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Sacred groves in southern eastern ghats, India: Are they better managed than forest reserves?

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Abstract: We test the generally held belief that sacred forests are better managed than forest reserves. Towards this end, tree diversity, population structure and their relation to site disturbances were studied in five replicate stands each of sacred forests and reference reserve forests in southern Eastern Ghats of Andhra Pradesh. In each of the study sites, two belt transects of size 5 x 1000 m were laid down randomly for assessing tree species. A total of 7836 trees belonging to 158 species were inventoried in all the stands. The stands in the sacred forests were more diverse, had higher basal area, and showed fewer signs of disturbance than the reference forest stands, supporting the view that local communities afford better protection and management to sacred groves. We suggest that the long-term sustenance of biodiversity in sacred forest sites require an integrated approach involving local communities as well the government sector.

Resumen: Pusimos a prueba la creencia generalizada de que los bosques sagrados están mejor manejados que las reservas forestales. Para ello, se estudió la diversidad de árboles, la estructura poblacional y su relación con disturbios del sitio en cada uno de cinco rodales replicados de bosque sagrado y de bosques de reserva de referencia en el sur de los Ghates Orientales de Andhra Pradesh. En cada sitio de estudio se trazaron aleatoriamente dos transectos de banda de 5 × 1000 m para evaluar a las especies arbóreas. Se inventariaron en total 7836 árboles pertenecientes a 158 especies en todos los rodales. Los rodales en los bosques sagrados fueron más diversos, tuvieron una mayor área basal y mostraron menos signos de disturbio que los bosques de reserva de referencia, lo cual apoya el punto de vista de que las comunidades locales ofrecen una mejor protección y un manejo más adecuado a los bosques sagrados. Sugerimos que el mantenimiento a largo plazo de la biodiversidad en los sitios de bosque sagrado requiere un enfoque integral que involucre tanto a las comunidades locales como al sector gubernamental.

Resumo: Nós testamos a crença generalizada de que as florestas sagradas são mais bem geridas do que as reservas florestais. Para esse fim, estudámos, numa amostra de cinco parcelas replicadas em cada floresta sagrada e reserva florestal no sudeste dos Ghats em Andhra

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Pradesh, a diversidade arbórea, a estrutura da população e suas relações com as perturbações dos sítios. Para avaliar as espécies de árvores foram estabelecidas aleatoriamente dois transeptoscom a dimensão de 5 x 1000 mem cada um dos locais do estudo. No conjunto de todas as parcelas foram inventariadas 7.836 árvores, pertencentes a 158 espécies. As parcelas nas florestas sagradas apresentaram maior diversidade, maior área basal, e mostraram poucos sinais de perturbação quando comparadas com as dos povoamentos florestais de referência, apoiando a visão de que as comunidades locais podem proporcionar uma melhor protecção e manejo de bosques sagrados. Sugerimos que a sustentabilidade a longo prazo da biodiversidade em sítios florestais sagrados exige uma abordagem integrada envolvendo as comunidades locais, bem como das autoridadesdo sector.

Key words: Disturbance, Eastern Ghats, population structure, reserve forest, sacred grove, tree diversity, tropical forest.

Introduction

Sacred groves are patches of native vegetation traditionally protected by local communities, and are unique, and significant, examples of *in situ* biodiversity conservation (Sunitha & Rao 1999; Upadhaya *et al.* 2003). The nature of religiousness associated with sacred groves suggests that the practice of sacred groves dates back to the nomadic hunter-gatherer age of human history (Gadgil & Vartak 2004). It is generally believed that, owing to their religious significance, sacred groves are better protected and managed, and hence harbour richer plant diversity than other forests (Gadgil & Vartak 1975), though this has not been substantiated through systematic quantitative analyses. We compared plant diversity of sacred forests with that of reference reserve forest stands in the southern Eastern Ghats of Andhra Pradesh to test the hypothesis that sacred forest sites are better managed than reserve forest stands.

There are a number of sacred groves all across India. The state of Andhra Pradesh, alone, has over 500 sacred groves (Anon. 1996), locally known as *Pavithravanalu* (Rao *et al.* 2001). The sacred groves of Southern Andhra Pradesh have immense significance as the region covers a center of plant diversity, viz., the Nallamalais, and an endemic centre, the Tirupathi - Kadapa hills (also referred to as the Seshachalam hills). A total of 100 major groves have been recorded from the Southern Andhra Pradesh region, and together they are home to about 1100 wild and naturalized vascular plant species (Rao 1998). The area in which the present study was conducted is part of the Tirupati-Kadapa hills, in the Chittoor district of Andhra Pradesh.

