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Woody Species Composition and Diversity Analysis in the S.T. Hindu College Campus Located at Nagercoil, Kanniyakumari District, Tamil Nadu, India

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ABSTRACT

A survey was carried out to record the status, composition and diversity of woody plant species (includes trees, shrubs and lianas) growing in the S.T. Hindu College (known as South Travancore Hindu College) campus (STHC), located in Nagercoil town, headquarter of Kanniyakumari District, Tamil Nadu, India. The survey results indicate that the total number of woody plants recorded in the STHC campus is 872 belongs to 29 families 50 genus and 50 species. The woody species comprises 90% trees, 8% shrubs and 2% lianas. Among the 29 families, Caesalpineaceae and Mimosaceae represented more number (4) of genus and species whereas the Verbinaceae family contains maximum (204) number of individuals of woody plants. About 62% of the woody species comes under <50cm GBH and 64% comes under <15cm DBH size categories. Of the 50 species, Tectona grandis represent maximum number of individuals (196) and higher relative density (RD=22.48) while maximum relative dominance noted in Pheltophorum pterocarpum (RDo=26.96) and total basal area (TBA=133462.20cm^2), and maximum average basal area (ABA=3289.34cm^2) was represented by Terminalia indica. Based on number of individuals/species, 74% of the species with 13.07% individuals comes under rare and very rare category, while 12% of the species with 76.83% individuals comes under dominant and predominant category. Based on relative density (RD), about 5 species are abundant with RD=72.59%, 7 species under rare (RD=10.67%) and 37 species under threatened/endangered category with RD=12.50%. In the study area, woody species diversity was estimated in the form of Shannon-Weaver's Species Diversity (H'=2.556), Shimpson's Dominance Index/Diversity (DI/D=0.124), Simpsons Concentration of Dominance (cd/λ=0.876), Margalef's Index of Species Richness ($R_{Margalef}$ =7.238), Pielou's index of Species Evenness ($E_{Pielou's}$=0.655), and Species Heterogeneity (0.936). The results indicate that proper management and conservative measures need to be implemented for conservation of woody plant varieties in the S.T. Hindu College campus.

Key words: *Woody species, Diversity Indices, S.T. Hindu College, Nagercoil, Kanniyakumari District, Tamil Nadu.*

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INTRODUCTION

The natural forests are diminishing under pressures of urbanization and other human interferences. Urban landscapes and trees have been wonderful silent major urban infrastructure assets in our cities for decades and even centuries. Cities are biodiversity hot spots due to their variety of habitats available in public and private open spaces, including front and backyards. Planting trees in rural as well as in and around human settlements and cities will help increasing the forest cover, reduce pressure on forests and provide various services and goods to meet several demands. Trees are also important in the socio-cultural lives of the people. Floristic diversity assessment is tried at local levels to understand the present status and make effective management strategies for conservation. Trees outside the forest are an important resource and play a key role in sustainable biodiversity management. Since species diversity is important to maintain heterogeneity of a stable ecosystem, the diversity is to be preserved through appropriate measures. There is a need for an accelerated survey of plant resources with the objectives to conserve the aesthetic and economically important wild and semi-domesticated species[1]. Various studies[2-9] reported the status, composition, phytosociological attributes and diversity of flora in the campus of educational institutes in Tamilnadu. The present study was carried out to document the status, distribution pattern and diversity of woody plant species in the campus of S.T. Hindu College (known as South Travancore Hindu College) located in Nagercoil Municipality town, the headquarter of Kanniyakumari District, Tamil Nadu, India.

MATERIALS AND METHODS

Study Area

The study area, S.T. Hindu College (STHC), known as South Travancore Hindu College, located (8.182903°N; 77’40638°E) in Nagercoil Municipality Town, headquarter of Kanniyakumari district, Tamil Nadu, India. Kanniyakumari district is situated in the southernmost tip of Tamil Nadu, Southern Peninsular India (77.15’-77.30’E; 8.30’-8.15’ N) located in the part of Southern Western Ghats. The South Travancore Hindu College Association with temple trusts and individuals as shareholders was registered as a company on 1952 with a view to promoting the cause of higher education is South Travancore, now known as Kanniyakumari District. The college was granted affiliation on 1952 by the University of Travancore. The college was started as an intermediate college in 1952. In 1957, the college was first came to be affiliated to the University of Madras, then to Madurai Kamaraj University in 1966 and finally to Manonmaniam Sundaranar University in 1990. The college is located in the central part of Nagercoil, a semi-urban town, near Chettikulam junction. The college campus enriched with beautiful vegetation and occupies a land area of 21.95 acres.

