

Plant Biodiversity Assessment in Galikonda Forest, Eastern Ghats of Alluri Sitaramaraju District, Andhra Pradesh, India

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Abstract

Original Research Article

A landscape level plant diversity and population inventory was made in High altitude forest of eastern Ghats, Visakhapatnam District, Andhra Pradesh, India comprising mostly dry deciduous and moist deciduous forests. In all the three study sites, two belt transects of 5 × 1000 m size (totaling 1 ha) were laid in each site during 2022–2023 and all trees with ≥15 cm girth at breast height (gbh) were enumerated. Within each transect of 1000 x 5 m, quantitative data in respect of herb species was collected from two numbers of small sample plots each measuring 1m x 1 m. A total of 246 species was recorded on enumeration, of which 54 Trees, 50 Shrubs and 90 Herbs were noted.

Keywords: Plant biodiversity, Assessment, Galikonda forest, Visakhapatnam District, Andhra Pradesh.

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INTRODUCTION

Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. Biodiversity assessment is one of the sub-division of conservation biology having a major impact on the practice of conservation [1]. Conservation of forests calls for clear understanding of the details, such as forest type, cover density, species composition, and areal extent and their changes [2]. The quantitative plant diversity inventories are the fundamental tool for conservation and management of tropical forests [3], but as far as Andaman and Nicobar Islands are concerned they are limited. Much of the current knowledge is still based on qualitative surveys conducted in the twentieth century, which mainly dealt with the floristic account of trees and climbers [4]. Forest management and forest decision making is a continuous need for high quality information on forest resources and regular monitoring ongoing spatial process in forested landscape are great importance to successful and sustainable management of forest resources [5, 6].

In India, habitat destruction, over-exploitation, environmental pollution, and anthropogenic pressure are the major disturbances to forest ecosystems [7]. Both natural as well as manmade activities have an effect forest ecosystem. Deforestation and fragmentation,

over-exploitation, invasive species and climate change are the main drivers of tropical forest biodiversity loss [8-10]. The relative impacts of these threats vary among the world's major tropical forest regions [11]. Sustainable management and conservation of natural forests requires holistic understanding of the ecosystem structure and functions with the interacting biotic and abiotic elements [12, 13]. Tree species diversity is an important aspect of forest ecosystem diversity [14] and also fundamental to tropical forest biodiversity. Tree census plots have been established in forest types through tropical regions to monitor forest dynamics over time and to assess the effects of disturbance and climate change on plant demography [15, 16]. As the Eastern Ghats constitute important catchments of the peninsular and natural resources, they are threatened due to anthropogenic disturbances [17].

MATERIALS AND METHODS

Study Area

The study sites are located in the Visakhapatnam district of Andhra Pradesh, India which are part of the Eastern Ghats of northern Andhra Pradesh. The district lies between 17° 15' and 18° 32' Northern latitude and 83° 54' and 83° 30' in Eastern longitude with an altitude varying between 355-1200 m mean sea level.

Field Methods

In all the three study sites, two belt transects of 5 × 1000 m size (totaling 1 ha) were laid in each site

during 2022–2023 and all trees with ≥ 15 cm girth at breast height (gbh) were enumerated. Within each transect of 1000 X 5 m, quantitative data in respect of herb species was collected from two numbers of small sample plots each measuring 1m X 1 m. The representative taxa were collected and identified with the help of floras [18-20] and made into herbarium. The voucher specimens were housed in the Botany Department Herbarium (BDH), Department of Botany, Andhra University, Visakhapatnam.

Data Analysis

Phytosociological characteristics of plant communities like; a) Frequency (percent of all transects in which a species was present), b) density (ratio of total number of trees to total number of transects) and c) abundance (ratio of total number of trees to total number of transects of occurrence) were recorded. The floristic structure was examined by Importance Value Index (IVI) following [21] where the relative values of frequency, density and basal cover for a species was derived as the value expressed in terms of percentage of the sum of the values for all the species in the plant community [22] Family Importance Value (FIV) was taken as the sum of relative density, relative diversity, and relative basal cover. The relative diversity of a family was evaluated as the number of species within the family expressed as percentage of total number of species within all the families represented in the community [23]. The dominance was determined by Simpson's index ($Cd = \sum(ni/N)^2$), and diversity as Shannon's Index ($H = -\sum(ni/N) \log(ni/N)$), where ni = importance value index of species i , N = sum of importance value index for the community. Evenness was calculated by Pielou's index ($D = \sum pi^2 / \ln S$), where S is the species richness of the community [24].

RESULT AND DISCUSSION

Galikonda forestis situated in Ananthagiri Mandal, Visakhapatnam District, Andhra Pradesh,

which is 115km away from Visakhapatnam town. It covers an area of 1 ha. It lies between $11^{\circ}75'82''$ North latitude and $75^{\circ}53'67''$ East longitude. The vegetation is thick with evergreen and semi-evergreen species. A total of 246 species was recorded on enumeration, of which 54 Trees, 50 Shrubs and 90 Herbs were noted.

