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Tree Species Diversity and Population Structure in Tropical Dry Deciduous Forest of Sri Lankamalleswara Wildlife Sanctuary, South Eastern Ghats, India

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ABSTRACT
Tree species enumeration was carried out in dry deciduous forests of Sri Lankamalleswara wildlife sanctuary by laying 25 quadrats of 20 X 20 m size each at five varied elevation ranges totaling to 5 ha. A total of 3856 tree individuals (≥30 cm gbh) belonging to 127 tree species, 95 genera and 42 families were recorded. Mean tree species diversity was 73 species/ha and mean tree density 771±157 individuals/ha. Shannon-weiner index was 3.99 and the mean basal area was 22.9±2.4 m^2 ha^{-1}. Rank abundance curve revealed that these dry deciduous forests were dominated by few tree species as only four tree species namely *Pterocarpus santalinus, Anogeissus latifolia, Chloroxylon swietenia* and *Terminalia alata* comprised of 36% of total density and 29.6% of total IVI and top ten dominant species comprised of 47.7% of total tree density, 46% of total basal area and 41.1% of IVI. Spearman rank correlation revealed a significant positive relationship between altitude and tree density and significant negative relation with Shannon Weiner index. Frequency of tree individuals with increasing gbh classes revealed a reverse 'J' shaped curve and majority of tree individuals (57.5%) were recorded in lower gbh class. Along the altitude gradient, *Anogeissus latifolia* is the dominant tree in the foot hills with co-dominants like *Pterocarpus santalinus, Chloroxylon swietenia, Dalbergia paniculata, Polyalthia cerassoides* while the middle elevation was dominated by *Pterocarpus santalinus* with co-dominants like *Chloroxylon swietenia, Anogeissus latifolia, Buchanania axillaris.* On the hill tops *Pterocarpus santalinus* stood as the dominant tree along with co-dominants like *Terminalia alata* and *Anogeissus latifolia*.

Key words Dry deciduous forest, population structure, south Eastern Ghats, tree diversity, Wildlife sanctuary

INTRODUCTION

Tropical forests are the richest biodiversity sites among the terrestrial ecosystems as they occur in wide range of topographical features and climatic conditions (Anitha et al. 2010) and thus conservation of tropical forests is synonymous with conservation of biodiversity (Singh and Khushwaha 2008). Among the tropical forests, tropical dry forests represent 42% of the tropical forest regions and occur mainly in Central and South America, Africa, Central Asia, India, and Australia (Ratnam et al. 2019). In India, dry and dry deciduous forests constitute the largest forest area by sharing about 36.2 % of the total forested area. These tropical dry forests occur in those regions where prominent seasonality prevails with a dry season of 2-6 months in each year and with a mean annual temperature >25°C, precipitation between 700-2000 mm and owing to these environmental conditions, Eastern Ghats comprise of varied tropical dry forests across their hill ranges (Reddy et al. 2015) in which southern Eastern Ghats constitute mainly dry deciduous forests (Pragasan and Parthasarathy 2010). Alarmingly 16-40% of forest loss has been recorded over the past 95 years and major portions of natural forests are in degraded stage throughout the Eastern Ghats region (Ramachandran et al. 2019). But these dry forests provide ecosystem services like watershed protection, microclimate regulation, soil fertility and biodiversity maintenance (Ratnam et al. 2019). Further it was noted that the changes in forest composition and structure will negatively affect in providing the ecosystem services ability in the future (Agarwala et al. 2016).

Forests can be characterized by attributes such as tree diversity, basal area, girth class distribution and species abundance distributions (Giriraj et al. 2008). Especially tree diversity can be recognized as fundamental to forest diversity as trees provide resources and habitats for majority of the species (Pragasan and Parthasarathy 2010). The tree community structure among the dry deciduous forests is highly influenced by anthropogenic disturbances (Baboo et al. 2017), extent of rainfall and physiographic features like altitude and aspect (Reddy et al. 2011). Further along with altitude factor, co-factors such as topography, aspect, slope, soil texture, soil fertility etc., will further effect the forest composition (Sharma et al. 2018). In this context both large scale as well as small scale floristic inventories at 1 ha scale helps to provide knowledge to understand the effects of human activities on forest structure (Mani and Parthasarathy 2006). The wildlife protected areas in India are once originally reserve forests and hence have had a history of exploitation (Tripathi and Singh 2009). Hence, for fulfilling the conservation goals under REDD+ mechanism of UNFCCC which focuses on preserving forest diversity, forest carbon stock as well as economic upliftment of forest dependent people; the information on forest structure and plant resources will be of most useful (Aye et al. 2014). Thus information on diversity and forest structure of wildlife protected areas is of immense importance to design and strengthen the conservation strategies to maintain the diversity and ecosystem services.

