Phytosociological analysis of Downuru Sacred Grove in Koyyuru Mandal, Visakhapatnam District, Andhra Pradesh, India

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Abstract
The present investigation reflects the findings of phytosociological attributes which have been undertaken in the sacred grove of Downuru, Koyyuru Mandal, Visakhapatnam district of Andhra Pradesh, India. The vegetation types of district are mainly Semi evergreen deciduous forest. Vegetation analysis was conducted during 2014 - 2015. The survey documentation of the plant species in the Sacred Grove areas of District recorded 50 species of trees and 28 species of shrubs and 80 species of herbs and climbers.

Keywords: *Phytosociological analysis, Downuru sacred grove, Koyyuru Mandal, Visakhapatnam District*.

INTRODUCTION

The traditional worship practices show the symbiotic relation of human beings and nature. Indigenous communities all over the world lived in harmony with the nature and conserved its valuable biodiversity. Sacred groves are patches of native vegetation traditionally protected by local communities, and are unique, and significant, examples of *in situ* biodiversity conservation [1-2]. A good example of such traditional practices is the conservation and protection of small forest patches by dedicating them to the local deities by various indigenous communities of the world. Such forest patches are called "sacred groves". Sacred groves are the tracts of virgin forest that were left untouched by the local inhabitants, harbour rich biodiversity, and are protected by the local people due to their cultural and religious beliefs and taboos that the deities reside in them.

It is generally believed that, owing to their religious significance, sacred groves are better protected and managed, and hence harbor richer plant diversity than other forests [3]. In India as well as in parts of Asia and Africa, care and respect for nature has been influenced by religious beliefs and indigenous practices. The existence of sacred Groves has been reported in many parts of Asia, Africa, Europe, Australia and America [4]. Groves are also reported from Ghana, Nigeria, Syria, Turkey and Japan [5]. The vegetation of the sacred groves has certain distinctive ecological characteristics. The sacred groves of Kerala have distinct tiers of trees, shrubs and herbs, climbers and stranglers, epiphytes, parasites, and many wild relatives of cultivated plants [6]. Broadly, the vegetation of these groves has been classified into two types viz. evergreen type and the moist deciduous type [7]. Due to the advent of industrialization, urbanization and changing socio-economic scenario, the cultural norms and taboos were annihilated, leading to drastic deterioration of these natural resources. There need to be serious efforts to conserve these groves from further depletion.

MATERIALS AND METHODS

Downuru Sacred Grove is situated in Koyyuru Mandal, Visakhapatnam District, Andhra Pradesh, which is 110 km away from Visakhapatnam town. It lies between $17^{0}45^{1}.779^{11}$N North latitude and $082^{0}32^{1}.444^{11}$E East longitude and the Elevation of the grove 179M. The vegetation is thick with semi-evergreen species.

Regular field trips to the groves were carried out at seasons representing pre monsoon, monsoon and post monsoon. During field visits, plant species were identified, phytosociological studies were carried out and specimens were collected. Plant materials collected were made into herbarium specimens following standard herbarium techniques [8] and are deposited at Herbarium of the Department of Botany, Andhra University, Visakhapatnam for reference. Plant specimens are identified using relevant local floras [9-12].

For phytosociological studies of major plants, frequency, density, abundance and thereby Importance Value Index (IVI) of species were worked out using Quadrate method, as proposed by Curtis [13]. This index is used to determine the overall importance of each species in the community structure. For calculating this index, percentage values of relative frequency, relative density and relative abundance are summed up. *Species diversity analysis* Species diversity was calculated using the Simpson index [14] and Shannon-Wiener index [15] and also used by other index for calculating the diversity of the species in a area.

RESULT AND DISCUSSION

A total of 158 species was recorded on enumeration, of which 80 of climbers and herbs, 28 shrubs, 50 trees are noted. A total of 389 individuals belonging to 50 species, 28 families were recorded in the 0.5-ha^{-1} plot and the vegetation type is semi evergreen deciduous vegetation. Out of 32 families, Rubiaceae, Mimosaceae, Ebenaceae with 4 species, Verbenaceae 3, Tiliaceae, Rutaceae, Rhamnaceae, Moraceae, Flacourtiaceae, Euphorbiaceae and Caesalpiniaceae each one has 2 species, and remaining 21 families consists single species are given in (**Fig. 1).**

Fig. 1 Family wise analysis of Tree Taxa in Downuru Sagred Grove.