Trees

A total of 351 individuals belonging to 54 species, 48 genera and 29 families were recorded in the 1-ha⁻¹ plot and the vegetation type is moist deciduous vegetation. Out of which Euphorically with 6 species, Moraceae 4, Verbenaceae, Rubiaceae, Ebenaceae, Combretaceae and Anacardiaceae each one has 3 species, Sterculiaceae, Sapotaceae, Mimosaceae, Flacourtiaceae, Caesalpiniaceae, Burseraceae and Annonaceae each one has 2 species and remaining 15 families consists single species. A total density of the tree species 35.10 plants/ ha⁻¹. In this undisturbed forest area *Bridelia airy-shawii* (2.10/ ha⁻¹) has the highest density. The other tree species having high density were *Protium serratum* (2.00 / ha⁻¹), *Garuga pinnata* (1.90/ ha⁻¹), *Mallotus phillipensis* (1.30/ ha⁻¹) and least density of this area *Crateva magna* (0.10/ha⁻¹). The total basal area of this site is 14.358 plants/ ha⁻¹, with a maximum contribution by girth classes 61-90cm and 121-150cm. Basal area and tree density are correlated against each other, the stand density is more for small stemmed individuals (31-60cm) and (61-90cm). Predominant tree is *Xylocarpa xylocarpa* and *Bombax ceiba* and dominant trees are *Mangifera indica*, *Anogeissus latifolia*, *Syzygium cumini*, *Alangium salviifolium* and *Dalbergia latifolia*. Among the tree species *Protium serratum* were the dominant trees species with highest IVI (16.848/ ha⁻¹) followed by *Garuga pinnata* (16.219ha⁻¹), *Bridelia airy-shawii* (14.018/ha⁻¹), *Anogeissus latifolia* (11.204/ ha⁻¹) and *Mallotus phillipensis* (10.818/ ha⁻¹) are given in (Table 1). The Dominance index of tree taxa is (0.02853), Simpson index is (0.9715), Shannon index is (3.738) and Evenness index is (0.7783).

Table 1: Phytosociological analysis of Tree species in Galikonda forest plant Biodiversity

| S.No. | Species Name | Family | RD | RF | RBA | IVI |
|-------|---|------------------|-------|-------|-------|--------|
| 1 | <i>Albizia amara</i> (Roxb.)B.Boivin | Mimosaceae | 1.425 | 1.648 | 0.548 | 3.621 |
| 2 | <i>Albizia procera</i> (Roxb.) Benth | Mimosaceae | 2.564 | 2.747 | 3.689 | 9.001 |
| 3 | <i>Annona reticulata</i> L. | Annonaceae | 0.570 | 1.099 | 0.075 | 1.743 |
| 4 | <i>Anogeissus latifolia</i> (DC.) Wallich | Combretaceae | 3.419 | 3.297 | 4.488 | 11.204 |
| 5 | <i>Antidesma acidum</i> Retz. | Stilaginaceae | 1.140 | 1.648 | 0.376 | 3.164 |
| 6 | <i>Artocarpus heterophyllus</i> Lam. | Moraceae | 0.570 | 1.099 | 0.387 | 2.056 |
| 7 | <i>Bridelia airy-shawii</i> (L.) A.Juss. | Euphorically | 5.983 | 3.297 | 4.738 | 14.018 |
| 8 | <i>Buchanania lanzan</i> Spreng. | Anacardiaceae | 0.570 | 0.549 | 0.502 | 1.621 |
| 9 | <i>Callicarpa arborea</i> Roxb. | Verbenaceae | 1.709 | 1.648 | 1.995 | 5.353 |
| 10 | <i>Callicarpa tomentosa</i> (L.) Murr. | Verbenaceae | 0.855 | 1.648 | 1.367 | 3.870 |
| 11 | <i>Canthium dicoccum</i> (Gaertn.) Merr. | Rubiaceae | 2.849 | 2.747 | 1.810 | 7.406 |
| 12 | <i>Cassia fistula</i> L. | Caesalpiniaceae | 1.425 | 2.198 | 0.895 | 4.518 |
| 13 | <i>Chloroxylon swietenia</i> (Roxb.) DC. | Flindersiaceae | 2.564 | 2.198 | 1.246 | 6.008 |
| 14 | <i>Cleistanthus collinus</i> (Roxb.) Benth. Hook.f. | Euphorically | 1.994 | 1.648 | 0.533 | 4.176 |
| 15 | <i>Cochlospermum religiosum</i> (L.) Alston | Cochlospermaceae | 0.570 | 0.549 | 0.201 | 1.320 |
| 16 | <i>Crateva magna</i> (Lour.) DC. | Capparaceae | 0.285 | 0.549 | 0.112 | 0.946 |

