



Floristic diversity and phyto-sociological studies of Sanjavanam sacred grove in G. Madugula Mandal, Visakhapatnam District, AP, India

K. Satyavathi, D. Sandhya Deepika and S.B. Padal*

Department of Botany, Andhra University, Visakhapatnam – 530003, AP, India
sbpadal08@gmail.com

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Abstract

The floristic diversity and phyto-sociological studies of the Sanjavanam sacred grove in G. Madugula Mandal, Visakhapatnam district, Andhra Pradesh, India were investigated. For quadrat studies 0.5 hectare of forest stands of the sacred grove area was selected and 10 sample quadrates' 1m × 1m for herbs, 5m × 5m for shrubs and 10m × 10m for trees, were laid down randomly for vegetation analysis. A total of 155 species was recorded on enumeration, of which 55 trees, 25 shrubs, 60 herbs and 15 climbing species are noted from random quadrates covering 0.5 hectare area.

Keywords: Sanjavanam Sacred grove, Biodiversity conservation, G. Madugula Mandal, Visakhapatnam District.

Introduction

Sacred groves are important ecological centers to study the potential vegetation. Recently efforts have been made by the scientist to define the sacred groves. Biodiversity is the very basis of human survival and economic development¹ and upon which communities, countries and future generations depended². All forms of vegetation in the sacred groves are supposed to be under the protection of the reigning deity of that grove, and the removal of even a small twig is taboo³. 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 forests⁴, though this has not been substantiated through systematic quantitative analyses. In peninsular India, quantitative phytodiversity inventories are available from the forests of the Western Ghats, whereas study on Eastern Ghats is lacking. The wide range of topography, varied climate favours luxurious growth of vegetation and forest. It remains as a neglected area with very few attempts made for such studies in Eastern Ghats of Tamil Nadu⁵⁻⁶. These kinds of studies are poorly explored in the State of Andhra Pradesh which covers almost 50% of the forest area in Eastern Ghats.

The biodiversity, density, population structure and dispersion of all trees and lianas above 10 cm GBH were investigated into hectars (four 0.5 hector plots) of a sacred grove tropical dry evergreen forest at Puthupet in the coramandal coast of South India⁷. There are some interesting reviews on sacred groves of India, emphasizing biodiversity conservation (especially on floral aspects), natural resource management, cultural and conservation values but details of biodiversity and ecology are not yet covered⁸⁻¹¹. The report of WWF -A.P. has more than 750 SGs from 23 districts of the State as follows (figures in parenthesis are number of groves in the respective district) -

Adilabad (2), Anantapur (73), Chittoor (133), Cuddapah (76), East Godavari (10), Guntur (17), Hyderabad (13), Karimnagar (4), Khammam (4), Krishna (12), Kurnool (115), Mahabubnagar (9), Medak (4), Nalgonda (9), Nellore (87), Nizamabad (7), Prakasam (59), Ranga Reddy (10), Srikakulam (30), Visakhapatnam (30), Vizianagaram (32), Warangal (3), West Godavari (17)¹². Due to rigorous generation of trees sacred groves have high diversity of plants than formal reserves of these groves have high tree diversity and are dominated by the same¹³⁻¹⁵.

Study area: Sanjavanam Sacred Grove is situated in G. Madugula Mandal, Visakhapatnam District, Andhra Pradesh, which is 145 km away from Visakhapatnam town. It covers an area of 0.5 ha. Gangaraju Madugula is located at 18.0167°N 82.5000°E. It has an average elevation of 1097 metres (3602 ft). The vegetation is thick with evergreen and semi-evergreen species.

Methodology

Phytosociological studies were carried out during year 2015-2016 at G. Madugula Mandal, Sanjavanam Sacred Grove, Visakhapatnam District, Andhra Pradesh. The following phytosociological parameters were undertaken for the study. Density, Relative Density, Frequency, Relative Frequency, Abundance, Relative Dominance, IVI (Importance Value Index). IVI is the sum total of Relative Density, Relative Dominance and Relative Frequency for a species were estimated using 10 randomly placed quadrats (10x10m²) for trees, shrubs (5x5m²) and herbs (1x1m²) at each study site of sacred grove. Similarly climbers of all sizes whose base fell inside the plot (10 x10m²) were studied at each study site¹⁶⁻¹⁷. The diversity indices were calculated using the software PAST.

Dominance Index¹⁸: It is a measure of dominance since it is weighted towards the abundances of commonest species. It is estimated by using formula: $D = \sum (ni/N)^2$ or Pi^2 .

Diversity Indices: Species diversity indices namely Shannon-Wiener index were calculated¹⁹. Shannon-Wiener index is a measure of the average degree of 'uncertainty' in predicting to what species an individual chosen at random from a collection of S species and N individuals will belong. It is estimated by using formula: $H' = -\sum (ni/N) \ln (ni/N)$. Where, ni = number of individuals belonging to the species, N = Total number of individuals in the sample.

Results and discussion

A total of 155 species was recorded on enumeration, of which 55 trees, 25 shrubs, 60 herbs and 15 climbers are noted.

A total of 525 individuals belonging to 55 species, 49 genera and 28 families were recorded in the 0.5-ha⁻¹ plot and the vegetation type is moist deciduous vegetation. Out of 28 families, Euphorbiaceae with 6 species, Rubiaceae and Combretaceae with 5, Anacardiaceae 4, Caesalpiniaceae 3, Sterculiaceae, Rutaceae, Oleaceae, Moraceae, Mimosaceae, Loganiaceae, Burseraceae, Bignoniaceae and Apocynaceae each one has 2 species and remaining families consists single species.