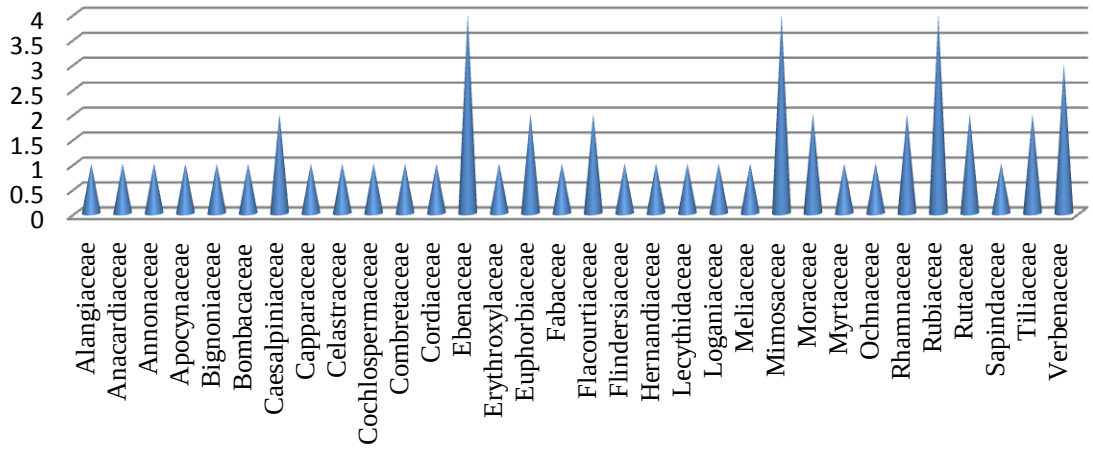


Table – 1 shows the findings of observation determined with reference to frequency, density and basal area m^2 ha-^{1}, and IVI and diversity index of all tree species. The total density ha-^{1} in this area was recorded to be 389 individual trees per 0.5 hectors land area.

Out of 50 tree taxa, *Bridelia Montana* has the highest density *(*2.700) followed by the other tree species having high density were *Wrightia tinctoria* and *Alangium salvifolium (*2.20), *Acacia catechu (*2.10), *Gyrocarpus americanus*, *Diospyros chloroxylon and Casearia tomentosa (*1.90), *Erythroxylon monogynum* (1.60) and *Ziziphus mauritiana, Grewia rothii, Diospyros sylvatica* and *Chloroxylon swietenia*. Each one has (1.50)

The total basal area m^2 ha-^{1} occupied by the total tree species is 2.964 m^2 ha-^{1} of which the maximum values were found for species in this sacred grove *Gyrocarpus americanus* shows highest basal area (0.260) followed by *Wrightia tinctoria* (0.180), *Bridelia montana* (0.176), *Acacia catechu* (0.165), *Alangium salvifolium* (0.160), *Diospyros chloroxylon* (0.153), *Bombax ceiba* (0.146) and *Ziziphus mauritiana* (0.119).

The highest IVI values was calculated for *Bridelia montana* exhibited higher IVI value of (18.733) followed by *Gyrocarpus americanus* (17.740), *Wrightia tinctoria* (16.984), *Alangium salvifolium* (16.896), *Acacia catechu* (16.810), *Diospyros chloroxylon* (14.716) and *Casearia tomentosa* (12.774).

The Dominance index of tree taxa is (0.0354), Simpson index is (0.9646), Shannon index is (3.562), Evenness index is (0.7046), Menhinick index is (2.535), Margalef index (8.217), Equitability index is (0.9105), Fisher_alpha index (15.26) and Berger-Parker index (0.06941) are given in (**Fig. 2**).

A total of 290 Shrubs individuals belonging to 28 species and 14 families were recorded in the 0.5-ha^{-1} plot. Out of the 14 families, Euphorbiaceae with 7, Acathaceae 5, Verbenaceae 3, Urticaceae and Poaceae each one has 2 species remaining nine families consists single species.

Among ten dominant shrubs *Dendrocalamus strictus* exhibited higher denisity ((3.40) followed by the other shrub species having high density were *Boehmeria macrophylla*, (2.20), *Zanthoxylum armatum* (1.50), *Boehmeria glomerulifera, Boehmeria glomerulifera, Barleria cristata* and *Jatropha gossypifolia* (1.30),

Calotrophis gygantium and *Justicia adhatoda* (1.20), *Breynia retusa*. *Zizipus oenoplia, Justicia betonica* each one has (1.10).