Materials and methods

Study area

The study was conducted in 10 sites located in Chittoor East and West forest divisions (12° 37' N to 14° 8' N and 78° 14' E to 79° 55' E) (Fig. 1). Five of the 10 sites represent sacred forest (SF): Sadasivakona (SDK), Singirikona (SGK), Kailasakona (KLK), Bupathayyakona (BTK), and Talakona

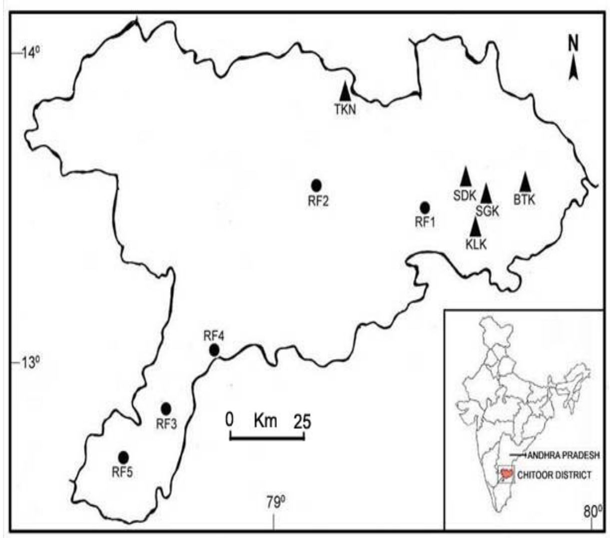

Fig. 1. Map showing the relative location of the study sites in Chittoor District of Andhra Pradesh. (Inset: map showing the location of Chittor District within the state of Andhra Pradesh in India).

Table 1. Tree density (individuals > 30 cm DBH), basal area, species richness, and diversity for the 10 sacred forest and reference forest sites studied. Also shown are cumulative disturbance scores calculated for each of the sites (see text for explanation).

Variables	Sacred Forest Sites					Reference Forest Sites				
	SDK	SGK	KLK	BTK	TKN	RF1	RF2	RF3	RF4	RF5
Location	N13°32' E79°35'	N13°27' E79°38'	N13°22' E79°37'	N13°28' E79°37'	N13°49' E79°12'	N13°26' E79°30'	N13°35' E79°12'	N12°51' E 79°34'	N13°7' E78°41'	N12°46' E78°24'
Size (ha)	35	30	25	25	50	NA	NA	NA	NA	NA
No. of species	55	46	42	47	66	31	46	41	40	31
Stand density (stems ha^{-1})	975	937	929	1018	999	575	595	732	613	563
Basal area (m^2 ha^{-1})	16.599	27.9	24.3	21.7	31.7	11.6	13.8	10.5	15.7	14.7
Shannon index	3.291	3.216	2.939	3.28	3.96	2.68	3.147	3.222	3.234	2.902
Total Cumulative Disturbance Score	3	3	4	3	2	10	6	7	10	11

(TKN); the other five sites are reference reserve forest (RF) stands (Table 1). The sites were selected based on field observations to represent the entire range of conditions in terms of topography, plant diversity, canopy cover, and disturbance. The approximate area of the five sacred groves ranges from 25 - 50 ha (Table 1); the area estimates are based on nearby village devotees' perceptions. All the study sites are composed of dry deciduous type of vegetation (Champion & Seth 1968) and are located at an elevation range of 400 - 750 m above MSL. The study sites experience a mean annual temperature of 30 °C and annual rainfall of about 935 mm, and are influenced by both the south-west and north-east monsoons. The terrain is largely hilly, with boulders and sandy soil, but there are a few areas that have well drained black soils with high soil moisture. Human habitations are located within a radius of 5-16 km of all the SF and RF sites.

Lord Shiva is the chief deity in all the five sacred groves. The local temple trusts manage the sanctum sanctorum in the sacred groves, and since the groves fall in reserve forest areas, the forest department manages the plant resources. All the groves selected for the present study have perennial water sources. Annual celebrations are held in the sacred groves for 3 days during the festival of Sivarathri (in March). Hundreds of people from nearby villages and towns attend the festivals. The reference forest stands are part of the Chittoor Reserve Forest, which is fully managed by the forest department.

