthupet (PTP) – Parthasarathy and Sethi (1997); Thirumanikkuzhi (TMK) – Parthasarathy and Karthikeyan (1997); Kuzhanthaikuppam (KKM) –Parthasarathy and Karthikeyan (1997); Suriyampettai (SMP) –King (1997); Marakkanam (MRF) –Visalakshi (1995); Keezhbuvanagiri (KBG) – present study; Kilialamman (KLM) – present study; Periyakattupalayam (PKP) – present study; Periyamudaliar Chavadi (PMC) – present study.

Results

Floristic composition

The KBG grove had 55 species belonging to 53 genera and 31 families of Angiosperms (Table 1), all confined to a small but fairly preserved part of the grove. Woody species totalled 19 (Table 2). The climbers were represented by *Abrus precatorius* (Fabaceae-Faboideae), *Capparis sepiaria* (Capparaceae), *C. zeylanica* (Capparaceae), *Cayratia pedata* (Vitaceae), *Cissus quandrangularis* (Vitaceae), *Coccinia indica* (Cucurbitaceae), *Cocculus hirsutus* (Menispermaceae), *Hemidesmus indicus* (Asclepiadaceae), *Jasminum auriculatum* (Oleaceae) and *Tinospora cordifolia* (Menispermaceae).

The KLM grove had 45 species belonging to 43 genera and 33 families. Of these, 19 were tree species, eight shrubs, nine herbs, eight climbers and one liana. The climbers were *Asparagus racemosus* (Liliaceae), *C. quadrangularis* (Vitaceae), *C. indica* (Cucurbitaceae), *Dioscorea oppositifolia* (Dioscoreaceae), *Gloriosa superba* (Liliaceae), *H. indicus* (Asclepiadaceae) and *T. cordifolia* (Menispermaceae). *Combretum albidum* (Combretaceae) (gbh 22 cm) was a stout liana.

Taxonomically, a total of 40 species belonging to 38 genera and 25 families were present in the PKP grove. Among these were 12 trees, nine shrubs, nine herbs, nine climbers and one liana. *A. precatorius* (Fabaceae-Faboideae), *Cayratia pedata* (Vitaceae), *C. hirsutus* (Menispermaceae), *Coccinia grandis* (Cucurbitaceae), *Pyrenecantha volubilis* (Icacinaceae), *Solanum trilobatum* (Solanaceae), *Tiliacora acuminata* and *T. cordifolia* (Menispermaceae) were the climbers. The only liana found was *Capparis zeylanica* (Capparaceae).

Overall, 36 species belonging to 36 genera and 26 families were recorded from the PMC grove. Habit-wise, 15 were tree species, seven shrubs, nine herbs, three climbers and two parasites. The climbers were *Capparis brevispina* (Capparaceae), *Passiflora foetida* (Vitaceae) and *Tinospora cordifolia*. *Cassytha filiformis*

(Lauraceae) and *Dendrophthoë falcata* (Loranthaceae) anchored on *A. elaeagnoidea* or *A. monophylla* were the parasites.

Population structure

There were 238 trees in 3.6 ha at PMC, 149 in 1.0 ha at KLM, 81 in 1.0 ha at KBG and 61 in 0.4 ha at PKP (Table 2). At KBG, the formation consisted of both tall and medium sized trees. *Azadirachta indica*, *Cassia siamea*, *Crataeva magna*, *Lepisanthes tetraphylla* and *Tamarindus indica* belonged to the canopy layer; *Atalantia monophylla*, *Cassia fistula* and *Strebulus asper* belonged to the under-storey. *Borassus flabellifer*, being tall and monopodial, trooped out of the sparse and disjunct canopy layer. *L. tetraphylla* had the maximum number of 20 individuals, followed by *C. siamea* ($n = 14$). The palmyra palm tree, *B. flabellifer* ($n = 11$) was the other dominant member. But the characteristically arid species *P. cinerarea* also had 13 trees. However, the low but well-spreading *P. juliflora* with its straggling branches stretching in all directions blurred the distinction between the strata. It is a heliophilic exotic invader of degraded land.