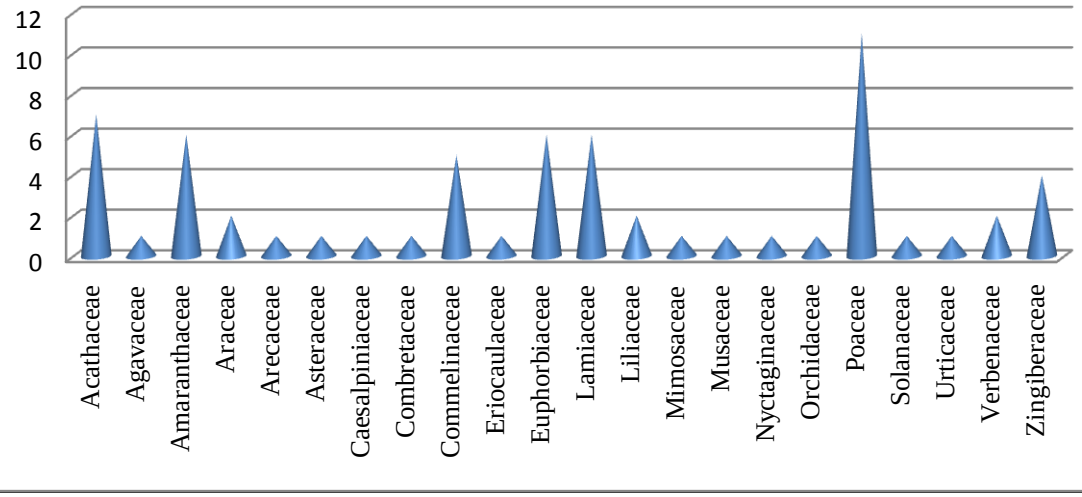
Among the dominant shrub species *Breynia vitis-idea*exhibited highest abundance (5.000) followed by *Dendrocalamus strictus* (4.857), *Viscum articulatum* (4.500), *Calotrophis gygantium*, *Clerodendrum serratum* and *Phoenix loureirii* (4.000), *Breynia retusa* and *Justicia betonica* both contributed with (3.667).

The maximum IVI values determined for shrub species was by the species namely, *Dendrocalamus strictus* was the dominant species with highest IVI (24.243) followed by the other species like *Boehmeria macrophylla* (14.220), *Barleria cristata* (12.659), *Boehmeria glomerulifera* and *Jatropha gossypifolia* (12.243), *Justicia adhatoda* (12.101), *Calotrophis gygantium* (11.957) and *Breynia vitis-idea* (11.645) are given in (**Table .2**).

The Dominance index of Shrubs is (0.04476), Simpson index is (0.9552), Shannon index is (3.237), Evenness index is (0.9089), Menhinick index is (1.644), Margalef index (4.762), Equitability index is (0.9713), Fisher_alpha index (7.647) and Berger-Parker index (0.1172) are given in (**Fig.2**).

The status of herbaceous layer which is constituted by an association of 64 species belongs to 22 families. Out of 22 families, Poaceae with 11 species, Acathaceae 7, Lamiaceae, Euphorbiaceae, Amaranthaceae each one has 6, Commelinaceae with 5, Zingiberaceae 4, Verbenaceae, Liliaceae, Araceae each one has 2 species, remaining 12 families consists single species.

Fig. 3 Family wise analysis of Herbs in Downuru Sacred Grove.



Out of 64 herbs in this grove *Aerva lanata* has the highest density (8.90) followed by *Brachiaria ramosa* with (8.70), *Acalypha indica* (8.00), *Brachiaria distachya* (7.90) and *Celosia argentena* with (7.70). Among ten abundance herbs in this grove *Boerhavia diffusa* (16.25) has the highest abundance followed by *Brachiaria distachya* has (15.80), *Brachiaria ramose* with (12.43), *Amaranthus viridis*, (11.17) and *Blepharis maderaspatensis* with (9.17).

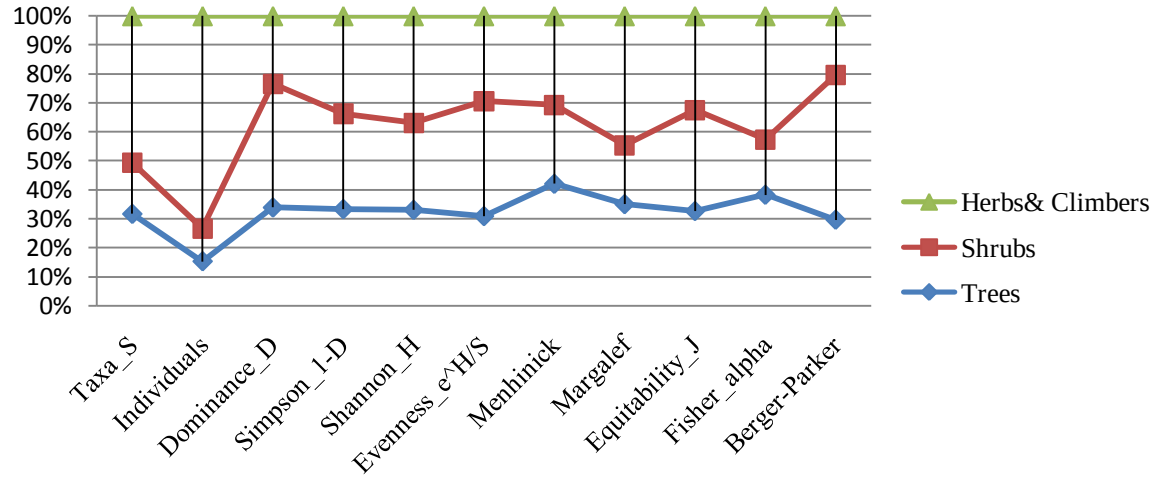
Table – 3 reveals that maximum IVI values of herbaceous layer in this area was recorded by species viz. *Brachiaria distachya* is the dominant species with highest IVI (10.193) followed by *Brachiaria ramose* (10.118), the other co-dominant species were *Aerva lanata* (9.926), *Boerhavia diffusa* (9.328), *Acalypha indica* (9.177) and *Celosia argentena* with (8.931).

