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Plant biodiversity of two tropical dry evergreen forests in the Pondicherry region of South India and the role of belief systems in their conservation

M.P. RAMANUJAM[1,*] and D. KADAMBAN[2]
[1] *Botany Laboratory, Centre for Post-graduate Studies, Pondicherry 605 008, India;*
[2] *Department of Botany, Tagore Arts College, Pondicherry 605 008, India; *Author for correspondence (e-mail: mali@md3.vsnl.net.in)*

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Abstract. Natural vegetation on the south-eastern coast of Peninsular India has now been reduced to patches, some of which are preserved as sacred groves. The plant biodiversity and population structure of woody plants (>20 cm girth at breast height; gbh) in two such groves, Oorani and Olagapuram, occurring on the north-west of Pondicherry have been analyzed. A total of 169 angiosperms have been enumerated from both sites. The Oorani grove (3.2 ha) had 74 flowering plant species distributed in 71 genera and 41 families; 30 of them are woody species, 8 are lianas and 4 are parasites. The Olagapuram grove (2.8 ha) was more species-rich with 136 species in 121 genera of 58 families; woody species were fewer (21) while 9 lianas and 3 parasites occurred. The vegetation structure indicates that the Oorani grove is a relic of tropical dry evergreen forest, whereas Olagapuram is reduced to a thorny woodland. The latter is heavily degraded as it has lost the status of a sacred grove because of its conversion to Eucalyptus plantations. The Oorani grove has an Amman temple in the centre. The attendant cultural rites and religious rituals have perpetuated the status of a sacred grove which has ensured the protection of the grove.

Key words: biodiversity conservation, sacred groves, tropical dry evergreen forest

Introduction

In India, dry tropical forests occupy 46% of the total forest cover which is largely shrinking due to lopping, overgrazing and extraction of minor and major forest produce. The high rate of extinction of tropical species aggravated by conversion of forest land for agriculture and plantations threatens to erode their biodiversity seriously (Singh and Singh 1998). In this context, conservation of biodiversity calls for reorientation of strategies wherein the cultural traditions are also incorporated (Ramakrishnan et al. 1998).

Sacred groves are patches of climax vegetation protected on religious grounds subtended by cultural practices. They have been identified all over the world and in all shades of cultures. In India, the groves have been reported from the forest ranges in the hills, leeward arid regions of the deserts and the agricultural plains as well (Ramakrishnan et al. 1998). Whereas larger groves are considered mini-biosphere

reserves, the smaller ones are also of biological value as they harbour some old and magnificent specimen of trees and climbers (Gadgil and Vartak 1975).

The south-eastern coast of South India has a type of vegetation classified as tropical dry evergreen forests (Champion and Seth 1968) which are in varying stages of degradation (Meher-Homji 1974; Rao and Meher-Homji 1993). However, certain isolated patches are reported to be preserved in their original form as sacred groves and as protected areas. Recently, the biodiversity and forest structure of four sacred groves around Pondicherry and occurring at Thirumanikuzhi, Suriampettai and Kuzhanthaikuppam and Puthupet have been studied (King 1997; Parthasarathy and Karthikeyan 1997; Parthasarathy and Sethi 1997; Visalakshi 1997). Kadamban (1998) enumerated 80 sacred groves from a sector of this coast encompassing the Marakkanam–Pondicherry–Cuddalore regions. Despite these attempts, studies on species composition and stand structure which are a prerequisite for devising proper strategies for conservation and management of biodiversity contained in the tropical dry evergreen forests/groves, are far from adequate (Kadamban and Ramanujam 1999). Also deficient is information on cultural and religious linkages to conservation (Ramakrishnan et al. 1998).

In this background, we studied the floristics of the two patches of forest in the Pondicherry bioregion and examined the role of belief system in their differential conservational status.

Methods

Study area

The study area is located on the south-eastern coastal belt of India which harbours several patches of dry evergreen forest vegetation. Two patches of such vegetation existing at Oorani (12°01′ N, 79°56′ E) and Olagapuram (12°01′ N, 79°51′ E) lying to the north of Pondicherry between Marakkanam and Tindivanam in Villupuram Revenue District of Tamilnadu (Figure 1) were taken up in the study. Both sites lie towards the southern tip but on opposite sides of the Kaliveli tank which is one of the largest wetlands along the coast of Bay of Bengal.

Climate and soil

A typical maritime tropical climate with a disymmetric rainfall regime prevails in the study area. The weather is generally humid and hot for most part of the year. The south-west monsoon contributes 20% of total rainfall in the July–September period but the retreating north-east monsoon, accounting for 61% of the total, is the principal rainy season covering October, November and December. The mean annual rainfall in the Pondicherry region was 1373 mm with 57.25 mean rainy days.