At KLM, the population was largely concentrated in four species, viz. *Calophyllum inophyllum* ($n = 75$), *Ficus hispida* ($n = 14$), *Lepisanthes tetraphylla* ($n = 22$) and *B. flabellifer* ($n = 10$). The palmyra palm tree had been planted in the drier parts of the grove. A small aroid, *Theriophonum minutum* is part of the ground vegetation. Robust trees of *C. inophyllum* were evenly distributed in the grove. However, 58 of its 75 trees were multi-stemmed and their coppices appeared in 7 to 17 clusters. Along with *Ficus racemosa*, *F. amplissima*, *Syzygium cumini*, the canopy layer was dense and continuous. The under-storey consisting of *A. indica*, *A. monophylla*, *Morinda pubescens* and *Pongamia pinnata* was uneven.

Population-wise, *B. flabellifer* with 30 specimens dominated the grove, interspersed with 12 trees of *T. indica* at PKP. A big banyan tree, *F. benghalensis* stood at the centre. Nine trees of *Atalantia monophylla*, seven of *M. pubescens* and two of *A. indica* were medium-sized and occurred randomly.

Aglaia elaeagnoidea, an evergreen species with 86 trees dominates the population at PMC, followed by *B. flabellifer* ($n = 47$) and *Pterospermum suberifolium* ($n = 40$). *Garcinia spicata* ($n = 18$), *S. cumini* ($n = 11$) and *L. tetraphylla* ($n = 25$) were sparsely distributed. Two layers, the top storey represented by *B. flabellifer*, *P. suberifolium* and *S. cumini*, and the under-storey consisting of *A. indica*, *G. spicata* and *L. tetraphylla* were distinguishable. But the latter storey was more continuous and even than the canopy layer. *B. flabellifer*, which mars the typical forest physiognomy, is a recent introduction.

Vegetation analysis

In the KBG grove, just three tamarind trees contributed to the bulk of the BV (47.97 $m^3\ ha^{-1}$) and BA (4.09 $m^2\ ha^{-1}$); the share of five trees of *C. magna* was 27.11 $m^3\ ha^{-1}$ to the BV and 3.13 $m^2\ ha^{-1}$ to the BA. The lone tree of *Lannea coromandelica*

Table 3. Phytosociological analysis of woody taxa.

Species (family)	No. of indls.	BA	BV	IVI
Keezhbuvanagiri grove				
Atalantia monophylla (Rutaceae)	1	0.03	0.21	4.20
Azadirachta indica (Meliaceae)	4	0.26	1.22	14.94
Borassus flabellifer (Arecaceae)	11	2.44	24.22	40.35
Capparis zeylanica (Capparaceae)	1	0.02	0.06	4.14
Cassia fistula (Fabaceae-Caesalpinioideae)	1	0.04	0.19	4.27
Cassia siamea (Fabaceae-Caesalpinioideae)	14	1.09	7.08	38.17
Crataeva magna (Capparaceae)	5	3.13	27.11	34.60
Flacourtia indica (Flacourtiaceae)	1	0.02	0.06	4.14
Ixora arborea (Rubiaceae)	2	0.04	0.12	8.28
Lannea coromandelica (Anacardiaceae)	1	0.92	11.95	9.92
Lepisanthes tetraphylla (Sapindaceae)	20	2.12	10.98	52.19
Prosopis cinerarea (Fabaceae-Mimosoideae)	13	1.35	10.65	38.6
Strebulus asper (Moraceae)	2	0.04	0.11	8.28
Tamarindus indica (Fabaceae-Caesalpiniodeae)	3	4.09	47.97	32.73
Kilialamman grove				
Acacia leucophloea (Fabaceae-Mimosoideae)	1	0.21	2.57	3.07
Atalantia monophylla (Rubiaceae)	4	0.25	1.41	5.21
Azadirachta indica (Meliaceae)	9	1.59	13.28	21.5
Borassus flabellifer (Arecaceae)	10	1.99	17.23	18.29
Calophyllum inophyllum (Guttiferae)	75	19.35	150.08	145.39
Ficus amplissima (Moraceae)	1	2.86	34.36	11.60
Ficus hispida (Moraceae)	14	1.05	4.93	28.29
Ficus racemosa (Moraceae)	1	0.42	3.79	3.75
Lepisanthes tetraphylla (Sapindaceae)	22	1.82	10.76	34.42
Morinda pubescens (Rubiaceae)	1	0.16	0.66	2.91
Pandanus odoratissimus (Pandanaceae)	4	0.35	2.04	5.54
Pamburus missionis (Rutaceae)	2	0.21	0.80	5.47
Polyalthia longifolia (Anonaceae)	2	0.41	4.81	6.11
Pongamia pinnata (Fabaceae-Faboideae)	1	0.24	0.94	3.17
Syzygium cumini (Myrtaceae)	1	0.06	0.32	2.59
Periyakattupalayam grove				
Atalantia monophylla (Rutaceae)	9	0.89	4.43	34.44
Azadirachta indica (Meliaceae)	2	0.41	2.33	11.30
Borassus flabellifer (Arecaceae)	30	8.04	88.4	105.76
Ficus benghalensis (Moraceae)	1	2.15	43.32	11.00
Morinda pubescens (Rubiaceae)	7	1.18	6.06	28.51
Tamarindus indica (Fabaceae-Caesalpinoideae)	12	23.71	321.42	108.98
Periyamudaliyar chavadi grove				
Aglaia elaeagnoidea (Meliaceae)	86	49.99	265.04	77.51
Anacardium occidentale (Anacardiaceae)	4	7.10	47.23	5.94
Azadirachta indica (Meliaceae)	2	2.47	17.13	3.05
Borassus flabellifer (Arecaceae)	47	41.31	529.51	45.74
Cocos nucifera (Arecaceae)	2	0.61	3.03	2.54
Drypetes sepiaria (Euphorbiaceae)	1	0.54	3.23	1.33
Garcinia spicata (Clusiaceae)	18	34.45	263.61	27.06
Lepisanthes tetraphylla (Sapindaceae)	25	35.46	197.52	32.58
Morinda pubescens (Rubiaceae)	1	0.19	0.58	1.24
Pongamia pinnata (Fabaceae-Faboideae)	1	4.59	45.95	2.46
Pterospermum suberifolium (Sterculiaceae)	40	106.67	939.79	67.84
Syzygium cumini (Myrtaceae)	11	76.29	612.99	32.70