Data Collection

An inventory of woody plant species was conducted in the campus of S.T. Hindu College, from July, 2014 to August, 2014. All woody species (Girth size ≥10cm) present in the study area were identified and recorded by the botanical name or by local name that was later confirmed by using the regional flora. All individuals of woody species (trees, shrubs and lianas) are counted and recorded except the individuals in hedgerows. No herbs were counted due to the difficulty in differentiating stems. The botanical inventory was conducted only once in the study area. Thus, the seasonal variation in woody species structure was not assessed. Species were identified using regional floras[10, 11] for all documental species. The binomial and author citation were checked thoroughly with IPNI[12]. The woody (climbers, shrub and trees) plant’s community organization, distribution and diversity studies were conducted by survey method. In the present study, the woody plants (with a girth size ≥10cm at breast height-GBH) in the study area were counted. Woody species were assigned to different size classes based on GBH: 10-50, 50-100, 100-150, 150-200, ≥200cm; and to different DBH size classes: <15, 15-30, 30-45, 45-60 and ≥60cm.

Data Analysis

Various attributes and diversity indices of woody plants were determined following standard methods. The basal area of each species is computed using the values of GBH and DBH to determine total basal area of all species and average basal area of individual species as well as all the species. The basal area was also used to determine the relative density and relative dominance of woody species. Based on the number of individuals in each species, the woody plants were grouped into very rare (represented by <2 individuals), rare (2 - <10 individuals), common (10 - <25 individuals), dominant (25-50 individuals) and predominant (>50 individuals) following Kadavual and Parthasarathy[13]. The various woody species were scored according to their relative densities (RD) to determine, weather the species comes under abundant (RD ≥ 5.00); frequent (4.0 ≤ RD ≤ 4.99); occasional (3.00 ≤ RD ≤ 3.99); rare (1.00 ≤ RD ≤ 2.99); or threatened / endangered (0.00 ≤ RD ≤ 1.00) category[14] (Daniel *et al*., 2012). Ten top ranking species were determined based on total value of the species for all phytosociological parameters of woody species. Data obtained from tree species composition was analyzed to obtain relative density (RD), relative abundance (RA/Pi) and the relative dominance was estimated based on total basal area (RDo)[14-16].

$$Relative\ Density\ (RD\%) = \frac{No.of\ individuals\ of\ each\ species}{Total\ no.of\ individuals\ of\ all\ species}\ x\ 100$$

$$Relative\ abundance\ (RA/Pi) = \frac{Relative\ density\ of\ species}{100}$$

$$Domiance\ (Do) = \frac{Basal\ area\ of\ the\ individual\ species}{Basal\ area\ of\ all\ the\ species}$$

$$Relative\ Dominance\ (RDo\%) = \frac{Total\ Basal\ Area\ of\ each\ species}{Total\ Basal\ Basal\ of\ all\ species}\ x100$$

Standard methods were followed to estimate different diversity indices. Data obtained from relative density (abundance) ($P_i = n_i/N$) was used to compute the Shannon - Weaver's (Weiner's) Diversity index[17] for the study area, i.e., $H' = -\Sigma P_i\ In\ P_i$. Where, H' =Shennon-Weaver's Diversity index; P_i =relative abundance of the 'i'th species; InP_i =Natural logarithm of the corresponding relative abundance (Pi = ni/N) of the species. Margalef index of species richness (SR) is calculated by using the formula: $SR = \frac{S-1}{I_n(N)}$; Where, S =Number of species; N =Total number of individuals[18, 19]. Pielou's index of species evenness[20] was computed using the formula: $E_{Pielou} = \frac{H'}{I_n(S)}$; Where, H' = Shannon-Weiner's Diversity Index; I_n = Natural logarithm of species; S =Number of species. Simpson's diversity (D) is calculated by using the formula: $D = 1 - \lambda$ [19, 21], Where, λ = Simpson's concentration of dominance ($1-\sum P_i^2$); $P_i = n_i/N$; n_i =Number of individuals in each species; N =Total number of individuals in all species. Simpson's Dominance Index (DI) [22, 23] was determined by using the formula: $DI = \sum(Pi)^2$; Where, P_i =ni/N. Species heterogeneity, defined as the reciprocal of Simpson index or under root of concentration of dominance (cd), was determined as: $= \frac{1}{\sqrt{cd}}$.

RESULTS AND DISCUSSION

Attributes of woody species

In this study, the data collected from S.T. Hindu College campus by survey method was analyzed to record the phytosociological attributes and diversity of woody plants. Table 1- shows the botanical name, common name, family, number of individuals/species, GBH (cm) and DBH (cm) of woody plants identified. A total of 50 woody species belongs to 50 genus and 29 families with 872 individuals were recorded in the study area. A floristic study carried out by Parthipan *et al.* [9] in the campus of S.T. Hindu College indicate the presence of 89 woody species (includes 47 trees and 42 shrubs). The less number of woody species recorded in this study as compared to number of species reported earlier[9] may be due to counting woody species with ≤10cm girth (gbh) size only. Figure 1 shows the distribution pattern of woody species recorded in the study area includes 45 trees, 4 shrubs and 1 liana. Among the species,

Tectona grandis having maximum number of 196 individuals and is followed by *Leucaenea leucocephala* with 152 individuals and *Cocos nucifera* with 137 individuals in STHC campus.

