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Research Article

Density, Species richness and Diversity of Trees in a Sacred Grove-Tropical Dry Deciduous Forest, Dharmapuri District, Tamil Nadu, South India

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Abstract: A quantitative tree survey was conducted to record density, species richness and diversity of trees in a sacred grove-tropical dry deciduous forest, Dharmapuri district, Tamil Nadu, south India. All trees ≥10 cm girth at breast height (gbh.; 137 cm from the ground) was measured. In all, 26 species belonging to 25 genera and 16 families recorded from study area. This study recorded 16.72 m^2 ha^{-1} basal area of trees in study area. The study area had the Shannon diversity index H = 2.83; Shannon equitability index H' = 0.87, and Simpson dominance index D = 0.08. Density, species richness and diversity of trees recorded in study area are low, equal as well as high compared to tropical forests elsewhere.
Keywords: stand basal area; diversity indices; sacred grove; tropical trees; moderate diversity.

INTRODUCTION

Forest generates timber, fiber, fuel wood and non-timber products; regulates environment through carbon sequestration and storage and conserves biodiversity, soil and water [1]. Forest is one of the important economic sources of the nation [2], supporting human life by contributing edible materials such as fruits, tubers, seeds, oils, and plant products such as fuel, fodder biomass, construction materials, gums, resins, tannins, dyes, and medicinal plants [1]. Many of the modern drugs have originated from the wild e.g. salicylic acid, a constituent of aspirin initially isolated from willow trees, and quinine (an effective anti-malarial drug) was first discovered in *Cinchona offifinalis* (Rubiaceae), [3]. It is reported that tropical forests harbour about 170, 000 plant species (two-thirds of all plant species on earth), [4]. Prance et al. estimated that tropical forests hold more than 200,000 species of phanerogamic plants occupying just 6% of the earth's land surface [5].

Knowing and understanding ecology of tropical forests is essential for formulating important strategies for forest conservation and management. Protection of tropical forests from further damage and extension of forest area through sustainable management are important tasks and then only forests can provide inevitable environmental and social services to all living-beings [1]. Tropical dry deciduous forest (TDDFs) is one of the least studied forests in Tamil Nadu hence this study planned to know about tree density, diversity and species richness in a sacred grove TDDF at Kariyapatti (KP), Dharmapuri district in Tamil Nadu.

MATERIALS AND METHODS

Study area

The district is located between latitudes N 11 47' and 12 33' and longitudes E 77 02' and 78 40'. Occupies an area of 4497.77 km² (i.e. 3.46% of Tamil Nadu) and has a population of 2,856,300 (as of 2001). It is bounded on the north by Krishnagiri District, on the east by Tiruvannamalai District and Viluppuram District on the south by Salem District, and on the west by Karnataka's Chamarajanagar District. The whole district is surrounded by hills and forests. This district endowed with rich biodiversity especially hills of Chitheri and Theerthamalai having rich tree diversity.

Field survey

A one hectare (100m×100m) square plot was laid in study site. One hectare area was divided in to a hundred 10m×10m workable sub-plots. All trees ≥10 cm girth at breast height (gbh.; 137 cm from the ground) was measured. The quantitative forest survey was conducted during April-December, 2012 to reveal tree density, richness, diversity, dominance etc. For multi-stemmed trees, the girth of individual stem was measured separately, basal area calculated and summed-up. All recorded trees were identified to species level with the help of regional floras.

Diversity indices

Shannon diversity (*H*) and Equitability index (E_H)

A diversity index reveals the structure of biological community in terms of numerical value. It gives more information on community composition than species richness. Further, it offers insights in to rarity and commonness of species in a community, thereby diversity index functions as an important tool for biologists in the understanding of community structure.