A total of 16 climbers belong to 8 families. Among the climbers, *Asparagus racemosus* exihibited highest density (3.40) followed by *Cassytha filiformis* (3.20), *Thunbergia frgrans* (3.20), *Tragia involucrate* (2.20) and *Stemona tuberose* (1.10). Among the climbers, *Thunbergia frgrans was* the highest abundance (5.75) followed by *Asparagus racemosus* (4.86), *Tragia involucrata* (4.40), *Aristolochia tagala* (3.00) and *Dioscorea pentaphylla* (2.50).

The most abundant species was *Asparagus racemosus* exhibited highest IVI (5.026) followed by *Cassytha filiformis* (4.914), *Tragia involucrata* (3.745) and *Stemona tuberosa* (2.501). The Dominance index of Herbs and Climbers is (0.0244), Simpson index is (0.9756), Shannon index is (3.979), Evenness index is (0.6685), Menhinick index is (1.85), Margalef index (10.49), Equitability index is (0.9081), Fisher alpha index (16.98) and Berger-Parker index (0.04759) are given to (**Fig. 2**).

Forest are comparable with other forest communities of India. Rao and Mishra [16] observed 61 tree and shrub species in tropical forest of Chitrakoot. 53 and 57 tree and shrub species have been reported for tropical semi-evergreen forest of Manipur, North-East India. Tropical Evergreen forest of Courtallum reserve forest of Western Ghats [17-18]. Tropical forests of Andaman Islands [19]. The tree density in the sanctuary areas has been found higher than the tropical evergreen forests of Western as well as Eastern Ghats where it ranges from 419-716 stem ha-1 [20-23].

Fig. 2 Biodiversity indices in Downuru Sacred Grove.



CONCLUSION

These groves are abode of various floristic elements and necessary efforts need to be taken to protect the sacred groves to prevent the loss of biodiversity. In addition regular monitoring is required to evaluate the loss of diversity. The protection of the groves and conservation of their valuable biodiversity and cultural diversity can be achieved through people's participation only.

Management of groves is very much related to the social and cultural-religious norms of nearby communities. Studies have pointed out that ecological profiles can be used as indicators of grove management. A community managed, well maintained grove might have higher stem density, higher basal area and good regeneration potential. In contrast, disturbed groves were often dominated by heliophilic open space species [24-28].

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Table 1. Phytosociological analysis of tree species in Downuru Sacred grove (DSG)

Species Name	**Family**	**D**	**F**	**BA**	**RD**	**RF**	**RBA**	**IVI**
Acacia catechu (L.f.) Willd.	Mimosaceae	2.100	1.00	0.165	5.398	5.848	5.563	16.810
Acacia leucophloea (Roxb.) Willd.	Mimosaceae	0.700	0.40	0.072	1.799	2.339	2.446	6.584
Alangium salviifolium (L.f.) Wangerin	Alangiaceae	2.200	1.00	0.160	5.656	5.848	5.393	16.896
Albizia chinensis (Osbeck) Merr.	Mimosaceae	0.700	0.20	0.053	1.799	1.170	1.777	4.746
Anogeissus acuminata (Roxb. ex DC.) Guill.	Combretaceae	0.600	0.30	0.052	1.542	1.754	1.751	5.048
Atalantia monophylla DC.	Rutaceae	0.400	0.20	0.017	1.028	1.170	0.583	2.781
Azadirachta indica A.Juss.	Meliaceae	0.200	0.10	0.015	0.514	0.585	0.505	1.603
Bauhinia racemosa Lam.	Caesalpiniaceae	0.300	0.20	0.019	0.771	1.170	0.639	2.580
Bombax ceiba L.	Bombacaceae	0.500	0.20	0.146	1.285	1.170	4.932	7.387
Bridelia montana (Roxb.) Willd.	Euphorbiaceae	2.700	1.00	0.176	6.941	5.848	5.944	18.733
Canthium dicoccum (Gaertn.) Merr.	Rubiaceae	0.300	0.10	0.016	0.771	0.585	0.556	1.912
Careya arborea Roxb.	Lecythidaceae	0.200	0.10	0.013	0.514	0.585	0.429	1.528