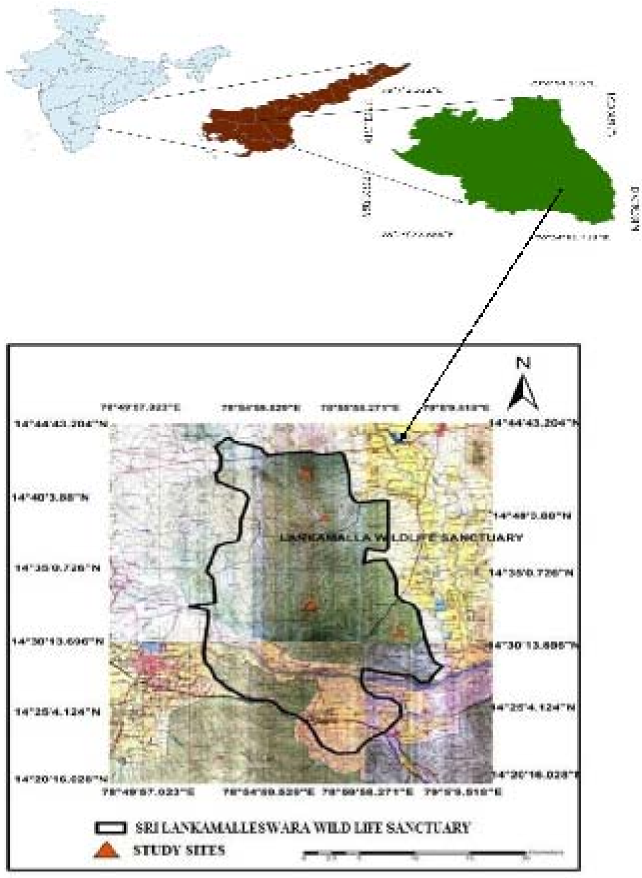

Figure 1. Study area

STUDY AREA

Eastern Ghats are discontinuous hill ranges along the east coast and they can be categorized into Northern and Southern Eastern Ghats and Tirupati-Cuddapah-Nallamalai hills of South Eastern Ghats represent a minor area of endemic region (Singh et al. 2015). The hill ranges of Sri Lankamalleswara Wild life Sanctuary (SLKM) are part of the Southern Eastern Ghats (Fig. 1). It lies between $14^0 30'$ - $14^0 42'$N, $78^0 56'$ -$79^0 00'$E in Kadapa district of Andhra Pradesh. They form island (lanka) like hill ranges between Nallamala and Sheshachalam hill ranges of South Eastern Ghats. The hill ranges are within an elevation range of 160-620 m. The Lankamalla hill ranges start from the north of Penna river and rise into broken hill ranges and these forests support the only known population of almost extinct rare bird Jerdon's courser (*Cursorius bitorquatus*, Rawat 1997). In order to protect the rare bird and conserve the dry deciduous forest for the ecosystem services, an area of 464.42 km^2 was delineated from Reserve forest and wild life sanctuary protection status was provided to this area. The fuel wood collection and movement of vehicles on festival days, cattle grazing and illegal Red sanders logging are the prevalent anthropogenic disturbances in the sanctuary.

The study area receives a mean annual rain fall of 690-760 mm with majority of rainfall during (84%) from S-W monsoon (June to September) with a peak during the August month and lesser amount (16%) of rainfall from North East monsoon (November to December). The area is noted for hot as well as early setting of summer (February to June) where the forest feature deserted look as all species remain leaf less under intense summer with dry hot heavy winds. The minimum and maximum temperature range during hot summer is 29 to 46^{0}C. The study area comprises of shallow red ferruginous loam soil derived from Shales, Quartzites and Sandstone primary rocks. The soil depth is low endowed with pebbles.

METHODOLOGY

Tree diversity enumeration was carried out in different hill range areas by laying 20 X 20 m quadrats (n=25) at five different elevation ranges (between 220-620 m at 80 m interval) totaling to five hectares. In each quadrat, all trees >30 cm girth at breast height (gbh) of 1.37 m were enumerated. At each elevation the quadrates were randomly laid and marked with the help of Global Positioning System (Model Garmin GPS map 78s) on Survey of India topographic maps. The diversity indices of tree species were computed based on Magurran (2004). Tree community structure was analysed as per Curtis and McIntosh (1951). Population structure was analysed in terms of the frequency of tree individuals with increasing gbh classes. Tree species assemblages were evaluated on the basis of the degree of similarity in their occurrence by using PCA (Principal Component Analysis). Elevation was considered as an environmental variable and both species and sample (sites) ordinations were observed from a single analysis. The pattern was explained based on the obtained correlation coefficient values between ordination score and species.

RESULTS

A total of 3856 individuals (≥30 cm gbh) belonging to 127 tree species belonging to 95 genera and 42 families was inventoried in SLKM wildlife sanctuary (Appendix 1). The mean and range of tree species were 73 species/ha and 47-105 species/ha and the range and mean tree density were 599 to 974 individuals/ha and 771±157, respectively (Table 1). Shannon-weiner index, Simpson index value (1-D) and Pielou's evenness index was 3.99, 0.045 and 0.81, respectively. The mean and range of basal area recorded in the forest stands were 26.14±4.43 and 22.45 to 32.79 m^2/ha, respectively. The species area curve (Fig. 2) showed a steep rise in the curve with 74 species at foot hills (220-300m) and an addition of 31 species and 19 tree species at mid and high elevation quadrats. Further, four species namely *Boswellia ovalifoliolata, Cipadessa baccifera, Erythrina stricta* and *Schrebera swietenoides* at 540 m elevation and two species namely *Eriolaena lushingtonii* and *Hymenodictyon orixense* were recorded exclusively in the top hill study site only (620m). The Spearman rank correlation revealed a significant positive relationship between altitude and tree density and positive relationship between altitude and basal area. While significant negative relation was recorded between altitude and Shannon Weiner index and a negative relationship was observed between altitude and tree species richness (Table 2).