Species diversity and equitability were calculated by the Shannon's diversity index (*H*) and Shannon's evenness (E_H) respectively [7].

$$H = -\sum_{i=1}^{S} Pi \ ln \ Pi$$

Where: *H* = the Shannon diversity index; P_i = fraction of the entire population made up of species *i*; *S* = number of species encountered; ∑ = sum from species 1 to species *S*. The Shannon diversity index (*H*) is commonly used to characterise species diversity in a community. This index considers both abundance and evenness of the species present. Shannon's equitability (E_H) calculated by dividing *H* by H_{max} (where H_{max} = ln*S*). Shannon's evenness (E_H) = H / H_{max} = H / ln *S*.

Simpson's index (*D*)

Simpson's dominance index (*D*) was calculated as in Magurran [6].

$D = \sum n_i(n_i-1)/N(N-1)$

Where D is measure of dominance; n_i = the number of individuals in the i^{th} species; N = the total number of individuals of all the species in the sample.

RESULTS

Density

A sum of 517 trees recorded from a hectare in study area (Table 1, 2). Number of individuals represented by each species' varied considerably. *Strychnos nux-vomica* represented by 70 individuals followed by *Azadirachta indica* (60 trees), *Atalantia monophylla* (56), *Strychnos potatorum* (55) and *Benkara malabarica* (46). On the other hand, two species namely, *Premna latifolia* and *Canthium dicoccum* were represented by just single individual in study area.

Table-1. Details of quantitative assessment of trees recorded in a tropical dry deciduous forest, Dharmapuri district, Tamil Nadu

Variable	Value
Stand density (trees ha^{-1})	517
Species richness (ha^{-1})	26
Stand basal area (m^2 ha^{-1})	16.72
Shannon index (*H*)	2.83
Shannon Equitability Index (*H'*)	0.87
Simpson index (*D*)	0.08

Species richness

In all, 26 species belonging to 25 genera and 16 families encountered from study area (Table 1). The family Loganiaceae had large number of individuals 125 trees ha^{-1} followed by Rutaceae (107), Rubiaceae (76) and Meliaceae (60). Conversely, the family Moraceae had least number of trees i.e., 5 ha^{-1} followed by Anacardiaceae (6 trees) and Ebenaceae (7) in study area.

Tree stands' basal area

We recorded 16.72 m^2 ha^{-1} basal area of trees in study area. *Azadirachta indica* had the largest share in forest stand basal area (8.63 m^2 ha^{-1}) followed by *Strychnos nux-vomica* (3.25 m^2 ha^{-1}) and *Atalantia monophylla* (0.87 m^2 ha^{-1}). In opposition, with only one individual *Canthium dicoccum* contributed just 0.001 m^2 ha^{-1} to site's basal area in study site.

Diversity indices

The study area had the Shannon diversity index *H* = 2.83; Shannon equitability index *H'* = 0.87, and Simpson dominance index *D* = 0.08. These indices are indicating that the present study area is moderately diverse.

Girth class and stand density

The contribution of smaller stem size class (10-90 cm gbh) to forest stand density is 86.52%. Likewise, the proportion of forest stand density formed by larger stem girth class (> 90 cm gbh) is 13.48% in study site (Table 3).

Contributions of girth classes to forest stand basal area

The basal area contribution of girth classes to stand basal area varied considerably in study area. The larger stem girth class >210 cm contributed a higher proportion to forest stand basal area i.e., 27.73% (6.25 m^2 ha^{-1}) in this study.

The lower girth class i.e., 10-30 cm gbh had least share in stand basal area. The smaller stem girth size (10-30 cm gbh) had least share in stand basal area 3.36% (0.76 m^2 ha^{-1}) in study site.

Table-2: Binomial, family and density of tree species in study area.