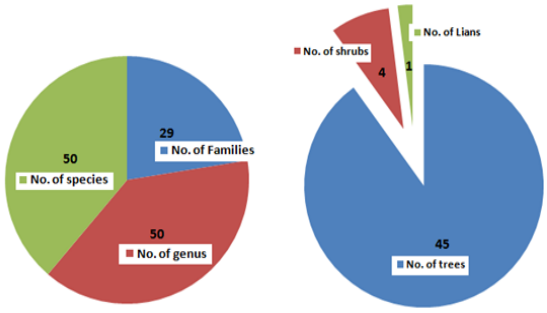
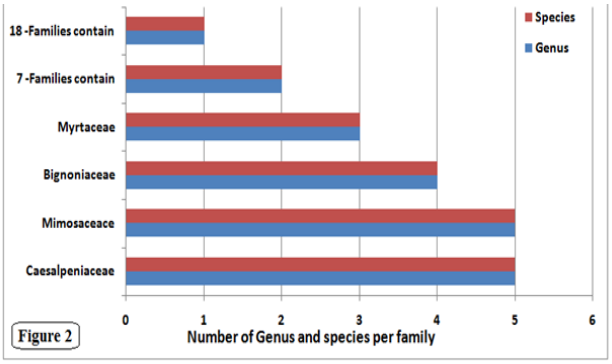


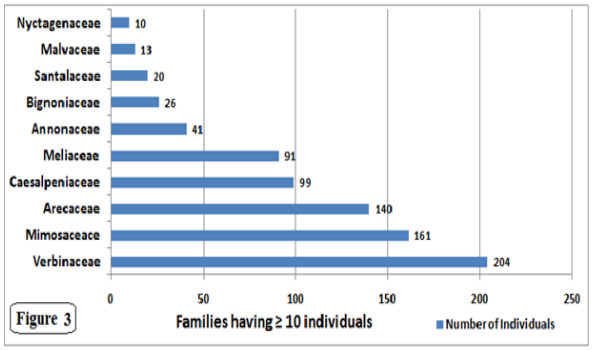
Figure 1: Distribution pattern of woody plants in the STHC campus.

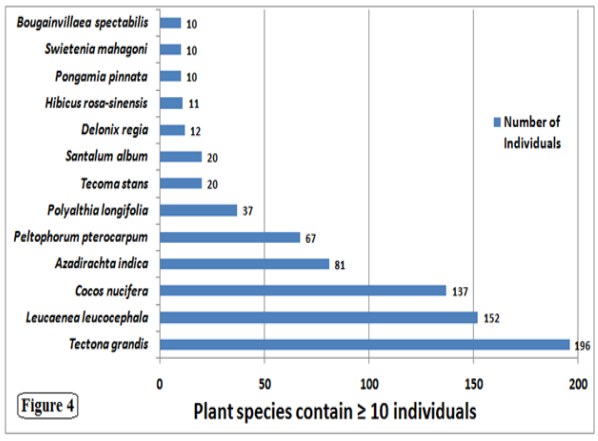


STHC campus has two dominant family – Caesalpineaceae and Mimosaceae, with 5genus and species each, and one co-dominant family (Bignoniaceae) with 4genus and species (Figure 2). Top 10 families and species having more number of individuals are presented in figures 2 and 3. Among the families, Verbinaceae having 204 individuals and is followed by Mimosaceae with 161 individuals and Arecaceae with 140 individuals (Figure 3). Among the top 10 species (Figure 4), *Tectona grandis* is dominant with 196 individuals (22.48%) and *Leucaenea leucocephala* is co-dominant with 152 individuals (17.43%), and *Cocos nucifera* with 137 individuals (15.71%).

GBH and DBH Measurements

The measurement of tree growth provided important information about the dynamics of that ecosystem. In the present study, the girth/diameter (GBH/DBH) size of the woody species (>10 cm/>3.18 cm) were measured and used to analyze various other factors. The girth of the woody species varied from 10 cm GBH/3.18 cm DBH (in *Duaranta plumieri*) to 349cm GBH/111.15 cm DBH (in *Peltophorum pterocarpum*) and the average girth size ranges from 13.25 cm GBH/4.22 cm DBH (in *Duaranta plumier*) to 201.50 cm GBH/64.17 cm DBH (in *Enterolobium saman*) (Table 1). The estimated total girth (GBH) size of woody plants was ranged from 25 cm (*Muntingia calabra*) to 13629.50 cm (*Techtona grandis*) with an average of 1222.97 cm per species and 70.12 cm per individual. The total diameter (DBH) of the woody plants was estimated and it was ranged from 7.96 cm (*Muntingia calabra*) to 4340.61 cm (*Tectona grandis*) with an average of 389.48 cm/species and 22.33 cm/individual. Usually, 200cm girth size of trees is considered as mature. In STHC campus, from the total of 872 individuals of 50 woody species counted, 9 individuals (3 from *Azadirachta indica* and 2 from *Delonix regia*, and each one from *Mangifera indica*, *Syzigium cumini*, *Terminalia indica*, and *Enterolobium saman*) belongs to 6 species measured over 200cm GBH/64cm DBH (Table 2).