Based on the number of tree individuals, tree species are classified as predominant (≥ 150 individuals), dominant (50-150 individuals), common (10-50 individuals) and less frequent (<10 individuals). The predominant group accounted for 4 species and 36% of total tree density and 29.6% of total IVI. While ten species represented dominant

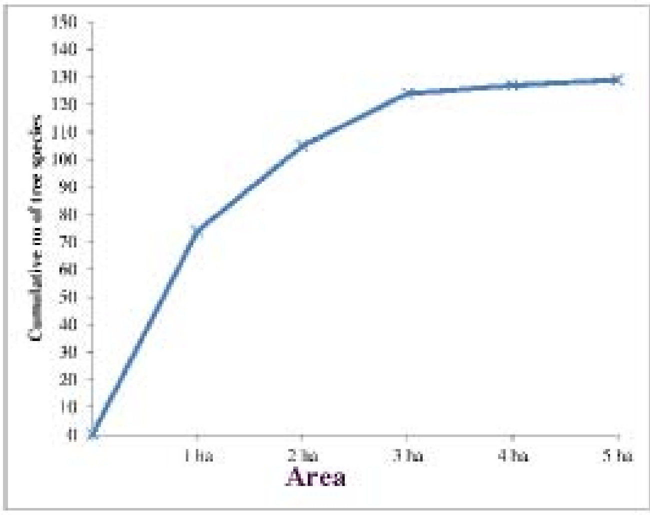

Figure 2.Species accumulation curve showing the increase in species richness

Table 1. Tree density, diversity indices, basal area in Lankamalla forest (LKM)

S. No	Parameter	Vlue
1	Total tree species	127
2	Number of genera	95
3	Number of families	42
4	Tree density	3856
5	Number of individuals ha^{-1}	771
6	Mean basal area (m^2 ha^{-1})	25.88
7	Shannon index (H')	3.99
8	Simpson index (1-D)	0.045
9	Evenness, E'=H'/lns	0.81
10	Mean gbh (cm)	59.54

Table 2. Correlation between altitude and species richness, tree density, basal area and Shannon index in Lankamalla forest (LKM)

Altitude	No of tree species	Tree density	Basal area (m^2/ha)	Shannon index	Correlation
220-300	74	599	23.32	4.06	Altitude Vs Species richness -0.72 p>0.05
300-380	105	684	23.45	4.23	Altitude Vs Tree density 0.9 p<0.05
380-460	78	702	22.45	3.62	Altitude Vs Basal area 0.6 p >0.05
460-540	60	974	32.79	3.15	Altitude Vs Shannon -0.9 - 0.037
540-620	47	896	28.76	2.2	

category comprised of 17.4 % of tree density and 16.7% of total IVI. 62 species constituted common category comprised of 39.8% of tree density and 44% of total IVI. Further, 53 species were included in less frequent category that comprised of 6.6% total tree density and 9.5% of total IVI. A total of two tree species namely *Capparis grandis* and *Gardenia gummifera* are recorded with single individual, 26 tree species have registered 2 to 5 tree individuals and 53 tree species have registered less than ten individuals. The species-rank abundance curve showed a typical reverse 'J' shaped curve with top four species namely *Pterocarpus santalinus, Anogeis suslatifolia, Chloroxylon swietenia* and *Terminalia alata* sharing 29.6% of total IVI and top ten species with 41.1% of total IVI and the rest of 108 species with 59% of IVI (Fig. 3). *Pterocarpus santalinus* ranked the most dominant tree species sharing 11.1% of total IVI value followed by *Anogeissus latifolia* with 9.2% of total IVI. In the whole five ha study plots, *Pterocarpus santalinus* was recorded in 97 quadrats (77.6%) with 544 total individuals. The number of individuals distributed in the increasing gbh classes showed reverse 'J' shaped curve. The lower gbh class (30-60 cm) comprised of 119 species and was represented by high percentage of individuals (57.5%) and 34% of basal area. A total 26 tree species were inventoried only within the 30-60 gbh class and they include *Glochidium zeylanicum, Holorrhaena pubecens, Litsea glutinosa, Sterculia villosa*, while 105 species were recorded in 61-90 cm gbh class which have (Table 3) contributed 36.1% of total density and higher proportion of total basal area (48.1%). The 91-120 cm gbh class has included 51 tree species that constituted 5.7 % of total density and 14.6% of total basal area. In the higher gbh classes, >120 cm, a total of 16 species comprising of 23 tree individuals and 3.3% of basal area was recorded and among them three species such as *Ceiba pentandra*, *Ficus amplissima* and *Terminalia arjuna* were found to be dominating.