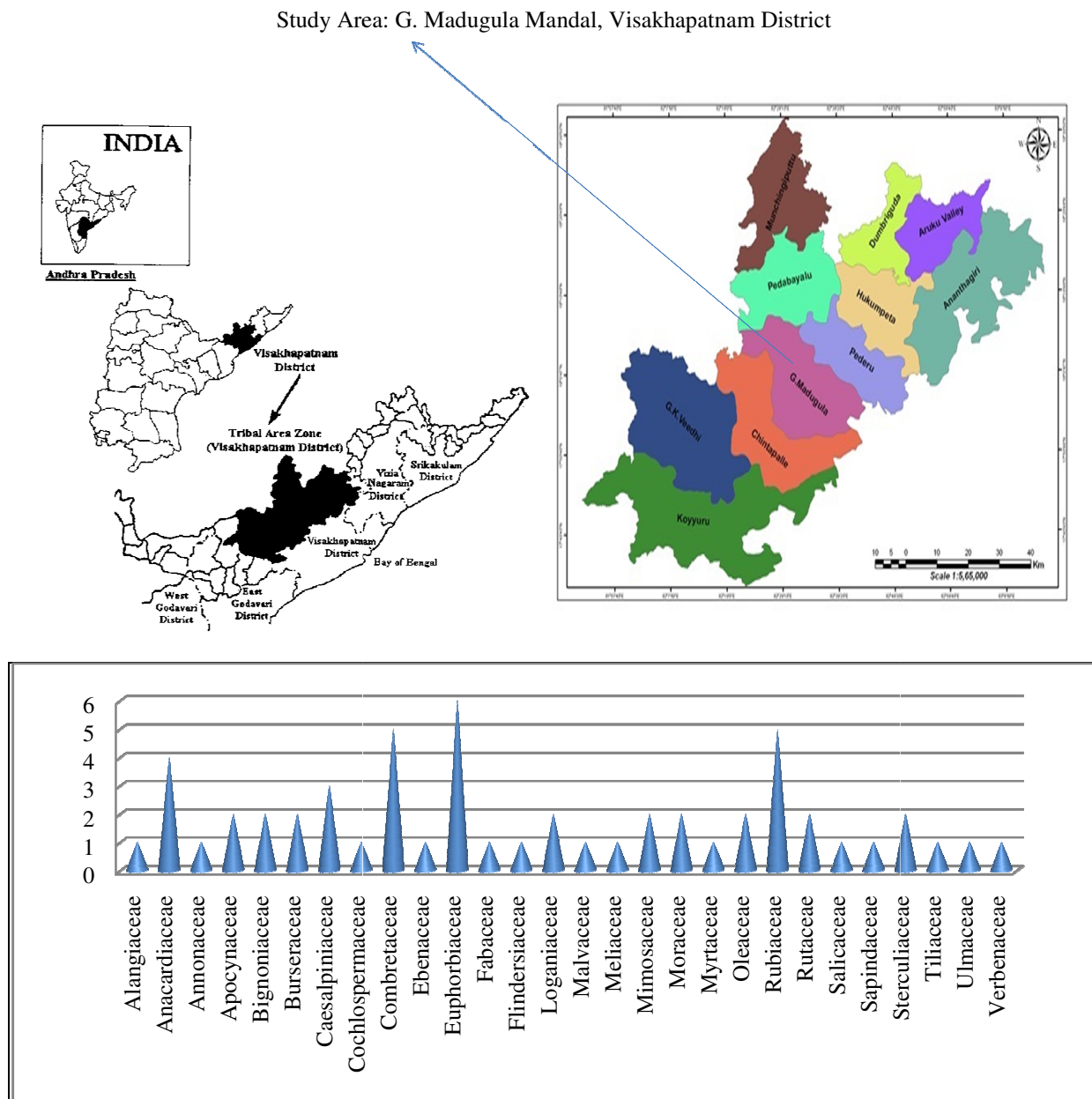


Figure-1: Shows Family wise analysis of Tree taxa in SSG.

In this sacred grove area *Anogeissus latifolia* (4.600/ha⁻¹) has the highest density followed by *Mallotus philippensis* (3.900/ha⁻¹), *Lannea coromandelica* (3.100/ha⁻¹), *Xylia xylocarpa* (3.100/ha⁻¹), *Cleistanthus collinus* and *Pterospermum xylocarpum* both contributed (2.200/ha⁻¹) and *Garuga pinnata* (2.100/ ha⁻¹). However, the most abundant tree species was *Anogeissus latifolia* (3.444/ ha⁻¹) followed by *Tamarindus indica* (3.300/ha⁻¹), *Mangifera indica* (2.185/ha⁻¹), *Xylia xylocarpa* (2.007/ha⁻¹), *Garuga pinnata* (1.321/ha⁻¹), *Mitragyna parvifolia* (1.139/ha⁻¹), *Schleichera oleosa* (1.019/ha⁻¹) and *Mallotus philippensis* (1.011/ha⁻¹) (Figure-1).

Among the tree species *Anogeissus latifolia* was the most dominant species with highest IVI (24.249/ha⁻¹) followed by *Lannea coromandelica* (18.209/ha⁻¹), *Xylia xylocarpa* (16.334/ha⁻¹), *Haldinia cordifolia* (15.246/ha⁻¹), *Mallotus philippensis* (15.100/ha⁻¹), *Garuga pinnata* (11.341/ha⁻¹) are given in Table-1. The Dominance index of tree taxa is (0.03655), Simpson index is (0.9634) and Shannon index is (3.607).

A total of 966 individuals belonging to 25 species, 19 genera and 12 families were recorded in the 0.5-ha⁻¹ plot. Out of 12 families, Euphorbiaceae with 7 species, Acanthaceae 4, Verbenaceae 3, Urticaceae and Poaceae with 2 species, remaining seven families consists single species.