BA – basal area; BV – bio volume; IVI – importance value indices.

contributed 95 m^3 ha^{-1} and 0.9 m^2 ha^{-1}, respectively to BV and BA. The IVI showed that five species with 53 trees cornered 60% of the values; just one species of *L. tretraphylla* had 16% of the importance value (Table 3).

Calophyllum inophyllum dominated the vegetation at KLM ($n = 75$) with high BV (150.08 m^3 ha^{-1}) and BA (19.35 m^2 ha^{-1}) followed by the lone but robust tree *F. amplissima*, contributing 34.36 m^3 ha^{-1} to BV and 2.86 m^2 ha^{-1} to BA. The multi-stemmed nature of *C. inophyllum* is a factor for cornering nearly half of the importance value (145.39). *L. tetraphylla* is a distant second (34.42).

In the PKP grove, 12 robust tamarind trees, *T. indica* were overwhelmingly dominant (BV 321.42 m^3 ha^{-1} and BA 23.71 m^2 ha^{-1}). *Borassus flabellifer* ($n = 30$), because of its numerical superiority, ranked second with 88.4 m^3 ha^{-1} and 8.04 m^2 ha^{-1}, respectively. These two tree species accounted for two-thirds of the IVI. Despite their having only nine and seven members, *A. monophylla* and *M. pubescens* together shared ca. 20% of the value. A single banyan tree (*F. benghalensis*) contributed 43.32 m^3 ha^{-1} to BV and 2.15 m^2 ha^{-1} to BA.

At PMC, the most populous share of *A. elaeagnoidea* ($n = 86$) was 265.04 m^3 ha^{-1} to BV and 49.99 m^2 ha^{-1} to BA. *Pterospermum suberifolium* ($n = 40$) also contributed 93.79 m^3 ha^{-1} to BV and 106.67 m^2 ha^{-1} to BA, which was impressive. But, just 11 robust specimens of *S. cumini* contributed 612.99 m^3 ha^{-1} and 76.29 m^2 ha^{-1}, respectively. Two other tree taxa, *G. spicata* and *L. tetraphylla*, also contributed substantially to the vegetation structure. The IVI pattern was fairly distributed between six species with the three most abundant species, *A. elaeagnoidea*, *P. suberifolium* and *B. flabellifer*, notching up the top three rankings.