The PCA has resulted in segregation of '4th ' and '5th ' study plots being laid at high altitudes formed a group (Fig. 4) and the rest of three study plots segregated far away. The F1 and F2 ordinate axes have accounted for 59.23% and 16.36% totaling to 75.6% variability. The study plots 1 to 5 being laid at low altitudes and higher altitudes, respectively, are segregated by F1 axis and study plot 3 variability was associated with F2 axis. A total of 29 tree species were found to correlate with F1 axis and among them 12 tree species had shown negative correlation suggesting their occurrence in lower altitudes. Especially those species segregated nearer to the origin plane like *Cleistanthus collinus, Wrightia tinctoria, Pterospermum xylocarpum, Madhuca indica, Lagerstroemia parviflora, Hardwickia binata* and *Dalbergia paniculata* have conspicuously occurred in lower altitudes. While 17 species namely *Anogeissus latifolia, Boswellia ovalifoliolata, Chloroxylon swietenia, Pterocarcarpus santalinus* etc., were found to be positively correlated with F1 axis scores suggesting their occurrence towards increasing altitudes from the foothills, species like *Boswellia serrata* and *Erythrina stricta* were positively correlated with F2 axis scores indicating their presence on slope and tending towards higher elevation and *Diospyros montana* was found negatively correlated with F2 axis scores suggesting their trend from slope and towards low altitudes.