Believing trees to be the abode of gods and ancestral spirits, the local communities have established rules and customs to ensure protection through prohibition of the felling of trees, the collection of any material from the forest floor, and the killing of animals. Despite these traditional restrictions, however, all the sites experience various levels of human disturbance. The sacred sites have been subject to moderate biotic pressures over the years, such as selective tree felling for timber and the extraction of non-timber forest produce. Cattle grazing has also been noticed in four of the five sacred forests (SDK, SGK, BTK and TKN) and occasional human-caused fires, to encourage grass growth for livestock, are known to occur in two of the sites (SGK and KLK). Disturbance scores were assigned to all 10 SF and RF sites based on 6 factors, namely, signs of lopping, the presence of cut stumps, soil removal, grazing, fire, and invasive weeds. The presence of various types of disturbance was assessed qualitatively, and scored as absent (0), low (1), medium (2), or high (3) to arrive at a cumulative score of disturbance (Table 1).

Sampling design and measurements

In all the 10 study sites, two belt transects of size 5 x 1000 m (totaling to 1 ha) were laid at random. Depending on the shape of the forest stand, these transects were split into 2 or 5 sub-transects of size 5 x 500 m or 5 x 200 m, respectively. All trees ≥ 30 cm diameter at breast height (DBH) encountered in the sampled units were enumerated. For multi-stemmed trees, bole diameter was measured separately for each stem, and then basal area was calculated and summed. Voucher specimens of the representative taxa were collected, identified, and made into a herbarium. The relationship between species richness and disturbance score was analysed using the Spearman rank correlation (Zar 1999). Floristic diversity was measured using the Shannon-Wiener index (Shannon & Weaver 1963), H', such that:

$$H' = -\sum (ni/N) \ln (ni/N)$$

where, ni = number of individuals belonging to the ith species

N = total number of individuals in the sample.

In addition, stands were compared with the help of the Jaccard similarity index (Jaccard 1901), SJ, such that:

$$SJ = C/a+b+C$$

where, C is the number of species shared by two sites.

a and b are the number of species unique to each of the sites.

Trees were grouped by diameter classes, viz., 30 - 49, 50 - 69, 70 - 89, and > 90 cm; and were analyzed for species richness, density and basal area. To examine the species similarity among the SF and RF sites, an agglomerative hierarchical clustering analysis has been performed and represented as a dendrogram based on Jaccard coefficient similarity index using Biodiversity pro (1997).

Results and discussion

Disturbance scores in study sites

The cumulative disturbance scores for SF sites ranged from 2 to 4, while the RF sites had cumulative disturbance scores that ranged from 6 to 11 (Table 1). This indicates prioritized conservation efforts by local communities in the SF stands, rather than in the RF stands.

All six factors of disturbance were observed in the RF sites, whereas cut stumps were observed in none of the SF sites, and lopping was observed in only one of the five SF sites. Man-made fires, grazing, and the presence of large populations of invasive weeds were observed to a much greater extent in RF stands compared with SF stands. The common invasive species found in both SF and RF sites are *Lantana camara* var. *aculeata* and 'congress weed,' *Parthenium hysterophorus.*

Species richness

A total of 158 tree species (≥ 30 cm DBH) representing 110 genera and 50 families were recorded in all the sampled units of the ten study sites (Appendix Table 1)). Of the 158 species, 156 were angiosperms and 2 were the gymnosperms *Cycas beddomei* and *C. circinalis*. The dominant family was Euphorbiaceae represented by 18 species, followed by Rubiaceae (14 species), Moraceae (10 species), Mimosaceae (7 species), Fabaceae and Rutaceae (with 6 species each), and Anacardiaceae, Combretaceae, Cordiaceae, Ebenaceae, Meliaceae and Verbenaceae (with 5 species each); 20 families were represented by just a single species.

The mean ± SD of species richness in the SF sites was 51.2 ± 9.5 species per ha with a range from 42 - 66 species per ha (Table 1). The mean species richness in the RF sites was 37.8 ± 6.6 species per ha with a range from 31 - 46 species per ha. The observed difference in species richness between SF and RF was significant (t-test, n = 5, $P < 0.032$). Of the total 158 species, 63 (40 %) were common to all the SF and RF stands, 71 species (45 %) were exclusive to the SF sites and 24 species (15 %) were exclusive to the RF sites. Seven species that are endemic to the southern Eastern Ghats, *Albizia thompsonii*, *Boswellia ovalifoliolata, Cycas beddomei, Pterocarpus santalinus* (Rao *et al.* 2003), *Shorea tumbuggaia, Syzygium alternifolium* and *Terminalia pallida* (Ahmedullah & Nayar 1986) occurred in the sacred groves, but were distinctly absent in the reference forest reserves. Of these, the first four species are categorized as threatened at different levels (Rao *et al.* 2003).