| S.No. | Species Name | Family | RD | RF | RBA | IVI |
|-------|--|-----------------|----------------|----------------|----------------|----------------|
| 17 | <i>Diospyros melanoxylo</i> Roxb. | Ebenaceae | 1.140 | 1.099 | 0.419 | 2.657 |
| 18 | <i>Diospyros montana</i> Roxb | Ebenaceae | 2.279 | 2.198 | 3.311 | 7.788 |
| 19 | <i>Diospyros sylvatica</i> Roxb. | Ebenaceae | 3.704 | 2.747 | 1.599 | 8.050 |
| 20 | <i>Ficus microcarpa</i> L. f. | Moraceae | 0.570 | 0.549 | 0.523 | 1.642 |
| 21 | <i>Ficus palmata</i> Forssk | Moraceae | 0.570 | 0.549 | 0.521 | 1.640 |
| 22 | <i>Ficus semicordata</i> Buch. ex J.E. Smith | Moraceae | 1.425 | 1.648 | 1.325 | 4.398 |
| 23 | <i>Firmiana colorata</i> (Roxb.) R. Br. | Sterculiaceae | 0.570 | 0.549 | 0.529 | 1.648 |
| 24 | <i>Flacourtia jangomas</i> (Lour.) Raeusch. | Flacourtiaceae | 0.570 | 1.099 | 0.507 | 2.175 |
| 25 | <i>Garuga pinnata</i> Roxb. | Burseraceae | 5.413 | 4.396 | 6.410 | 16.219 |
| 26 | <i>Glochidion velutinum</i> Wight | Euphorically | 0.855 | 1.099 | 0.563 | 2.516 |
| 27 | <i>Glochidion zeylanicum</i> (Gaertn.) A.Juss. | Euphorically | 0.570 | 0.549 | 0.750 | 1.869 |
| 28 | <i>Gmelina arborea</i> Roxb. ex Sm. | Verbenaceae | 2.849 | 2.747 | 2.580 | 8.177 |
| 29 | <i>Grewia tiliifolia</i> Vahl. | Tiliaceae | 2.849 | 2.747 | 2.446 | 8.042 |
| 30 | <i>Haldinia cordifolia</i> (Roxb.) Ridsdale | Rubiaceae | 1.709 | 1.648 | 2.010 | 5.367 |
| 31 | <i>Homalium nepaulense</i> Benth. | Flacourtiaceae | 1.425 | 1.648 | 0.955 | 4.028 |
| 32 | <i>Kydia calycina</i> Roxb. | Malvaceae | 2.564 | 2.747 | 1.901 | 7.213 |
| 33 | <i>Lannea coromandelica</i> (Houtt.) Merr | Anacardiaceae | 2.279 | 2.198 | 2.164 | 6.641 |
| 34 | <i>Litsea glutinosa</i> (Lour.) C. B. Rob. | Lauraceae | 1.425 | 1.648 | 0.606 | 3.679 |
| 35 | <i>Macaranga peltata</i> (Roxb.) Müll.Arg. | Euphorically | 2.849 | 2.747 | 2.064 | 7.660 |
| 36 | <i>Madhuca longifolia</i> (J.Koenig ex L.) J.F. | Sapotaceae | 1.140 | 1.099 | 3.131 | 5.370 |
| 37 | <i>Mallotus philippensis</i> (Lam.) Müll.Arg. | Euphorically | 3.704 | 3.297 | 3.817 | 10.818 |
| 38 | <i>Mangifera indica</i> L. | Anacardiaceae | 0.285 | 0.549 | 0.068 | 0.902 |
| 39 | <i>Michelia champaca</i> L. | Magnoliaceae | 0.570 | 0.549 | 7.666 | 8.786 |
| 40 | <i>Milium tomentosa</i> (Roxb.) J. Sinclair | Annonaceae | 0.855 | 1.099 | 0.918 | 2.871 |
| 41 | <i>Mimusops elengi</i> L. | Sapotaceae | 0.285 | 0.549 | 0.029 | 0.864 |
| 42 | <i>Mitragyna parvifolia</i> (Roxb.) Korth. | Rubiaceae | 0.855 | 1.099 | 0.634 | 2.588 |
| 43 | <i>Pongamia pinnata</i> (L.)Pierre | Fabaceae | 0.855 | 1.099 | 5.277 | 7.231 |
| 44 | <i>Protium serratum</i> (Wall. ex Colebr.) Engl. | Burseraceae | 5.698 | 5.495 | 5.655 | 16.848 |
| 45 | <i>Schleichera oleosa</i> (Lour.) Oken | Sapindaceae | 3.134 | 2.747 | 2.663 | 8.544 |
| 46 | <i>Sterculia urens</i> Roxb. | Sterculiaceae | 1.994 | 1.648 | 1.099 | 4.742 |
| 47 | <i>Syzygium cumini</i> (L.) Skeels | Myrtaceae | 2.279 | 2.198 | 3.449 | 7.926 |
| 48 | <i>Tamarindus indica</i> L. | Caesalpiniaceae | 0.855 | 1.099 | 1.193 | 3.147 |
| 49 | <i>Terminalia alata</i> Heyne ex Roth | Combretaceae | 1.994 | 2.198 | 1.249 | 5.441 |
| 50 | <i>Terminalia chebula</i> Retz. | Combretaceae | 2.564 | 2.747 | 3.037 | 8.348 |
| 51 | <i>Toona ciliata</i> M. Roem | Meliaceae | 3.134 | 3.297 | 2.625 | 9.056 |
| 52 | <i>Trema orientalis</i> (L.) Bl | Ulmaceae | 1.709 | 1.648 | 1.657 | 5.015 |
| 53 | <i>Wrightia tinctoria</i> | Apocynaceae | 3.419 | 3.297 | 1.497 | 8.213 |
| 54 | <i>Zanthoxylum armatum</i> DC. | Rutaceae | 0.570 | 1.099 | 0.190 | 1.859 |
| | Total | | 100.000 | 100.000 | 100.000 | 300.000 |

RD= Relative Density, RF=Relative frequency, RBA=Relative Basal area, IVI=Importance value index.