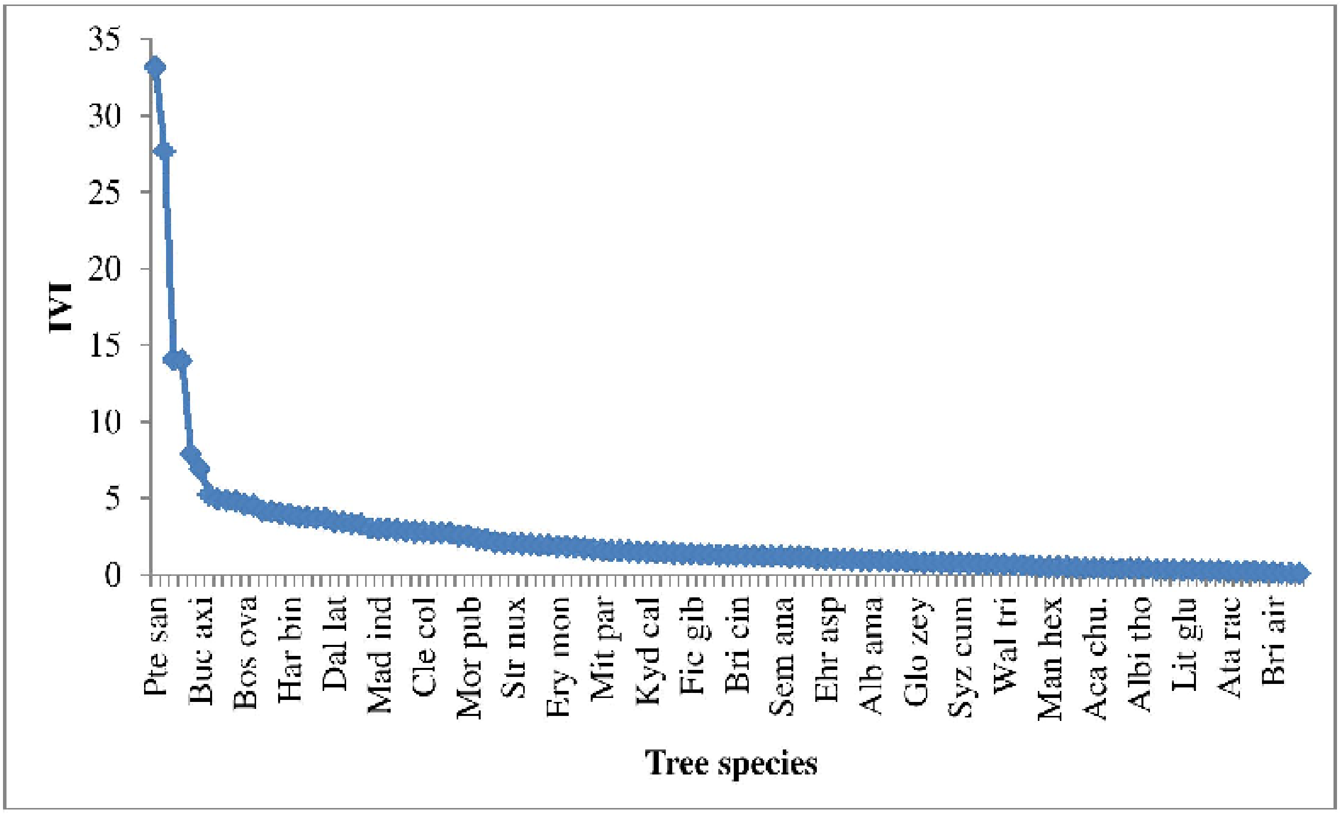

Figure 3. Rank abundance curve showing reverse J shape

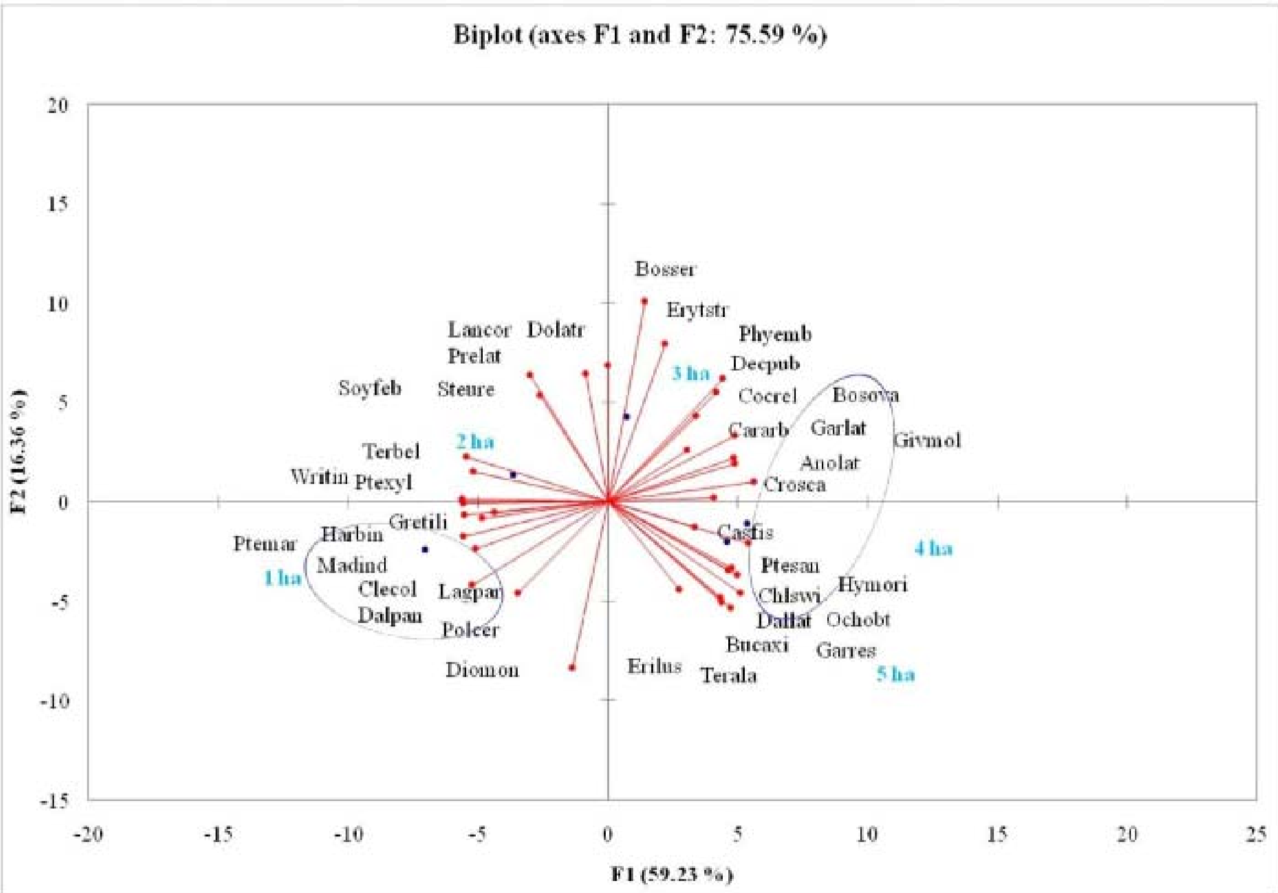

Figure 4. PCA of the tree species association with increase in altitude

Table 3. Distribution of gbh class wise tree species richness, tree density and basal area in Lankamalla forest (LKM).

Gbh class (cm)	No of species	No of individuals(%)	Basal area(%)
30-60	119	2218 (57.52)	34
61-90	105	1393 (36.13)	48.12
91-120	51	222 (5.76)	14.6
>120	16	23 (0.60)	3.2