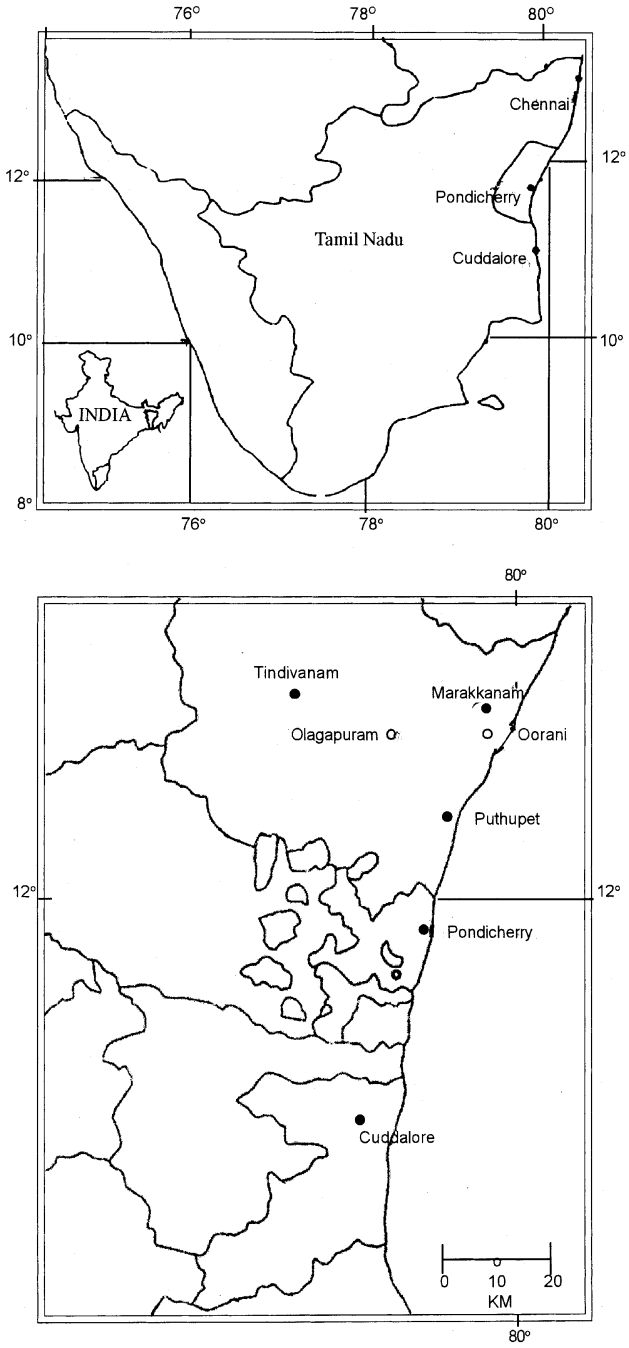

Figure 1. Geographical location of the study areas.

The minimum temperature was 19.2 °C in January and the maximum was 40 °C in June. The mean relative humidity was 77%. The weather is generally cool during December–February and the late nights are dewy. The soil is sandy to sandy loam in texture overlying the Miocene Cuddalore sandstone formation (Meher-Homji 1974, 1986). Some physico-chemical characteristics of soils from the study sites are given in Table 1.

Biocultural perspectives

The Oorani grove is 500 m away from the habitation. At the edge of the grove is an open shrine of Lord Siva under a banyan tree with a granite Bull (Nandhi) facing him. A well-built, modern, concrete temple is located in the centre of the grove. The presiding deity is Selliamman, a powerful goddess worshipped by the people. Beside the temple are broken terracotta horses.

The Olagapuram forest is an islet of vegetation amidst Eucalyptus plantations which again is contiguous to another patch of degraded scrub jungle abutting a temple of Lord Perumal. The villagers claim that the entire stretch between the temple and the present study site along with the intervening plantations was a continuous forest till the 1970s but large tracts were subsequently cleared for raising Eucalyptus plantations. People occasionally worship the termite mound (called Puthu in local dialect) but there is no icon or image of any deity.

Information on the location of the grove and the temple complex were recorded by direct observations during field visits. Traditions, beliefs, taboos, restrictions and folklore pertaining to each temple were recorded from at least 100 devotees/villagers and verified from a cross section of the devotees of different gender, caste or community. The data were immediately transferred onto a questionnaire modelled after the World Wide Fund for Nature and Nature Conservation (WWF) format. Wherever possible, the conversations were also recorded on audio tapes.

Table 1. Characteristics of soil from Oorani (ORN) and Olagapuram (OLM).

	Site	
Characteristics	ORN	OLM
Texture	Sandy	Sandy loam
pH	5.4	5.6
Organic matter (%)	2.01	1.58
Organic carbon (%)	1.16	0.80
Nitrogen (mg g^{-1})	0.72	1.40
Potassium % as K_2O	0.13	0.36
Phosphorus % as P_2O_5	BDL[a]	0.06

[a] Below detectable level.

Vegetation analyses

A total of 25 plots of 20 × 20 m adding up to 1.0 ha were marked for vegetation analysis in each site. Plots were laid contiguously but the continuity was broken to exclude the temples whenever necessary. An inventory of all plants was made but only living trees ≥20 cm girth at breast height (gbh) were numbered and analysed. This girth class was chosen in view of the low stature of the forests. For the multi-stemmed trees, girth measurements were made separately, basal area calculated and added up. Species identification was counter-checked with herbarium collections of the French Institute of Pondicherry. Nomenclature of species mostly follows Flora of Tamil Nadu (Nair and Henry 1983; Henry et al. 1987, 1989).

Species diversity

Alpha diversity pattern, i.e., woody species richness and species packing, was analyzed by calculating the Shannon index for species richness and the Simpson index for species packing as outlined by Magurran (1988). Relative density, relative frequency, relative dominance and importance value index (IVI) were calculated according to the formulae of Cottam and Curtis (1956).