Discussion

The four sacred groves at KBG, KLM, PKP, and PMC, together measuring 6 ha, accounted for 111 species belonging to 103 genera in 53 families, which is floristically significant (Tables 1 and 3). Though there were 47 woody species in all, they were not uniformly and overlappingly distributed among the groves (Table 2); only two species, *A. indica* and *B. flabellifer*, occurred in all the four groves; three species, viz. *A. monophylla*, *M. pubescens* and *T. indica*, each occurred in all but one. Certain other species were exclusive to a grove. Accordingly, 10 species in KBG, nine in KLM and six in PMC were exclusive constituents. Considering that KBG is a memorial grove and KLM and PKP are groves of select species, their diverse origin might be a reason for the apparent dissimilarity in species composition; only PMC is an ideal grove. The differences in the species composition and physiognomy of vegetation might be due to soil characteristics as well (Murphy and Lugo 1986). Accordingly, the habitat was partly swampy in the KLM grove; it was clayey in KBG and PKP, whereas it was sandy loam in PMC.

By comparison with the neighbouring groves, the present sites had a maximum of 21 species only and cannot be termed species-rich (Table 2). Puthupet (PTP) had 51 spp. in 15 ha and is the most specious grove in this region, followed by 42 in Kulandaikuppam (KKM) in 3.2 ha and 38 in Thirumanikkuzhi (TMK) in 1.2 ha.

Here, the disparity is apparently due to the lower girth class of 10 cm chosen for the study (Parthasarathy and Sethi 1997). Adopting the same 20 cm girth threshold, Ramanujam and Kadamban (2001) have accounted for 21 and 30 species from Oorani (ORN) and Olagapuram (OLM) groves, respectively. However, a maximum of 65 species has been recorded only from the Marakkanam Reserve Forest (MRF), which is the nearest natural formation, 35 km northeast of Pondicherry. It harbours a patch of tropical dry evergreen forest (TDEF) covering 245 ha. While it is true that islets of vegetation like sacred groves cannot be very speciose, the low species range recorded for the groves in general and for the study sites in particular is a pointer to the alarming rates of erosion of biodiversity.

Data on vegetation analysis indicate that the stand density of the four groves, ranging from 80 to 160 stems per hectare, compares poorly with the other groves in this coastal sector (Table 2). It is far below the 280 recorded for MRF nearby (Visalakshi 1995). Though some other groves like PTP, TMK and KKM had more stems, it is again due to the inclusion of boles less than 20 cm. However, two other sites, viz. ORN and OLM, were denser for the same girth threshold. Overall, none of the groves had the stand density range of 245–859 recorded for tropical forests (Ashton 1964; Campbell et al. 1992). As low density of trees necessitates inbreeding, reduces reproductive capability and limits variation (Ledig 1992), the presence of mostly age-old specimens at PMC is a worrisome factor.

Robust trees of *B. flabellifer* and *T. indica*, besides well-grown trees of *A. monophylla* and *M. pubescens*, characterised the PKP grove. The KLM grove, though dominated by fewer species like *C. inophyllum*, *F. hispida* and *L. tetraphylla*, is a unique habitat. Situated nearer to the backwaters, the soil is swampy in most part. The luxuriance of *Pandanus odoratissimus* and the cane-reed *Calamus rotang* around the sacred pond resembles the swampy groves of Kerala (Krishnamoorthy 1960).

Based on the data, it is not difficult to comment on the type of formations encountered. The patchy vegetation at PMC was a mixture of deciduous and evergreen trees numbering 281, forming an apparently two-layered forest. Tall and robust trees of *B. flabellifer*, *L. tetraphylla*, *P. suberifolium* and *S. cumini* constituted the upper storey. Medium sized trees of *A. elaeagnoidea*, *D. sepiaria* and *G. spicata* occurred in the lower storey. Such a two-layered structure is characteristic of TDEF, which is a special type of formation confined only to the southeast coast of India and the northwest part of Sri Lanka (Blasco and Legris 1973; Rao and Meher-Homji 1993). Based on form and content, the PMC grove could be considered a relict of an erstwhile TDEF.