DISCUSSION

The range of 47-105 tree species indicates rich and varied distribution of tree species in these hill ranges. The studies on dry forests revealed that the tree species richness differ with respect to habitat conditions (Yadav and Gupta 2006), disturbance levels (Sagar et al. 2003, Ramana and Reddy 2020) and altitude (Reddy et al. 2011). The presence of 47 tree species at top elevation (460-620m) and significant negative relationship with Shannon index with altitude in the sanctuary suggest marked effect of altitude on tree species occurrence although the hills are of low altitude range. In the present study elevation of 300-460m have represented high tree species richness and got decreased when elevation of 460-620m was reached. The study in North Eastern Ghats indicate that higher tree species richness was found to be high at moderate elevation of 600–800m and got decreased with elevation (800-1000m) (Reddy et al. 2011). Similar kind of hump shaped distribution with higher species richness in the middle elevation was recorded in Juri forests of Bangladesh (Sarker et al. 2014). The Importance Value Index (IVI) values indicate the ability of the dominant species in utilizing the resources in a better way (Curtis and McIntosh 1951) and to know their ecological amplitude (Sagar et al. 2003). In the present study, *Pterocarpus santalinus*, *Anogeissus latifolia, Chloroxylon swietenia* and *Terminalia alata* ranked as first four dominant trees by sharing 30% of the total IVI values indicating their tolerance towards fires and harsh dry conditions and reflecting their high ecological significance. The dominance of this group of species can be viewed from their ability to re-sprout from basal root crowns after disturbance. But few of the less common species like *Pterocarpus marsupium*, *Lagerstroemia parviflora*, *Kydia calycina* also have have the capacity of re-sprouting. Thus, in addition to re-sprouting ability among these predominant tree species, the other ecological features like better seed germination rate, sapling and seedling survival would have assured the dominance of these tree species in these dry forests, as also observed in Sariska Tiger Reserve forests (Yadav and Gupta 2006). Girth class distributions provide information about the changes in population structure and potential regeneration process that prevails in the forest (Pragasan and Parthasarathy 2010). A typical reverse 'J' shape curve suggests that mature tree individuals will be replaced well with younger tree individuals in the sanctuary. Further a positive skewness towards the lower gbh classes is observed and it indicates that lower girth class tree individuals occur in more abundance than expected. But among the population structures of the five predominant tree species only *Pterocarpus santalinus* and *Anogeissus latifolia* had revealed gradual decrease of tree individuals with increase in gbh classes featuring the reverse J shape curve. While *Chloroxylon swietenia* had considerable abundance in 61-90 cm gbh class and *Terminalia alata* and *Boswellia serrata* had showed uni-modal curve revealing the lack of lower girth class. Thus overall J shape curve was overwhelmingly influenced by the top most two predominant species. Similar pattern of reverse J shape curves were recorded in Vindhyan hills (Sagar et al. 2003) South Eastern Ghats of Tamil Nadu (Pragasan and Parthasarathy 2010) and North central Eastern Ghats (Reddy et al. 2011).

The predominant species can be used to define the community structure of the forest (Panda et al. 2013). The dry forests were found to be dominated by four tree species namely *Pterocarpus santalinus, Anogeissus latifolia, Chloroxylon swietenia* and *Terminalia alata* as they registered 36% of total density but their distribution differed across the forests. *Pterocarpus santalinus* was predominant in the hill slopes, while *Anogeissus latifolia* was found to be consistently ranked as second dominant tree in all the study plots except in the low altitude where it was the most dominating. *Terminalia alata* dominant in top hill study plots was less abundant at lower altitude and absent in the foot hills. The PCA ordination with altitude as a variable has shown that along with *Pterocarpus santalinus* and *Anogeissus latifolia* tree species, *Polyalthia cerassioides*, *Wrightia tinctoria*, *Dalbergia paniculata* are commonly associated at foot hills, *Dolichandrone atrovirens*, *Croton scabiosus*, *Ochna obtusata*, *Erythrina stricta*, *Sterculia urens*, *Boswellia serrata* are found to be dominant on the slopes tending towards down side and species such as *Givotia moluccana*, *Terminalia alata*, *Buchanania axillaris*, *Syzygium alternifolium* towards to the top hill altitude. Similar kind of effects of slope and aspect factors were recorded in Sariska Tiger Reserve project dry forests as *Anogeissus pendula, Lannea coromandelica, Sterculia urens* were found on the cooler north-facing slope and *Boswellia serrata, Acacia catechu, Zizizphus mauritiana* in the drier south facing slopes (Yadav and Gupta 2006).

CONCLUSIONS

A total of 3856 individuals (>30cm) belonging to 127 tree species with a mean (771±157/individuals/ha) and tree density range 599-974 individuals/ha were recorded. The top ten dominant species comprised of 47.7% of total tree density, 46% of total basal area and 41.1% of IVI. Thus few species have dominated the forest structure in SLKM sanctuary. The analysis in terms of IVI indicated that *Pterocarpus santalinus* is the ecologically significant dominant tree and the co-dominants are *Anogeissus latifolia* and *Chloroxylon swietenia* registering cumulatively 25%-35% of the total IVI values. The tree species richness along the increasing altitude revealed a uni-modal shape with increase in altitude species richness and Shannon index reached a maximum at 400-500m latitude and later got decreased. In regard to increase in altitude, *Anogeissus latifolia* is the dominant tree in the foot hills with co-dominants like *Pterocarpus santalinus-Chloroxylon swietenia- Dalbergia paniculata-Polyalthia cerassoides* and in middle elevation the dominant tree is *Pterocarpus santalinus* featuring with co-dominants like *Chloroxylon swietenia-Anogeissus latifolia- Buchanania axillaris* and on the top hills the *Pterocarpus santalinus* stood as the dominant tree along with co-dominants like *Terminalia alata- Anogeissus latifolia*. Thus the analysis indicated different combinations of dominants and co-dominants. The forest stand structure in terms of abundance of trees along the increasing gbh classes exhibited a typical reverse 'J' shaped curve indicating the expanding population structure and the matured tree individuals will be replaced by younger individuals in future. Thus SLKM sanctuary showed higher density of low girth trees but higher basal area was recorded in 61-90 cm gbh class indicating the availability of mature stands in the forest.