In this sacred grove area *Dendrocalamus strictus* and *Clerodendrum philippinum* has the highest density (7.800/ ha⁻¹) followed by *Thysanolaena maxima* (6.900/ha⁻¹), *Clerodendrum serratum* (6.700/ha⁻¹), and *Calotrophis gygantium* (5.600/ha⁻¹), *Phyllanthus reticulates*, *Justicia adhatoda*, *Gmelina asiatica*, *Colebrookea oppositifolia* and *Breynia vitis-idea* (4.500/ha⁻¹). However, the most abundant climbing species was *Thysanolaena maxima* (17.250/ha⁻¹) followed by *Dendrocalamus strictus* (15.600/ha⁻¹), *Gmelina asiatica* (15.000/ha⁻¹), *Colebrookea oppositifolia* (11.250/ha⁻¹), *Clerodendrum philippinum* (9.750/ha⁻¹), *Homonoia riparia* (8.500/ha⁻¹) and *Calotrophis gygantium* (8.000/ha⁻¹). Among the shrub species *Dendrocalamus strictus* was the most dominant species with highest IVI (20.190/ha⁻¹) followed by *Thysanolaena maxima* (19.432/ha⁻¹), *Clerodendrum philippinum* (19.179/ha⁻¹), *Clerodendrum serratum* (17.510/ha⁻¹), *Calotrophis gygantium* (15.225/ha⁻¹), *Gmelina asiatica* (14.998/ ha⁻¹), and *Colebrookea oppositifolia* (13.681/ha⁻¹). The Dominance index of tree taxa is (0.04981), Simpson index is (0.9502), and Shannon index is (3.094) (Figure-2).

A total of 3671 individuals belonging to 60 species, 51 genera and 20 families were recorded in the 0.5-ha⁻¹ plot. Out of 20 families, Poaceae with 11 species, Acanthaceae 7, Lamiaceae, Euphorbiaceae and Amaranthaceae with 6 species, Commelinaceae with 5, Zingiberaceae 4, Liliaceae and Araceae with 2 species and remaining 11 families consists single families.

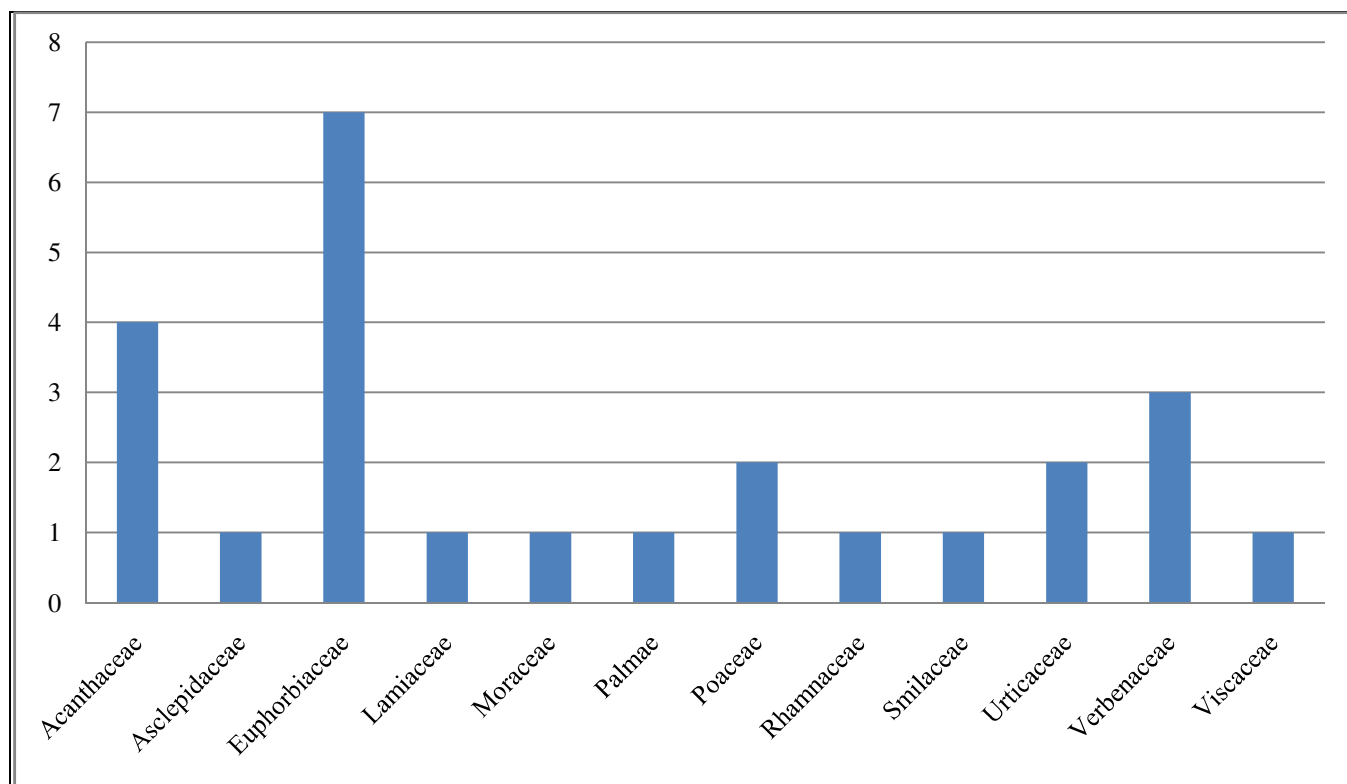


Figure-2: Family wise analysis of Shrubs in SSG.

