INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE

ISSN: 2067-533X Volume 9, Issue 4, October-December 2018: 777-794 www.ijcs.uaic.ro

DIVERSITY AND PHYTOSOCIOLOGICAL ATTRIBUTES OF TREES OF BARATANG ISLAND, ANDAMAN AND NICOBAR ISLANDS, INDIA

Madiga BHEEMALINGAPPA,
Madha Venkata SURESH BABU, Boyina Ravi PRASAD RAO*

Biodiversity Conservation, Department of Botany, Sri Krishnadevaraya University, Ananthapuramu – 515003. Andhra Pradesh, India.

Abstract

In the present study we have analysed the tree species diversity and other phytosociological attributes of trees of Baratang Island, located in Middle Andamans. A total of 234 tree species representing 164 genera and 59 families were recorded in the sampled units. A total of 8657 tree individuals were enumerated. The range of tree density among the grids is 162-403 trees per 0.5ha. The most dominant species are Pterocarpus dalbergioides, Rhizophora apiculata, Gyrocarpus americanus, Tetrameles nudiflora, Bruguiera gymnorrhiza, Lagerstroemia hypoleuca, Terminalia bialata, Bambusa schizostachyoides, Rhizophora mucronata and Parishia insignis. The mean+SD basal area in the sampled grids was 21.59± 13.70 m2 ha-1 and ranged as low as 3.58 m2ha-1 to high as 65.03 m2ha-1. The overall population structure of tree species shows a reverse J-shaped population. The study gives an understanding of the diversity and pattern of tree population which will be of immense use in future forest conservation and management.

Keywords*: Baratang Island; Middle Andamans; Tree species; Phytosociological attributes.*
.

Introduction

Tropical forests throughout the world are experiencing heavy biotic interference in terms of habitat destruction, encroachment, over-exploitation, illegal collection, and unscientific extraction of plant resources. *Continuing species extinctions far above the historic rate, loss of habitats and changes in the distribution and abundance of species are projected throughout this century according to all scenarios analyzed in Global Biodiversity Outlook-3* [1]. The greatest threat to biodiversity worldwide is habitat loss and fragmentation, with climate change soon becoming another colossal threat. The widespread loss and degradation of native forests is now recognized as a global environmental crisis. From 2000-2005, global forest area was declined by around 20 million ha/yr [2]. Natural habitat destruction is more pronounced in islands around the world. In the Conference of Parties Meet [3], Islands while considering as biodiversity hotspots are reported facing the highest rates of extinction and biodiversity loss, resulting from, *inter alia*, invasive alien species and increasingly intense and frequent natural disasters; parties were therefore urged to redouble their efforts to conserve and protect island biodiversity, for the sake of the future of the planet.

* Corresponding author: biodiversityravi@gmail.com

Trees, the dominant life form of the tropical forests, are of exceptional ecological importance as they provide habitat for a wide range of other life forms and their benefits to humanity are multifarious. Trees especially inhabited in islands have critical role at local and global level in forest conservation and management; carbon sequestration and consequently climate change. Continued decline or loss of tree populations can have a major impact on the local forest structure. Around 7,800 tree species are currently recorded as threatened with extinction at the global scale [4]. Inventory of trees helps in understanding the structure of forests population study of trees will be of immense help in determining the regeneration of species which is crucial in their conservation.

Present study is intended to provide a complete inventory of trees along with their ecological attributes and their conservation per se in Baratang, the second largest island in middle Andamans, Andaman and Nicobar Islands. Present work was carried out for a period of 4 years during 2010-2014 as part of the research project sponsored by Department of Biotechnology, Government of India which was initiated to study the quantification and for mapping plant resources of Andaman and Nicobar islands. The data generated in the present study will be useful for a range of research, policy and intellectual property rights.

Materials and Methods

Study area

The Andaman group of Islands comprises 324 Islands. They lay between 10º to 14º North Latitudes 92º to 94º East Longitudes (Fig. 1). They are divided into North, Middle and South Andamans. The Forest Survey of India Report (FSI, 2011) the forest cover in Andaman Islands is 5343km^2 accounting for 83.38% of the total geographical area. Four of the world's 34 recognized biodiversity hotspots overlap India's geographic boundaries: the Andaman Islands are part of the Indo-Burma hotspot [5]. Andaman and Nicobar Islands harbours about 2800 vascular plant species, of which about 400 are trees and 118 of them are endemic. Current work is the first ever systematic attempt towards a fine scale quantitative assessment of tree resources in Baratang Island.

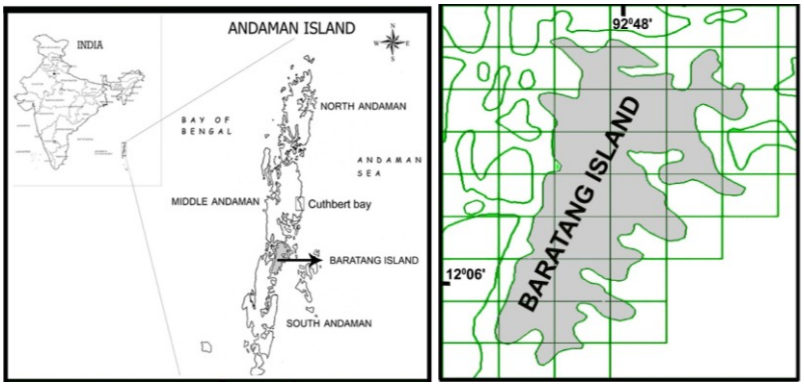

Fig. 1. The Study Area of Baratang Island of Andaman and Nicobar Island

Baratang Island, the study area of the present work is the second largest island in Middle Andaman. Baratang extended over 297.6km^2. The Island has an elevation range from sea level to 74m above MSL. Many seasonal streams are there in the island. The climate is typical of tropical islands being always warm and humid but with sea-breezes. Rainfall is irregular, but usually dry during the North-East, and very wet during the South-West monsoon. Temperature ranges between 22ºC and 30ºC and average annual rainfall 3000 to 3500mm and with mean relative humidity between 82 to 85%. Of the 11 mud Volcanoes in Andaman Islands, the

prominent are barren island volcano and mud volcano near Baratang. Many perennial streams are there in Baratang Island. Forest area of Baratang islands extends over 283.2km^2 (95% of the total geographical area).

Forest area of Baratang islands extends over 283.2km^2 (95% of the total geographical area). Different types of forests met with Baratang island are: Giant evergreen forest, Andaman evergreen forest, secondary evergreen forest, semi-evergreen forest, moist deciduous forest, Bamboo, mangrove forest, littoral forest and teak forests (IIRS, 2003). Andaman and Nicobar Islands harbor about 2800 species of vascular plants with varied economic importance, of which about 320 are endemic to the eco-region. Baratang Island comprise about an estimated 930 vascular plant species and is blessed with a unique tropical rainforest canopy, comprised of a mixed flora with elements from Indian, Myanmarese, Malaysian, Indonesian and endemic floral species.

Tropical evergreen forests of Baratang Island are dominated by *Dipterocarpus spp., Artocarpus spp., Knema andamanica, Myristica spp. Dehaasia spp., Magnolia andamanica, Sageraea elliptica, Terminalia mannii Garcinia spp., Calophyllum spp. Elaeocarpus spp. Aglaia spp.* and *Polyalthia spp.* Semi evergreen forests are dominated *Dipterocarpus spp., Dillenia andamanica, Dysoxylum spp., Mangifera andamanica, Diospyros spp.* and *Sterculia spp.* and *Walsura spp.,* Moist deciduous forests are dominated by *Pterocarpus dalbergioides, Tetrameles nudiflora, Dipterocarpus spp., Terminalia spp., Sterculia spp., Lagerstroemia hypoleuca* and *Pterygota alata.* Dry deciduous forests are dominated by *Albizia spp., Adenanthera pavonina, Tectona grandis,* and *Lagerstroemia hypoleuca.* Mangroves comprise about 115km^2 in Baratang Island. Important mangrove species found in these islands include- *Rhizophora mucronata, Bruguiera gymnorrhiza, Avicennia officinalis, Heritiera littoralis, Sonneratia caseolaris, Exoecaria agallocha, Aegiceras corniculatum, Nypa fruticans etc.* Littoral forests are dominated by *Manilkara littoralis, Gyrocarpus americanus, Hibiscus tiliaceus, Thespesia populnea,* and *Barringtonia asiatica.*

Methodology

Sampling design for the study area

The plant resources were quantitatively assessed through 34 grids of size 3.25×3.25km, covering the whole terrain. The grids were stratified based on NDVI value 130 using remote sensed (IRS) datasets. The Survey of India toposheets with a scale of 1:50,000 and 1:25,000 were used for reference. Each toposheet of 1:50,000 scales encompass 16 grids and 1:25,000 scale toposheets, 4 grids. These grids are represented as north-west (NW1, NW2, NW3 and NW4), north-east (NE1, NE2, NE3 and NE4), south-west (SW1, SW2, SW3 and SW4) and south-east (SE1, SE2, SE3 and SE4).