Category of Woody Plants

The woody plants identified in the study area were categorized based on GBH/DBH size classes, no. of individuals/species, and relative density/species. To determine the population structure of woody species in the study area, the plants were categorized into different girth-class and diameter-class. The size class distribution of woody species can provide a reliable overall indication of changes in species selection overtime[24, 25]. Although data on species distribution in time are not available, size class distributions to differentiate between species which have been planted over a number of years (which should have a more evenly distributed age structure), from species which have been selected for planting recently (whose distribution should be dominated by smaller trees), or species which have been planted widely in the past and recently been discontinued (whose distribution should therefore be dominated by larger trees)[26, 27].

Table 1: List of woody species recorded in the study area of S.T. Hindu College Nagercoil, Kanniyakumari District, Tamil Nadu

Sl. No.	Botanical Name of the species	Common name	Family	Life form	NI	GBH (cm)*	DBH (cm)*
1	*Acacia mangium* Wild	Mangium	Mimosaceae	Tree	1	62.00	19.75
2	*Albizzia lebbeck* Benth (Lin)	Vagai	Mimosaceae	Tree	4	83.00	26.44
3	*Annona squamosa* L.	Setha	Annonaceae	Tree	4	21.75	6.93
4	*Azadirachta indica* A. Juss.	Vembu	Meliaceae	Tree	81	89.40	28.47
5	*Bambusa arundinacea* Willd	Moongil	Poaceae	Tree	4	24.75	7.88
6	*Bougainvillaea spectabilis*	Paper rose	Nyctagenaceae	Lians	10	25.10	7.99
7	*Callistemon lanceolatus* Dc.	Bottle brush	Myrtaceae	Tree	1	54.00	17.20
8	*Caryota urens* L.	Koondalpanai	Arecaceae	Tree	3	105.00	33.44
9	*Cassia fistula* L.	Kanikonnai	Caesalpeniaceae	Tree	8	68.63	21.86
10	*Casuarina equisetifolia* Forst.	Savukku	Casuarinaceae	Tree	2	140.00	44.59
11	*Cocos nucifera* L.	Thennai	Arecaceae	Tree	137	80.81	25.73
12	*Crescentia alata* L	Thiruvodu	Bignoniaceae	Tree	1	46.00	14.65
13	*Cycas circinalis* L.	Cycas	Cycadaceae	Tree	1	182.00	57.96
14	*Delonix regia* (Bol) Raf.	Gulmohar/kattuthee	Caesalpeniaceae	Tree	12	90.17	28.72
15	*Dracana angustifolia* (Medik.) Roxb.	Dracanea	Liliaceae	Shrub	3	20.67	6.58
16	*Duranta plumeri* Jacq.	Golden dew drrop	Verbinaceae	Tree	8	13.25	4.22
17	*Eleocarpus tuberculatus* Roxb	Uthracham	Eleocarpaceae	Tree	1	74.00	23.57
18	*Emblica officinalis* Gaertn.	Nelli	Euphorbiaceae	Tree	4	40.00	12.74
19	*Entrolobium saman* (Jeca) Prain.	Rain tree	Mimosaceae	Tree	2	201.50	64.17
20	*Ficus religiosa* L.	Arasu	Moraceae	Tree	1	43.00	13.69
21	*Hibiscus rosa-sinensis* L.	Sembaruthi	Malvaceae	Shrub	11	21.36	6.80
22	*Jacaranda mimosifolia* D.Don.	Jacaranda	Bignoniaceae	Tree	1	36.00	11.46
23	*Lawsonia inermis* L.	Maruthani	Lythraceae	Tree	1	30.00	9.55
24	*Leucaenea leucocephala* (Lam) de Wil.	Cubapul	Mimosaceae	Tree	152	32.29	10.28
25	*Madhuca indica* J.f. Gemel.	Eluppai	Sapotaceae	Tree	3	89.33	28.45
26	*Mangifera indica* L.	Mango	Anacardiaceae	Tree	8	145.38	46.30
27	*Michella champaca* L.	Chempakam	Magnoliaceae	Tree	1	43.00	13.69
28	*Millingtonia hortensis* L.	Panneerpoo	Bignoniaceae	Tree	4	22.25	7.08
29	*Mimusops elengi* L	Mazhizham	Sapotaceae	Tree	4	75.25	23.97
30	*Morinda pubescens* Roxb. Var.	Manjanathi	Rubiaceae	Tree	8	60.63	19.31
31	*Muntingia calabra* L.	Kuruvipalam	Tiliaceae	Tree	1	25.00	7.96
32	*Murraya koeingii* (L) Spr.	Karuvepilai	Rutaceae	Tree	4	18.00	5.73
33	*Peltophorum pterocarpam* (DC) Backerx. Heyne	Perunkonrai	Caesalpiniaceae	Tree	67	140.68	44.80
34	*Pithecelobium dulce* (Roxb) Bth.	Kodukapuli	Mimosaceae	Tree	2	44.50	14.17
35	*Plumeria obtusa* L.	White temple tree	Apocynaceae	Tree	1	80.00	25.48
36	*Polyalthia longifolia* (Sonn) Thw.	Azoka	Annonaceae	Tree	37	85.05	27.09
37	*Pongamia pinnata* (L) Pierre	Pungam	Caesalpiniaceae	Tree	10	73.70	23.47
38	*Prosopis spicigera* Linn.	Vanni	Fabaceae	Shrub	5	76.20	24.27
39	*Psidium gujava* L.	Koyya	Myrtaceae	Tree	2	17.00	5.42
40	*Santalum album* L.	Santal	Santalaceae	Tree	20	28.65	9.12
41	*Saraca asoca* (Roxb) deWillde.	Asokam	Caesalpeniaceae	Tree	2	60.50	19.27
42	*Swietenia mahagoni* (L.)	Mahagoni	Melioaceae	Tree	10	71.80	22.87
43	*Syzigium cumini* (L.) Skeels.	Navalmaram	Myrtaceae	Tree	2	196.50	62.58
44	*Tabernaemontana divaricata* R.Br. exRoem &Schult	Nandia vavattai	Apocynaceae	Shrub	2	23.00	7.33
45	*Tamarindus indica* Linn.	Puli	Fabaceae	Tree	2	158.50	50.48
46	*Tecoma stans* (L.) Hb. & K.	Manjapoo	Bignoniaceae	Tree	20	29.20	9.30
47	*Tectona grandis* L.f.	Thekku	Verbinaceae	Tree	196	69.54	22.15
48	*Terminalia cattappa* L.	Badam	Combretaceae	Tree	4	76.50	24.36
49	*Thespesia populnea* Soland.	Poovarasu	Malvaceae	Tree	2	117.50	37.42
50	*Zizipus mauritiana* Lamk. (l) Gaertn, non Miller	Elanthai	Rhamnaceae	Tree	2	89.50	28.50
	NI -Number of individuals	*Average of DBH & DBH per individual			**Total - 872**	**3501.84**	**1115.24**