Casearia tomentosa Roxb.	Flacourtiaceae	1.900	0.80	0.095	4.884	4.678	3.211	12.774
Cassia fistula L.	Caesalpiniaceae	1.200	0.40	0.094	3.085	2.339	3.162	8.586
Cassine glauca (Rottb.) Kuntze	Celastraceae	0.300	0.10	0.033	0.771	0.585	1.114	2.470
Chloroxylon swietenia DC.	Flindersiaceae	1.500	0.50	0.109	3.856	2.924	3.676	10.456
Cochlospermum religiosum (L.) Alston	Cochlospermaceae	0.800	0.40	0.064	2.057	2.339	2.157	6.553
Cordia dichotoma G.Forst.	Cordiaceae	0.400	0.20	0.040	1.028	1.170	1.351	3.549
Crateva magna (Lour.) DC.	Capparaceae	0.100	0.10	0.007	0.257	0.585	0.241	1.083
Dalbergia paniculata Roxb.	Fabaceae	0.400	0.20	0.041	1.028	1.170	1.383	3.580
Dichrostachys cinerea (L.) Wight & Arn.	Mimosaceae	0.400	0.20	0.015	1.028	1.170	0.491	2.689
Diospyros chloroxylon Roxb.	Ebenaceae	1.900	0.80	0.153	4.884	4.678	5.153	14.716
Diospyros montana Roxb.	Ebenaceae	0.200	0.10	0.010	0.514	0.585	0.322	1.421
Diospyros sylvatica Roxb.	Ebenaceae	1.500	0.50	0.085	3.856	2.924	2.872	9.652
Dolichandrone falcata (Wall. ex DC.) Seem.	Bignoniaceae	0.600	0.30	0.039	1.542	1.754	1.327	4.624
Erythroxylon monogynum Roxb.	Erythroxylaceae	1.600	0.70	0.091	4.113	4.094	3.062	11.269
Euphorbia antiquorum L.	Euphorbiaceae	0.400	0.20	0.020	1.028	1.170	0.673	2.871
Ficus racemosa L.	Moraceae	0.200	0.10	0.032	0.514	0.585	1.086	2.185
Flacourtia jangomas (Lour.) Raeusch.	Flacourtiaceae	0.200	0.10	0.005	0.514	0.585	0.174	1.273
Gardenia gummifera L.f.	Rubiaceae	0.800	0.40	0.055	2.057	2.339	1.852	6.248
Gmelina arborea Roxb.	Verbenaceae	0.100	0.10	0.004	0.257	0.585	0.142	0.984
Grewia rothii DC.	Tiliaceae	1.500	0.80	0.102	3.856	4.678	3.440	11.975
Grewia tiliifolia Vahl	Tiliaceae	0.300	0.20	0.031	0.771	1.170	1.039	2.980
Gyrocarpus americanus Jacq.	Hernandiaceae	1.900	0.70	0.260	4.884	4.094	8.762	17.740
Ixora pavetta Andr.	Rubiaceae	0.600	0.30	0.024	1.542	1.754	0.816	4.113
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	1.000	0.40	0.084	2.571	2.339	2.851	7.760
Maba buxifolia (Rottb.) Pers.	Ebenaceae	0.800	0.40	0.028	2.057	2.339	0.947	5.343
Morinda pubescens Sm.	Rubiaceae	0.600	0.30	0.041	1.542	1.754	1.382	4.679
Murraya paniculata (L.) Jack	Rutaceae	0.200	0.10	0.006	0.514	0.585	0.194	1.293
Ochna obtusata DC.	Ochnaceae	0.200	0.10	0.008	0.514	0.585	0.264	1.363
Polyalthia cerasoides (Roxb.) Benth.	Annonaceae	0.100	0.10	0.003	0.257	0.585	0.087	0.929
Premna tomentosa Willd.	Verbenaceae	0.500	0.20	0.024	1.285	1.170	0.825	3.280
Sapindus emarginatus Vahl	Sapindaceae	0.700	0.30	0.057	1.799	1.754	1.910	5.464
Streblus asper Lour.	Moraceae	0.300	0.10	0.014	0.771	0.585	0.469	1.825
Strychnos nux-vomica L.	Loganiaceae	0.600	0.20	0.052	1.542	1.170	1.750	4.462
Syzygium cumini (L.) Skeels	Myrtaceae	0.100	0.10	0.005	0.257	0.585	0.168	1.009
Vitex pinnata L.	Verbenaceae	0.100	0.10	0.011	0.257	0.585	0.387	1.229
Wrightia tinctoria R.Br.	Apocynaceae	2.200	0.90	0.180	5.656	5.263	6.066	16.984
Ziziphus mauritiana Lam.	Rhamnaceae	1.500	0.60	0.119	3.856	3.509	4.003	11.368
Ziziphus xylopyrus Hochst. ex A.Rich.	Rhamnaceae	0.300	0.20	0.020	0.771	1.170	0.673	2.614
Total		**38.900**	**17.10**	**2.964**	**100.000**	**100.000**	**100.000**	**300.000**

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 Shrubs in Downuru Sacred Grove (DSG).