A belt transect of 1000×5m was randomly laid in each grid with nylon ropes. Based on heterogeneity of the terrain, these transects were split into 2 sub-transects. A total of 36 transects were laid down and all the grids with their respective toposheet numbers, number of sub transects laid, dominant vegetation type, elevation range of representative location are tabulated (Table 1). The entire tree population of ≥30cm at 1.37 meter height (dbh) within transects were enumerated and voucher specimens were collected for species confirmation and herbarium sheets were deposited in the herbarium of S. K. University, Ananthapur (SKU).

Data analysis

Species diversity indices such as Shannon index for species diversity measurement $H' = -\Sigma [(ni/N)\log2(ni/N)]$, where: ni is the total number of individuals of i^{th} species and N is the total number of individuals of all species [6] and the Simpson index for measurement of dominance, i.e. $Cd = -\Sigma(ni/N)2$, where ni and N are the same as those for the Shannon–Weiner information function [7] were also computed as ecological measures to study natural ecosystems for assessment of diversity and relative dominance. To understand a species share in the tree community, the species importance value index [8] and family importance value index

[9] were calculated. The species area curves plated as species increment with every 0.5ha area. Cluster analysis was done to know the similarity in species composition among the different grids. Based on the girth recorded at diameter breast height (dbh), frequency distribution of the various girth classes *viz*., <30, 30-59, 60-89, 90-119, 120-149, 150-179, 180-209, 210-239, 240-269, 270-299 and >300cm of tree species was arrived and Kolmogorov- Smirnov test was done to know the level of significance [10] among the different sites.

Table 1. Stratified Grid ID, Community type, Location and elevation in Baratang Island

S. No.	Grid-ID	No. of Transects	Vegetation Type	Representative Location	Elevation Range MSL(m)
1	86D/12SE3P3	1	Mangrove	Lime-stone caves	7-12
2	86D/15SE2P1	1	Mangrove	Pawoji camp	4 -7
3	86D/15SE2P2	1	Semi evergreen	Pawoji camp	61-70
4	86D/15SW1P2	2	Mangrove	Gandhi jetty NW	25- 28
5	86D/15SW1P4	1	Mangrove	Gandhi jetty	6 -16
6	86D/15SW2P2	1	Semi evergreen	Flat Bay	20-48
7	86D/15SW2P3	1	Moist deciduous & Mangrove	way to Gandhi Jetty	3-63
8	86D/15SW2P4	1	Evergreen	Adezig	35-76
9	86D/15SW3P2	1	Mangrove	Gandhi Jetty NE	10 -52
10	86D/15SW4P1	1	Evergreen	way to Pawoji camp	60 -70
11	86D/15SW4P2	1	Semi evergreen	Adezig E	55- 70
12	86D/15SW4P3	1	Evergreen	Pawoji camp	19 - 43
13	86D/15SW4P4	1	Semi evergreen	Pawoji camp	6 -13
14	86D/16 NW2P2	1	Mangrove & Moist deciduous	Nilambur to Baludera	33- 50
15	86D/16NE1P2	1	Semi evergreen	Nilambur	45 -55
16	86D/16NW1P1	1	Semi evergreen	Flat Bay	51- 59
17	86D/16NW1P2	1	Littoral & Moist deciduous	Udayghar	10 -35
18	86D/16NW1P3	1	Moist deciduous	Flat Bay to Adezig	45- 50
19	86D/16NW1P4	1	Moist deciduous	Lorozig camp	66-70
20	86D/16NW2P1	1	Moist deciduous	Sundarghar	34- 64
21	86D/16NW2P3	1	Moist deciduous	South creek	32 -70
22	86D/16NW2P4	1	Moist deciduous	Baludera	28- 43
23	86D/16NW3P1	1	Moist deciduous	Lorozig E	13- 25
24	86D/16NW3P2	1	Moist deciduous	Sundarghar	38- 62
25	86D/16NW3P3	1	Semi evergreen	Pawoji camp south	30- 47
26	86D/16NW3P4	1	Semi evergreen	Nilambur	19- 44
27	86D/16NW4P1	1	Littoral & Moist deciduous	South creek	11- 69
28	86D/16NW4P2	1	Littoral & Moist deciduous	Baludera	15-37
29	86D/16NW4P3	1	Littoral & Moist deciduous	Lokrachang to Pawoji camp	14- 15
30	86D/16SW1P1	2	Moist deciduous	Jarawa creek	03- 20
31	86D/16SW1P2	1	Littoral & Moist deciduous	Jarawa creek	15- 31
32	86D/16SW1P3	1	Semi evergreen	Kokroco creek	5- 22
33	86D/16SW1P4	1	Littoral/Moist deciduous	Lime-stone caves	24- 26
34	86D/16SW3P1	1	Littoral	Lokrachang	4 - 6

Results and Discussion

Tree species richness

A total of 234 tree species (≥15cm DBH) representing 164 genera and 59 families were recorded in all the sampled units (34 grids). Of these, 234 are angiosperms and 2 are gymnosperms: *Cycas zeylanica and Podocarpus neriifolius.* The dominant family is Moraceae represented by 14 species, followed by Annonaceae and Phyllanthaceae (12 species each),

Anacardiaceae (10), Arecaceae, Rutaceae and Meliaceae (9 species each), Malvaceae-Sterculioideae (8), Fabaceae-Mimosoideae and Rubiaceae (7 species each), Combretaceae, Euphorbiaceae, Fabaceae-Faboideae and Myristicaceae (6 species each). Twenty two families are represented by single species.

The mean species richness in Baratang Island is 45±18.42 per 0.5ha with a range of 9-72 species (Table 2).

Table 2. Grid-wise Diversity, Quantitative Attributes in Baratang Island

S. No	Grid - ID	Species Richness	Density	Basal area (m^2ha^{-1})	Simpson Index	Shannon Index	EvennessIndex
1	86D/12SE3P3	17	361	5.85	0.7879	1.986	0.4286
2	86D/15SE2P1	12	317	4.67	0.834	2.035	0.6377
3	86D/15SE2P2	59	178	16.86	0.9748	3.856	0.8012
4	86D/15SW1P2	11	298	5.56	0.8314	2	0.6714
5	86D/15SW1P4	14	398	8.19	0.8493	2.162	0.6206
6	86D/15SW2P2	55	173	13.09	0.972	3.783	0.7994
7	86D/15SW2P3	44	241	44.32	0.933	3.286	0.6075
8	86D/15SW2P4	63	196	25.79	0.9761	3.917	0.7972
9	86D/15SW3P2	15	347	5.13	0.7822	1.885	0.4391
10	86D/15SW4P1	56	205	15.23	0.9734	3.806	0.8031
11	86D/15SW4P2	72	195	16.18	0.9771	4.007	0.7635
12	86D/15SW4P3	65	204	13.74	0.9745	3.908	0.7665
13	86D/15SW4P4	55	163	48.64	0.9737	3.813	0.8235
14	86D/16NE1P2	56	186	24.23	0.9754	3.844	0.834
15	86D/16NW1P1	53	163	39.92	0.9705	3.728	0.7849
16	86D/16NW1P2	55	253	19.18	0.9597	3.567	0.6439
17	86D/16NW1P3	59	201	30.28	0.9708	3.787	0.7477
18	86D/16NW1P4	52	184	24.91	0.9484	3.446	0.6031
19	86D/16NW2P1	35	207	16.18	0.9229	3.111	0.6412
20	86D/16NW2P2	42	261	19.72	0.9288	3.266	0.6239
21	86D/16NW2P3	67	317	14.67	0.9664	3.81	0.6741
22	86D/16NW2P4	59	314	32.79	0.9639	3.689	0.6782
23	86D/16NW3P1	61	212	35.57	0.9667	3.755	0.7006
24	86D/16NW3P2	60	170	20.31	0.9756	3.906	0.8285
25	86D/16NW3P3	57	169	31.18	0.9754	3.86	0.833
26	86D/16NW3P4	58	173	13.96	0.9739	3.819	0.7852
27	86D/16NW4P1	39	403	26.29	0.9025	2.9	0.466
28	86D/16NW4P2	46	341	17.65	0.9429	3.266	0.5696
29	86D/16NW4P3	36	338	14.38	0.9421	3.165	0.6582
30	86D/16SW1P1	42	353	30.90	0.9157	3.078	0.5168
31	86D/16SW1P2	25	325	14.06	0.92	2.808	0.6634
32	86D/16SW1P3	54	315	65.04	0.9608	3.575	0.6613
33	86D/16SW1P4	27	288	16.02	0.9276	2.949	0.7069
34	86D/16SW3P1	9	208	3.59	0.7502	1.603	0.5518

The species richness is maximum in one of the grid of Adezig E (86D/15SW4P2) followed by South creek area (86D/16NW2P3) and Pawoji camp (86D/15SW4P3). The lowest species richness (9) is recorded in Lokrachang (86D/16SW3P1). Of the 34 grids, 20 represent more than 45 species and 6 grids less than 20 species. The species richness trend among the grids indicate that the tree species richness varied according to the disturbance gradient in different grids and the top 10 species-rich grids are presented in figure 2.