The highest diversity of 66 tree species occurred in 1 ha of the TKN sacred grove. Interestingly, the other sacred groves, although they were relatively more disturbed than TKN, nonetheless had a high species richness compared with the five RF sites. High species richness in the sacred groves could be attributed to better protection and relatively sustainable harvesting of resources by the local communities. The low tree species richness in the RF stands could be attributed to high biotic interference. A significant negative correlation was found between species richness and disturbance score across the study sites (coefficient of correlation, r = 0.831, $P < 0.01$; Fig. 2).

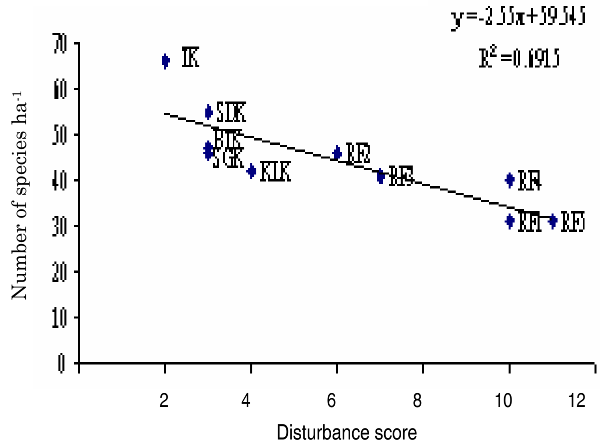

Fig. 2. Correlation of species richness and disturbance score across the sacred forest and reference forest sites.

Our findings are comparable with studies in other deciduous forests in India. Kadavul & Parthasarathy (1999) and Chittibabu & Parthasarathy (2000) recorded 42 - 47 and 26 - 56 tree species per ha, respectively, in deciduous forests of the Kolli and Kalrayan hills in Tamil Nadu. Sukumar *et al.* (1992) have reported 31 woody species from the Mudumalai tropical deciduous forests of Tamil Nadu, while Sagar *et al.* (2003) have reported 49 tree species in dry forests of the Vindhyan hill ranges in northern India. Sunitha (2002) studied 14 sacred groves in Kurnool district of Andhra Pradesh and recorded a maximum of 83 tree species in the 50 ha Upper Ahobilam sacred grove.

Diversity and similarity indices

The Shannon index of species diversity varied across the ten study sites. For the SF, the mean ± SD of the Shannon index was 3.336 ± 0.375 with a range from 2.939 to 3.957. For the RF the mean ± SD of the Shannon index was 3.037 ± 0.238 with a range from 2.684 to 3.234 (Table 1). These values are comparable with values from the Gundlabrahmeswaram wildlife sanctuary, located 200 km from the study sites in the southern Eastern Ghats. The maximum Shannon index of 3.96 calculated for the wildlife sanctuary (Khadar Basha 2009) is similar to the maximum values calculated for sacred forests in this study. This suggests that the sacred forests received relatively good protection, on par with a wildlife sanctuary.

The Jaccard coefficient of similarity based on the distribution of species richness shows a wide range of 0.068 to 0.406 in sacred and reference forest stands. The dendrogram (Fig. 3) illustrates that the forest sites split into 2 clusters: all the sacred forest stands are held together as one cluster, with the exception of SGK; the reference forest stands form another cluster. This indicates more similarity among sacred forest sites and dissimilarity between sacred forest and reference forest sites.

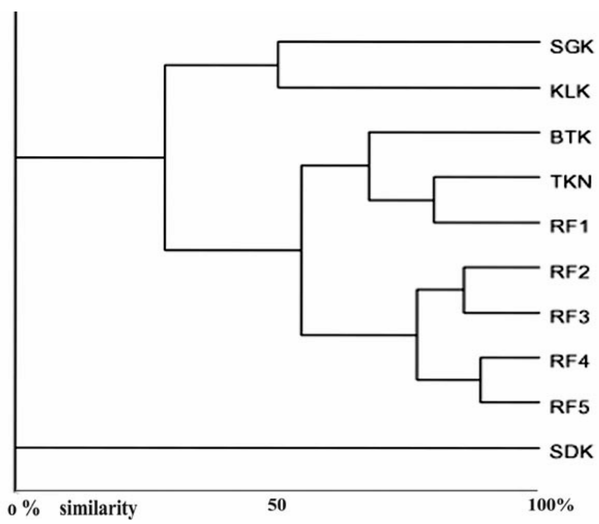

Fig. 3. Dendrogram of tree species composition of the different study sites.