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Appendix 1. Details of tree species, family, tree density and important value index

Name of the tree species	Family	Individuals	IVI
Acacia chundra (Roxb.ex Rottl.) Willd.	Mimosaceae	5	0.40
Actinodaphne madraspatana Beed.ex Hook.f.	Lauraceae	20	1.22
Aegle marmelos (L.) Cor.	Rutaceae	18	1.29
Aglaia elaegnoidea (Juss.) Benth.	Meliaceae	6	0.77
Alangium salvifolium (L.f.)Wang.	Alangiaceae	8	0.79
Albizia amara (Roxb.) Boiv.	Mimosaceae	7	0.91
Albizia lebbeck (L.) Benth.	Mimosaceae	2	0.25
Albizia odoratissima (L. f.) Benth.	Mimosaceae	8	0.88
Albizia thompsoni Brandis	Mimosaceae	3	0.38
Anogeissus latifolia (Roxb.exDC.) Wall.exGuill&Perr.	Combretaceae	452	27.65
Antidesma ghaesembilla Gaertn.	Stilaginaceae	16	1.22
Atalantia racemosa Wt.&Arn.	Rutaceae	2	0.24
Bauhinia racemosa Lam.	Caesalpiniaceae	9	0.97
Boswellia ovalifoliolata Bal.et Henry	Burseraceae	61	4.58
Boswellia serrata Roxb.ex Colebr.	Burseraceae	103	7.88
Bridelia airy-shawii P.J.Li.	Euphorbiaceae	2	0.15
Bridelia cinerascens Gehrm.	Euphorbiaceae	16	1.26
Bridelia montana Roxb.	Euphorbiaceae	17	1.40
Buchanania axillaris (Desr.) Ramam.	Anacardiaceae	95	6.92
Butea monosperma (Lam.) Taub.	Fabaceae	17	1.48
Capparis grandis L.f.	Capparaceae	1	0.11
Careya arborea Roxb.	Lecithidaceae	44	4.17
Cassia fistula L.	Caesalpiniaceae	29	2.32
Cassine glauca (Rottb.) O.Kuntze	Celastraceae	13	1.21
Ceiba pentandra (L.) Gaertn.	Bombacaceae	2	0.32
Celtis philippensis Blancho	Ulmaceae	10	1.27
Ceriscoides turgida (Roxb.) Tirveng.	Rubiaceae	4	0.45
Chloroxylon swietenia DC.	Flindersiaceae	183	14.05
Chukrasia tabularis A dr. Juss.	Meliaceae	9	0.91
Cipadessa baccifera (Roth)Miq.	Meliaceae	4	0.44
Cleistanthus collinus (Roxb.) Hook.f.	Euphorbiaceae	41	2.80
Cochlospermum religiosum (L.) Alston	Cochlospermaceae	55	4.09
Commiphora caudata (Wt.&Arn.)Engler	Burseraceae	17	1.80
Cordia dichotoma Forst. & Forst.f.	Cordiaceae	5	0.95
Crateve magna (Lour.)DC.	Capparaceae	6	0.68
Croton scabiosus Bedd.	Euphorbiaceae	55	2.85
Dalbergia latifolia Roxb.	Fabaceae	49	3.43
Dalbergia paniculata Roxb.	Fabaceae	34	3.29
Deccania pubescens (Roth.) Tirveng.	Rubiaceae	38	3.33
Dichrostachys cinerea (L.) Wight & Arn.	Mimosaceae	2	0.27
Diospyros chloroxylon Roxb.	Ebenaceae	14	1.32
Diospyros ebenum Koen.	Ebenaceae	2	0.16
*Diospyros melanoxylon*Roxb.	Ebenaceae	52	4.01
Diospyros montana Roxb.	Ebenaceae	20	1.98
Dolichandrone atrovirens (Roth) Sprague	Bignoniaceae	32	2.80
Dolichandrone falcata (Wall.exDC.) Seem	Bignoniaceae	3	0.25
Drypetes sepiaria (Wt.&Arn.) Pax & Hoffm.	Euphorbiaceae	2	0.22
Ehretia aspera Willd.	Cordiaceae	13	1.03
Eriolaena lushingtonii Dunn	Sterculiaceae	25	1.65
Erythrina stricta Roxb.	Fabaceae	46	3.75
*Erythroxylum monogynum*Roxb.	Erythroxylaceae	23	1.84
Ficus amplissima Smith	Moraceae	4	0.67
Ficus arnottiana (Miq) Miq.	Moraceae	4	0.51
Ficus gibbosa BI.	Moraceae	12	1.34