Findings in the present study are comparable with the studies carried out in Andaman Islands and other forests of India. *K.P. Tripathi et al.* [11] have reported 25-61 species/ha in Saddle peak of North Andaman Islands and 58-59 species ha^{-1} in Great Andaman group by *H. Padalia et al.* [12]. *P. Rama Chandra Prasad et al.* [13] reported species richness of 39.5-54.28 per hectare in the North Andaman Islands. For two locations (Kalapahad and Macarthy Valley) in the Middle Andaman Island, *M. Rajkumar and N. Parthasarathy* [14] performed complete enumerations of tree species in continuous areas of one hectare, recording 68 and 75 species in

the two areas respectively. *S. Gupta and P. Rama Chandra Prasad* [15] have reported 87 species ha^{-1} in tropical moist deciduous forest and 94 species ha^{-1} in tropical evergreen forest in of the Middle Andaman Island. As may be expected, these figures are lower than those found elsewhere, for which records for a number of random quadrats have been combined. In mature continental tropical forest, the species richness range from 60 to 283 species/ha [16]. In Malay Peninsula of Southeast Asia, the highest richness recorded so for is 255 species in a hectare [17].

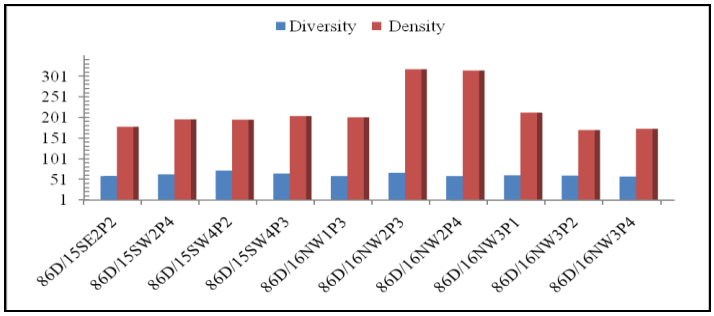

Fig. 2. Top Ten Diversified Grids of Baratang Island

In Southern Eastern Ghats of India *B. Rao et al.* [18] have reported 31-66 species per 0.5ha. *K. Kadavul and N. Parthasarathy* [19] and *C.V. Chittibabu and N.Parthasarathy* [20] recorded 42-47 and 26-56 tree species per ha, respectively in deciduous forests of the Kolli and Kalrayan hills in Tamil Nadu. *R. Sukumar et al.* [21] have reported 31 woody species from the Mudumalai tropical deciduous forests of Tamil Nadu, while *R. Sagar et al.* [22] reported 49 tree species in dry forests of the Vindhyan hill ranges in Northern India. Baratang Island has a lower number of species compared with similar forests in Amazonin Equator with 307 species [23]. In tropical evergreen forests of Chandoli National Park, northern Western Ghats the species richness varied from 25 to 57 per 0.5ha [24].

Diversity indices

The Simpsonindex of species dominance varied across Baratang Island. The mean±SD of Simpson index is 0.9294±0.063 with a range from 0.703 to 0.969 per 0.5ha (Table 2). The highest value 0.977 is observed in 86D/15SW4P2 (Adezig E) followed by 0.976 in 86D/15SW2P4 (Adezig). The high values for Simpson's index indicated high floristic richness of the forest. The lowest value in 0.750 in way to Lokrachang (86D/16SW3P1) followed by 0.782 in Gandhi Jetty NE (86D/15SW3P2). Similar observations were made by Rama Chandra *Prasad et al.*[13] in the North Andaman Island and Stutee Gupta and Rama Chandra Prasad [15] in the Middle Andaman, but the values were slightly higher in, *viz*., 86D/15SW4P2 (Adezig E) followed by 0.976 in 86D/15SW2P4 (Adezig). The Simpson's index in the present study (0.750 – 0.977) is towards the upper end of values reported in various dry deciduous forest of India: 0.67 to 2.09 [25-18] and evergreen forests of Western Ghats: 0.78 to 0.95 [26-27].

The Shannon index of species diversity varied across 34 grids. The mean±SD of the Shannon index is 3.275±0.708 with a range from 1.603 to 4.007 per 0.5ha (Table 2). The highest value 4.00 is observed in 86D/15SW4P2 (Adezig E) followed by 3.91 in 86D/15SW2P4 (Adezig). The lowest value is 1.60 in ways to Lokrachang (86D/16SW3P1) followed by 1.88 in Gandhi Jetty NE (86D/15SW3P2). The Shannon value is quite high compared to 2.20-2.62 for the forests of Kodayar in the Western Ghats of southern India [28]. More comparable values were reported from in southern Eastern Ghats of Andhra Pradesh with diversity index values of 3.96 [18] and Kalakad Reserved Forests (3.69) in Western Ghats [29].

The Evenness index varied across the study area. The mean±SD of the Evenness index is 0.680±0.114 and ranges from 0.833 in 86D/16NW3P3 (Pawoji camp south point) to 0.439 in 86D/15SW3P2 (Gandhi Jetty NE). The equitability ratio (E = 0.83) were high which indicate moderate representation of most of the species in the grid (Table 2).

Cluster Analysis

The dendrogram based on the distribution of tree species composition using Jaccard coefficient of similarity value of the 34 grids produced different distinct clusters (Fig. 3). The high species rich grids (86D/15SW2P4, 86D/15SW4P2, 86D/15SW4P3, 86D/16NW2P3 and 86D/16NW3P1) are held together and formed as one cluster. The low species rich grids form another cluster (86D/12SE3P3, 86D/15SE2P1, 86D/15SW1P2, 86D/15SW1P4, 86D/15SW3P2 and 86D/16SW3P1). This indicates more similarity among the high species rich grids and vice-versa among the low diversified grids.

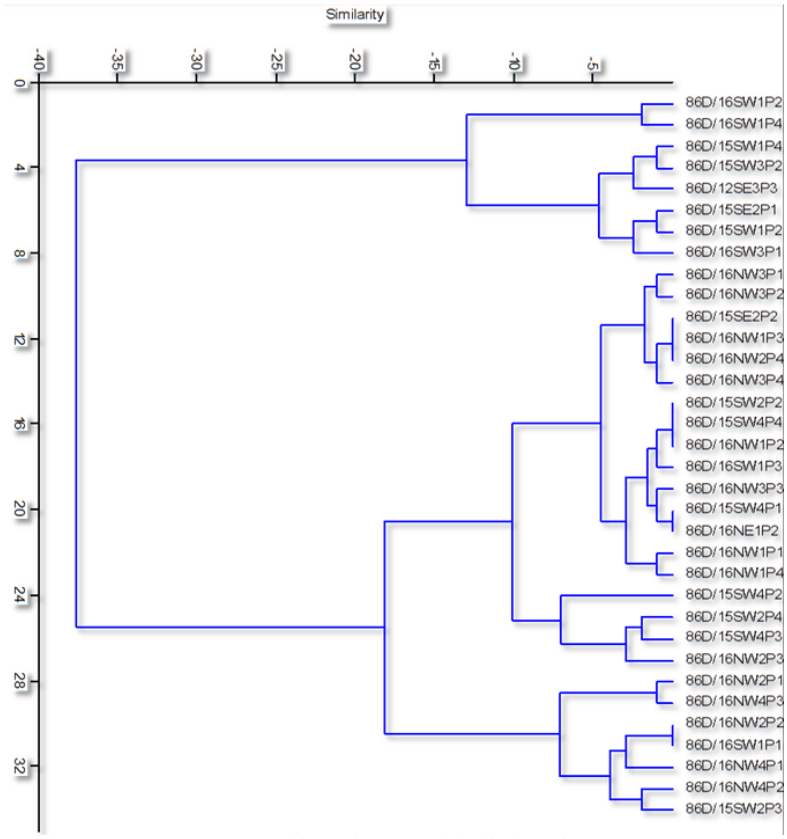

Fig. 3. Grid-Dendrogram of Similarity Index.

Species area curves

The species accumulation curve plotted between cumulative number of tree species and number of belt-transects revealed that for study site captured about 54% of species at the 4ha scale and about 80% at 9ha scale, and then it raised gradually with an addition of 1 to 2 species for every 0.5ha. The species-area curve showed an increase in species until it attained an asymptote around 16.5ha (Fig. 4**)** which indicates that the sampling was sufficient and more or less representative sample was collected by this sampling method.