Tree density and basal area

A total of 4858 trees (mean ± SD, 971.6 ± 38.49 trees per ha; range, 929 - 1018 trees ha^{-1}) are present in the five 1-ha plots of sacred tropical dry deciduous forest stands, which is about 37 % greater than the reference forest sites (total 3078 trees; mean ± SD, 615.6 ± 67.81 trees ha^{-1}; range, 563 - 732 trees per ha) (Table 1). The SF site, BTK, had the highest stand density of 1018 trees ha^{-1}, which was about 9 % greater than the lowest stand density of 929 trees per ha at KLK, among the five sacred forest sites. The reference forest site, RF1, had the lowest stand density (563 stems ha^{-1}) when compared with all the other study sites. The mean stem density of the sacred sites (971.6 trees over > 30 cm DBH per ha) is far higher than findings from other similar tropical dry deciduous forests, for example, 591 trees per ha in tropical dry deciduous forest of Orissa (Sahu *et al.* 2007).

The mean ± SD basal area of the sacred forest was 24.5 ± 5.8 m^2 ha^{-1}. The basal area of individual sacred forest sites ranged from as low as 16.6 m^2 ha^{-1} in site SDK to as high as 31.7 m^2 ha^{-1} in TKN. In the reference reserve forest the mean ± SD basal area was 13.3 ± 2.2 m^2 ha^{-1}, with a much narrower range, from a low of 10.5 m^2 ha^{-1} in site RF3 to a high of 15.7 m^2 ha^{-1} in site RF4 (Table 1). Abundance values of the tree species recorded in the study sites are presented in Appendix Table 1.

Forest structure

The species richness, density and basal area were greater in SF sites compare to RF sites across all diameter classes. The tree size-class distribution of both the SF and RF sites followed a reverse J-pattern (Fig. 4). The t-test showed that there was no significant difference between SF and RF sites with respect to density, but that they differed in basal area value ($P < 0.03$). The mean basal area of the higher girth class (> 90 cm) was about 65 % greater in SF sites (41.28 m^2 ha^{-1}) than the RF sites (14.49 m^2 ha^{-1}) (Fig. 4) and this is attributed to the presence of huge trees of wild *Mangifera indica* along the stream beds in one of the SF sites (SGK). The relationship between basal area and disturbance scores showed a negative correlation for both sacred forest ($r^2 = 0.449$, $P < 0.05$) and reference forest areas ($r^2 = 0.402$, $P < 0.05$). Our observations in the field suggest that man-made fires could be responsible for tree seedling mortality in RF sites and are comparable with observations of Khumbongmayum *et al.* (2005).

Conclusions

In the present study, compared with the reference forest stands, the five sacred groves had high species richness and diversity, presence of global endemics, high density, and high basal area. This could be attributed to less anthropogenic pressures in the sacred forest stands compared with forest reserves, as indicated by the cumulative disturbance score. In the reserve forest the visible disturbances were primarily in the form of tree lopping, man-made fires, grazing and invasive

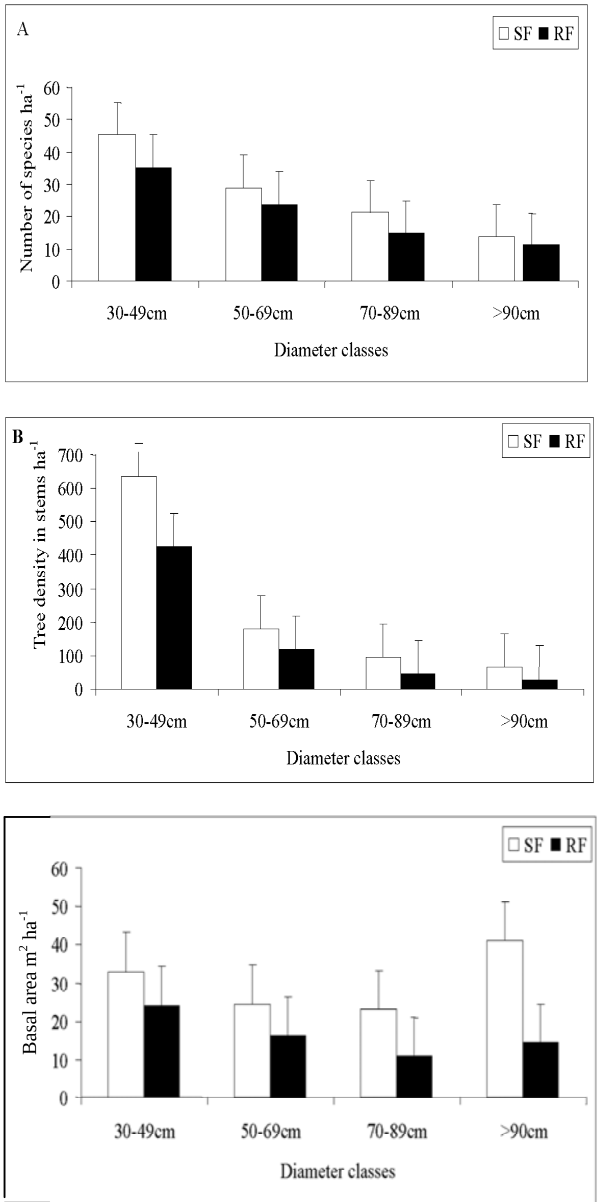

Fig. 4. Bar graphs showing species richness (A), tree density (B), and basal area (C) grouped by size class in sacred and reserve forests. Values are means; error bars denote standard deviations; n=5.