Results

The Oorani grove measures 3.2 ha and there are several thickets on its periphery. The canopy is dense with very few openings. The vegetation is a mixture of tall and medium-sized trees; the ground vegetation is sparse and the bushes are rare. In contrast, the vegetation at Olagapuram spread over 2.8 ha is dominated by many short statured trees; plants are mostly low spreading, often armed with thorns and spines and are sclerophyllous. Winding footpaths caused by frequent human visits have created many gaps.

Vegetation profile

A total of 169 species of angiosperms were enumerated in the floristic survey (Table 2). Olagapuram had 136 species belonging to 121 genera and 58 families of which 35% were herbaceous elements; deciduous species were 42 and evergreens 32. *Capparis* spp., *Catunaregam spinosa*, *Flacourtia indica*, *Pterolobium hexapetalum*, *Securinega leucopyrus* were evergreens. Some like *Butea monosperma*, *Lannea coramandelica*, *Maytenus emarginatus*, *Canthium dicoccum*, *Zizyphus oenoplea*, *Buchanania axillaris*, *Dolichandrone falcata* and *Gmelina asiatica* were deciduous or brevi-deciduous. Many of the component species like *Cadaba fruticosa*, *M. emarginatus*, *Acacia chundra*, *Dichrostachys cinerea*, *F. indica*, *Scutia myrtina*, *Z. oenoplea*,

Table 2. Distribution of plants in Oorani (ORN) and Olgapuram (OLM).

No. of species	ORN	OLM
Total	74	136
Herbaceous species	15	46
Woody species		
Shrub	22	41
Tree	25	37
Liana	8	9
Evergreen	27	42
Deciduous	24	32
Parasites	4	3

Z. rugosa, *Terenna asiatica*, *Dodonea viscosa*, *Manilkara hexandra* and *G. asiatica* were sclerophyllous scrubs; most of them were armed with spines and thorns. Oorani had 74 species belonging to 71 genera and 41 families; woody species accounted for 80%. There were 27 deciduous and 24 evergreen species at Oorani but the stand was overwhelmingly dominated by *Memexylon umbellatum* and *Drypetus sepiaria*.

Species which normally grow tall, for example, *A. chundra*, *Anogeissus latifolia*, *Bauhinia recemosa*, *B. monosperma*, *Diospyros ebenum*, *Sapindus emarginatus*, etc. were very short in Olagapuram. Some others like *Azadirachta indica*, *D. ferrea*, *Walsura trifoliata* which had grown taller at the other site did not reach their normal height here; in fact, 64.56% trees were small and no tree exceeded 5 m height (Figure 3). Shrubs like *C. dicoccum*, *Carissa spinorum*, *Mimosa intsia* were clustered into bushes. Even tree species like *Chloroxylon swietenia*, *M. umbellatum* were so. The formation was almost open with a number of gaps.

In contrast, two strata were discernible at Oorani. The over storey consisted of trees in the height range of 7–12 m. *Albizia amara*, *Dalbergia paniculata*, *L. coromandelica*, *Lepisanthes tetraphylla*, *Pterospermum suberifolium* and *Syzygium cumini* belonged to this category. The canopy was denser and almost closed with the crowns overlapping. Trees of *Aglaiea elaegnoidea*, *Commiphora caudata*, *D. ebenum*, *Garcinia spicata* and *M. hexandra* grew upto 7 m and were part of the lower strata.

Woody species richness and diversity analysis

Only 30 species out of the total woody elements of 55 at Oorani, and 21 out of 87 at Olagapuram had boles of gbh $\geq$20 cm (Table 3). The diversity analysis was calculated for the individuals contained in them.

Oorani had a Shannon index of 2.08 and Simpson index of 0.22 for the woody species (Table 3) which were 2.42 and 0.13, respectively, for Olagapuram. However, the species distribution appeared to be more even in Olagapuram than in Oorani as indicated by an evenness of 0.79 and 0.61, respectively.

Table 3. Comparative vegetation analysis of tropical dry evergreen forest (TDEF) sites.

Parameter	TDEF sites						
	ORN	OLM	PTP	TMK	KKM	SMP	MRF
No. of woody species	30	21	51	38	42	28	65
No. of genera	28	19	46	35	37	24	66
No. of families	22	14	30	26	26	16	36
Girth class (cm)	≥20	≥20	≥10	≥10	≥10	≥30	≥20
Simpson index	0.22	0.13	0.21	0.13	0.17	0.77	–
Shannon index	2.08	2.42	2.28	2.57	2.35	1.61	1.61
Evenness	0.61	0.79	0.44	0.71	0.63	0.85	–
Density	1070	953	1130	674	1367		280
Basal area ($m^2\ ha^{-1}$)	25.55	4.31	36.8	29.5	23.75	21.54	11.14

Source: Oorani (ORN): Present study; Olagapuram (OLM): Present study; 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).