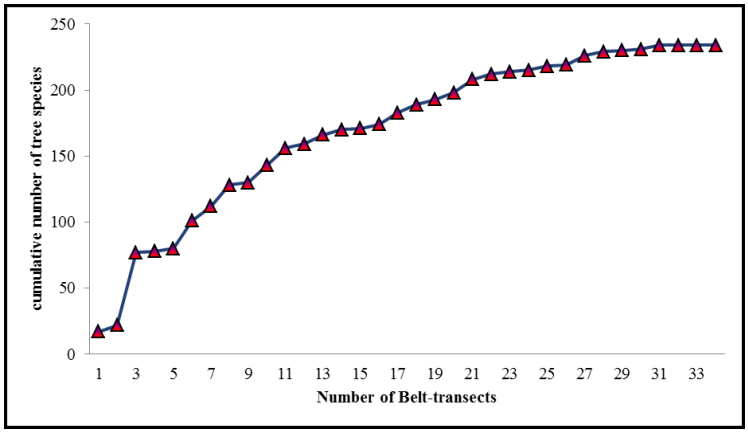

Fig. 4. Species- Area Curves 0f Trees in Baratang Island.

Tree density and stand basal area

A total of 8657 tree individuals are enumerated from 36 transects of 34 grids (**Table 2)**. The mean±SD of the density is 254.61±76.07 with a range from 162-403 per 0.5ha. South creek (86D/16NW4P1) has the highest stand density of 403 trees per 0.5ha. The lowest stand density of 162 trees per 0.5ha was recorded in 86D/16NW1P1 (Nilambur).

Ranges of tree density among the grids are 162-403 trees per 0.5ha. In general it is observed that tree density varied with forest type, forest age class, tree species and size class, site history, site condition and other factors. The tree density have reported to range from 870 to 976 trees/ha tropical forest of the Middle Andaman Island [15]. Studies in tropical forests of other parts of the world also reveal a wide range of densities of trees (>30cm dbh) ranging from 98 trees/ha in Panamanian equatorial insular forest [30] to 1720 trees/ha in Amazonian tropical rain forest [31].

The mean±SD basal area of the study area was 21.59±13.700m^2/ha and ranged as low as 3.587m^2/ha in 86D/16SW3P1 (Lokrachang) to as high as 65.037m^2/ha in 86D/16SW1P3 (Kokroco) (Table 2**).** The high annual precipitation rate and equable climate in the study area may have contributed to high tree growth rates and high tree basal area. *S. Gupta and P. Rama Chandra Prasad* [15] basal area have reported from 49.000 to 56.757m^2/ha tropical forest of Middle Andaman Island. The dominant families based on basal area are Fabaceae with 206.047m^2/ha followed by Hernandiaceae with 71.537m^2/ha, Datiscaceae with 62.807m^2/ha and Combretaceae with 48.347m^2/ha.

Species density

Evaluation of density-dependent status of species in a study site is important for conservation and management of forests. The population density of 234 tree species varied considerably across the 34 grids. *Rhizophora apiculata* was the most abundant species (9.41%, 822 stems) in the study area followed by *Bruguiera gymnorrhiza* (5.26%, 456 stems), *Rhizophora mucronata* (4.88%, 423 stems), *Pterocarpus dalbergioides* (4.87%, 422 stems), *Lagerstroemia hypoleuca* (4.03%, 349 stems) and *Avicennia marina* (2.85%, 247 stems). Whereas 07 species represents only single individual including *Canariumdenticulatum*, *Dalbergia pinnata, Drypetes andamanica*, *Ehretia laevis, Lysiloma latisiliquum, Magnolia champaca* and *Rinorea bengalensis* (Table 3). It is observed that the top ten abundant species have shared nearly 40% of the total density of the study area. The formation series, edaphic factors as well as annual rainfall are responsible for the difference in forest structure among various tropical dry deciduous forest formations.

Table 3. Quantitative Attributes of Trees in Baratang Island

S.No.	Name of the Species	TNI	BA	RDOM	RD	RF	IVI
1	*Pterocarpus dalbergioides*	422	205.482	27.991	4.875	1.827	34.693
2	*Rhizophora apiculata*	822	13.485	1.837	9.495	0.848	12.180
3	*Gyrocarpus americanus*	88	71.119	9.688	1.017	1.044	11.748
4	*Tetrameles nudiflora*	82	62.809	8.556	0.947	1.305	10.808
5	*Bruguiera gymnorrhiza*	456	21.284	2.899	5.267	0.783	8.950
6	*Lagerstroemia hypoleuca*	349	23.700	3.228	4.031	1.109	8.369
7	*Terminalia bialata*	160	24.949	3.399	1.848	1.761	7.008
8	*Bambusa schizostachyoides*	32	43.699	5.953	0.370	0.391	6.714
9	*Rhizophora mucronata*	423	5.603	0.763	4.886	0.522	6.171
10	*Parishia insignis*	112	21.373	2.912	1.294	1.370	5.575
11	*Pterygota alata*	171	11.245	1.532	1.975	1.827	5.334
12	*Terminalia procera*	140	15.433	2.102	1.617	1.566	5.285
13	*Dipterocarpus grandiflorus*	117	13.218	1.801	1.352	1.370	4.522
14	*Allophyllus cobbe*	114	12.284	1.673	1.317	1.109	4.099
15	*Canarium euphyllum*	67	12.917	1.760	0.774	1.500	4.034
16	*Pterospermum aceroides*	164	2.869	0.391	1.894	1.631	3.916
17	*Avicennia marina*	247	1.917	0.261	2.853	0.587	3.701
18	*Heritiera littoralis*	169	3.336	0.454	1.952	0.979	3.385
19	*Knema andamanica*	119	2.139	0.291	1.375	1.305	2.971
20	*Dillenia andamanica*	71	7.401	1.008	0.820	1.044	2.872
21	*Sterculia villosa*	88	3.259	0.444	1.017	1.370	2.830
22	*Phoenix paludosa*	174	1.021	0.139	2.010	0.587	2.736
23	*Lumnitzera littorea*	150	2.612	0.356	1.733	0.522	2.610
24	*Diospyros pyrrhocarpa*	109	2.068	0.282	1.259	1.044	2.585
25	*Lannea coromandelica*	64	3.943	0.537	0.739	1.109	2.385
26	*Syzygium samarangense*	67	7.223	0.984	0.774	0.587	2.345
27	*Pajanelia longifolia*	55	2.428	0.331	0.635	1.370	2.336
28	*Ceriops tagal*	141	1.157	0.158	1.629	0.522	2.308
29	*Pterocymbium tinctorium*	39	5.489	0.748	0.451	1.109	2.307
30	*Excoecaria agallocha*	118	2.018	0.275	1.363	0.652	2.290
31	*Sterculia campanulata*	64	4.797	0.653	0.739	0.848	2.241
32	*Diospyros pilosiuscula*	85	1.922	0.262	0.982	0.979	2.222
33	*Planchonia andamanica*	39	4.341	0.591	0.451	1.174	2.216
34	*Pandanus odorifer*	74	1.086	0.148	0.855	1.174	2.177
35	*Ficus hispida*	77	0.722	0.098	0.889	1.174	2.162
36	*Dipterocarpus gracilis*	37	5.964	0.812	0.427	0.913	2.153
37	*Artocarpus gomezianus*	38	5.665	0.772	0.439	0.913	2.124
38	*Diospyros kurzii*	66	1.257	0.171	0.762	1.109	2.043
39	*Goniothalamus macranthus*	62	1.160	0.158	0.716	1.109	1.983
40	*Caryota mitis*	55	1.522	0.207	0.635	1.109	1.952
41	*Artocarpus altilis*	38	3.974	0.541	0.439	0.913	1.894
42	*Buchanania splendens*	54	1.093	0.149	0.624	1.109	1.882
43	*Oroxylum indicum*	44	1.636	0.223	0.508	1.044	1.775
44	*Garcinia andamanica*	59	1.103	0.150	0.682	0.913	1.745
45	*Terminalia citrina*	40	3.668	0.500	0.462	0.783	1.745
46	*Dipterocarpus alatus*	39	3.165	0.431	0.451	0.848	1.730
47	*Elaeocarpus rugosus*	48	3.159	0.430	0.554	0.718	1.702
48	*Tabernaemontana alternifolia*	49	0.486	0.066	0.566	1.044	1.676
49	*Dipterocarpus kerrii*	27	2.818	0.384	0.312	0.979	1.674
50	*Pleiospermium alatum*	55	0.608	0.083	0.635	0.913	1.631
51	*Firmiana colorata*	42	1.521	0.207	0.485	0.913	1.606
52	*Avicennia officinalis*	73	2.730	0.372	0.843	0.326	1.541
53	*Bombax insigne*	36	2.946	0.401	0.416	0.718	1.535
54	*Miliusa globosa*	45	0.533	0.073	0.520	0.913	1.506
55	*Mimusops elengi*	45	1.207	0.164	0.520	0.718	1.402
56	*Garcinia xanthochymus*	40	1.012	0.138	0.462	0.783	1.383
57	*Diploknema butyracea*	16	2.921	0.398	0.185	0.783	1.366
58	*Evodia glabra*	42	0.300	0.041	0.485	0.783	1.309
59	*Myristica irya*	33	1.024	0.139	0.381	0.783	1.304
60	*Chukrasia tubularis*	25	2.495	0.340	0.289	0.652	1.281
61	*Mussaenda macrophylla*	39	0.434	0.059	0.451	0.718	1.227
62	*Albizia procera*	19	2.080	0.283	0.219	0.718	1.220
63	*Aglaia elaeagnoidea*	24	1.079	0.147	0.277	0.783	1.207
64	*Dillenia pentagyna*	27	1.298	0.177	0.312	0.718	1.206
65	*Grewia calophylla*	55	0.560	0.076	0.635	0.457	1.168
66	*Leea angulata*	30	0.167	0.023	0.347	0.783	1.152
67	*Baccaurea ramiflora*	28	1.009	0.137	0.323	0.652	1.113
68	*Albizia saman*	15	4.915	0.670	0.173	0.261	1.104
69	*Xylocarpus granatum*	40	1.819	0.248	0.462	0.391	1.101
70	*Semecarpus prainii*	19	0.343	0.047	0.219	0.783	1.049
71	*Litsea kurzii*	26	0.384	0.052	0.300	0.652	1.005