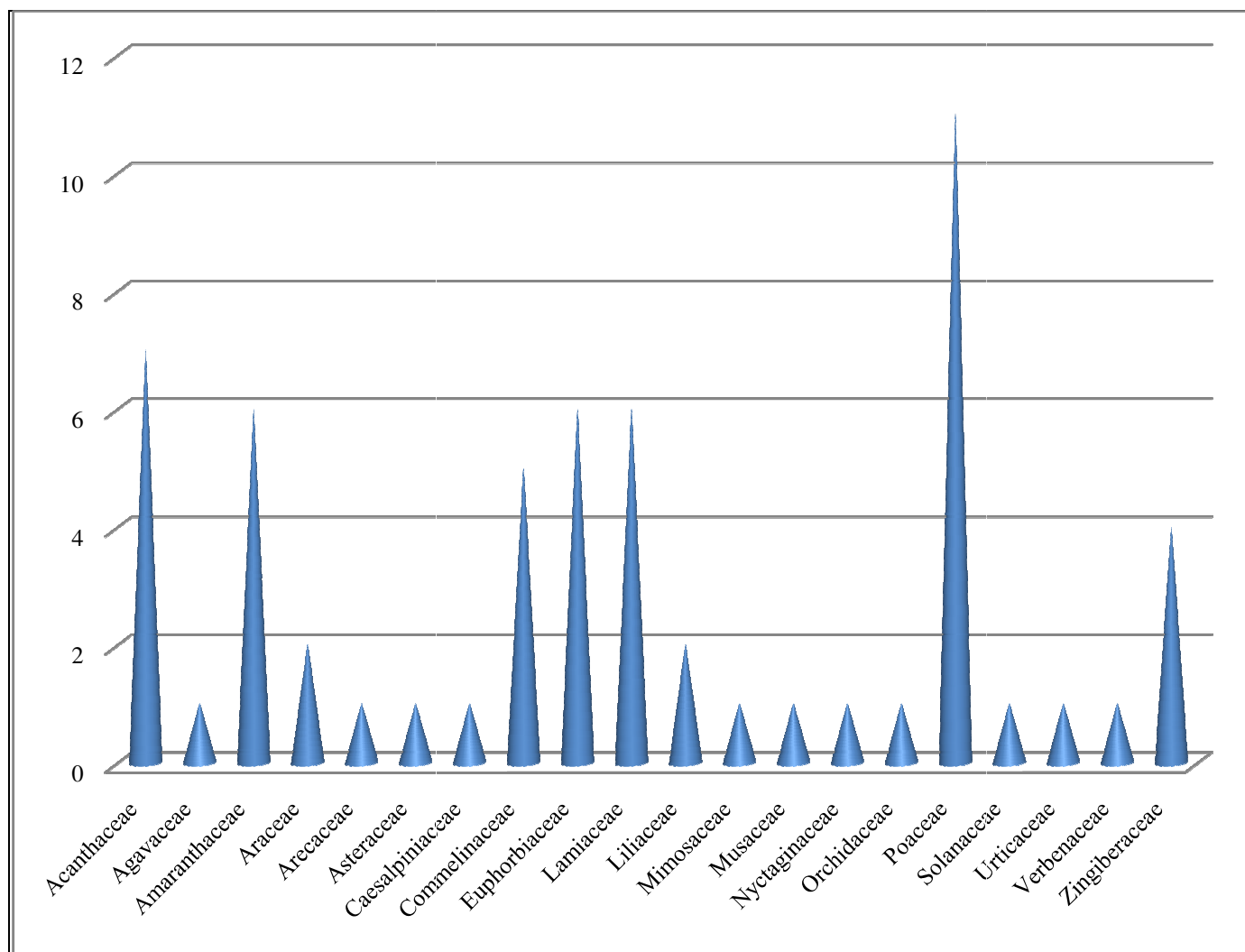


Figure-3: Family wise analysis of Herbs in SSG.

In this sacred grove area *Cynodon dactylon* has the highest density followed by *Cassia tora* ($23.40/\text{ha}^{-1}$) *Boerhavia diffusa* ($23.10/\text{ha}^{-1}$), *Brachiaria distachya* ($21.20/\text{ha}^{-1}$), *Cyanotis tuberosa* ($21.10/\text{ha}^{-1}$), *Eleusine indica* ($20.00/\text{ha}^{-1}$), *Blepharis maderaspatensis* ($14.50/\text{ha}^{-1}$) and *Hyptis suaveolens* ($13.40/\text{ha}^{-1}$). However, the most abundant herbaceous species was *Brachiaria ramosa* ($24.600/\text{ha}^{-1}$) followed by *Cynodon dactylon* and *Cassia tora* ($23.400/\text{ha}^{-1}$), *Boerhavia diffusa* ($23.100/\text{ha}^{-1}$), *Brachiaria distachya* ($21.200/\text{ha}^{-1}$) and *Cyanotis tuberosa* ($21.100/\text{ha}^{-1}$). Among the herbaceous species *Cynodon dactylon* and *Cassia tora* were the most dominant species with highest IVI ($13.543/\text{ha}^{-1}$) followed by *Boerhavia diffusa* ($13.401/\text{ha}^{-1}$), *Brachiaria distachya* ($12.504/\text{ha}^{-1}$), *Cyanotis tuberosa* ($12.457/\text{ha}^{-1}$), *Eleusine indica* ($11.938/\text{ha}^{-1}$) and *Blepharis maderaspatensis* ($9.512/\text{ha}^{-1}$). The Dominance index of tree taxa is (0.03329), Simpson index is (0.9667), and Shannon index is (3.715).

A total of 621 individuals belonging to 15 species, 8 genera and 8 families were recorded in the 0.5-ha^{-1} plot. Out of 8 families,

Dioscoriaceae with 7 species, Aristolochiaceae with 2, remaining 6 families with single species. In this undisturbed sacred grove area *Piper trioicum* has the highest density ($8.00/\text{ha}^{-1}$) followed by *Dioscorea oppositifolia*, *Dioscorea glabra* ($6.70/\text{ha}^{-1}$), *Diplocyclos palmatus*, *Diplocyclos palmatus* ($5.60/\text{ha}^{-1}$), *Asparagus racemosus* and *Dioscorea pentaphylla* ($4.50/\text{ha}^{-1}$). However, the most abundant climbing species was *Diplocyclos palmatus* ($9.333/\text{ha}^{-1}$) followed by *Piper trioicum* ($8.889/\text{ha}^{-1}$), *Stemona tuberosa* ($8.500/\text{ha}^{-1}$), *Asparagus racemosus*, *Dioscorea pentaphylla* ($7.500/\text{ha}^{-1}$) and *Dioscorea bulbifera* ($7.000/\text{ha}^{-1}$).