Vegetation structure

The stand density was $1070\ ha^{-1}$ in Oorani and was slightly higher than the 953 at Olagapuram. The difference in the basal area contribution was more glaring; whereas Oorani had $25.55\ m^3\ ha^{-1}$, it was a mere $4.31\ m^2\ ha^{-1}$ for Olagapuram (Table 3). The pattern of girth class distribution ends abruptly in Olagapuram as no specimen exceeded 80 cm gbh (Figure 2). In fact, more than 70% of the stems were in the girth class of 20–40 cm; only two were in 60–80 cm category. However, the trees of Oorani were distributed in more girth and height classes (Figures 2 and 3). The biovolume was $41.5\ m^3\ ha^{-1}$ at Oorani but a mere $1.85\ m^3\ ha^{-1}$ at Olagapuram (Table 3).

Family and species representation

Fabaceae was the most speciose family at both sites (Table 4). At Oorani, Meliaceae and Anacardiaceae had three species each while Ebenaceae, Myrtaceae and Rutaceae had two each; 14 families were represented by just one species each. At Olagapuram, the species-rich families were fewer; Anacardiaceae, Euphorbiaceae and Rubiaceae had two species each whereas nine families were monotypic.

Five of the woody species in Oorani and two of Olagapuram were represented by one or two individuals only. Although only one tree of *Semecarpus anacardium* (height 15 m; gbh 170 cm) occurred at Oorani, it accounted for the biovolume of $4.39\ m^3$ and basal area of $2.72\ m^2$ and IVI of 15.85. Considering that there were 642 individuals at the Oorani grove, this tree stood out impressively.

The IVI for the species and families (Table 4) indicate that at Oorani, Melastomataceae ($n = 237$), Euphorbiaceae ($n = 177$), Sterculiaceae ($n = 31$), Anacardiaceae ($n = 29$), and Fabaceae ($n = 12$) were the dominant families. Boraginaceae,

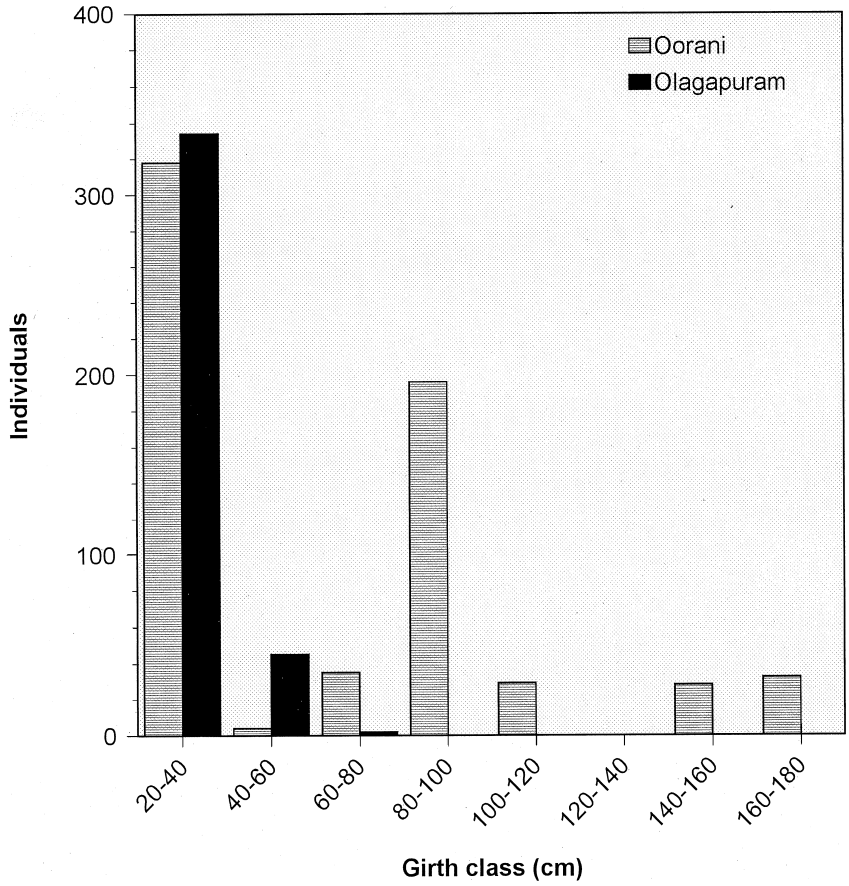

Figure 2. Girth class distribution of woody taxa in the study areas.

Celastraceae, Meliaceae, Moraceae, Sapotaceae and Verbenaceae were represented by more than five individuals. At the species level, *Memecylon umbellatum* (46.55), *D. sepiaria* (41.63), *P. suberifolium* (26.84), *L. coramandelica* (22.65), and *L. tetraphylla* (16.65) dominated in that order. *M. umbellatum* was dominant at Olagapuram (42.44) also followed by *A. odoratissima* (30.72) and *B. axillaris* (30.72). Family-wise Fabaceae (73.13), Melastomataceae (42.44) and Anacardiaceae (39.27) were dominant here.