Name of the plant	**Family**	**D**	**F**	**A**	**RD**	**RF**	**RAB**	**IVI**
Alangium salviifolium (L.f.) Wang.	Alangiaceae	1.00	0.40	2.500	3.448	3.604	3.198	10.250
Barleria cristata L.	Acathaceae	1.30	0.60	2.167	4.483	5.405	2.771	12.659
Barleria longiflora L.f.	Acathaceae	0.80	0.40	2.000	2.759	3.604	2.558	8.920
Boehmeria macrophylla Hornem.	Urticaceae	1.50	0.70	2.143	5.172	6.306	2.741	14.220
Boehmeria glomerulifera Miq.	Urticaceae	1.30	0.40	3.250	4.483	3.604	4.157	12.243
Breynia retusa (Dennst.) Alston	Euphorbiaceae	1.10	0.30	3.667	3.793	2.703	4.690	11.186
Breynia vitis-idea (Brum.f.) Fischer	Euphorbiaceae	1.00	0.20	5.000	3.448	1.802	6.395	11.645
Calotropis gigantea (L.) W. T. Aiton	Asclepidaceae	1.20	0.30	4.000	4.138	2.703	5.116	11.957
Clerodendrum philippinum Mold.	Verbenaceae	0.80	0.40	2.000	2.759	3.604	2.558	8.920
Clerodendrum serratum (L.) Moon.	Verbenaceae	0.80	0.20	4.000	2.759	1.802	5.116	9.677
Colebrookea oppositifolia J.E. Smith	Lamiaceae	0.40	0.20	2.000	1.379	1.802	2.558	5.739
Curculigo orchioides Gaertn.	Hypoxidaceae	0.60	0.20	3.000	2.069	1.802	3.837	7.708
Dendrocalamus strictus (Roxb.ex DC.)	Poaceae	3.40	0.70	4.857	11.724	6.306	6.213	24.243
Ecbolium viride (Forssk.) Alston	Acathaceae	0.80	0.50	1.600	2.759	4.505	2.046	9.310
Gmelina asiatica L.	Verbenaceae	0.90	0.50	1.800	3.103	4.505	2.302	9.910
Homonoia riparia Lour.	Euphorbiaceae	1.10	0.60	1.833	3.793	5.405	2.345	11.543
Jatropha curcas L.	Euphorbiaceae	1.00	0.40	2.500	3.448	3.604	3.198	10.250
Jatropha gossypifolia L.	Euphorbiaceae	1.30	0.40	3.250	4.483	3.604	4.157	12.243
Justicia adhatoda L.	Acathaceae	1.20	0.60	2.000	4.138	5.405	2.558	12.101
Justicia betonica L.	Acathaceae	1.10	0.30	3.667	3.793	2.703	4.690	11.186
Phoenix loureirii Kunth	Palme	0.80	0.20	4.000	2.759	1.802	5.116	9.677
Phyllanthus reticulatus Poir.	Euphorbiaceae	0.90	0.40	2.250	3.103	3.604	2.878	9.585
Securinega virosa (Roxb. ex Willd.)	Euphorbiaceae	0.80	0.60	1.333	2.759	5.405	1.705	9.869
Smilax perfoliata Lour.	Smilaceae	0.60	0.20	3.000	2.069	1.802	3.837	7.708
Streblus asper (Retz.) Lour.	Moraceae	0.50	0.30	1.667	1.724	2.703	2.132	6.559
Thysanolaena maxima (Roxb.)	Poaceae	0.80	0.40	2.000	2.759	3.604	2.558	8.920
Viscum articulatum Burm. f.	Viscaceae	0.90	0.20	4.500	3.103	1.802	5.756	10.661
Zizipus oenoplia (L.) Mill.	Rhamnaceae	1.10	0.50	2.200	3.793	4.505	2.814	11.112
	Total	**29.00**	**11.10**	**78.183**	**100.000**	**100.000**	**100.000**	**300.000**

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

Table 3. Phytosociological analysis of Herbs & Climbers in Downuru Sacred Grove (DSG).

Name of the Plants	**Family**	**D**	**F**	**A**	**RD**	**RF**	**RAB**	**IVI**
Acalypha indica L.	Euphorbiaceae	8.00	1.00	8.00	4.278	2.513	2.386	9.177
Acampe praemorsa (Roxb.)	Acathaceae	1.20	0.60	2.00	0.642	1.508	0.596	2.746
Achyranthes aspera L.	Amaranthaceae	6.70	1.00	6.70	3.583	2.513	1.998	8.094
Aerva lanata (L.) A.L. juss. ex Schultes	Amaranthaceae	8.90	1.00	8.90	4.759	2.513	2.654	9.926
Agave angustifolia Haw.	Agavaceae	3.40	0.80	4.25	1.818	2.010	1.268	5.096
Alternanthera sessilis (L.) R. Br.	Amaranthaceae	2.40	0.90	2.67	1.283	2.261	0.795	4.340
Amaranthus spinosus L.	Amaranthaceae	5.60	0.70	8.00	2.995	1.759	2.386	7.139