Name of the tree species	Family	Individuals	IVI
Ficus microcarpa L.f.	Moraceae	4	0.63
Ficus mollis Vahl	Moraceae	10	1.14
Ficus virens Ait. Hort.	Moraceae	3	0.38
Flacourtia ramontchi L'Herit.	Flacourtiaceae	34	2.73
Gardenia gummifera L.f.	Rubiaceae	1	0.10
Gardenia latifolia Ait.	Rubiaceae	44	3.40
Gardenia resinifera Roth	Rubiaceae	40	2.96
Garuga pinnata Roxb.	Burseraceae	14	1.17
Givotia moluccana (L.) Sreem.	Euphorbiaceae	55	4.78
Glochidion zeylanicum (Gaertn.) Juss.	Euphorbiaceae	13	0.81
Grewia tiliifolia Vahl.	Tiliaceae	26	2.13
Gyrocarpus americanus Jacq.	Hernandiaceae	10	1.39
Haldinia cordifolia (Roxb.) Ridsd.	Rubiaceae	16	1.53
Hardwickia binata Roxb.	Caesalpiniaceae	41	3.90
Holarrhena pubescens (Buch.-Ham.) Wall.	Apocynaceae	6	0.50
Holoptelea integrifolia (Buch.-Ham.) Wall.exDon	Ulmaceae	10	1.44
Hymenodictyon orixense (Roxb.) Mabb.	Rubiaceae	39	3.77
Kydia calycina Roxb.	Malvaceae	16	1.45
Lagerstroemia parviflora Roxb.	Lythraceae	29	2.73
Lannea coromandelica (Houtl.) Merr.	Anacardiaceae	54	5.22
Lepisanthes tetraphylla (Vahl.) Radlk.	Sapindaceae	6	0.62
Limonia acidissima L.	Rutaceae	3	0.32
Litsea glutinosa (Lour.) C.B.Clarke.	Lauraceae	4	0.29
Madhuca indica J. Gmelina	Sapotaceae	29	3.00
Maerua apetala (Roth) Jacobs	Capparaceae	7	0.70
Mallotus philippensis (Lam.) Muell.-Arg.	Euphorbiaceae	11	0.97
Mangifera indica L.	Anacardiaceae	21	1.99
Manilkara hexandra (Roxb.)Dub.	Sapotaceae	6	0.51
Miliusa tomentosa (Roxb).	Annonaceae	10	0.67
Mitragyna parvifolia (Roxb.) Korth.	Rubiaceae	15	1.60
Morinda pubescens J.E. Smith	Rubiaceae	26	2.53
Naringi alata (Wall.exWt&Arn.) Ellis	Rutaceae	15	1.17
Naringi crenulata (Roxb.) Nicolson	Rutaceae	2	0.22
Ochna obtusata DC.	Ochnaceae	77	4.93
Pamburus missionis (Wt.) Swingle	Rutaceae	2	0.21
Phoenix loureirii Kunth, Enum.	Arecaceae	28	2.74
Phyllanthus emblica L.	Euphorbiaceae	50	3.66
Phyllanthus indofischeri Bennet	Euphorbiaceae	9	0.90
Pleurostylia opposita (Wall.) Alston	Celastraceae	4	0.40
Polyalthia cerasoides (Roxb.) Bedd.	Annonaceae	67	4.84
Premna latifolia Roxb.	Verbenaceae	22	1.91
Premna tomentosa Willd.	Verbenaceae	1	0.10
Pterocarpus marsupium Roxb.	Fabaceae	29	2.53
Pterocarpus santalinus L.f.	Fabaceae	544	33.14
Pterospermum xylocarpum (Gaertn.)Sant.&Wagh.	Sterculiaceae	23	2.30
Radermachera xylocarpa (Roxb.) Schum.	Bignoniaceae	6	0.51
Sapindus emarginatus Vahl.	Sapindaceae	10	0.81
Sapium insigene (Royle)Trimen	Euphorbiaceae	16	1.34
Schleichera oleosa (Lour.) Oken	Sapindaceae	25	2.91
Schrebera swietenoides Roxb.	Oleaceae	17	1.54
Sapindus emarginatus Vahl.	Sapindaceae	12	1.21
Soymida febrifuga (Roxb.) Juss.	Meliaceae	25	2.06
Sterculia urens Roxb.	Sterculiaceae	46	3.67
Sterculia villosa Roxb.	Sterculiaceae	6	0.39
Stereospermum personatum (Hassk.) Chatter.	Bignoniaceae	17	1.73
Stereospermum suaveolens (Roxb.) DC.	Bignoniaceae	3	0.39

Name of the tree species	**Family**	**Individuals**	**IVI**
Strychnos nux-vomica L.	Loganiaceae	25	2.04
Strychnos potatorum L.f	Loganiaceae	3	0.28
Syzygium alternifolium (Wt.) Walp.	Myrtaceae	29	1.90
Syzygium cumini (L.) Skeels	Myrtaceae	8	0.73
Tectona grandis L.f.	Verbenaceae	11	1.00
Terminalia alata Heyne ex Roxb	Combretaceae	211	13.97
Terminalia arjuna Roxb.ex DC.	Combretaceae	7	1.06
Terminalia bellirica (Gaertn.)Roxb.	Combretaceae	37	4.54
Terminalia chebula Retz.	Combretaceae	23	1.82
Trema orientalis (L.)	Ulmaceae	14	0.74
Vitex altissima L.f.	Verbenaceae	12	1.54
Vitex leucoxylon L.f.	Verbenaceae	16	1.44
Vitex pinnata L.	Verbenaceae	11	0.90
Walsura trifoliata (Juss.) Harms.	Meliaceae	6	0.66
Wrightia tinctoria (Roxb.) R.Br.	Apocynaceae	36	3.02
Wrigthtia arborea (Dennst.)Mabb.	Apocynaceae	16	0.94
Ziziphus xylopyrus (Retz.)Willd.	Rhamnaceae	12	1.25
Total		**3856**	**300.0**