Shrub

A total of 505 individuals belonging to 50 species, 48 genera and 25 families were recorded. Out of 25 families, Fabaceae with 6 species, Rutaceae and Malvaceae both contributed with 5, Verbenaceae and Euphorically with 4, Tiliaceae 3, Rhamnaceae, Opiliaceae, Meliaceae and Caesalpiniaceae each one has 2 species and remaining 15 families consists single species. In this undisturbed sacred grove area *Abutilon indicum* (3.40/ ha⁻¹) has high density followed by the other shrub species having high density were *Cipadessa baccifera* and *Abutilon hirtum* (2.30/ ha⁻¹), *Clerodendrum philippinum* (2.20/ ha⁻¹) and *Desmodium pulchellum* (2.10/ ha⁻¹). However, the most abundant

species was *Abutilon indicum* (4.25/ ha⁻¹) followed by *Desmodium pulchellum* (4.20/ ha⁻¹), *Clerodendrum philippinum* (3.67/ ha⁻¹), *Flacourtia indica* (3.50/ ha⁻¹), *Abutilon hirsutum* (3.29/ ha⁻¹) and *Hyptis suaveolens* (3.00/ ha⁻¹). Among the shrub species *Abutilon indicum* was the dominant species with highest IVI (14.132/ ha⁻¹) followed by *Cipadessa baccifera* (10.854/ ha⁻¹), *Abutilon hirsutum* (10.605/ ha⁻¹), *Clerodendrum philippinum* (10.375/ ha⁻¹), *Desmodium pulchellum* (10.294/ha⁻¹) and *Chromolaena odorata* (9.967/ ha⁻¹) are given in (Table 2). The Dominance index of shrubs is (0.02648), Simpson index is (0.9735), Shannon index is (3.784) and Evenness index is (0.8799).

Table 2: Phytosociological analysis of Shrubs in Galikonda forest plant Biodiversity