Amaranthus viridis L.	Amaranthaceae	6.70	0.60	11.17	3.583	1.508	3.330	8.421
Andrographis paniculata (Burm.f.)	Acathaceae	2.20	0.80	2.75	1.176	2.010	0.820	4.007
Anisochilus carnosus (L.f.) Wall.	Lamiaceae	1.20	0.50	2.40	0.642	1.256	0.716	2.614
Apluda mutica L.	Poaceae	1.10	0.60	1.83	0.588	1.508	0.547	2.643
Arisaema tortuosum (Wall.) schott	Arecaceae	2.30	0.40	5.75	1.230	1.005	1.715	3.950
Aristolochia indica L.	Aristolochiaceae	0.20	0.20	1.00	0.107	0.503	0.298	0.908
Aristolochia tagala Cham.	Aristolochiaceae	0.30	0.10	3.00	0.160	0.251	0.895	1.306
Arundo donax L.	Poaceae	6.70	0.80	8.38	3.583	2.010	2.498	8.091
Asparagus racemosus Willd.	Liliaceae	3.40	0.70	4.86	1.818	1.759	1.449	5.026
Blepharis maderaspatensis (L.) Heyne	Acathaceae	5.50	0.60	9.17	2.941	1.508	2.734	7.183
Boerhavia diffusa L.	Nyctaginaceae	6.50	0.40	16.25	3.476	1.005	4.847	9.328
Brachiaria distachya (L.) Stapf	Poaceae	7.90	0.50	15.80	4.225	1.256	4.712	10.193
Brachiaria ramosa (L.) Stapf	Poaceae	8.70	0.70	12.43	4.652	1.759	3.707	10.118
Cassia tora L.	Caesalpiniaceae	3.40	0.60	5.67	1.818	1.508	1.690	5.016
Cassytha filiformis L.	Lauraceae	3.20	0.80	4.00	1.711	2.010	1.193	4.914
Celosia argentena L.	Amaranthaceae	7.70	0.90	8.56	4.118	2.261	2.552	8.931
Chlorophytum arundinaceum Baker	Liliaceae	0.40	0.20	2.00	0.214	0.503	0.596	1.313
Colocasia esculenta (L.) Schott	Araceae	3.40	0.50	6.80	1.818	1.256	2.028	5.103
Commelina attenuata Koen.	Commelinaceae	2.30	0.60	3.83	1.230	1.508	1.143	3.881
Commelina bengalensis L.	Commelinaceae	2.20	0.50	4.40	1.176	1.256	1.312	3.745
Commelina diffusa Brum.f.	Commelinaceae	1.10	0.60	1.83	0.588	1.508	0.547	2.643
Costus speciosus (koen.) J.E.Smith	Zingiberaceae	1.10	0.70	1.57	0.588	1.759	0.469	2.816
Croton bonplandianus Baill.	Euphorbiaceae	6.50	1.00	6.50	3.476	2.513	1.939	7.927
Cyanotis cristata (L.) D. Don	Commelinaceae	3.40	0.60	5.67	1.818	1.508	1.690	5.016
Cyanotis tuberosa (Roxb.)	Commelinaceae	3.20	0.70	4.57	1.711	1.759	1.363	4.833
Cynodon dactylon (L.) Pers.	Poaceae	2.20	0.80	2.75	1.176	2.010	0.820	4.007
Cyperus brevifolius (Rottb) Hassk.	Poaceae	1.20	0.90	1.33	0.642	2.261	0.398	3.301
Cyperus cuspidatus Kunth	Poaceae	2.20	0.50	4.40	1.176	1.256	1.312	3.745
Dioscorea bulbifera L.	Diacoriaceae	0.80	0.40	2.00	0.428	1.005	0.596	2.029
Dioscorea glabra Roxb.	Diacoriaceae	0.90	0.60	1.50	0.481	1.508	0.447	2.436
Dioscorea hispida Dennst.	Diacoriaceae	0.40	0.20	2.00	0.214	0.503	0.596	1.313
Dioscorea oppositifolia L.	Diacoriaceae	0.60	0.30	2.00	0.321	0.754	0.596	1.671
Dioscorea pentaphylla L.	Diacoriaceae	0.50	0.20	2.50	0.267	0.503	0.746	1.516
Dioscorea tomentosa Koen. ex Spreng.	Diacoriaceae	0.70	0.50	1.40	0.374	1.256	0.418	2.048
Dioscorea wallichi Hook.f.	Diacoriaceae	0.80	0.40	2.00	0.428	1.005	0.596	2.029
Diplocyclos palmatus (L.) Jeffrey	Cucurbitaceae	0.90	0.50	1.80	0.481	1.256	0.537	2.274
Eleusine indica (L.) Gaertn.	Poaceae	1.10	0.30	3.67	0.588	0.754	1.094	2.436
Ensete glaucum (Roxb.) E.E. Cheesm.	Musaceae	1.30	0.40	3.25	0.695	1.005	0.969	2.670
Eranthemum capense L.	Acathaceae	1.10	0.50	2.20	0.588	1.256	0.656	2.501
Eriocaulon truncatum Buch.-Ham.	Eriocaulaceae	2.20	0.40	5.50	1.176	1.005	1.640	3.822
Euphorbia heterophylla L.	Euphorbiaceae	0.40	0.20	2.00	0.214	0.503	0.596	1.313
Globba marantina L.	Zingiberaceae	1.10	0.40	2.75	0.588	1.005	0.820	2.413
Gloriosa superba L.	Liliaceae	0.50	0.20	2.50	0.267	0.503	0.746	1.516