weeds. The present pilot study supports the view that better quality of flora is maintained in the sacred forest stands, but moderate disturbances in the sacred sites warrants further conservation efforts. The present study provides a basis for long-term studies that could provide better insights into the dynamics of sacred forest sites and reserve forests.

Acknowledgments

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Appendix Table 1. List of all tree species encountered in both sacred forest (SF) and reference forest reserve (RF) sites in order of decreasing abundance.

Name of the tree taxa	Family	SF	RF	Total
Anogeissus latifolia (Roxb.ex DC.) Wall.ex Guill. & Perr.	Combretaceae	184	260	444
Chloroxylon swietenia DC.	Flindersiaceae	260	175	435
Terminalia pallida Brandis	Combretaceae	387	-	387
Syzygium alternifolium (Wight) Walp.	Myrtaceae	382	-	382
Albizia amara (Roxb.) Boivin	Mimosaceae	54	316	370
Ochna obtusata DC. var. *obtusata*	Ochnaceae	309	10	319
Wrightia tinctoria R. Br.	Apocynaceae	81	171	252
Pterocarpus santalinus L. f.	Fabaceae	241	-	241
Gardenia gummifera L.f.	Rubiaceae	197	22	219
Commiphora caudata (Wight & Arn.) Engler	Burseraceae	179	26	205
Acacia catechu (L.f.) Willd.	Mimosaceae	25	169	194
Buchanania axillaris (Desr.) Ramam.	Anacardiaceae	136	41	177
Ixora arborea Roxb.ex Smith	Rubiaceae	116	32	148
Ziziphus xylopyrus (Retz.) Willd.	Rhamnaceae	69	65	134
Canthium dicoccum (Gaertn.) Teijsm. & Binn	Rubiaceae	53	78	131
Strychnos potatorum L.f.	Loganiaceae	34	96	130
Hardwickia binata Roxb.	Caesalpiniaceae	-	123	123
Shorea tumbuggaia Roxb.	Dipterocarpaceae	123	-	123
Memecylon umbellatum Burm.f.	Melastomataceae	117	5	122
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	94	27	121
Cochlospermum religiosum (L.) Alston	Cochlospermaceae	81	29	110
Drypetes sepiaria (Wight & Arn.) Pax & Hoffm.	Euphorbiaceae	45	63	108
Dalbergia paniculata Roxb.	Fabaceae	36	71	107
Terminalia alata Heyne ex Roth.	Combretaceae	56	42	98
Dolichandrone atrovirens (Roth) Sprague	Bignoniaceae	49	46	95
Diospyros melanoxylon Roxb.	Ebenaceae	37	57	94
Shorea roxburghii G.Don	Dipterocarpaceae	94	-	94
Sapindus emarginatus Vahl.	Sapindaceae	21	71	92
Madhuca indica J. Gmelin.	Sapotaceae	45	45	90
Boswellia serrata Roxb. ex Colebr.	Burseraceae	50	38	88
Strychnos nux-vomica L.	Loganiaceae	65	14	79
Premna tomentosa Willd.	Verbenaceae	5	67	72
Dillenia bracteata Wight	Dilleniaceae	66	-	66
Grewia damine Gaertner	Tiliaceae	50	16	66
Phyllanthus emblica L.	Euphorbiaceae	50	15	65
Mangifera indica L.	Anacardiaceae	63	-	63
Euphorbia nivulia Buch.-Ham.	Euphorbiaceae	-	60	60
Diospyros chloroxylon Roxb.	Ebenaceae	34	23	57
Gyrocarpus americanus Jacq.	Hernandiaceae	-	54	54
Gardenia latifolia Ait.	Rubiaceae	20	32	52
Albizia lebbeck (L.) Willd.	Mimosaceae	36	12	48

Contd...

Appendix Table 1. Continued.