Table 2: Woody plants having more than 200cm GBH and 60cm DBH size category

S. No.	Name of the woody species	No. of individuals	GBH (cm)	DBH (cm)
1	*Azadirachta indica*	3	212.00	67.52
2	*Delonix regia*	2	229.00	72.93
3	*Entrolobium saman*	1	208.00	66.21
4	*Mangifera indica*	1	232.00	73.89
5	*Syzigium cumini*	1	211.00	67.20
6	*Tamarindus indica*	1	289.00	91.40

Table 3: Category of woody species recorded in the study area of STHC

S. No.	Girth (gbh) size class	No. of Species & (%)	No. of individuals & (%)
1	10cm to 50cm	31 (62%)	337 (38.64%)
2	50cm to 100cm	26 (52%)	384 (44.04%)
3	100cm to 150cm	14 (28%)	102 (11.70%)
4	150cm to200cm	8 (16%)	27 (3.10%)
5	≥200cm	7 (14%)	22 (2.52%)
	Total	**50 (100%)**	**872 (100%)**
S. No.	**Diameter (dbh) size class**	**No. of Species & (%)**	**No. of individuals & (%)**
1	< 15cm	32 (64%)	321 (36.81%)
2	15cm to 30cm	27 (54%)	357 (40.94%)
3	30cm to 45cm	15 (30%)	140 (16.05%)
4	45cm to60cm	9 (18%)	25 (2.89%)
5	≥60cm	7 (14%)	29 (3.33%)
	Total	**50 (100%)**	**872 (100%)**
	Based on number of individuals		
S. No.	**Woody species category**	**No. of Species**	**Total No. of individuals**
1	Very rare (< 2)	11 (22%)	11 (1.26%)
2	Rare (2 to 10)	26 (52%)	98 (11.24%)
3	Common (10 to 25)	7 (14%)	93 (10.67%)
4	Dominant (25 to 50)	1 (2%)	37 (4.24%)
5	Predominant (> 50)	5 (10%)	633 (72.59%)
	Total	**50 (100%)**	**872 (100%)**
	Based on relative density (RDe%)		
1	Abundant (≥ 5)	5 (10%)	72.59%
2	Frequent (4 - 4.99)	1 (2%)	4.24%
3	Occational (3 - 3.99)	0 (0%)	0%
4	Rare (1 to 2.99)	7 (14%)	10.67%
5	Threatened/Endangered (0 - 0.99)	37 (64%)	12.50%
	Total	**50 (100%)**	**100%**