Hygrophila auriculata (Schum.)	Acathaceae	0.60	0.30	2.00	0.321	0.754	0.596	1.671
Hyptis suaveolens (L.) Poit.	Lamiaceae	0.70	0.30	2.33	0.374	0.754	0.696	1.824
Indoneesiella echioides (L.) Sreemadh.	Acathaceae	0.80	0.40	2.00	0.428	1.005	0.596	2.029
Lasia spinosa (L.) Thw.	Araceae	0.90	0.40	2.25	0.481	1.005	0.671	2.157
Leptochloa panicea (Retz.) Ohwi	Poaceae	2.20	0.60	3.67	1.176	1.508	1.094	3.778
Leucas indica (L.) R.Br. ex Vatke	Lamiaceae	1.10	0.50	2.20	0.588	1.256	0.656	2.501
Mimosa pudica L.	Mimosaceae	0.40	0.20	2.00	0.214	0.503	0.596	1.313
Ocimum americanum L.	Lamiaceae	5.60	0.80	7.00	2.995	2.010	2.088	7.092
Ocimum basilicum L.	Lamiaceae	0.70	0.30	2.33	0.374	0.754	0.696	1.824
Parthenium hysterophorus L.	Asteraceae	0.60	0.30	2.00	0.321	0.754	0.596	1.671
Phyllanthus amarus Schum.&Thonn.	Euphorbiaceae	0.80	0.40	2.00	0.428	1.005	0.596	2.029
Phyllanthus maderaspatensis L.	Euphorbiaceae	0.30	0.20	1.50	0.160	0.503	0.447	1.110
Piper trioicum Roxb.	Piperaceae	0.40	0.20	2.00	0.214	0.503	0.596	1.313
Plectranthus mullis (Ait.) Spreng.	Lamiaceae	0.50	0.20	2.50	0.267	0.503	0.746	1.516
Pouzolzia zeylanica (L.) Bennett	Urticaceae	2.20	0.60	3.67	1.176	1.508	1.094	3.778
Premna tomentosa Willd.	Verbenaceae	3.30	0.60	5.50	1.765	1.508	1.640	4.913
Rostellularia diffusa (Willd.) Nees	Acathaceae	0.40	0.30	1.33	0.214	0.754	0.398	1.365
Sebastiania chamaelea (L.)	Euphorbiaceae	2.10	0.40	5.25	1.123	1.005	1.566	3.694
Setaria pumila (Poir.) Roem. & Schult.	Poaceae	2.10	0.60	3.50	1.123	1.508	1.044	3.674
Solanum suratense Burm.f.	Solanaceae	2.20	0.30	7.33	1.176	0.754	2.187	4.117
Sorghum halepense (L.) Pers.	Poaceae	0.70	0.30	2.33	0.374	0.754	0.696	1.824
Stachytarpheta jamaicensis (L.)	Verbenaceae	0.80	0.30	2.67	0.428	0.754	0.795	1.977
Stemona tuberosa Lour.	Stemonaceae	1.10	0.50	2.20	0.588	1.256	0.656	2.501
Terminalia chebula Retz.	Combretaceae	0.40	0.20	2.00	0.214	0.503	0.596	1.313
Themeda triandra Forssk.	Poaceae	2.10	0.40	5.25	1.123	1.005	1.566	3.694
Thunbergia frgrans Roxb.	Thunbergiaceae	2.30	0.40	5.75	1.230	1.005	1.715	3.950
Tragia involucrata L.	Euphorbiaceae	2.20	0.50	4.40	1.176	1.256	1.312	3.745
Vanda tesellata (Roxb.) Hook.	Orchidaceae	2.30	0.30	7.67	1.230	0.754	2.287	4.270
Zingiber capitatum Roxb.	Zingiberaceae	0.70	0.40	1.75	0.374	1.005	0.522	1.901
Zingiber roseum (Roxb.) Roscoe	Zingiberaceae	0.80	0.30	2.67	0.428	0.754	0.795	1.977
	Total	**187.00**	**39.80**	**335.29**	**100.000**	**100.000**	**100.000**	**300.000**

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