The insidious effects of diachronic biotic stress are evident in both sites as there are several unique formations called thickets abutting the margins. Each thicket has a few stunted trees in the centre surrounded by dense shrubs; the thorny stragglers overgrow them while a few herbaceous plants find comfort in the shade provided; sometimes, the terrestrial orchid *Eulophia epidendraea* or *Sanseveria roxburghiana* are found underneath the thickets. *A. lebbeck*, *Atalantia monophylla*, *B. monosperma*, *L. tetraphylla*, *Phoenix sylvestris* are the common tree species, the shrubs being

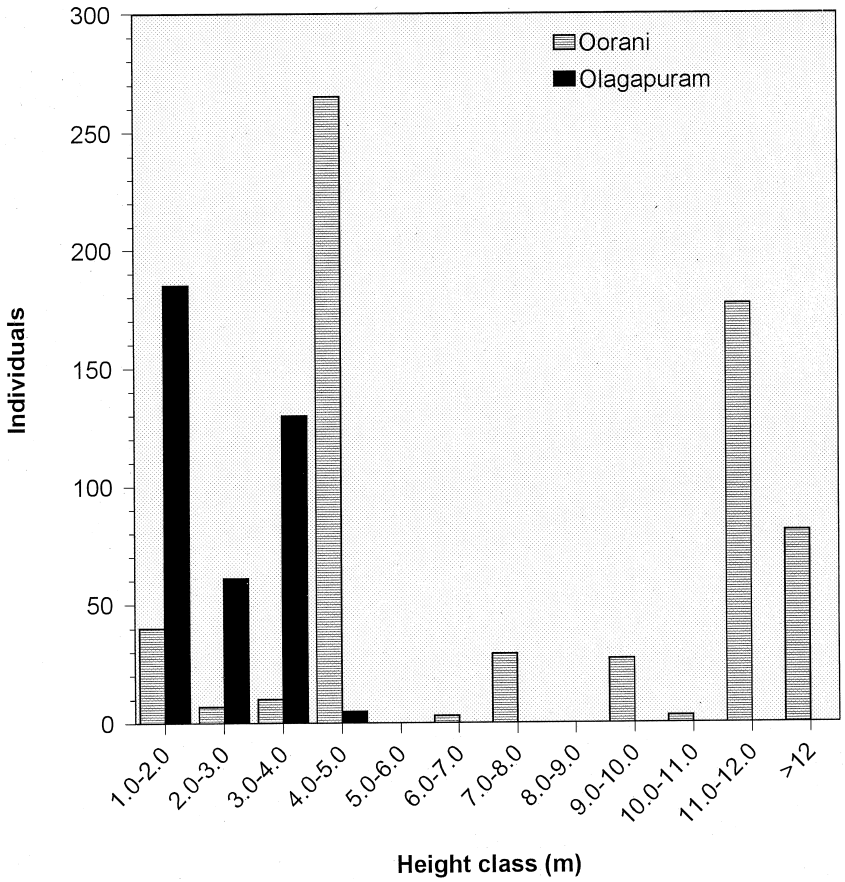

Figure 3. Height class distribution of woody taxa in the study areas.

Allophyllus serratus, *C. spinorum*, *D. ferrea*, *M. umbellatum*, etc. Climbers like *Cansjera rheedii*, *Capparis spinosa*, *Cissus quadrangularis*, *Gloriosa superba*, *Hemidesmus indicus*, *Tylophora indica*, etc. clothe the whole thickets. Occasionally, the plants of *Dendrophthoe falcata* are parasitic on *L. tetraphylla* or *A. lebbeck* while the wiry stems of another parasite, *Cassytha filiformis* twine around the branches of *A. serratus*.

Discussion

While reviewing the vegetation in the dry tropics, Murphy and Lugo (1986) found a range of 35–90 for species richness and a basal area range of 17–40 m^2 ha^{-1}. The number of woody species 30 and 21 reported for Oorani and Olagapuram respectively, is well within this range. This also compares well with the 28 species of Suriampettai

Table 4. Most important families of Oorani (ORN) and Olagapuram (OLM).

	ORN				OLM			
Family	Genus	Sp.	Indls.	FIV	Genus	Sp.	Indls.	FIV
Anacardiaceae	3	3	29	39.86	2	2	64	39.27
Arecaceae	1	1	5	10.27	–	–	–	0
Combretaceae	–	–	–	0	1	1	11	9.21
Euphorbiaceae	1	1	177	41.23	2	2	13	20.04
Fabaceae	3	4	10	26.17	4	6	69	73.13
Melastomataceae	1	1	237	46.55	1	1	108	42.44
Meliaceae	3	3	9	10.24	1	1	2	25.16
Moraceae	1	1	3	9.73	–	–	–	0
Myrtaceae	2	2	21	14.23	–	–	–	0
Rubiaceae	1	1	6	4.91	2	2	34	28.7
Rutaceae	2	2	7	7.49	1	1	24	17.02
Sapindaceae	1	1	29	16.65	–	–	–	0
Sapotaceae	1	1	4	3.55	1	1	23	13.48
Sterculiaceae	1	1	31	26.84	–	–	–	0

FIV: family index value, Indls.: individuals, Sp.: species.

and 38 of Thirumanikkuzhi and 42 of Kulandhaikuppam in this region (Table 4). Marakkanam (MRF) is the most speciose site with 65 species followed by Puthupet which had 51 species. Of the seven sites compared, Marakkanam is a reserve forest and the rest are sacred groves – all harbouring tropical dry evergreen forest (TDEF) patches (King 1997; Parthasarathy and Karthikeyan 1997; Parthasarathy and Sethi 1997; Visalakshi 1997). Although all these sites are in the same coastal stretch, Puthupet is just 10 km away on the south; Marakkanam is still closer and lies 5 km to the north.