Table 4: Estimation of quantitative analysis of woody plants recorded in the STHC campus, Nagercoil, Kanniyakumari District, Tamil Nadu, India

Sl. No.	Botanical Name of the species	NI	Total BA (cm^2)	Average BA (cm^2)	RA (Pi)	RD (%)	Do	RDo (%)
1	*Acacia mangium*	1	306.20	306.20	0.001	0.11	0.0006	0.06
2	*Albizzia lebbeck*	4	2213.06	553.27	0.005	0.46	0.0045	0.45
3	*Annona squamosa*	4	153.51	38.38	0.005	0.46	0.0003	0.03
4	*Azadirachta indica*	81	67253.36	830.89	0.093	9.29	0.1359	13.58
5	*Bambusa arundinacea*	4	200.08	50.02	0.005	0.46	0.0004	0.04
6	*Bougainvillaea spectabilis*	10	608.20	60.82	0.012	1.15	0.0012	0.12
7	*Callistemon lanceolatus*	1	232.35	232.35	0.001	0.11	0.0005	0.05
8	*Caryota urens*	3	2649.56	883.19	0.003	0.34	0.0054	0.54
9	*Cassia fistula*	8	3444.51	431.80	0.009	0.92	0.0070	0.70
10	*Casuarina equisetifolia*	2	3132.64	1566.32	0.002	0.23	0.0063	0.63
11	*Cocos nucifera*	137	76217.02	556.33	0.157	15.71	0.1540	15.40
12	*Crescentia alata*	1	168.56	168.56	0.001	0.11	0.0003	0.03
13	*Cycas circinalis*	1	2638.44	2638.44	0.001	0.11	0.0053	0.53
14	*Delonix regia*	12	13495.70	1124.64	0.014	1.38	0.0273	2.73
15	*Dracaena angustifolia*	3	105.09	35.03	0.003	0.34	0.0002	0.02
16	*Duranta plumeri*	8	116.21	14.53	0.009	0.92	0.0002	0.02
17	*Eleocarpus tuberculatus*	1	436.32	436.32	0.001	0.11	0.0009	0.09
18	*Emblica officinalis*	4	538.32	134.58	0.005	0.46	0.0011	0.11
19	*Entrolobium saman .*	2	6474.94	3237.47	0.002	0.23	0.0131	1.31
20	*Ficus religiosa L.*	1	147.20	147.20	0.001	0.11	0.0003	0.03
21	*Hibiscus rosa-sinensis*	11	418.87	38.08	0.013	1.26	0.0008	0.08
22	*Jacaranda mimosifolia*	1	103.15	103.15	0.001	0.11	0.0002	0.02
23	*Lawsonia inermis*	1	71.59	71.59	0.001	0.11	0.0001	0.01
24	*Leucaenea leucocephala*	152	16060.29	105.66	0.174	17.43	0.0324	3.24
25	*Madhuca indica*	3	1974.70	658.23	0.003	0.34	0.0040	0.40
26	*Mangifera indica*	8	15905.02	1988.51	0.009	0.92	0.0321	3.21
27	*Michella champaca*	1	147.20	147.20	0.001	0.11	0.0003	0.03
28	*Millingtonia hortensis*	4	216.82	54.20	0.005	0.46	0.0004	0.04
29	*Mimusops elengi*	4	1815.03	453.76	0.005	0.46	0.0037	0.37
30	*Morinda pubescens .*	8	2508.68	313.58	0.009	0.92	0.0051	0.51
31	*Muntingia calabra*	1	49.76	49.76	0.001	0.11	0.0001	0.01
32	*Murraya koeingii*	4	104.30	26.07	0.005	0.46	0.0002	0.02
33	*Peltophorum pterocarpam*	67	133462.20	1991.97	0.077	7.68	0.2696	26.96
34	*Pithecelobium dulce*	2	435.94	217.97	0.002	0.23	0.0009	0.09
35	*Plumeria obtusa*	1	509.90	509.90	0.001	0.11	0.0010	0.10
36	*Polyalthia longifolia*	37	22472.21	607.36	0.042	4.24	0.0454	4.54
37	*Pongamia pinnata*	10	4544.82	454.48	0.012	1.15	0.0092	0.92
38	*Prosopis spicigera*	5	2329.22	465.84	0.006	0.57	0.0047	0.47
39	*Psidium gujava*	2	46.70	23.35	0.002	0.23	0.0001	0.01
40	*Santalum album*	20	1462.98	73.15	0.023	2.29	0.0030	0.30
41	*Saraca asoca*	2	583.98	291.99	0.002	0.23	0.0012	0.12
42	*Swietenia mahagoni*	10	4697.61	469.76	0.012	1.15	0.0095	0.95
43	*Syzigium cumini*	2	6182.03	3091.02	0.002	0.23	0.0125	1.25
44	*Tabernaemontana divaricata*	2	84.39	42.20	0.002	0.23	0.0002	0.02
45	*Tamarindus indica*	2	6578.28	3289.14	0.002	0.23	0.0133	1.33
46	*Tecoma stans*	20	1439.49	71.97	0.023	2.29	0.0029	0.29
47	*Tectona grandis*	196	84907.70	433.20	0.225	22.48	0.1715	17.15
48	*Terminalia cattappa*	4	1888.02	472.00	0.005	0.46	0.0038	0.38
49	*Thespesia populnea*	2	2237.85	1118.93	0.002	0.23	0.0045	0.45
50	*Zizipus mauritiana*	2	1282.61	641.31	0.002	0.23	0.0026	0.26
	Total	**872**	**495052.61**	**31721.67**	**1.000**	**100.00**	**1.0000**	**100.00**