| S.No | Name of the plants | Family | RD | RF | RAB | IVI |
|------|---|-----------------|------------|------------|------------|------------|
| 1 | <i>Abutilon hirsutum</i> (Phil.) Reiche | Malvaceae | 4.554 | 2.834 | 3.22 | 10.605 |
| 2 | <i>Abutilon indicum</i> (L.) Sweet | Malvaceae | 6.733 | 3.239 | 4.16 | 14.132 |
| 3 | <i>Acacia sinuata</i> (Lour.) Merr. | Mimosaceae | 2.376 | 2.024 | 2.35 | 6.750 |
| 4 | <i>Allophylus cobbe</i> (L.) Raeusch | Meliaceae | 2.178 | 2.429 | 1.79 | 6.402 |
| 5 | <i>Ardisia solanacea</i> (Poir.) Roxb. | Myrsinaceae | 2.178 | 2.429 | 1.79 | 6.402 |
| 6 | <i>Azima tetracantha</i> Lam. | Salvadoraceae | 1.188 | 1.619 | 1.47 | 4.276 |
| 7 | <i>Bridelia montana</i> (Roxb.) Willd. | Phyllanthaceae | 1.188 | 1.619 | 1.47 | 4.276 |
| 8 | <i>Caesalpinia bonduc</i> (L.) Roxb. | Caesalpinaceae | 1.584 | 2.024 | 1.57 | 5.175 |
| 9 | <i>Calotropis gigantea</i> (L.) Dryand. | Asclpiadaceae | 2.376 | 2.834 | 1.68 | 6.888 |
| 10 | <i>Capparis sepiaria</i> L. | Capparaceae | 1.584 | 3.239 | 0.98 | 5.802 |
| 11 | <i>Carissa spinarum</i> L. | Apocynaceae | 1.584 | 2.429 | 1.31 | 5.318 |
| 12 | <i>Cassia hirsuta</i> L. | Caesalpinaceae | 1.584 | 2.024 | 1.57 | 5.175 |
| 13 | <i>Chromolaena odorata</i> (L.) R.M.King | Astaraceae | 4.158 | 3.239 | 2.57 | 9.967 |
| 14 | <i>Cipadessa baccifera</i> (Roth) Miq. | Meliaceae | 4.554 | 4.049 | 2.25 | 10.854 |
| 15 | <i>Clerodendrum inerme</i> (L.) Gaertn. | Verbenaceae | 1.584 | 2.024 | 1.57 | 5.175 |
| 16 | <i>Clerodendrum philippinum</i> Schauer | Verbenaceae | 4.356 | 2.429 | 3.59 | 10.375 |
| 17 | <i>Clerodendrum serratum</i> (L.) Moon | Verbenaceae | 2.376 | 2.429 | 1.96 | 6.763 |
| 18 | <i>Crotalaria laburnifolia</i> L. | Fabaceae | 2.178 | 1.619 | 2.69 | 6.490 |
| 19 | <i>Derris trifoliata</i> Lour. | Fabaceae | 1.188 | 1.215 | 1.96 | 4.360 |
| 20 | <i>Desmodium caudatum</i> (Thunb.) DC | Fabaceae | 0.792 | 0.810 | 1.96 | 3.560 |
| 21 | <i>Desmodium pulchellum</i> (L.) Benth | Fabaceae | 4.158 | 2.024 | 4.11 | 10.294 |
| 22 | <i>Dodonaea viscosa</i> (L.) Jacq. | Sapindaceae | 1.386 | 1.215 | 2.28 | 4.885 |
| 23 | <i>Erythroxylum monogynum</i> Roxb. | Erythroxylaceae | 1.980 | 3.239 | 1.22 | 6.443 |
| 24 | <i>Euphorbia cattimandoo</i> Elliot ex Wight | Euphorically | 1.188 | 1.619 | 1.47 | 4.276 |
| 25 | <i>Euphorbia nerifolia</i> L. | Euphorically | 1.188 | 1.215 | 1.96 | 4.360 |
| 26 | <i>Flacourtia indica</i> (Burm.f.) Merr. | Salicaceae | 1.386 | 0.810 | 3.43 | 5.622 |
| 27 | <i>Flemingia stricta</i> Roxb. | Fabaceae | 1.188 | 1.215 | 1.96 | 4.360 |
| 28 | <i>Glycosmis mauritiana</i> (Lam.) Tanaka | Rutaceae | 2.376 | 1.619 | 2.94 | 6.932 |
| 29 | <i>Gmelina asiatica</i> L. | Verbenaceae | 1.584 | 2.024 | 1.57 | 5.175 |
| 30 | <i>Grewia abutilifolia</i> Vent. ex Juss. | Tiliaceae | 1.980 | 2.429 | 1.63 | 6.041 |
| 31 | <i>Grewia hirsuta</i> Vahl | Tiliaceae | 1.584 | 2.429 | 1.31 | 5.318 |
| 32 | <i>Grewia rothii</i> DC | Tiliaceae | 1.782 | 1.619 | 2.20 | 5.604 |
| 33 | <i>Helicteres isora</i> L. | Sterculiaceae | 2.178 | 2.834 | 1.54 | 6.550 |
| 34 | <i>Homonoia riparia</i> Lour | Euphorically | 1.188 | 1.619 | 1.47 | 4.276 |
| 35 | <i>Hugonia mystax</i> Cav | Linaceae | 1.188 | 1.215 | 1.96 | 4.360 |
| 36 | <i>Hyptis suaveolens</i> (L.) Poit. | Lamiaceae | 2.376 | 1.619 | 2.94 | 6.932 |
| 37 | <i>Indigofera cassioides</i> DC. | Fabaceae | 1.584 | 1.619 | 1.96 | 5.161 |
| 38 | <i>Jasminum angustifolium</i> (L.) Willd. | Opiliaceae | 1.188 | 1.619 | 1.47 | 4.276 |
| 39 | <i>Jasminum auriculatum</i> Vahl | Opiliaceae | 1.584 | 2.429 | 1.31 | 5.318 |
| 40 | <i>Melastoma malabathricum</i> L. | Malvaceae | 1.584 | 2.024 | 1.57 | 5.175 |
| 41 | <i>Murraya exotica</i> L. | Rutaceae | 1.188 | 1.619 | 1.47 | 4.276 |
| 42 | <i>Murraya koenigii</i> (L.) Spreng. | Rutaceae | 1.188 | 1.619 | 1.47 | 4.276 |
| 43 | <i>Pavonia zeylanica</i> (L.) Cav | Malvaceae | 1.584 | 1.619 | 1.96 | 5.161 |
| 44 | <i>Securinega virosa</i> (Roxb. ex Willd.) Baill. | Euphorically | 1.188 | 1.619 | 1.47 | 4.276 |
| 45 | <i>Solanum torvum</i> Sw. | Solanaceae | 1.584 | 2.024 | 1.57 | 5.175 |
| 46 | <i>Toddalia asiatica</i> (L.) Lam. | Rutaceae | 1.188 | 1.215 | 1.96 | 4.360 |
| 47 | <i>Urena lobata</i> L. | Malvaceae | 2.376 | 2.429 | 1.96 | 6.763 |
| 48 | <i>Zanthoxylum armatum</i> DC. | Rutaceae | 1.782 | 2.024 | 1.76 | 5.568 |
| 49 | <i>Ziziphus mauritiana</i> Lam. | Rhamnaceae | 1.584 | 1.619 | 1.96 | 5.161 |
| 50 | <i>Ziziphus rugosa</i> Lam. | Rhamnaceae | 1.386 | 1.215 | 2.28 | 4.885 |
| | Total | | 100 | 100 | 100 | 300 |

RD= Relative Density, RF=Relative frequency, RAB=Relative Abundance, IVI=Importance value index.