In the fairly preserved part of the grove at KBG, trees of *B. flabellifer*, *L. tetraphylla* and *T. indica* constitute a storey. Medium sized trees of *A. indica*, *C. magna* and *C. siamia* formed a subcanopy layer. However, the collective dominance of armed and ligneous species like *Azima tetracantha*, *Cadaba fruticosa*, *Carmona retusa*, *Flacourtia indica*, *Premna corymbosa* and *Terenna asiatica* (<20 cm), which were young and exuberant, was unmistakable. Therefore, it resembles a scrub woodland, which could have resulted from further degradation of deciduous forests. According to Meher-Homji (1993) of the French Institute of Pondicherry, when the

number of dry days increased in the past, the survival of evergreen and deciduous elements became difficult. Sclerophyllous and armed species recruited themselves and persisted, forming a scrub jungle which is another characteristic type of vegetation in this part of India (Blasco and Legris 1973; Meher-Homji 1974, 1986). It is significant that a grove – and a memorial grove as well – harbours such a typical forest patch.

The abundance of *C. inophyllum* in KLM is interesting from sociological and economical angles too. This tree, called ironwood tree, provided the wood for making boats and catamarans of fisher-folk, who are one of the ancient communities of India. The ancient settlers could have selectively raised and protected this species in a grove and sanctified it to ensure its conservation. The presence of tall, robust and multi-stemmed specimens of *C. inophyllum* testifies to the grove's antiquity. Paying special attention to a particular tree and protecting it with religious fervour is a Hindu religious tradition, as evident from the concept of 'sacred temple tree'. A huge specimen of ironwood tree is still worshipped as the sacred tree of the temple for Goddess Karpagambal at Chennai in Tamil Nadu (Amirthalingam 1998a, b). Furthermore, agglomerations of selected tree species constituting a village grove is called 'Thoppu' in local dialect. In fact, such village groves are one of the five types of 'Nandha Vanas' attached to the local temples, as deciphered from over 300 stone inscriptions of the medieval period (3rd–15th centuries) (Krishnamurthy 1998).

The groves also house certain rare taxa. For example, *Polyalthia suberosa* at KBG, *A. elaeagnoidea* at PMC and *Pamburus missionis* at KLM are typical evergreen taxa, which seldom occur in the wilderness but for the Western Ghats about 400 km away. In addition, the groves also contained several medicinal herbs like *Hemidesmus indicus* (KBG, KLM), *Andrographis paniculata* (KBG), *Dioscorea oppositifolia* (KLM), *Gloriosa superba* (KLM) and *Tinospora cordifolia* (KLM, PMC). Trees of *C. magna* (223 cm gbh, 12 m height), *L. tetraphylla* (170 cm gbh, 16.2 m height) and *T. indica* (240 cm gbh, 12.6 m height) in KBG, *A. elaeagnoidea* (60.6 cm gbh, 8.18 m height), *B. flabellifer* (95.9 cm gbh, 13.26 m height), *P. suberifolium* (128.7 cm gbh, 7.9 m height), *G. spicata* (111.9 cm gbh, 6.9 m height) and *S. cumini* (207.45 cm gbh, 10.7 m height) in PMC were impressively tall and robust, amplifying the diachronic protection enjoyed by the groves. They further justify the claim that the sacred groves are a museum of giant trees, gene banks of economic species, and refugia for rare and relict taxa besides serving as spiritual retreats (Gadgil and Vartak 1975; Ramanujam 2000).

Concluding remarks

Despite the cultural and religious traditions protecting the groves, evidences of deleterious human impacts are plenty in the study sites and demand serious consideration. The invasion of heliophilic exotic species, *Prosopis juliflora*, into the KBG grove, and encroachment of grove proper for agricultural and clay-mining purposes indicate the slackening of the religious hold on people. As degradation of

forests and fragmentation of habitats have been rampant world-wide, preservation of natural habitats, however small they might be, has become imperative. The reorientation of the strategies for conservation of biodiversity towards village-based institutions like the groves, along with the cultural traditions associated with them (Ramakrishnan 1998), assumes significance in this context. Thus, the enumeration of the groves in the Pondicherry region and assessing their floristic wealth would provide a strong basis for evolving measures for their protection.

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