Table 5. Most important species of Oorani (ORN) and Olagapuram (OLM) and their contribution to the important value index (IVI).

	ORN			OLM		
Species	Indls.	BA	IVI	Indls.	BA	IVI
Albizia amara	5	0.40	6.23	3	0.45	7.25
A. odoratissima	–	–	–	35	0.20	30.72
Borassus flabellifer	5	1.02	10.27	–	–	+
Buchanania axillaris	–	–	–	63	0.08	30.72
Chloroxylon swietenia	5	0.03	2.87	–	–	+
Drypetes sepiaria	177	0.71	41.63	–	–	–
Ficus benghalensis	3	1.13	9.73	–	–	–
Lannea coromandelica	27	1.82	22.65	1	0.13	9.07
Lepisanthes tetraphylla	29	0.41	16.65	–	–	–
Memecylon umbellatum	237	0.03	46.55	108	0.05	42.44
Pterospermum suberifolium	31	2.22	26.84	–	–	–
Syzygium cumini	17	0.64	11.52	–	–	–

Indls: individuals; BA: basal area.

Data on diversity analysis, viz. Shannon index of 2.08 and 2.28, Simpson index of 0.22 and 0.13 and evenness index of 0.61 and 0.79, respectively for Oorani and Olagapuram, are comparable to one or more of the sites. Of the seven sites, the lowest Shannon index of 1.61 was for Suriampettai and Marakkanam. Thirumanikkuzhi had the maximum of 2.57. As for the distribution, only at Puthupet the pattern was less even.

The stand density was 1070 stems at Oorani and 953 of >20 cm gbh at Olagapuram. Two other groves, Kuzhanthaikuppam and Thirumanikkuzhi, had 1367 and 974 stems per hectare, respectively. However, calculated for 10 cm gbh, the Puthupet grove had 1338 ha^{-1} (Parthasarathy and Sethi 1997). Despite enjoying the status of a reserve forest, Marakkanam had only 280 stems. Nonetheless, these data could be well within the range of 245–859 trees (>30 cm gbh) reported for tropical forests (Richards 1952; Ashton 1964; Campbell et al. 1992).

Although the basal area value of 25.55 for Oorani is closer to 22.45 $m^2\,ha^{-1}$ for the groves of Kulandhaikuppam and Thirumanikkuzhi, the Puthupet grove had a greater basal area of 32.8 $m^2\,ha^{-1}$ (Parthasarathy and Sethi 1997). For the dry tropics, the prescribed range was 17–40 $m^2\,ha^{-1}$ (Murphy and Lugo 1986) while the pantropical average was 32 $m^2\,ha^{-1}$ (Dawkins 1959). By comparison, Olagapuram is relegated to the last (4.31 $m^2\,ha^{-1}$), indicating a poor forest formation.

Viewed together, the stand structure and distribution pattern (Table 3; Figures 2 and 3) indicate that Oorani is an assemblage of tall and medium-sized trees resembling a forest while Olagapuram is a severely degraded patch of vegetation.

Whether the differences in the vegetation pattern are due to site heterogeneity as claimed by Parthasarathy and Karthikeyan (1997) for two neighbouring groves in the same edapho-climatic zone needs to be examined. The soil was sandy loam and the nutrient status differed only slightly (Table 1). Both were closer to a permanent water source, the Kaliveli tank, though situated on opposite sides. Hence, the reasons for the contrasting physiognomy could be due to the impacts of human interference. The dominance of herbs and shrubs, 99 out of the total 136, is a point in support. The data on height and girth class analysis further reveal that although there were 87 woody species including 37 trees, only 21 species had individuals exceeding the threshold limits. It is apparent that the trees were not allowed to grow to their natural sizes implying a chronic human interference.

The forests on the south-eastern coast are now present in patches. They are in various stages of degradation, representing the transitional stages from tropical evergreen or deciduous forest to scrub woodland (Meher-Homji 1994, 1995). The original Miocene evergreen tracts of the south-eastern coast were gradually degraded to deciduous forests and then to scrub woodlands consequent to the climatic transition through the millennia. Since moisture was a critical factor in the retention of greenness, dry periods extending over 6 months accelerated the decline towards deciduousness. Further, dwindling rainfall made the survival of the evergreens difficult and tilted the ratio in favour of deciduous elements (Meher-Homji 1992). In the long run, the vegetation

was converted to patches of scrub jungle consisting of short-statured trees with a high proportion of armed and ligneous species as found between Point Calimere in the south to Marakkanam in the north along the coast in Tamilnadu (Blasco and Legris 1973). Recognizing the ecological conundrum it presented, Meher-Homji (1974, 1986) comprehensively analysed the vegetational types in this region and graded them according to the degree of degradation. Although a few patches remain as tropical dry evergreen forest where deciduous and evergreen species co-exist in different proportions, several of them have been further degraded to scrub jungles and are described as associations of dominant species (Meher-Homji 1974, 1986).