Herbs

A total of 602 individuals belonging to 94 species, 69 genera and 25 families were recorded. Out of

28 families, Malvaceae 14, Astaraceae 10, Poaceae 8, Fabaceae and Commelinaceae 6, Zingiberaceae and Amaranthaceae 4, Tiliaceae, Solanaceae, Polygalaceae,

Euphorbiaceae and Acanthaceae with 3, Verbanaceae, Portulacaceae, Oxalidaceae, Cyperaceae, Convolvulaceae, Capparidaceae and Boraginaceae with 2 species remaining nine families consists single species. In this undisturbed forest area *Sida acuta* (3.20/ ha⁻¹) has the highest density followed by *Alysicarpus monilifer* (2.60/ ha⁻¹), *Aerva lanata* (2.50/ ha⁻¹), *Tridax procumbens*, *Siegesbeckia orientalis* (2.10/ ha⁻¹), *Synedrella nodiflora* (1.50/ ha⁻¹), and *Curcuma amada* (1.20 / ha⁻¹). However, the most abundant species was *Alysicarpus monilifer* (5.20/ ha⁻¹), *Impatiens balsamina*(4.00/ ha⁻¹), *Aerva lanata* (3.57/ ha⁻¹), *Sida*

acuta (3.20/ ha⁻¹), *Tephrosia purpurea* (3.00/ ha⁻¹), *Solanum nigrum*(2.67/ ha⁻¹). Among the herbaceous species *Sida acuta* was the dominant species with highest IVI (9.895/ ha⁻¹) followed by *Alysicarpus monilifer* (8.686/ ha⁻¹). The other co-dominant species were *Aerva lanata* (8.133/ ha⁻¹), *Tridax procumbens*, (7.481/ ha⁻¹) *Siegesbeckia orientalis* (7.218/ ha⁻¹), *Synedrella nodiflora* (5.813/ ha⁻¹), and *Curcuma amada* (5.110 / ha⁻¹) are given in (Table 3). The Dominance index of Herbs is (0.01776), Simpson index is (0.9822), Shannon index is (4.281) and Evenness index is (0.8034).

Table 3: Phytosociological analysis of Herbs in Galikonda forest plant Biodiversity

| S.No | Name of the Plants | Family | RD | RF | RAB | IVI |
|------|---|----------------|-------|-------|-------|-------|
| 1 | <i>Achyranthes aspera</i> L. | Amaranthaceae | 1.827 | 1.786 | 1.141 | 4.754 |
| 2 | <i>Aerva lanata</i> (L.) Juss. | Amaranthaceae | 4.153 | 2.083 | 2.223 | 8.459 |
| 3 | <i>Alternanthera sessilis</i> (L.) R.Br. ex DC. | Amaranthaceae | 1.163 | 1.786 | 0.726 | 3.675 |
| 4 | <i>Alysicarpus monilifer</i> (L.) DC. | Fabaceae | 4.319 | 1.488 | 3.237 | 9.044 |
| 5 | <i>Apluda mutica</i> L. | Poaceae | 1.495 | 1.786 | 0.934 | 4.214 |
| 6 | <i>Argemone mexicana</i> L. | Papaveraceae | 0.831 | 1.190 | 0.778 | 2.799 |
| 7 | <i>Arundinella ciliata</i> (Roxb.) Nees ex Miq | Poaceae | 1.163 | 0.893 | 1.452 | 3.508 |
| 8 | <i>Arundinella setosa</i> Trin. | Poaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 9 | <i>Biophytum sensitivum</i> (L.) DC. | Oxalidaceae | 1.329 | 1.786 | 0.830 | 3.945 |
| 10 | <i>Blepharis maderaspatensis</i> (L.) B.Heyne | Acatheae | 1.495 | 1.488 | 1.120 | 4.104 |
| 11 | <i>Blumea mollis</i> (D.Don) Merr. | Asteraceae | 1.163 | 0.893 | 1.452 | 3.508 |
| 12 | <i>Chlorophytum arundinaceum</i> Baker | Liliaceae | 1.163 | 1.190 | 1.089 | 3.443 |