BA -Basal area; RA -Relative abundance; RD -Relative density; D -Dominance; RDo -Relative dominance.

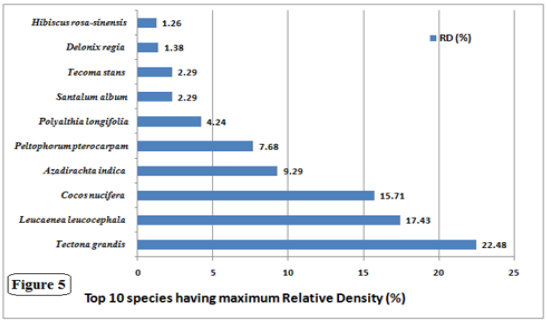
In the study area, most of individual comes under the girth size class of 15cm to 100cm GBH shows 44.04% (384 individuals and 26 species), whereas the diameter size class of <15cm to 30cm DBH shows 40.94% (257 individual and 27 species). This indicates that the majority of the woody species are young and recently planted. Very few species are found in the >200cm GBH and >60cm DBH size class appears to indicate that these species are matured and being gradually phased out in the study area. These species appear to be replaced by other plants.

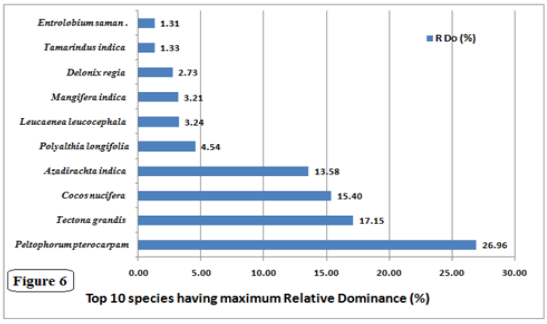
The distribution pattern of woody species scored according to different categories such as number of individuals per species and relative density in the study area. Based on the number of individuals/species, the woody plants are categorized into very rare, rare, common, dominant, and pre-dominant. In STHC campus, most of the species (52%) comes under rare category. In general, rare and very rare category (<10 individual/species) found in 37 species (11.37%) of woody plants while 6 species comes under dominant and predominant category with 670 individuals which is about 76.83% (Table 3). Based on relative density, the woody species are categorized into abundant, frequent, occasional, rare and threatened/endangered. In the study area, about 78% species comes under rare and threatened category (RD 0 to 2.99).

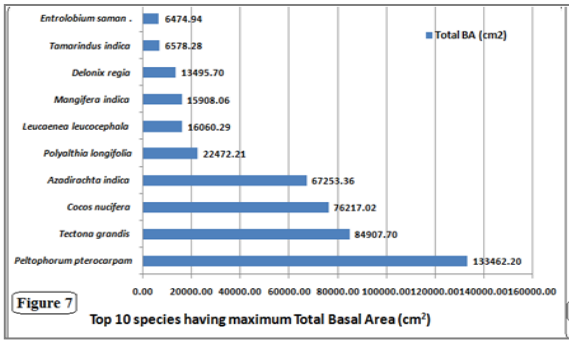
Phytosociological attributes of woody species

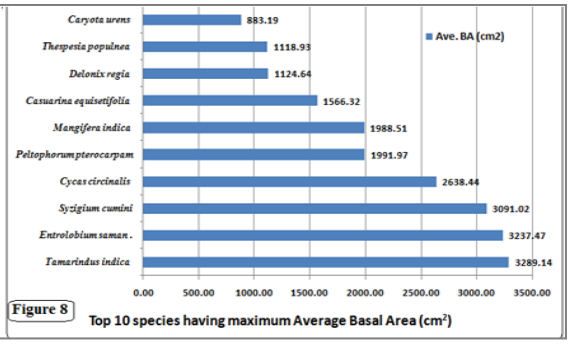
The results of relative abundance (RA/Pi) of woody species presented in table 4 and it ranges from 0.001 to 0.225, and maximum RA is noted in *Techtona grandis* and is followed by *Leucaenea lucocephala* (0.174) and *Cocos nucifera* (0.154). Relative density (RD %) of woody species recorded in STHC campus presented in table 4 and it ranges from 0.11 to 22.48 with a maximum in *Tectona grandis*. Figure 5 shows top 10 woody species having maximum relative density. Among the woody plants, above 10% of RD was noted in *Tectona grandis* (22.48%), *Leucaenea lucocephala* (17.41%) and *Cocos nucifera* (15.71%). The results of relative dominance (RDo) indicate that the relative dominance of woody species ranged from 0.01% (in *Psidium gujava* and *Muntingia calabra*) to 26.96% (in *Peltophorum pterocarpum*).