Accordingly, the formation at Oorani which has a fair proportion of deciduous and evergreen elements, can be described as an association of *M. umbellatum–D. sepiaria–P. suberifolium* and Olagapuram as *M. umbellatum–A. odoratissima–B. axillaris* association. The neighbouring grove at Puthupet is an association of *F. indica–M. umbellatum–C. dicoccum* (Parthasarathy and Sethi 1997) and in Marakkanam, it is *D. sepiaria–Strychnos colubrina–M. umbellatum* formation (Balasubramanian 1977). Six species, *D. sepiaria*, *M. hexandra*, *M. umbellatum*, *P. suberifolium*, *Carmona retusa* and *Garcinia spicata* are characteristic constituents of tropical dry evergreen forest of interior Tamil Nadu state. These are considered 'filler species' that intrude to fill the lacunae created by the disappearance of deciduous elements (Meher-Homji 1974). It is significant that all these species have also been recorded in the present study.

The Olagapuram patch resembles the adjoining Marakkanam Reserve Forest in species composition but differs vastly in stand structure; the latter is preserved as one of the best tropical dry evergreen forest formations which may be primarily due to the protection conferred by declaring it a reserve forest (Balasubramanian 1977). The other grove at Oorani shares several features, like the two layered strata, robust growth of trees and continuous canopy layer, with the Puthupet sacred grove which has been characterized as tropical dry evergreen forest (Parthasarathy and Sethi 1997) as described by Blasco and Legris (1973).

Conservational relevance

Certain observations are of botanical/conservational significance too. A single tree of *Semecarpus anacardium* (15 m tall; 170 cm gbh; biovolume 4.39 m^3; BA 2.72 m^2) accounted for an IVI of 15.85. Such giant specimens are characteristic of sacred groves as vouched by Vartak (1983) who described the groves as natural museums of living giant trees. Gadgil and Vartak (1976) reported a solitary liane of *Entada phaseoloides var. pursaetha* (>40 cm gbh) in an Uttara Kannada grove. Huge specimens of *Prosopis cineraria*, *Salvadora oleoides* and *C. decidua* are found in the Orans of Rajasthan (Meher-Homji 1986). *Pleurostylia opposita* of Celastraceae assuming a small tree habit was found only in Oorani and is reportedly next found at Point Calimere, about 240 km away. Likewise, two specimens of *C. strictum* occurred in

a grove of Maharashtra, which are otherwise confined to the Western Ghats 200 km southwards (Gadgil and Vartak 1976). *Derris ovalifolia* is reported to be an endangered taxon (Thothathri 1983; Ahmedullah and Nayar 1986). Mathews (1996) could relocate this taxon only after considerable difficulty.

At Olagapuram, the insectivorous plant, *Drosera burmannii*, the partial root parasite, *Striga asiatica* and *Osbeckia zeylanica* occurred in the open; *Ceropegia juncea* a climber and *Cleistanthus collinus*, an abundant bushy plant were again confined to Olagapuram only. Of these, *D. burmanii* is found in the adjoining Marakkanam forest (Balasubramanian 1977) and next at the Passamur hillock which is about 70 km northwest (Maheswaran et al. 1995). *Scilla hyacynthiana* and *Sida schimperiana* grow wild in the scrub jungles only (Balasubramanian 1977).

Biocultural perspectives

It is a paradox that the forest patch at Olagapuram was a part of the 384 ha forest area which enjoyed the status of the sacred grove earlier. With the creation of ca. 375 ha commercial Eucalyptus plantations, the present patch of forest has been vastly separated from the temple of Lord Perumal, which now lies about 2 km away. Understandably, it lost the status of a sacred grove and the consequential protection from human interference. It is a common place observation that people extract minor timber from *Cordia monoica*, *A. leucophloea* and *B. axillaris* for making agricultural implements; the traditional medical practitioners uninhibitedly collect medicinal plants; grazing and firewood collection go on unrestrictedly. Having lost the status of a sacred grove, the vegetation suffered from multi-factorial human impacts and was reduced to a patch of scrub jungle as it now exists.

From the protection angle, the presence of an Amman temple in the centre of the Oorani forest is significant in this context. It has long been maintained as a sacred grove. The people of the adjoining villages have an abiding faith in the prowess of the presiding deity. Hence, the extractive or consumptive practices are tabooed. Human visits are proscribed but for the ritualistic ceremonies of tonsuring of head cum earboring of the first-born child in the family. The three-day annual festival in the months of April–May is the only occasion when the villagers congregate in large numbers. Day-long prayers accompanied by the playing of musical instruments, sacrificing the goat and offering the cooked meat to the deity amidst chanting of verses mark the festivities. The outcome of such a blind faith is the main reason for the continued existence of this grove.

The present study, while inventorising the biodiversity and assessing the botanical significance of the two forest patches along the south-eastern coast of India, has also validated the recent shift (Ramakrishnan et al. 1998) in the conservational strategy towards Man and his religious and cultural traditions. The concept of sacred groves appears to be an efficacious tool in biodiversity conservation worth continuing into the next millennium.