Among the climber species *Piper trioicum* was the most dominant species with highest IVI ($31.620/\text{ha}^{-1}$) followed by *Dioscorea glabra* and *Dioscorea oppositifolia* ($28.005/\text{ha}^{-1}$), *Diplocyclos palmatus* ($25.374/\text{ha}^{-1}$), *Dioscorea bulbifera* ($24.651/\text{ha}^{-1}$) and *Asparagus racemosus* ($21.523/\text{ha}^{-1}$) are given in Table-4. The Dominance index of tree taxa is (0.08258), Simpson index is (0.9174), and the Shannon index is (2.583).

Table-1: Phytosociological analysis of tree species in Sanjavanam Sacred Grove (SSG).

Plant Species Name	Family	D	F	BA	RD	RF	RBA	IVI
<i>Aegle marmelos</i> (L.) Corrêa	Rutaceae	0.600	0.400	0.237	1.143	1.770	0.760	3.673
<i>Alangium salviifolium</i> (L.f.) Wangerin	Alangiaceae	0.100	0.100	0.005	0.190	0.442	0.016	0.649
<i>Albizia odoratissima</i> (L.f.) Benth.	Mimosaceae	0.300	0.200	0.184	0.571	0.885	0.592	2.048
<i>Anogeissus acuminata</i> (Roxb. ex DC.) Wall	Combretaceae	0.300	0.300	0.271	0.571	1.327	0.871	2.770
<i>Anogeissus latifolia</i> (Roxb. ex DC.) Wall.	Combretaceae	4.600	1.000	3.444	8.762	4.425	11.063	24.249
<i>Atlantia monophylla</i> DC.	Rutaceae	0.300	0.200	0.036	0.571	0.885	0.114	1.571
<i>Bauhinia malabarica</i> Roxb.	Caesalpiniaceae	0.600	0.300	0.241	1.143	1.327	0.775	3.246
<i>Bauhinia racemosa</i> Lam.	Caesalpiniaceae	0.200	0.200	0.063	0.381	0.885	0.202	1.468
<i>Bridelia retusa</i> (L.) A.Juss.	Euphorbiaceae	0.500	0.200	0.198	0.952	0.885	0.635	2.472
<i>Bridelia montana</i> (Roxb.) Willd.	Euphorbiaceae	1.100	0.600	0.295	2.095	2.655	0.949	5.699
<i>Buchanania lanzan</i> Spreng.	Anacardiaceae	0.900	0.500	0.214	1.714	2.212	0.686	4.613
<i>Canthium dicoccum</i> (Gaertn.) Merr.	Rubiaceae	1.000	0.500	0.171	1.905	2.212	0.549	4.667
<i>Casearia tomentosa</i> Roxb.	Salicaceae	0.500	0.200	0.022	0.952	0.885	0.070	1.908
<i>Chloroxylon swietenia</i> DC.	Flindersiaceae	0.900	0.600	0.180	1.714	2.655	0.577	4.946
<i>Cleistanthus patulus</i> (Roxb.) Müll.Arg.	Euphorbiaceae	2.200	0.800	0.254	4.190	3.540	0.814	8.545
<i>Cochlospermum religiosum</i> (L.) Alston	Cochlospermaceae	0.600	0.400	0.366	1.143	1.770	1.175	4.087
<i>Dalbergia paniculata</i> Roxb.	Fabaceae	1.100	0.600	0.923	2.095	2.655	2.964	7.714
<i>Diospyros sylvatica</i> Roxb.	Ebenaceae	0.600	0.300	0.071	1.143	1.327	0.229	2.699
<i>Ficus semicordata</i> Buch.-Ham. ex Sm.	Moraceae	0.300	0.200	0.054	0.571	0.885	0.175	1.631
<i>Ficus tomentosa</i> Roxb. ex Willd.	Moraceae	0.300	0.200	0.150	0.571	0.885	0.481	1.938
<i>Gardenia latifolia</i> Aiton	Rubiaceae	0.700	0.300	0.139	1.333	1.327	0.447	3.108
<i>Garuga pinnata</i> Roxb.	Burseraceae	2.100	0.700	1.321	4.000	3.097	4.243	11.341
<i>Grewia tiliifolia</i> Vahl	Tiliaceae	1.000	0.500	0.368	1.905	2.212	1.182	5.299
<i>Haldina cordifolia</i> (Roxb.) Ridsdale	Rubiaceae	2.000	0.800	2.458	3.810	3.540	7.896	15.246
<i>Holoptelea integrifolia</i> Planch.	Ulmaceae	0.300	0.200	0.239	0.571	0.885	0.768	2.225
<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	Rubiaceae	0.400	0.200	0.222	0.762	0.885	0.712	2.359
<i>Kydia calycina</i> Roxb.	Malvaceae	1.800	0.900	0.673	3.429	3.982	2.163	9.574
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	3.100	1.000	2.397	5.905	4.425	7.699	18.029