72	*Terminalia catappa*	33	1.583	0.216	0.381	0.391	0.988
73	*Adenanthera pavonina*	14	1.566	0.213	0.162	0.587	0.962
74	*Cleistanthus oblongifolius*	28	0.364	0.050	0.323	0.587	0.960
75	*Berrya cordifolia*	27	0.849	0.116	0.312	0.522	0.949
76	*Cratoxylum formosum*	31	1.344	0.183	0.358	0.391	0.933
77	*Dolichandrone spathacea*	39	0.647	0.088	0.451	0.391	0.930
78	*Trema tomentosa*	30	0.311	0.042	0.347	0.522	0.911
79	*Sterculia rubiginosa*	14	0.959	0.131	0.162	0.587	0.879
80	*Semecarpus kurzii*	22	0.499	0.068	0.254	0.522	0.844
81	*Rothmannia exaltata*	28	0.423	0.058	0.323	0.457	0.838
82	*Dasymaschalon dasymaschalum*	19	0.187	0.025	0.219	0.587	0.832
83	*Glochidion andamanicum*	30	0.431	0.059	0.347	0.391	0.797
84	*Fagraea racemosa*	19	0.357	0.049	0.219	0.522	0.790
85	*Murraya paniculata*	25	0.801	0.109	0.289	0.391	0.789
86	*Diospyros montana*	16	0.470	0.064	0.185	0.522	0.771
87	*Litsea glutinosa*	16	0.198	0.027	0.185	0.522	0.734
88	*Mallotus philippensis*	21	0.220	0.030	0.243	0.457	0.729
89	*Horsfieldia glabra*	18	0.455	0.062	0.208	0.457	0.727
90	*Diospyros undulata*	19	0.332	0.045	0.219	0.457	0.721
91	*Duabanga grandiflora*	12	1.310	0.178	0.139	0.391	0.708
92	*Sageraea elliptica*	20	0.591	0.080	0.231	0.391	0.703
93	*Elaeocarpus tectorius*	17	1.079	0.147	0.196	0.326	0.669
94	*Dracaena angustifolia*	11	0.141	0.019	0.127	0.522	0.668
95	*Pisonia umbellifera*	11	0.965	0.131	0.127	0.391	0.650
96	*Mangifera andamanica*	12	0.309	0.042	0.139	0.457	0.637
97	*Ficus callosa*	20	0.899	0.122	0.231	0.261	0.614
98	*Lepisanthes rubiginosa*	11	0.217	0.030	0.127	0.457	0.613
99	*Antidesma bhargavae*	16	0.185	0.025	0.185	0.391	0.602
100	*Garcinia cowa*	14	0.320	0.044	0.162	0.391	0.597
101	*Bruguiera cylindrica*	25	0.241	0.033	0.289	0.261	0.582
102	*Myristica andamanica*	13	0.275	0.037	0.150	0.391	0.579
103	*Briedelia tomentosa*	18	0.319	0.043	0.208	0.326	0.578
104	*Corypha umbraculifera*	13	1.502	0.205	0.150	0.196	0.550
105	*Albizia chinensis*	11	1.154	0.157	0.127	0.261	0.545
106	*Intsia bijuga*	16	1.164	0.159	0.185	0.196	0.539
107	*Sterculia parviflora*	21	0.670	0.091	0.243	0.196	0.530
108	*Psydrax dicoccos*	10	0.085	0.012	0.116	0.391	0.519
109	*Ailanthus excelsa*	11	0.463	0.063	0.127	0.326	0.516
110	*Vitex diversifolia*	12	0.376	0.051	0.139	0.326	0.516
111	*Hibiscus tiliaceus*	28	0.371	0.051	0.323	0.130	0.504
112	*Aporosa octandra*	15	0.384	0.052	0.173	0.261	0.487
113	*Planchonella obovata*	14	0.454	0.062	0.162	0.261	0.484
114	*Celtis philippensis*	12	0.140	0.019	0.139	0.326	0.484
115	*Trivalvaria costata*	12	0.124	0.017	0.139	0.326	0.482
116	*Goniothalamus malayanus*	15	0.280	0.038	0.173	0.261	0.472
117	*Manilkara littoralis*	9	1.223	0.167	0.104	0.196	0.466
118	*Mangifera sylvatica*	14	0.316	0.043	0.162	0.261	0.466
119	*Ficus rumphii*	8	0.773	0.105	0.092	0.261	0.459
120	*Macaranga peltata*	19	0.233	0.032	0.219	0.196	0.447
121	*Calophyllum inophyllum*	16	0.476	0.065	0.185	0.196	0.445
122	*Guettarda speciosa*	13	0.243	0.033	0.150	0.261	0.444
123	*Garcinia celebica*	15	0.384	0.052	0.173	0.196	0.421
124	*Annona muricata*	12	0.138	0.019	0.139	0.261	0.418
125	*Ficus benjamina*	11	0.154	0.021	0.127	0.261	0.409
126	*Cocos nucifera*	13	0.906	0.123	0.150	0.130	0.404
127	*Aphanamixis polystachya*	10	0.577	0.079	0.116	0.196	0.390
128	*Ganophyllum falcatum*	8	0.223	0.030	0.092	0.261	0.384
129	*Canthium glabrum*	9	0.122	0.017	0.104	0.261	0.382
130	*Ceiba pentandra*	10	0.932	0.127	0.116	0.130	0.373
131	*Neonauclea calycina*	11	0.347	0.047	0.127	0.196	0.370
132	*Leea asiatica*	13	0.094	0.013	0.150	0.196	0.359
133	*Aglaia silvestris*	9	0.382	0.052	0.104	0.196	0.352
134	*Champereia manillana*	6	0.115	0.016	0.069	0.261	0.346
135	*Sonneratia caseolaris*	15	0.281	0.038	0.173	0.130	0.342
136	*Fernandoa adenophylla*	6	0.078	0.011	0.069	0.261	0.341
137	*Mitragyna rotundifolia*	18	0.483	0.066	0.208	0.065	0.339
138	*Polyalthia crassa*	11	0.111	0.015	0.127	0.196	0.338
139	*Atalantia monophylla*	11	0.074	0.010	0.127	0.196	0.333
140	*Hernandia nymphaeifolia*	7	0.412	0.056	0.081	0.196	0.333
141	*Dendrolobium umbellatum*	10	0.123	0.017	0.116	0.196	0.328
142	*Hunteria zeylanica*	4	0.102	0.014	0.046	0.261	0.321
143	*Magnolia andamanica*	8	0.229	0.031	0.092	0.196	0.319
144	*Heynea trijuga*	11	0.434	0.059	0.127	0.130	0.317