| 13 | <i>Cleome gynandra</i> L. | Capparidaceae | 1.163 | 1.488 | 0.871 | 3.522 |
| 14 | <i>Cleome viscosa</i> L. | Capparidaceae | 1.163 | 0.893 | 1.452 | 3.508 |
| 15 | <i>Commelina benghalensis</i> L. | Commelinaceae | 1.329 | 0.893 | 1.660 | 3.882 |
| 16 | <i>Commelina diffusa</i> Burm.f. | Commelinaceae | 1.329 | 1.190 | 1.245 | 3.764 |
| 17 | <i>Commelina erecta</i> L. | Commelinaceae | 1.495 | 1.488 | 1.120 | 4.104 |
| 18 | <i>Commelina longifolia</i> Lam. | Commelinaceae | 1.495 | 1.190 | 1.401 | 4.086 |
| 19 | <i>Corchorus capsularis</i> L. | Tiliaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 20 | <i>Corchorus olitorius</i> L. | Tiliaceae | 0.831 | 0.893 | 1.037 | 2.761 |
| 21 | <i>Corchorus trilocularis</i> L. | Tiliaceae | 1.163 | 1.190 | 1.089 | 3.443 |
| 22 | <i>Costus speciosus</i> (J.Koenig) Sm. | Zingiberaceae | 1.329 | 0.893 | 1.660 | 3.882 |
| 23 | <i>Crinum asiaticum</i> Roxb. | Amaryllidaceae | 1.163 | 1.488 | 0.871 | 3.522 |
| 24 | <i>Curcuma amada</i> Roxb. | Zingiberaceae | 1.993 | 2.381 | 0.934 | 5.308 |
| 25 | <i>Curcuma decipiens</i> Dalzell | Zingiberaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 26 | <i>Curculigo orchiooides</i> Gaertn. | Hipoxidaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 27 | <i>Cyanotis cristata</i> (L.) D.Don | Commelinaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 28 | <i>Cyperus nutans</i> Vahl | Commelinaceae | 0.831 | 1.190 | 0.778 | 2.799 |
| 29 | <i>Cyperus rotundus</i> L. | Cyperaceae | 0.664 | 1.488 | 0.498 | 2.651 |
| 30 | <i>Desmodium gangeticum</i> (L.) DC. | Fabaceae | 0.664 | 0.893 | 0.830 | 2.387 |
| 31 | <i>Echinochloa colona</i> (L.) Link | Poaceae | 0.498 | 1.190 | 0.467 | 2.156 |
| 32 | <i>Echinochloa crus-galli</i> (L.) P.Beauv. | Poaceae | 0.997 | 1.786 | 0.622 | 3.405 |
| 33 | <i>Echinochloa frumentacea</i> Link | Poaceae | 0.498 | 1.190 | 0.467 | 2.156 |
| 34 | <i>Eclipta prostrata</i> (L.) L. | Astaraceae | 0.498 | 0.893 | 0.622 | 2.014 |
| 35 | <i>Elephantopus scaber</i> L. | Asteraceae | 0.498 | 1.190 | 0.467 | 2.156 |
| 36 | <i>Eleusine indica</i> (L.) Gaertn. | Poaceae | 0.831 | 1.488 | 0.622 | 2.941 |
| 37 | <i>Emilia sonchifolia</i> (L.) DC. ex DC. | Asteraceae | 1.661 | 2.083 | 0.889 | 4.634 |
| 38 | <i>Euphorbia hirta</i> L. | Euphorically | 1.163 | 0.893 | 1.452 | 3.508 |
| 40 | <i>Evolvulus alsinoides</i> (L.) L. | Convolvulaceae | 0.831 | 0.893 | 1.037 | 2.761 |
| 41 | <i>Evolvulus nummularius</i> (L.) L. | Convolvulaceae | 0.664 | 0.595 | 1.245 | 2.505 |
| 42 | <i>Fimbristylis ferruginea</i> (L.) Vahl | Cyperaceae | 1.329 | 1.190 | 1.245 | 3.764 |
| 43 | <i>Heliotropium curassavicum</i> L. | Boraginaceae | 0.498 | 0.893 | 0.622 | 2.014 |
| 44 | <i>Heliotropium indicum</i> L. | Boraginaceae | 0.166 | 0.298 | 0.622 | 1.086 |