Plant Species Name	Family	D	F	BA	RD	RF	RBA	IVI
<i>Macaranga peltata</i> (Roxb.) Müll.Arg.	Euphorbiaceae	1.000	0.300	0.478	1.905	1.327	1.536	4.768
<i>Mallotus philippensis</i> (Lam.) Müll.Arg.	Euphorbiaceae	3.900	1.000	1.011	7.429	4.425	3.247	15.100
<i>Mangifera indica</i> L.	Anacardiaceae	0.300	0.300	2.185	0.571	1.327	7.018	8.917
<i>Miliusa tomentosa</i> (Roxb.) J.Sinclair	Annonaceae	0.100	0.100	0.045	0.190	0.442	0.144	0.777
<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Rubiaceae	0.800	0.400	1.139	1.524	1.770	3.657	6.951
<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	0.800	0.400	0.088	1.524	1.770	0.282	3.576
<i>Oroxylum indicum</i> L.	Bignoniaceae	0.300	0.200	0.027	0.571	0.885	0.088	1.544
<i>Phyllanthus emblica</i> L.	Euphorbiaceae	0.400	0.200	0.048	0.762	0.885	0.154	1.801
<i>Premna tomentosa</i> Willd.	Verbenaceae	0.300	0.200	0.202	0.571	0.885	0.648	2.105
<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	Burseraceae	0.300	0.200	0.111	0.571	0.885	0.358	1.814
<i>Pterospermum xylocarpum</i> (Gaertn.) Oken	Sterculiaceae	2.200	0.700	0.826	4.190	3.097	2.653	9.941
<i>Schleichera oleosa</i> (Lour.) Oken	Sapindaceae	1.600	0.800	1.019	3.048	3.540	3.272	9.859
<i>Schrebera swietenoides</i> Roxb.	Oleaceae	0.900	0.400	0.496	1.714	1.770	1.592	5.076
<i>Semecarpus anacardium</i> L.f.	Anacardiaceae	0.700	0.300	0.439	1.333	1.327	1.411	4.072
<i>Sterculia urens</i> Roxb.	Sterculiaceae	0.700	0.300	0.127	1.333	1.327	0.408	3.068
<i>Stereospermum personatum</i> (Hassk.) Chatterjee	Bignoniaceae	0.100	0.200	0.156	0.190	0.885	0.500	1.576
<i>Strychnos nux-vomica</i> L.	Loganiaceae	1.200	0.500	0.427	2.286	2.212	1.372	5.870
<i>Strychnos potatorum</i> L. fil.	Loganiaceae	0.200	0.200	0.058	0.381	0.885	0.187	1.453
<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	0.200	0.200	0.242	0.381	0.885	0.776	2.042
<i>Tamarindus indica</i> L.	Caesalpinaceae	1.100	0.400	3.300	2.095	1.770	10.601	14.466
<i>Terminalia alata</i> Wall.	Combretaceae	0.200	0.200	0.194	0.381	0.885	0.623	1.889
<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	Combretaceae	0.200	0.200	0.418	0.381	0.885	1.343	2.609
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Combretaceae	0.300	0.200	0.388	0.571	0.885	1.246	2.702
<i>Trichilia connaroides</i> (Wight & Arn.)	Meliaceae	1.100	0.500	0.166	2.095	2.212	0.532	4.839
<i>Wrightia arborea</i> (Dennst.) D.J. Mabberley	Apocynaceae	0.300	0.300	0.067	0.571	1.327	0.215	2.114
<i>Wrightia tinctoria</i> R.Br.	Apocynaceae	1.800	0.600	0.274	3.429	2.655	0.881	6.965
<i>Xylia xylocarpa</i> (Roxb.) Taub.	Mimosaceae	3.100	0.900	2.007	5.905	3.982	6.447	16.334
Total		52.500	22.600	31.132	100.00	100.00	100.00	300.00

D=Density, F= Frequency, BA= Basal area, RD= Relative Density, RF=Relative frequency, RBA=Relative Basal area, IVI=Importance value index.

Table-2: Phytosociological analysis of Shrub species in Sanjavanam Sacred Grove (SSG).

Name of the Plants	Family	D	F	A	RD	RF	RAB	IVI
<i>Barleria cristata</i> L.	Acathaceae	3.400	0.500	6.800	3.520	3.623	3.702	10.845
<i>Barleria longiflora</i> L.f.	Acathaceae	1.200	0.600	2.000	1.242	4.348	1.089	6.679
<i>Boehmeria macrophylla</i> Hornem.	Urticaceae	2.300	0.700	3.286	2.381	5.072	1.789	9.242
<i>Boehmeria glomerulifera</i> Miq.	Urticaceae	1.100	0.400	2.750	1.139	2.899	1.497	5.534
<i>Breynia retusa</i> (Dennst.) Alston	Euphorbiaceae	4.500	0.500	9.000	4.658	3.623	4.900	13.181
<i>Breynia vitis-idea</i> (Brum.f.) Fischer	Euphorbiaceae	4.500	0.600	7.500	4.658	4.348	4.083	13.089
<i>Calotrophis gygantium</i> L.	Asclepidaceae	5.600	0.700	8.000	5.797	5.072	4.355	15.225
<i>Clerodendrum philippinum</i> Mold.	Verbenaceae	7.800	0.800	9.750	8.075	5.797	5.308	19.179
<i>Clerodendrum serratum</i> (L.) Moon.	Verbenaceae	6.700	0.900	7.444	6.936	6.522	4.053	17.510
<i>Colebrookea oppositifolia</i> J.E. Smith	Lamiaceae	4.500	0.400	11.250	4.658	2.899	6.124	13.681
<i>Dendrocalamus strictus</i> Guill. & per.	Poaceae	7.800	0.500	15.600	8.075	3.623	8.492	20.190
<i>Gmelina asiatica</i> L.	Verbenaceae	4.500	0.300	15.000	4.658	2.174	8.166	14.998
<i>Homonioia riparia</i> Lour.	Euphorbiaceae	3.400	0.400	8.500	3.520	2.899	4.627	11.046
<i>Jatropha curcas</i> L.	Euphorbiaceae	2.300	0.500	4.600	2.381	3.623	2.504	8.508
<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	2.300	0.600	3.833	2.381	4.348	2.087	8.816
<i>Justicia adhatoda</i> L.	Acathaceae	4.500	0.700	6.429	4.658	5.072	3.500	13.230
<i>Justicia betonica</i> L.	Acathaceae	3.400	0.400	8.500	3.520	2.899	4.627	11.046
<i>Phoenix loureirii</i> Kunth	Palmae	2.300	0.500	4.600	2.381	3.623	2.504	8.508
<i>Phyllanthus reticulatus</i> Poir.	Euphorbiaceae	4.500	0.600	7.500	4.658	4.348	4.083	13.089
<i>Securinega virosa</i> (Roxb. ex Willd.) Baill.	Euphorbiaceae	3.400	0.500	6.800	3.520	3.623	3.702	10.845
<i>Smilax perfoliata</i> Lour.	Smilacaceae	3.400	0.500	6.800	3.520	3.623	3.702	10.845
<i>Streblus asper</i> (Retz.) Lour.	Moraceae	3.200	0.600	5.333	3.313	4.348	2.903	10.564
<i>Thysanolaena maxima</i> (Roxb.)	Poaceae	6.900	0.400	17.250	7.143	2.899	9.391	19.432
<i>Viscum articulatum</i> Burm. f.	Viscaceae	0.800	0.600	1.333	0.828	4.348	0.726	5.902
<i>Zizipus oenoplia</i> (L.) Mill.	Rhamnaceae	2.300	0.600	3.833	2.381	4.348	2.087	8.816
Total		96.600	13.800	183.692	100.000	100.000	100.000	300.000

D=Density, F= Frequency, BA= Basal area, RD= Relative Density, RF=Relative frequency, RAB=Relative Abundance, IVI=Importance value index.