Binomial	Family	No. of individuals
Allophylus serratus (Hiern) Kurz	Sapindaceae	17
Atalantia monophylla DC.	Rutaceae	56
Azadirachta indica L.	Meliaceae	60
Benkara malabarica (Lam.) Tirveng.	Rubiaceae	46
Breynia vitis-idaea (Burm. f.) C.E.C. Fisch.	Euphorbiaceae	16
Canthium dicoccum (Gaertn.) Merr.	Rubiaceae	1
Cassia fistula L.	Caesalpiniaceae	9
Catunaregam spinosa (Thunb.) Tirveng.	Rubiaceae	11
Crateva magna (Lour.) DC.	Capparidaceae	9
Diospyros ebenum J. König	Ebenaceae	7
Drypetes sepiaria (Wight & Arn.) Pax & K. Hoffm.	Euphorbiaceae	6
Ehretia pubescens Benth.	Boraginaceae	13
Flacourtia indica (Burm. f.) Merr.	Flacourtiaceae	9
Glycosmis mauritiana Tanaka	Rutaceae	42
Gmelina asiatica L.	Verbenaceae	21
Ixora pavetta Andrews	Rubiaceae	8
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	6
Madhuca longifolia (J. König ex L.) J.F. Macbr.	Sapotaceae	10
Maytenus emarginata (Willd.) Ding Hou	Celastraceae	9
Morinda coreia Buch. -Ham.	Rubiaceae	9
Premna latifolia Roxb.	Verbenaceae	1
Securenega leucopyrus (Willd.) Muell.-Arg.	Euphorbiaceae	11
Streblus asper Lour.	Moraceae	5
Strychnos nux-vomica L.	Loganiaceae	70
Strychnos potatorum L.	Loganiaceae	55
Tarenna asiatica Kuntze ex K. Schum.	Rubiaceae	10
Total no. of trees		517

Table3: Density, frequency and basal area of trees (≥ 10 cm gbh) in study area.

Species	Family	Density	Frequency	Basal area (m^2 ha^{-1})
Strychnos nux-vomica	Loganiaceae	70	42	3.25
Azadirachta indica	Meliaceae	60	33	8.63
Atalantia monophylla	Rutaceae	56	42	0.87
Strychnos potatorum	Loganiaceae	55	28	0.31
Benkara malabarica	Rubiaceae	46	24	0.20
Glycosmis mauritiana	Rutaceae	42	12	0.06
Gmelina asiatica	Verbenaceae	21	14	0.61
Allophylus serratus	Sapindaceae	17	17	0.02
Breynia vitis-idaea	Euphorbiaceae	16	16	0.03
Cordia pubescens	Boraginaceae	13	11	0.20
Catunaregam spinosa	Rubiaceae	11	11	0.04
Securenega leucopyrus	Euphorbiaceae	11	11	0.01
Madhuca longifolia	Sapotaceae	10	4	0.40
Tarenna asiatica	Rubiaceae	10	10	0.02
Morinda coreia	Rutaceae	9	9	0.50
Cassia fistula	Caesalpiniaceae	9	9	0.20
Crateva magna	Capparidaceae	9	9	0.12
Maytenus emarginata	Celastraceae	9	9	0.05
Flacourtia indica	Flacourtiaceae	9	9	0.04
Ixora pavetta	Rubiaceae	8	8	0.08
Diospyros ebenum	Ebenaceae	7	7	0.10
Drypetes sepiaria	Euphorbiaceae	6	6	0.40
Lannea coromandelica	Anacardiaceae	6	5	0.41
Streblus asper	Moraceae	5	4	0.12
Premna latifolia	Verbenaceae	1	1	0.03
Canthium dicoccum	Rubiaceae	1	1	0.001
	Total	517	352	16.72

DISCUSSION

Density

Tree density of present study area (517 trees ha^{-1}) is comparable with dry tropical forests of Vindhyan hills (294-559 trees ha^{-1}) [7], dry deciduous forests of Mudumalai (518 trees ha^{-1}) [8], tropical dry deciduous forests of Udaipur (458-728 trees ha^{-1}) [9], tropical dry forests of Uttar Pradesh (515 trees ha^{-1}) [10], and deciduous forests of Andaman (519-623 trees ha^{-1}) [11].