| S.No | Name of the Plants | Family | RD | RF | RAB | IVI |
|------|---|-----------------|------------|------------|------------|------------|
| 45 | <i>Hibiscus lobatus</i> (Murray) Kuntze | Malvaceae | 0.166 | 0.298 | 0.622 | 1.086 |
| 46 | <i>Hibiscus vitifolius</i> L. | Malvaceae | 0.332 | 0.298 | 1.245 | 1.875 |
| 47 | <i>Impatiens balsamina</i> L. | Balsaminaceae | 0.664 | 0.298 | 2.490 | 3.452 |
| 48 | <i>Indigofera hirsuta</i> L. | Fabaceae | 0.498 | 0.595 | 0.934 | 2.027 |
| 49 | <i>Indigofera linifolia</i> (L.f.) Retz. | Fabaceae | 0.831 | 0.893 | 1.037 | 2.761 |
| 51 | <i>Justicia glauca</i> Rottler | Acanthaceae | 1.163 | 1.190 | 1.089 | 3.443 |
| 52 | <i>Justicia procumbens</i> L. | Acanthaceae | 0.831 | 0.595 | 1.556 | 2.982 |
| 54 | <i>Leucas biflora</i> (Vahl) Sm. | Lamiaceae | 0.498 | 0.893 | 0.622 | 2.014 |
| 55 | <i>Malvastrum coromandelianum</i> (L.) Garcke | Malvaceae | 0.664 | 0.595 | 1.245 | 2.505 |
| 56 | <i>Mimosa pudica</i> L. | Mimosaceae | 0.831 | 0.595 | 1.556 | 2.982 |
| 58 | <i>Oxalis corniculata</i> L. | Oxalidaceae | 0.498 | 0.893 | 0.622 | 2.014 |
| 59 | <i>Pavonia odorata</i> Willd. | Malvaceae | 0.664 | 1.190 | 0.622 | 2.477 |
| 60 | <i>Phyla nodiflora</i> (L.) Greene | Verbenaceae | 0.831 | 0.595 | 1.556 | 2.982 |
| 61 | <i>Phyllanthus amarus</i> Schumach. & Thonn. | Euphorically | 0.664 | 0.893 | 0.830 | 2.387 |
| 62 | <i>Phyllanthus maderaspatensis</i> L. | Euphorbiaceae | 0.831 | 1.190 | 0.778 | 2.799 |
| 63 | <i>Polycarpaea corymbosa</i> (L.) Lam. | Caryophyllaceae | 1.827 | 1.488 | 1.369 | 4.685 |
| 64 | <i>Polygala arvensis</i> Willd. | Polygalaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 65 | <i>Polygonum barbatum</i> L. | Polygonaceae | 0.997 | 0.893 | 1.245 | 3.134 |
| 66 | <i>Polygonum chinense</i> L. | Polygonaceae | 0.664 | 0.595 | 1.245 | 2.505 |
| 67 | <i>Portulaca oleracea</i> L. | Portulacaceae | 0.664 | 0.595 | 1.245 | 2.505 |
| 68 | <i>Portulaca quadrifida</i> L. | Portulacaceae | 0.831 | 0.595 | 1.556 | 2.982 |
| 69 | <i>Pouzolzia zeylanica</i> (L.) Benn. | Urticaceae | 0.332 | 0.298 | 1.245 | 1.875 |
| 70 | <i>Pupalia lappacea</i> (L.) Juss. | Amaranthaceae | 0.332 | 0.298 | 1.245 | 1.875 |
| 71 | <i>Rothia indica</i> (L.) Druce | Malvaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 72 | <i>Sida acuta</i> Burm.f. | Malvaceae | 5.316 | 2.976 | 1.992 | 10.284 |
| 73 | <i>Sida cordata</i> (Burm.f.) Borss.Waalk. | Malvaceae | 1.329 | 1.190 | 1.245 | 3.764 |
| 74 | <i>Sida cordifolia</i> L. | Malvaceae | 0.997 | 0.893 | 1.245 | 3.134 |
| 75 | <i>Sigesbeckia orientalis</i> L. | Astaraceae | 3.488 | 2.976 | 1.307 | 7.772 |
| 76 | <i>Solanum nigrum</i> L. | Solanaceae | 1.329 | 0.893 | 1.660 | 3.882 |
| 77 | <i>Solanum surattense</i> Burm. f. | Solanaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 78 | <i>Solanum trilobatum</i> L. | Solanaceae | 0.831 | 0.595 | 1.556 | 2.982 |
| 79 | <i>Sphaeranthus indicus</i> L. | Astaraceae | 0.664 | 0.893 | 0.830 | 2.387 |
| 80 | <i>Spilanthes calva</i> DC. | Astaraceae | 0.664 | 1.190 | 0.622 | 2.477 |
| 81 | <i>Stachytarpheta jamaicensis</i> (L.) Vahl | Verbanaceae | 0.664 | 0.595 | 1.245 | 2.505 |
| 82 | <i>Synedrella nodiflora</i> (L.) Gaertn. | Astaraceae | 2.492 | 2.381 | 1.167 | 6.040 |
| 83 | <i>Tephrosia purpurea</i> (L.) Pers. | Fabaceae | 0.997 | 0.595 | 1.867 | 3.459 |
| 84 | <i>Teramnus labialis</i> (L.f.) Spreng. | Fabaceae | 0.166 | 0.595 | 0.311 | 1.073 |
| 85 | <i>Thysanolaena maxima</i> (Roxb.) Kuntze | Poaceae | 0.332 | 0.893 | 0.415 | 1.640 |
| 86 | <i>Tridax procumbens</i> (L.) L. | Astaraceae | 3.488 | 2.381 | 1.634 | 7.503 |
| 87 | <i>Triumfetta pentandra</i> A.Rich. | Malvaceae | 1.495 | 1.190 | 1.401 | 4.086 |
| 88 | <i>Triumfetta pilosa</i> Roth | Malvaceae | 0.664 | 0.595 | 1.245 | 2.505 |
| 89 | <i>Triumfetta rhomboidea</i> Jacq. | Malvaceae | 0.498 | 0.893 | 0.622 | 2.014 |
| 90 | <i>Triumfetta rotundifolia</i> Lam. | Malvaceae | 0.997 | 1.190 | 0.934 | 3.121 |
| 91 | <i>Vernonia cinerea</i> (L.) Less. | Astaraceae | 0.664 | 0.893 | 0.830 | 2.387 |
| 92 | <i>Waltheria indica</i> L. | Malvaceae | 0.498 | 0.893 | 0.622 | 2.014 |
| 93 | <i>Xanthium strumarium</i> L. | Malvaceae | 0.831 | 0.595 | 1.556 | 2.982 |
| 94 | <i>Zingiber roseum</i> (Roxb.) Roscoe | Zingiberaceae | 1.163 | 0.893 | 1.452 | 3.508 |
| | | Total | 100 | 100 | 100 | 300 |

RD= Relative Density, RF=Relative frequency, RAB=Relative Abundance, IVI=Importance value index.

CONCLUSIONS

Considering over all phytosociological status of Galikonda forest, Visakhapatnam District, Eastern Ghats, India, it reveals that there is a big gap between the values of various parameters like IVI, density, frequency and abundance. There are many tree species having very low values of IVI and other parameters and these species

deserve more attention. A special care should be taken for growth of immature tree species growing in these forest areas. Further, this forest exhibits good regeneration status, and offer opportunities to investigate forest dynamics and changes in species relative abundances in the future.

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