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References

Ahemadullah M and Nayar MP (1986) Endemic Plants of Indian Region. Vol. I. Botanical Survey of India, Howrah, India

Ashton PS (1964) A quantitative phytosociological technique applied to tropical mixed rain forest vegetation. Malaysian Forester 27: 304–317

Balasubramanian K (1977) Biotaxonomical studies on the Kurumburam Reserve Forests, Coromandel Coast. PhD Thesis. Annamalai University, Annamalai Nagar, India

Blasco F and Legris P (1973) Dry evergreen forest of Point Calimere and Marakanam. Journal of Bombay Natural History Society 70: 279–294

Campbell DG, Stone JL and Rosas A Jr (1992) A comparison of the phytosociology and dynamics of three floodplain (Varzea) forest of known ages, Rio Jurua, Western Brazilian and Amazon. Botanical Journal of Linnean Society 108: 213–237

Champion HG and Seth SK (1968) A Revised Survey of the Forest Types of India. Government of India Press, New Delhi

Cottam G and Curtis JT (1956) The use of distance measure in phytosociological sampling. Ecology 37: 451–460

Dawkins HC (1959) The volume increment of natural tropical high forest and limitations of improvements. Empire Forest Review 38: 175–180

Gadgil M and Vartak VD (1975) Sacred groves of India: a plea for continued conservation. Journal of Bombay Natural History Society 72: 314–320

Gadgil M and Vartak VD (1976) The sacred groves of western ghats in India. Economic Botany 30: 152–160

Henry AN, Chithra V and Balakrishnan NP (1989) Flora of TamilNadu, India. Vol III. Botanical Survey of India, Coimbatore

Henry AN, Kumari GR and Chithra V (1987) Flora of Tamil Nadu, India. Vol II, Botanical Survey of India, Coimbatore

Kadamban D (1998) Biocultural perspectives and plant diversity of sacred groves and traditional medical knowledge in Pondicherry environs. PhD thesis, Pondicherry University, Pondicherry

Kadamban D and Ramanujam MP (1999) Sacred groves of Pondicherry bioregion: cultural connections to conservation of biodiversity. In: National Symposium on Emerging Trends in Plant Sciences, March 15–17. 1999 Abstract No 5.2, pp 41–42. Department of Botany, Sri Venkateswara University, Tirupati, India

King O (1997) Botanical and socio-cultural studies on sacred groves in Cuddalore District, Tamil Nadu, MPhil Dissertation, University of Madras. Department of Botany, Madras Christian College, Chennai, India

Magurran A (1988) Ecological Diversity and its Measurement. Princeton University Press, Princeton, New Jersey

Maheswaran B, Dayanandan P and Narasimhan D (1995) Miniature sacred grove near Vedanthangal Bird Sanctuary. In: Second Congress on Traditional Science and Technology of India. 26–31 December 1995, Anna University, Chennai, India. Abstract No Bio. 3

Mathew KM (1996) The distribution of the little known and rare *Derris ovalifoia* (Leguminosae: Papilionoideae) extended. Kew Bulletin 51: 561

Meher-Homji VM (1974) On the origin of the tropical dry evergreen forest of South India. International Journal of Ecology Environmental Science 1: 19–39
Meher-Homji VM (1986) Puthupet: a sacred termite-mound protects a forest. Blackbuck. 2: 1–4
Meher-Homji VM (1992) Evolutionary studies in plant geography. Biological Education 7: 262–277
Meher-Homji VM (1994) Climate changes over space and time: the repercussions on the flora and vegetation. Paleobotanist 42: 225–240
Meher-Homji VM (1995) Vegetation diversity in Peninsular India and its status of conservation. In: Chawan DD (ed) Environmental and Adaptive Biology of Plants, pp 3–6. Scientific Publishers, Jodhpur
Meher-Homji VM (1996) Endangered vegetational types of Peninsular India. The Botanica 46: 18–24
Murphy PG and Lugo AE (1986) Ecology of tropical dry forest. Annual Review of Ecology and Systematics 17: 67–88
Nair NC and Henry AN (1983) Flora of Tamil Nadu. Vol I. Botanical Survey of India, Coimbatore
Parthasarathy N and Karthikeyan R (1997) Plant Biodiversity inventory and conservation of two tropical dry evergreen forests on the coromandel coast, South India. Biodiversity and Conservation 6: 1063–1083
Parthasarathy N and Sethi P (1997) Trees and liana species diversity and population structure in a tropical dry evergreen forest in South India. Tropical Ecology 38: 19–30
Ramakrishnan PS, Saxena KG and Chandrashekara UM (1998) Conserving the sacred: For Biodiversity Management, UNESCO, Oxford and IBH Publ., New Delhi
Rao TA and Meher-Homji VM (1993) Dry coastal Ecosystem of the Indian sub-continent and islands. In: Van der Maarel E (ed) Ecosystem of the World. 2B. Dry Coastal Ecosystems: Africa, America, Asia and Oceania, pp 151–164. Elsevier, Amsterdam
Richards PW (1952) The Tropical Rain Forest. Cambridge University Press, London
Singh KP and Singh JS (1988) Certain structural and functional aspects of dry tropical forests and savanna. International Journal of Ecology and Environmental Sciences 14: 31–45
Thothathri K (1983) Studies in Leguminosae: 31. New taxa and notes on *Dalbergia* L F and Derris Lour., Proceedings of Indian Academy of Sciences (Plant Science) 92: 23–28
Vartak VD (1983) Observation of rare, imperfectly known and endemic plants in the sacred groves of Western Maharashtra. In: Jain SK and Rao RR (eds) An Assessment of Threatened Plants of India, pp 169–178. Botanical Survey of India, Howrah, India
Visalakshi N (1995) Vegetation analysis of two tropical evergreen forests in Southern India. Tropical Ecology 36: 117–127