On the other hand, density of trees recorded in present study is high compared to tropical dry deciduous forests of Western Ghats (243 trees ha^{-1}) [12], dry deciduous forests of Mudumalai (348 trees ha^{-1}) [13], tropical dry forests of Vindhyan hills (35-419 trees ha^{-1}) [14], tropical dry forests of Chattishgarh (216-292 trees ha^{-1}) [15], and deciduous forests of Mandla (324-476 trees ha^{-1}) [16]. Conversely, tree density of present study area is lower than what has been reported from dry deciduous forests of Andhra Pradesh (563-1018 trees ha^{-1}) [17], dry deciduous forests of Bandipur hills (905 trees ha^{-1}) [18], tropical dry deciduous forests of Karnataka (883 trees ha^{-1}) [19], tropical dry forests of Rajasthan (995 trees ha^{-1}) [9], tropical dry deciduous forests of Madhya Pradesh (690-2500 trees ha^{-1}) [20], and tropical deciduous forests of Mexico (804-2117 trees ha^{-1}), [21].

Species richness

Species richness recorded in this study (26 species ha^{-1}) is comparable with tropical dry deciduous forests of Udaipur (18-38 species ha^{-1}) [9]. However, species richness of present study area is higher than what has been reported earlier from tropical dry forests of Chattishgarh (5-9 species ha^{-1}) [15], tropical dry forests of Vindhyan hills (4-23 species ha^{-1}) [7], tropical dry deciduous forests of Madhya Pradesh (2-14 species ha^{-1}) [21] and dry deciduous forests of Mandla (12-14 species ha^{-1}) [16].

Basal area

Basal area recorded in present study (16.72 m^2 ha^{-1}) is greater than in tropical dry evergreen forest of Villupuram (4.31 m^2 ha^{-1}) [21], deciduous forests of BR hills (7.9 m^2 ha^{-1}) [22], tropical dry forests of Chattishgarh (4.99-7.34 m^2 ha^{-1}) [15], and, tropical dry forests of Vindhyan hills (1.30-13.78 m^2 ha^{-1}) [14]. However, basal area of present study area is lower than what has been reported for dry deciduous forests of Mudumalai (22.3 m^2 ha^{-1}) [13], tropical dry deciduous forests of Madhya Pradesh (93.93-155.48 m^2 ha^{-1}) [19], deciduous forests of Andaman (49.4-57.5 m^2 ha^{-1}) [11] and, tropical dry forests of Rajasthan (46.35 m^2 ha^{-1}) [9].

Diversity indices

Shannon index recorded in study area (H=2.83) is lower than those recorded in a tropical evergreen forest of Kerala (3.102) [24], in a tropical rain forest of Barro Colorado Island, Panama (4.8) [25], in species rich Silent valley, India (4.89) [24]. However, the index value obtained in this study is higher than those of reported earlier for a tropical dry evergreen forest (TDEF) of Cuddalore (2.35) [26], two TDEF sites of Coromandel Coast (1.82, 2.33) [27], and five inland TDEF sites of Pudukottai, Tamil Nadu (1.29 to 2.44) [28].

The Simpson dominance index value estimated for present study area (D=0.08) is higher than the value recorded for Silent Valley, Kerala (0.06; [24]) for Nelliampathy (0.06±0.14; [29]), and for giant evergreen forest of Andaman (0.07; [30]). The lower the index value, the higher the community is diverse.

CONCLUSION

Density, species richness and diversity of trees recorded in study area are low, equal as well as high compared to tropical forests elsewhere. This study concentrated only on a sacred grove-tropical dry deciduous forest, further studies are required to know the complete ecological structure of these relatively under-studied forests in Tamil Nadu state. Conservation of this kind of sacred grove forest is essential to protect native species from local extinctions. It has been largely recorded that scared grove forests are act as repositories of genetic diversity of native trees.

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