Total basal area (Dominance) of the woody species considered as dominance and relative dominance parameter. The TBA of all the woody species (Table 4) in the study area is estimated as 495065.55cm^2 and is ranged from 46.70cm^2 (in *Psidium gujva*) to 133462.26cm^2 (in *Peltophorum pterocarpum*) with an average of 9901.31cm^2/species and 567.74cm^2/individual. Figure 7 shows the top 10 woody species having maximum TBA (dominance). Among the top 10 species, *Peltophorum pterocarpum* shows more TBA (133462cm^2) and is followed by *Tectona grandis* with 84907.70cm^2 as compared to other species. The average basal area (ABA) of the woody species in STHC campus ranged from 14.53cm^2 (in *Duaranta plumieri*) to 3289.14cm^2 (in *Tamerindus indica*) with a total average basal area of 31721.07cm^2 (Table 5). Figure 8 shows top 10 woody species having maximum ABA in the study area. Three woody species –*Tamarindus indica, Entralobium saman, and Syzigium cumni* comes under top 10 categories in the study site with higher average basal area.









Diversity of woody species

Species diversity is one of the most important measures of community structure and it has been related to various ecological factors. The diversity of woody species, particularly trees is fundamental to plant diversity because they provide resources and habitats for almost all other species[28]. In this study, various diversity indices- Shannon-Weaver's Species Diversity Index, Simpson's Species Diversity Index, Species Richness, Species Evenness, and Indices of Heterogeneity of woody species were estimated (Table 5).

Table 5: Diversity indices of woody species in the study area of STHC

S. No.	Diversity Indices	
1	Shannon-Weaver Species Diversity Index (H')	2.556
2	Simpson's Diversity (D)/ Dominance Index (DI)	0.124
3	Margalef's Index of Species Richness ($R_{Margalef}$)	7.238
4	Pielou's Index of Species Evenness (E_{Pielou})	0.655
5	Simpson's Concentration of Dominance (cd/λ)	0.876
6	Species Heterogenity	0.936

Shannon-Weaver's Species Diversity Index (H') of woody species in the study area is noted as H' =2.567, whereas the Simpson's Dominance/Diversity Index is estimated as (D/DI =0.124). Mousumi Garai *et al.* [29] reported Shannon index value of tree species ranges from 2.435 to 2.788 and also recorded dominance index (D) of tree species ranges from 0.072 to 0.115 in three study sites of Durgapur Government college campus. The lower species diversity indicates heterogenous distribution of woody species in STHC campus. The lower diversity could be due to lower rate of evolution and diversification of communities[30].

The concept of species diversity relates simply to "richness" of a community or geographical area in species. In this study, Morgalef index of species richness was estimated as $SR_{Margalef}$ =7.238 (Table 5). Mousumi Garai *et al.* [29] recorded Margalef's species richness index of tree species ranges from 3.795 to 4.991 in three study sites of Durgapur Government college campus. Tree species richness at defined study sites and in minimum diameter classes gives a reliable instrument to indicate the diversity level of a study site[31].

Pielou's Index of Species Evenness was noted as E_{Pielou} =0.655 in the study area (Table 5). Mousumi Garai *et al.* [29] noted an evenness index value as 0.7186 to 0.8123 for tree species in three study sites of Durgapur Government college campus. Simpson's Concentration of Dominance (λ) of woody species was estimated in the study area and the results (Table 5) indicate that the concentration of dominance is λ =0.876. Species heterogeneity attribute of woody species in the study area is recorded as SH =0.936 (Table 5).

Plant diversity of an area is related to a variety of factors. Attempts to identify the trends in geographical distribution of plant diversity are an important task. The saving and establishment of plant communities is an essential duty of human society for conservation and avail the immense benefits of biodiversity. From the results of present study, it is concluded that proper management and conservative measures need to be implemented for conservation of woody plant varieties in the study area of S.T. Hindu College campus in Nagercoil. Because, the distribution pattern of most of the woody species found in the study area are comes under rare/very rare as well as contagious (patchy) communities. The results of this study also stress that there is a need to carry out efforts to documenting the available plant species in the human habitats, which can be lost from the natural environment, otherwise it will leads to desertification which associated with human activities.

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