145	*Antidesma montanum*	8	0.133	0.018	0.092	0.196	0.306
146	*Bombax ceiba*	7	0.214	0.029	0.081	0.196	0.306
147	*Nypa fruticans*	9	0.032	0.004	0.104	0.196	0.304
148	*Grewia heterotricha*	8	0.059	0.008	0.092	0.196	0.296
149	*Margaritaria indica*	7	0.097	0.013	0.081	0.196	0.290
150	*Azadirachta indica*	10	0.315	0.043	0.116	0.130	0.289
151	*Heteropanax fragrans*	6	0.167	0.023	0.069	0.196	0.288
152	*Xylocarpus moluccensis*	11	0.218	0.030	0.127	0.130	0.287
153	*Knema globularia*	7	0.532	0.072	0.081	0.130	0.284
154	*Streblus asper*	7	0.051	0.007	0.081	0.196	0.284
155	*Chionanthus parkinsonii*	6	0.117	0.016	0.069	0.196	0.281
156	*Gomphandra comosa*	6	0.097	0.013	0.069	0.196	0.278
157	*Sonneratia alba*	9	0.316	0.043	0.104	0.130	0.277
158	*Pemphis acidula*	11	0.141	0.019	0.127	0.130	0.277
159	*Barringtonia racemosa*	9	0.306	0.042	0.104	0.130	0.276
160	*Mangifera indica*	4	0.240	0.033	0.046	0.196	0.275
161	*Micromelum minutum*	6	0.057	0.008	0.069	0.196	0.273
162	*Alstonia kurzii*	8	0.364	0.050	0.092	0.130	0.272
163	*Cordia subcordata*	6	0.047	0.006	0.069	0.196	0.271
164	*Phoenix sylvestris*	5	0.074	0.010	0.058	0.196	0.264
165	*Albizia lebbeck*	4	0.556	0.076	0.046	0.130	0.252
166	*Orophea monosperma*	4	0.035	0.005	0.046	0.196	0.247
167	*Pongamia pinnata*	6	0.324	0.044	0.069	0.130	0.244
168	*Areca triandra*	8	0.086	0.012	0.092	0.130	0.235
169	*Thespesia populnea*	8	0.085	0.012	0.092	0.130	0.234
170	*Artocarpus heterophyllus*	5	0.265	0.036	0.058	0.130	0.224
171	*Aporosa villosa*	6	0.129	0.018	0.069	0.130	0.217
172	*Streblus taxoides*	12	0.094	0.013	0.139	0.065	0.217
173	*Orophea torulosa*	7	0.032	0.004	0.081	0.130	0.216
174	*Chydenanthus excelsus*	6	0.076	0.010	0.069	0.130	0.210
175	*Syzygium cumini*	5	0.134	0.018	0.058	0.130	0.206
176	*Aegle marmelos*	5	0.129	0.018	0.058	0.130	0.206
177	*Dracontomelon dao*	5	0.111	0.015	0.058	0.130	0.203
178	*Cerbera odollam*	5	0.083	0.011	0.058	0.130	0.200
179	*Ficus tinctoria subsp. gibbosa*	4	0.168	0.023	0.046	0.130	0.200
180	*Barringtonia asiatica*	5	0.081	0.011	0.058	0.130	0.199
181	*Dichapetalum gelonioides ssp. andamanicum*	5	0.063	0.009	0.058	0.130	0.197
182	*Ochna integerrima*	5	0.059	0.008	0.058	0.130	0.196
183	*Peltophorum pterocarpum*	4	0.141	0.019	0.046	0.130	0.196
184	*Ardisia humilis*	5	0.046	0.006	0.058	0.130	0.194
185	*Lumnitzera racemosa*	10	0.101	0.014	0.116	0.065	0.194
186	*Phyllochlamys spinosa*	5	0.028	0.004	0.058	0.130	0.192
187	*Cynometra iripa*	5	0.015	0.002	0.058	0.130	0.190
188	*Dehaasia kurzii*	4	0.048	0.006	0.046	0.130	0.183
189	*Aidia cochinchinensis*	4	0.018	0.002	0.046	0.130	0.179
190	*Podocarpus neriifolius*	2	0.153	0.021	0.023	0.130	0.174
191	*Borassus flabellifer*	6	0.289	0.039	0.069	0.065	0.174
192	*Carallia brachiata*	3	0.051	0.007	0.035	0.130	0.172
193	*Ailanthus triphysa*	3	0.025	0.003	0.035	0.130	0.168
194	*Horsfieldia irya*	5	0.133	0.018	0.058	0.065	0.141
195	*Dipterocarpus turbinatus*	2	0.366	0.050	0.023	0.065	0.138
196	*Archidendron clypearia*	2	0.358	0.049	0.023	0.065	0.137
197	*Cycas zeylanica*	5	0.103	0.014	0.058	0.065	0.137
198	*Glochidion zeylanicum var. tomentosum*	4	0.126	0.017	0.046	0.065	0.129
199	*Euphorbia trigona*	5	0.039	0.005	0.058	0.065	0.128
200	*Murraya koenigii*	5	0.038	0.005	0.058	0.065	0.128
201	*Syzygium claviflorum*	4	0.117	0.016	0.046	0.065	0.127
202	*Averrhoa carambola*	5	0.031	0.004	0.058	0.065	0.127
203	*Memecylon caeruleum*	4	0.055	0.007	0.046	0.065	0.119
204	*Drypetes assamica*	3	0.090	0.012	0.035	0.065	0.112
205	*Sandoricum koetjape*	2	0.160	0.022	0.023	0.065	0.110
206	*Ficus chartacea*	3	0.059	0.008	0.035	0.065	0.108
207	*Glochidion zeylanicum*	3	0.056	0.008	0.035	0.065	0.108
208	*Dillenia indica*	3	0.043	0.006	0.035	0.065	0.106
209	*Ficus fistulosa*	3	0.042	0.006	0.035	0.065	0.106
210	*Cordia dichotoma*	3	0.031	0.004	0.035	0.065	0.104
211	*Suregada multiflora*	3	0.030	0.004	0.035	0.065	0.104
212	*Macaranga andamanica*	3	0.028	0.004	0.035	0.065	0.104
213	*Orophea hexandra*	3	0.027	0.004	0.035	0.065	0.104
214	*Glycosmis pentaphylla*	3	0.015	0.002	0.035	0.065	0.102
215	*Drypetes longifolia*	2	0.092	0.013	0.023	0.065	0.101
216	*Spondias cytherea*	2	0.089	0.012	0.023	0.065	0.100

217	*Garuga pinnata*	2	0.088	0.012	0.023	0.065	0.100
218	*Canarium denticulatum*	2	0.078	0.011	0.023	0.065	0.099
219	*Dalbergia latifolia*	2	0.070	0.010	0.023	0.065	0.098
220	*Drypetes bhattacharyae*	2	0.046	0.006	0.023	0.065	0.095
221	*Ficus copiosa*	2	0.040	0.006	0.023	0.065	0.094
222	*Glochidion calocarpum*	2	0.035	0.005	0.023	0.065	0.093
223	*Caryota urens*	2	0.032	0.004	0.023	0.065	0.093
224	*Erythrina variegata*	2	0.028	0.004	0.023	0.065	0.092
225	*Cordia grandis*	2	0.020	0.003	0.023	0.065	0.091
226	*Senna sophera*	2	0.017	0.002	0.023	0.065	0.091
227	*Orophea polycarpa*	2	0.013	0.002	0.023	0.065	0.090
228	*Lysiloma latisiliquum*	1	0.056	0.008	0.012	0.065	0.084
229	*Dalbergia pinnata*	1	0.015	0.002	0.012	0.065	0.079
230	*Canarium denticulatum*	1	0.014	0.002	0.012	0.065	0.079
231	*Ehretia laevis*	1	0.011	0.002	0.012	0.065	0.078
232	*Magnolia champaca*	1	0.009	0.001	0.012	0.065	0.078
233	*Drypetes andamanica*	1	0.008	0.001	0.012	0.065	0.078
234	*Rinorea bengalensis*	1	0.008	0.001	0.012	0.065	0.078

Species-wise tree basal area

The highest basal area (Table 3) is recorded for *Pterocarpus dalbergioides* (205.48m^2/ha), followed by *Gyrocarpus americanus* (71.11m^2/ha), *Tetrameles nudiflora* (62.80m^2/ha), *Bambusa schizostachyoides* (43.69m^2/ha), *Terminalia bialata* (24.94m^2/ha), *Lagerstroemia hypoleuca* (23.70m^2/ha), *Parishia insignis* (21.37m^2/ha), *Bruguiera gymnorrhiza* (21.28m^2/ha), *Terminalia procera* (15.43m^2/ha) and *Rhizophora apiculata* (13.48m^2/ha). These ten species registered 68.56% of the total basal area of all the species. The lowest basal area was recorded for *Rinorea bengalensis* (0.008m^2/ha), followed by *Drypetes andamanica* (0.008m^2/ha), *Magnolia champaca* (0.009m^2/ha), *Ehretia laevis,* (0.011m^2/ha) and *Orophea polycarpa* (0.013m^2/ha).