Name of the tree taxa	Family	SF	RF	Total
Cassia fistula L.	Caesalpiniaceae	13	35	48
Ficus benghalensis L.	Moraceae	34	13	47
Gardenia resinifera Roth	Rubiaceae	42	5	47
Tamarindus indica L.	Caesalpiniaceae	33	13	46
Alangium salvifolium (L.f.) Wangerin	Alangiaceae	2	43	45
Cycas beddomei Dyer	Cycadaceae	42	-	42
Atalantia monophylla (L.) Correa	Rutaceae	25	15	40
Citrus aurantium L.	Rutaceae	38		38
Ficus mollis Vahl.	Moraceae	24	12	36
Soymida febrifuga (Roxb.) A. Juss.	Meliaceae	1	35	36
Albizia odoratissima (L. f.) Benth.	Mimosaceae	18	17	35
Deccania pubescens (Roth) Tirveng.	Rubiaceae	21	10	31
Crataeva magna (Lour.) DC.	Capparaceae	30		30
Cassine glauca (Rottb.) O. Kuntze	Celastraceae	16	13	29
Diospyros montana Roxb.	Ebenaceae	12	17	29
Phoenix sylvestris (L.) Roxb.	Arecaceae	29	-	29
Premna latifolia Roxb. var. *latifolia*	Verbenaceae	-	29	29
Sterculia urens Roxb.	Sterculiaceae	5	24	29
Bauhinia racemosa Lam.	Caesalpiniaceae	12	15	27
Dalbergia lanceolaria L. f.	Fabaceae	1	26	27
Trema orientalis (L.) Bl.	Ulmaceae	27	-	27
Antidesma ghaesembilla Gaertner	Euphorbiaceae	26		26
Maba buxifolia (Rottb.) A.L. Juss.	Ebenaceae		26	26
Pterospermum xylocarpum (Gaertner) Sant. & Wagh	Sterculiaceae	23	2	25
Vitex altissima L. f.	Verbenaceae	25	-	25
Walsura trifolia (A. Juss.) Harms	Meliaceae	25	-	25
Holarrhena pubescens (Buch.-Ham.) Wall.	Apocynaceae	19	4	23
Terminalia chebula Retz.	Combretaceae	10	13	23
Vitex pinnata L.	Verbenaceae	5	18	23
Glycosmis pentaphylla (Retz.) DC.	Rutaceae	-	22	22
Ailanthus excelsa Roxb.	Simaroubaceae	2	19	21
Polyalthia cerasoides (Roxb.) Beddome	Annonaceae	18	2	20
Acacia nilotica (L.) Willd. ex Del. subsp. *nilotica*	Mimosaceae	-	19	19
Pterocarpus marsupium Roxb.	Fabaceae	5	14	19
Cleistanthus collinus (Roxb.) Hook.f.	Euphorbiaceae	-	18	18
Ehretia aspera Willd.	Cordiaceae	10	8	18
Erythroxylum monogynum Roxb.	Erythroxylaceae	3	15	18
Givotia moluccana (L.) Sreem.	Euphorbiaceae	-	17	17
Stereospermum personatum (Hassk.) Chatterjee	Bignoniaceae	17	-	17
Grewia flavescens Juss.	Tiliaceae	3	13	16
Suregada angustifolia (Bail.ex Muell.-Arg.) Airy Shaw	Euphorbiaceae	16	-	16
Ximenia americana L.	Olacaceae	16	-	16

Contd...

Appendix Table 1. Continued.