Table-3: Phytosociological analysis of Herb species in Sanjavanam Sacred Grove (SSG).

Name of the Plants	Family	D	F	A	RD	RF	RAB	IVI
<i>Acalypha indica</i> L.	Euphorbiaceae	6.00	0.800	7.500	1.634	1.995	1.498	5.128
<i>Acampe praemorsa</i> (Roxb.)	Acatheaceae	1.30	0.400	3.250	0.354	0.998	0.649	2.001
<i>Achyranthes aspera</i> L.	Amaranthaceae	5.90	1.000	5.900	1.607	2.494	1.179	5.280
<i>Aerva lanata</i> (L.) A.L. juss. ex Schultes	Amaranthaceae	7.00	0.700	10.000	1.907	1.746	1.998	5.650
<i>Agave angustifolia</i> Haw.	Agavaceae	0.90	0.400	2.250	0.245	0.998	0.450	1.692
<i>Alternanthera sessilis</i> (L.) R. Br. ex DC.	Amaranthaceae	3.40	0.600	5.667	0.926	1.496	1.132	3.555
<i>Amaranthus spinosus</i> L.	Amaranthaceae	5.60	0.800	7.000	1.525	1.995	1.399	4.919
<i>Amaranthus viridis</i> L.	Amaranthaceae	6.70	0.500	13.400	1.825	1.247	2.677	5.749
<i>Andrographis paniculata</i> (Burm.f.) Wall.ex Ness	Acatheaceae	7.80	0.900	8.667	2.125	2.244	1.731	6.101
<i>Anisochilus carnosus</i> (L.f.) Wall. ex Benth	Lamiaceae	5.60	0.600	9.333	1.525	1.496	1.865	4.886
<i>Apluda mutica</i> L.	Poaceae	12.30	0.900	13.667	3.351	2.244	2.730	8.325
<i>Arisaema tortuosum</i> (Wall.) schott	Arecaceae	3.20	0.300	10.667	0.872	0.748	2.131	3.751
<i>Arundo donax</i> L.	Poaceae	12.40	1.000	12.400	3.378	2.494	2.477	8.349
<i>Blepharis maderaspatensis</i> (L.) Heyne ex Roth	Acanthaceae	14.50	0.900	16.111	3.950	2.244	3.219	9.413
<i>Boerhavia diffusa</i> L.	Nyctaginaceae	23.10	1.000	23.100	6.293	2.494	4.615	13.401
<i>Brachiaria distachya</i> (L.) Stapf	Poaceae	21.20	1.000	21.200	5.775	2.494	4.235	12.504
<i>Brachiaria ramosa</i> (L.) Stapf	Poaceae	12.30	0.500	24.600	3.351	1.247	4.915	9.512
<i>Cassia tora</i> L.	Caesalpinaceae	23.40	1.000	23.400	6.374	2.494	4.675	13.543
<i>Celosia argentea</i> L.	Amaranthaceae	3.40	0.500	6.800	0.926	1.247	1.359	3.532
<i>Chlorophytum arundinaceum</i> Baker	Liliaceae	3.40	0.500	6.800	0.926	1.247	1.359	3.532
<i>Colocasia esculenta</i> (L.) Schott	Araceae	2.30	0.400	5.750	0.627	0.998	1.149	2.773
<i>Commelina attenuata</i> Koen.	Commelinaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Commelina bengalensis</i> L.	Commelinaceae	2.30	0.800	2.875	0.627	1.995	0.574	3.196
<i>Commelina diffusa</i> Brum.f.	Commelinaceae	3.40	0.600	5.667	0.926	1.496	1.132	3.555
<i>Costus speciosus</i> (koen.) J.E.Smith	Zingiberaceae	4.30	0.400	10.750	1.171	0.998	2.148	4.317
<i>Croton bonplandianus</i> Baill.	Euphorbiaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Cyanotis cristata</i> (L.) D. Don	Commelinaceae	3.50	0.900	3.889	0.953	2.244	0.777	3.975
<i>Cyanotis tuberosa</i> (Roxb.)	Commelinaceae	21.10	1.000	21.100	5.748	2.494	4.216	12.457
<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	23.40	1.000	23.400	6.374	2.494	4.675	13.543
<i>Cyperus brevifolius</i> (Rottb) Hassk.	Poaceae	6.50	0.800	8.125	1.771	1.995	1.623	5.389