Importance Value Index (IVI)

IVI isthe most important parameter used to understand the ecological significance of the species and community organization in relation to the competitive ability. Table 3 present the IVI calculated for the tree taxa encountered in the study area. *Pterocarpus dalbergioides* is the most dominant species (IVI=34.69; occupied 11.56% of the total tree species) followed by *Rhizophora apiculata* (12.08; 4.06%), *Gyrocarpus americanus* (11.74; 3.91%), *Tetrameles nudiflora* (10.80; 3.60%), *Bruguiera gymnorrhiza* (8.95; 2.98%), *Lagerstroemia hypoleuca* (8.66; 2.78%), *Terminalia bialata* (7.00; 2.33%), *Bambusa schizostachyoides* (6.71; 2.23%), *Rhizophora mucronata* (6.17; 2.05%) and *Parishia insignis* (5.57; 1.85%).

The IVI values revealed that Baratang Island is dominated by relatively few species. It is observed that the top ten dominant tree species have shared nearly 38% of the total IVI values of the study area. The higher value of IVI indicates that all the available resources are being utilized by these species and left over are being trapped by another species as competitors and associates. *Pterocarpus dalbergioides* showed maximum IVI value at all grids and emerged as dominant species of the dry deciduous forest ecosystem of the study area.

P.S. Roy et al. [32] reported the dominance of *Dipterocarpus griffithii* and *Artocarpus heterophyllum* in the TEG forest of the Bakulatala Range of the Middle Andaman Island. *Myristica* sp. was reported dominant in the unlogged forest of the Interview Islands, lying west of the Middle Andaman Island [33]. Similarly, *P. Rama Chandra Prasad et al.* [13] was reported the dominance of *Dipterocarpus gracilis* in the TEG forest and *Pterocarpus dalbergioides* in the TMD forest of the North Andaman Island. *Rajkumar and Parthasarathy* [14] from their studies in giant evergreen forests of Kalapahar and Macathy Valley in the MAI, also reported *Dipterocarpus* sp. as dominant. *S. Gupta and P. Rama Chandra Prasad* [15] identified *Myristica andamanica* as the most dominant species in evergreen forest, contributing high IVI (38.12) and *Pterocarpus dalbergioides* (IVI = 28.92) in moist deciduous forest in Middle Andaman Island.

Family Importance Value index (FIV)

The contribution of 56 plant families towards species diversity and density varied across the sampled sites. Fabaceae and Malvaceae represented by 17 species each, followed by Moraceae (15 species), Annonaceae and Phyllanthaceae (12 species each), Anacardiaceae (10), Arecaceae, Rutaceae and Meliaceae (9 species each), Rubiaceae (7), Combretaceae, Euphorbiaceae and Myristicaceae (6 species each).

Taking into consideration of FIV, Fabaceae appear more dominant. FIV is an independent of species richness but depends on high density of the species and its basal area. Although Fabaceae is represented by 17 species, but because of its large dbh (206.04m^2/ha) and high density (536 individuals) it ranked first with a high FIV of 43.161 (14.38%) followed by Rhizophoraceae 29.39 (9.79%), Malvaceae 23.65 (7.88), Combretaceae 15.30 (5.10%), Hernandiaceae 11.69 (3.89%), Anacardiaceae 11.68 (3.89%) Moraceae 11.55 (3.85%) and Tetramelaceae 9.93 (3.31%) (Table 4).

Table 4. Family-Wise Importance Value Index (FIV) in Baratang Island.

S. No.	Family	SR	TNI	BA	RDIV	RD	RDOM	FIV
1	Fabaceae	17	536	218.066	7.264	6.191	29.705	43.161
2	Rhizophoraceae	5	1867	41.769	2.137	21.566	5.690	29.393
3	Malvaceae	17	923	38.891	7.692	10.662	5.297	23.652
4	Combretaceae	6	533	48.346	2.564	6.157	6.586	15.307
5	Hernandiaceae	2	95	71.530	0.855	1.097	9.744	11.696
6	Anacardiaceae	10	308	28.316	4.274	3.558	3.857	11.689
7	Moraceae	15	275	14.455	6.410	3.177	1.969	11.556
8	Tetramelaceae	1	82	62.809	0.427	0.947	8.556	9.931
9	Lythraceae	4	384	24.437	1.709	4.436	3.329	9.474
10	Phyllanthaceae	12	180	3.456	4.256	1.256	0.553	8.569
11	Dipterocarpaceae	5	222	25.530	2.137	2.564	3.478	8.179
12	Annonaceae	12	212	3.230	5.128	2.449	0.440	8.017
13	Arecaceae	9	285	5.462	3.846	3.292	0.744	7.882
14	Poaceae	1	32	43.699	0.427	0.370	5.953	6.750
15	Meliaceae	9	142	7.479	3.846	1.640	1.019	6.505
16	Ebenaceae	5	295	6.049	2.137	3.408	0.824	6.368
17	Rutaceae	9	163	2.367	3.846	1.883	0.322	6.051
18	Myristicaceae	6	195	4.557	2.564	2.253	0.621	5.437
19	Euphorbiaceae	6	120	2.638	5.638	1.568	0.567	5.364
20	Acanthaceae	2	320	4.647	0.855	3.696	0.633	5.184
21	Sapindaceae	3	133	12.724	1.282	1.536	1.733	4.552
22	Rubiaceae	7	111	1.617	2.991	1.282	0.220	4.494
23	Burseraceae	4	72	13.097	1.709	0.832	1.784	4.325
24	Clusiaceae	5	144	3.295	2.137	1.663	0.449	4.249
25	Bignoniaceae	4	144	4.789	1.709	1.663	0.652	4.025
26	Dilleniaceae	3	101	8.743	1.282	1.167	1.191	3.640
27	Sapotaceae	4	84	5.805	1.709	0.970	0.791	3.471
28	Myrtaceae	3	76	7.473	1.282	0.878	1.018	3.178
29	Lecythidaceae	4	59	4.805	1.709	0.682	0.655	3.045
30	Apocynaceae	4	66	1.035	1.709	0.762	0.141	2.613
31	Elaeocarpaceae	2	65	4.237	0.855	0.751	0.577	2.183
32	Lauraceae	3	46	0.630	1.282	0.531	0.086	1.899
33	Putranjivaceae	4	55	1.299	0.362	1.277	0.213	1.431
34	Pandanaceae	1	74	1.086	0.427	0.855	0.148	1.430
35	Boraginaceae	3	11	0.097	1.282	0.127	0.013	1.422
36	Ulmaceae	3	42	0.451	0.855	0.485	0.061	1.401
37	Vitaceae	2	43	0.261	0.855	0.497	0.036	1.387
38	Simaroubaceae	3	14	0.487	0.855	0.162	0.066	1.083
39	Magnoliaceae	2	9	0.238	0.855	0.104	0.032	0.991
40	Hypericaceae	1	31	1.344	0.427	0.358	0.183	0.969
41	Gentianaceae	1	19	0.357	0.427	0.219	0.049	0.695
42	Nyctaginaceae	1	11	0.965	0.427	0.127	0.131	0.686
43	Lamiaceae	1	12	0.376	0.427	0.139	0.051	0.617
44	Asparagaceae	1	11	0.141	0.427	0.127	0.019	0.574

45	Araliaceae	1	6	0.167	0.427	0.069	0.023	0.519
46	Oleaceae	1	6	0.117	0.427	0.069	0.016	0.513
47	Opiliaceae	1	6	0.115	0.427	0.069	0.016	0.512
48	Stemonuraceae	1	6	0.097	0.427	0.069	0.013	0.510
49	Cycadaceae	1	5	0.103	0.427	0.058	0.014	0.499
50	Dichapetalaceae	1	5	0.063	0.427	0.058	0.009	0.494
51	Ochnaceae	1	5	0.059	0.427	0.058	0.008	0.493
52	Myrsinaceae	1	5	0.046	0.427	0.058	0.006	0.491
53	Oxalidaceae	1	5	0.031	0.427	0.058	0.004	0.489
54	Memecylaceae	1	4	0.055	0.427	0.046	0.007	0.481
55	Podocarpaceae	1	2	0.153	0.427	0.023	0.021	0.471
56	Violaceae	1	1	0.008	0.427	0.012	0.001	0.440
	Grand Total	**234**	**8657**	**734.1**	**100**	**100**	**100**	**300**

Moraceae, Annonaceae and Phyllanthaceae despite of their high species richness do not have high FIV value because of their lower density and lower basal areas. At the 1-ha scale, the family richness of different tropical forests varied greatly [34]. The FIV is 14 - 31 ha^{-1} in the six plots in low land rain forest of Mexico [35].