Name of the tree taxa	Family	SF	RF	Total
Dichrostachys cinerea (L.) Wight & Arn.	Mimosaceae	-	15	15
Morinda pubescens J.E. Smith	Rubiaceae	-	15	15
Cycas circinalis L.	Cycadaceae	3	11	14
Manilkara hexandra (Roxb.) Dubard	Sapotaceae	4	10	14
Schleichera oleosa (Lour.) Oken.	Sapindaceae	-	14	14
Azadirachta indica A. Juss.	Meliaceae	7	6	13
Lagerstroemia parviflora Roxb.	Lythraceae	13	-	13
Lepisanthes tetraphylla (Vahl) Radlk.	Sapindaceae	-	13	13
Ziziphus mauritiana Lam. var. *mauritiana*	Rhamnaceae	3	10	13
Bombax ceiba L.	Bombacaceae	12	-	12
Grewia tiliaefolia Vahl	Tiliaceae	12	-	12
Bridelia retusa (L.) Sprengel	Euphorbiaceae	10	-	10
Canthium parviflorum Lam.	Rubiaceae		10	10
Dolichandrone falcata (Wall.ex DC.) Seem.	Bignoniaceae	10		10
Mitragyna parvifolia (Roxb.) Korth.	Rubiaceae	7	3	10
Naringi crenulata (Roxb.) Nicolson	Rutaceae		10	10
Phoenix loureirii Kunth	Arecaceae	10	-	10
Tectona grandis L. f.	Verbenaceae	10	-	10
Actinodaphne madraspatana Bedd.ex Hook.f.	Lauraceae	10	-	10
Dalbergia latifolia Roxb.	Fabaceae		9	9
Pittosporum napaulense (DC.) Rehder & Wilson	Pittosporaceae	9		9
Rhus mysorensis G. Don.	Anacardiaceae	-	9	9
Macaranga peltata (Roxb.) Muell.-Arg.	Euphorbiaceae	8	-	8
Schrebera swietenioides Roxb.	Oleaceae		8	8
Mitragyna parvifolia (Roxb.) Korth.	Rubiaceae	7	-	7
Semecarpus anacardium L. f.	Anacardiaceae	7	-	7
Boswellia ovalifoliolata Bal. et Henry	Burseraceae	6	-	6
Bridelia montana (Roxb.) Willd.	Euphorbiaceae	1	5	6
Careya arborea Roxb.	Lecythidaceae	6	-	6
Cordia wallichii G.Don.	Cordiaceae	-	6	6
Wendlandia gamblei Cowan	Rubiaceae	6	-	6
Cordia macleodii Hook.f. & Thoms.	Cordiaceae	5	-	5
Dillenia pentagyna Roxb.	Dilleniaceae	5	-	5
Glochidion zeylanicum (Gaertn.) Juss.	Euphorbiaceae	5	-	5
Limonia acidissima L.	Rutaceae	5	-	5
Phyllanthus indofischeri Bennet	Euphorbiaceae	5	-	5
Plecospermum spinosum Trecul.	Moraceae	5	-	5
Pleurostylia opposita (Wall.) Alston	Celastraceae	5	-	5
Plumeria alba L.	Apocynaceae	-	5	5
Chukrasia tabularis A. Juss.	Meliaceae	5	-	5
Cassia roxburghii DC.	Caesalpiniaceae	-	4	4
Cordia dichotoma Forst. f.	Cordiaceae	4		4

Contd...

Appendix Table 1. Continued.

Name of the tree taxa	Family	SF	RF	Total
Ficus arnottiana (Miq.) Miq.	Moraceae	1	3	4
Mallotus philippensis (Lam.) Muell.-Arg.	Euphorbiaceae	4		4
Pongamia pinnata (L.) Pierre	Fabaceae	-	4	4
Syzygium cumini (L.) Skeels	Myrtaceae	4	-	4
Bridelia cinerascens Gehrm.	Euphorbiaceae	3	-	3
Carallia brachiata (Lour.) Merr.	Rhizophoraceae	3	-	3
Ficus dalhousiae Miq.	Moraceae	3	-	3
Homalium zeylanicum (Gard.)Benth.	Flacourtiaceae	3	-	3
Phyllanthus polyphyllus Willd.	Euphorbiaceae	3	-	3
Santalum album L.	Santalaceae	3	-	3
Sapium insigne (Royle) Trimen	Euphorbiaceae	-	3	3
Streblus asper Lour.	Moraceae	3	-	3
Albizia thompsonii Brandis	Mimosaceae	2	-	2
Cleistanthus patulus (Roxb.) Muell.-Arg.	Euphorbiaceae	2	-	2
Cocos nucifera L.	Arecaceae	2	-	2
Diospyros ovalifolia Wight	Ebenaceae	2	-	2
Ficus hispida L.f.	Moraceae	-	2	2
Ficus rumphii Blume	Moraceae	2	-	2
Flacourtia ramontchi L.	Flacourtiaceae	2	-	2
Glochidion tomentosum Dalz.	Euphorbiaceae	2	-	2
Haldinia cordifolia (Roxb.) Ridsd.	Rubiaceae	2	-	2
Miliusa tomentosa (Roxb.) Sinclair	Annonaceae	2	-	2
Murraya paniculata (L.) Jack	Rutaceae	2	-	2
Pterospermum canescens Roxb.	Sterculiaceae	2	-	2
Ceriscoides turgida (Roxb.) Tirveng.	Rubiaceae	1	-	1
Cordia monoica Roxb.	Cordiaceae	1	-	1
Ficus religiosa L.	Moraceae	1	-	1
Ficus semicordata Buch.-Ham.	Moraceae	1	-	1
Manilkara roxburghiana (Wight) Dubard	Sapotaceae	1	-	1
Melia azedarach L.	Meliaceae	1	-	1
Mimusops elengi L.	Sapotaceae	1	-	1
Psidium guajava L.	Myrtaceae	1	-	1
Terminalia paniculata Roth.	Combretaceae	1	-	1
	Number of species	132	87	
	Total abundance	4858	3078	7936