<i>Cyperus cuspidatus</i> Kunth	Poaceae	2.10	0.600	3.500	0.572	1.496	0.699	2.768
<i>Eleusine indica</i> (L.) Gaertn.	Poaceae	20.00	1.000	20.000	5.448	2.494	3.996	11.938
<i>Ensete glaucum</i> (Roxb.) E.E. Cheesm.	Musaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Eranthemum capense</i> L.	Acathaceae	2.10	0.500	4.200	0.572	1.247	0.839	2.658
<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Globba marantina</i> L.	Zingiberaceae	3.40	0.300	11.333	0.926	0.748	2.264	3.939
<i>Gloriosa superba</i> L.	Liliaceae	3.40	0.500	6.800	0.926	1.247	1.359	3.532
<i>Hygrophila auriculata</i> (Schum.)	Acathaceae	3.20	0.400	8.000	0.872	0.998	1.598	3.467
<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	13.40	0.900	14.889	3.650	2.244	2.975	8.869
<i>Indoneesiella echioides</i> (L.) Sreemadh.	Acathaceae	2.30	0.600	3.833	0.627	1.496	0.766	2.889
<i>Lasia spinosa</i> (L.) Thw.	Araceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Leptochloa panicea</i> (Retz.) Ohwi	poaceae	2.10	0.500	4.200	0.572	1.247	0.839	2.658
<i>Leucas indica</i> (L.) R.Br. ex Vatke	Lamiaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Mimosa pudica</i> L.	Mimosaceae	3.40	0.500	6.800	0.926	1.247	1.359	3.532
<i>Ocimum americanum</i> L.	lamiaceae	2.30	0.600	3.833	0.627	1.496	0.766	2.889
<i>Ocimum basilicum</i> L.	Lamiaceae	3.40	0.700	4.857	0.926	1.746	0.970	3.642
<i>Parthenium hysterophorus</i> L.	asteraceae	2.10	0.500	4.200	0.572	1.247	0.839	2.658
<i>Phyllanthus amarus</i> Schum.&Thonn.	Euphorbiaceae	2.30	0.600	3.833	0.627	1.496	0.766	2.889
<i>Phyllanthus maderaspatensis</i> L.	euphorbiaceae	2.30	0.500	4.600	0.627	1.247	0.919	2.792
<i>Plectranthus mullis</i> (Ait.) Spreng.	Lamiaceae	3.40	0.700	4.857	0.926	1.746	0.970	3.642
<i>Pouzolzia zeylanica</i> (L.) Bennett	Urticaceae	2.10	0.500	4.200	0.572	1.247	0.839	2.658
<i>Rostellularia diffusa</i> (Willd.) Nees	Acathaceae	6.60	0.700	9.429	1.798	1.746	1.884	5.427
<i>Sebastiania chamaelea</i> (L.)	Euphorbiaceae	4.50	0.800	5.625	1.226	1.995	1.124	4.345
<i>Solanum suratense</i> Burm.f.	Solanaceae	4.50	0.600	7.500	1.226	1.496	1.498	4.220
<i>Sorghum halepense</i> (L.) Pers.	Poaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Stachytarpheta jamaicensis</i> (L.)	Verbenaceae	3.40	0.700	4.857	0.926	1.746	0.970	3.642
<i>Themeda triandra</i> Forssk.	Poaceae	4.50	0.500	9.000	1.226	1.247	1.798	4.271
<i>Vanda tessellata</i> (Roxb.) Hook. ex G. Don	Orchidaceae	2.30	0.700	3.286	0.627	1.746	0.656	3.029
<i>Zingiber capitatum</i> Roxb.	Zingiberaceae	3.40	0.500	6.800	0.926	1.247	1.359	3.532
<i>Zingiber roseum</i> (Roxb.) Roscoe	Zingiberaceae	2.30	0.600	3.833	0.627	1.496	0.766	2.889
Total		367.10	40.10	500.533	100.000	100.000	100.000	300.000

D=Density, F= Frequency, BA= Basal area, RD= Relative Density, RF=Relative frequency, RAB=Relative Abundance, IVI=Importance value index.

Table-4: Phytosociological analysis of Climber species in Sanjavanam Sacred Grove (SSG).

Name of the Plants	Family	D	F	A	RD	RF	RA	IVI
<i>Aristolochia indica</i> L.	Aristolochiaceae	1.200	0.500	2.400	1.932	4.808	2.723	9.463
<i>Aristolochia tagala</i> Cham.	Aristolochiaceae	1.300	0.600	2.167	2.093	5.769	2.458	10.320
<i>Asparagus racemosus</i> Willd.	Liliaceae	4.500	0.600	7.500	7.246	5.769	8.508	21.523
<i>Cassytha filiformis</i> L.	Lauraceae	2.300	0.600	3.833	3.704	5.769	4.348	13.821
<i>Dioscorea bulbifera</i> L.	Dioscoriaceae	5.600	0.800	7.000	9.018	7.692	7.941	24.651
<i>Dioscorea glabra</i> Roxb.	Dioscoriaceae	6.700	1.000	6.700	10.789	9.615	7.600	28.005
<i>Dioscorea hispida</i> Dennst.	Dioscoriaceae	4.500	0.800	5.625	7.246	7.692	6.381	21.320
<i>Dioscorea oppositifolia</i> L.	Dioscoriaceae	6.700	1.000	6.700	10.789	9.615	7.600	28.005
<i>Dioscorea pentaphylla</i> L.	Dioscoriaceae	4.500	0.600	7.500	7.246	5.769	8.508	21.523
<i>Dioscorea tomentosa</i> Koen. ex Spreng.	Dioscoriaceae	3.400	0.700	4.857	5.475	6.731	5.510	17.716
<i>Dioscorea wallichii</i> Hook.f.	Dioscoriaceae	2.200	0.800	2.750	3.543	7.692	3.120	14.355
<i>Diplocyclos palmatus</i> (L.) Jeffrey	Cucurbitaceae	5.600	0.600	9.333	9.018	5.769	10.588	25.374
<i>Piper trioicum</i> Roxb.	Piperaceae	8.000	0.900	8.889	12.882	8.654	10.083	31.620
<i>Stemona tuberosa</i> Lour.	Stemonaceae	3.400	0.400	8.500	5.475	3.846	9.642	18.963
<i>Tragia involucrata</i> L.	Euphorbiaceae	2.200	0.500	4.400	3.543	4.808	4.991	13.342
Total		62.100	10.40	88.154	100.000	100.000	100.000	300.000

D=Density, F= Frequency, BA= Basal area, RD= Relative Density, RF=Relative frequency, RAB=Relative Abundance, IVI=Importance value index.

Conclusion

Results of the study led to the conservation that the reserve forests of Visakhapatnam district has good species richness, diversity, dominance and stand density when compared to certain other dry deciduous forests and calculation of IVI have helped in understanding the ecological significance of species. There is a over exploitation of trees by the local population, has resulted in depletion of biodiversity which is usually accompanied by species extinction and reduction in biodiversity. So it needs a sustainable conservation since it harbours most of the threatened, rare and endangered species in some core forest pockets.

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