Six families Rhizophoraceae (1867 individuals comprising 21.56%) Malvaceae-Sterculioideae (730, 08.43%), Fabaceae (536, 6.19%) Combretaceae (533, 6.15% each), Lythraceae (360, 4.25%) and Acanthaceae (320, 4.10%) were abundant in terms of density; totaling to 50% of the forest stand. Similarly, based on the FIV, Myristicaceae (33.89) and Fabaceae (29.71) were found to be the dominant families in TEG and TMD forests respectively in Middle Andaman Island [15]. In the North Andaman Islands, *P. Rama Chandra Prasad et al*. [13] have reported that based on stem density Myristicaceae, Ebenaceae; genera wise Euphorbiaceae, Rubiaceae and species wise Euphorbiaceae (both the forests) dominated in TEG and TMD respectively. *H. Padalia et al.* [12] also reported maximum number of species in the Euphorbiaceae. It is therefore inferred that whereas, in spite of their proximity, forests in the two major island groups of the Andaman differ significantly in their structure and composition at the higher taxonomic level of classification and the MAI have more heterogeneous representation at higher levels.

Combretaceae, Euphorbiaceae, and Fabaceae constituted the predominant plant families by density in Nallamalais forest and Seshachalam hill ranges of Eastern Ghats, India [36-37]. Melastomataceae (22%), Oleaceae (26%) and Lauraceae (28%) formed bulk of the tree population in Kolli hills, Shervarayan hills of Eastern Ghats and Kalakad forest respectively [38]. Dominant tree species in Maraca Island, Brazilis *Peltogyne gracilipes* (Caesalpiniaceae) [39]. Dipterocarpaceae is the dominant family in Malaysia [17, 40].

Population Structure of forest stand

Tree species richness and stem density across girth classes in the study areas decreased from the smallest to high girth trees, while the occurrence rate of species increased with girth size-class >15cm to >300cm gbh(girth at breast height). Tree density and species richness consistently decreased with increasing girth class. An obvious variation in representation of tree species and the proportion of dominant species in the study area can directly be attributed to rainfall distribution and favorable edaphic conditions. The highest tree stand density and species richness of Baratang Island were found in the girth class of 30 to 59cm gbh and 60 to 89cm gbh.

The contribution of lower girth class size (30-59 cm gbh) tree density among the forest stands is 46.32% and basal area covers 8.02%. The density of medium girth class size (120-149cm gbh) covers 5.84% with a basal area of 9.72%. The high girth class size density (>300cm gbh) is 1.64% with a basal area of 40.18% was recorded. All the tree species of Baratang Island are distributed in various girth classes represent the reverse J shaped structure which indicates a good regeneration of tree species (Fig. 5).

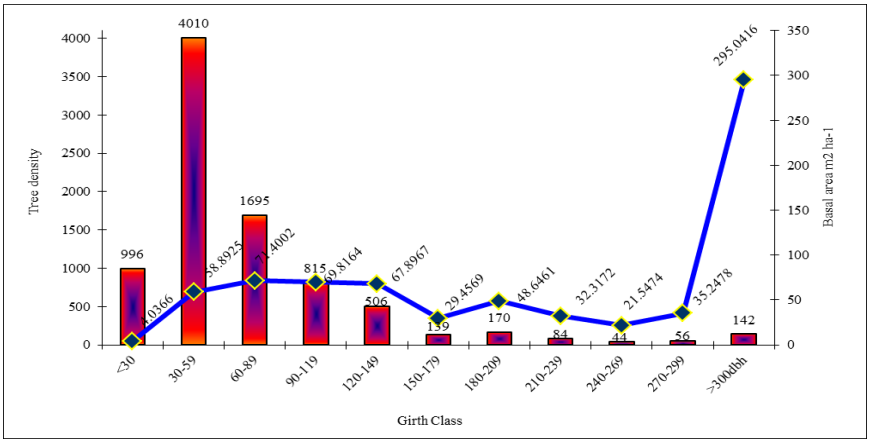

Fig. 5. Girth Class Distribution of Forest Stand in Baratang Island

J.S. Denslow [41] correlated basal area with the rate of disturbance, and diameter distributions are commonly used to assess the disturbance effect within forest. In general, in Indian forests subjected to selective felling in the past, high density of low girthed trees and single species dominance is observed [41]. The formation series, edaphic factors as well as annual rainfall are responsible for the difference in forest structure among various tropical forest formations. *B. Rao et al.* [18] reported the reverse J shaped structure for girth class distribution of species in different parts of southern Eastern Ghats of Andhra Pradesh.

Conclusions

From the present study, Andaman Islands in general and Baratang Island in particular are found still rich in tree species diversity, although great disturbance to the natural habitats in recent times. Although these unique forests contain good stands of commercially valuable trees, stocking is variable. With ever increasing human population in Baratang islands, pressure on forests for domestic needs, damage to forests in the form of selective felling and encroachment of forest land has increased substantially in recent times. In the light of high tree diversity effective conservation of Andaman group of islands, which is one of the centers of plant diversity and endemism in India is imminent. There is an urgent need to protect and preserve these important and fragile island forests.

Acknowledgement

The authors are grateful ~~thanks~~ to Department of biotechnology, New Delhi for financial assistance (BT/PR12954/NDB/52/146/2009) and Andaman Circle Forest officials for their help in field work. Thanks are also due to Prof.K.N.Ganeshaiah, Dr. M. Sanjappa, Dr. C. Murugan and other Principal Investigators of the project and Botanical Survey of India, Port Blair Office for providing facilities. We thank Dr. K. Prasad and Dr. M. Chennakesavulu Naik for their help in field work.

References

[1] * * *, ***Global Biodiversity Outlook 3***. Secretariat of the Convention on Biological Diversity, Montréal, 2010.

[2] J. Hansen, R. Ruedy, M. Sato, K. Lo, *Global surface temperature change,* **Reviews of Geophysics**, **48**, 2010, RG 4004, doi:10.1029/2010RG000345.

[3] * * *, **Report of the Eleventh Meeting of the Conference of the Parties to the Convention on Biological Diversity**, UNEP/CBD/COP/11, Eleventh Meeting Hyderabad, India, 8-19 October 2012. [Accessed on April 16, 2017]
[4] S. Oldfield, C. Lusty, A. Mackinven, **The World List of Threatened Trees,** vol**.** 1, World Conservation Press:, 1998, p. 650.
[5] N. Myers, R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, J. Kent, *Biodiversity hotspots for Conservation priorities,* **Nature, 403**, 2000, pp. 853-858.
[6] C.Z.Shannon, W. Weaver, **The Mathematical Theory of Communication.** Univ. Illionis Press, Urbana, 1963.
[7] E.H. Simpson, *Measurement of Diversit,* **Nature, 163**(4148), 1949, p. 688.
[8] J.T. Curtis, R.P. McIntosh, (1951). *The interrelationships of certain analytic and synthetic phytosociological characters*, **Ecology, 31**, 1950, pp.434 - 455.
[9] S.A.Mori, B.M. Boom, A.M. Carvalho, T.S. Dos Santos, *Southern Bahian moist forests*, **Botanical Review, 49**(2), 1983, pp.155-232.
[10] Z.H. Jerrold, **Biostatistical Analysis**. Fouth edition, Pearson Education, London, 1999.
[11] K.P.Tripathi, S.Tripathi, T.Selven, K. Kumar, K.K.Singh, (2004). *Community structure and species diversity of Saddle Peak forests in Andaman Island*, **Tropical Ecology,** 45, 2004, pp. 241-250.
[12] H. Padalia, N. Chauhan, M.C. Portal, P.S. Roy, *Phytosociological observations on tree species diversity of Andaman Islands*, *India*, **Current Science***,* **87,** 2004, pp. 799-806.
[13] P. Rama Chandra Prasad, C. Sudhakar Reddy, C.B.S. Dutt, *Phyto-diversity assessment of tropical rainforest of North Andaman Islands, India,* **Research Journal of Forestry**, 1(1), 2007, pp. 27–39.
[14] M. Rajkumar, N. Parthasarathy, *Tree Diversity and Structure of Andaman Giant Evergreen Forests, India*. **Taiwania, 53**, 2008, pp. 356-368.
[15] S. Gupta, P. Rama Chandra Prasad, *Analysis of Tree Diversity Patterns in the Tropical Evergreen and Moist Deciduous Forests of the Middle Andaman Islands*, **India Journal Biodiversity Management and Forestry***,* **2**(3), 2013, p.114. *doi:10.4172/2327-4417.1000114.*
[16] O.L. Phillips, P. Hall, A.H. Gentry, S.A. Sawyer, R. Vásquez, *Dynamics and species richness of tropical rain forests*. **Proceedings National Academy of Sciences USA, 91**, 1994, p. 2805–2809.
[17] T.C. Whitmore, **Tropical Rain Forests of the Far East**, Second edition. Oxford University Press. Oxford, 1984, p. 352.
[18] B. Ravi Prasad Rao, M.V. Suresh Babu, V. Srinivasa Rao, S. Sunitha, K.N. Ganeshaiah, *Are sacred groves better managed than natural forest?* **Tropical Ecology**, **52**(1), 2011, pp.79-90.
[19] K. Kadavul, N. Parthasarathy, *Plant diversity and conservation of tropical semi-evergreen forest in the Shervarayan hills of Eastern Ghats, India,* **Tropical Ecology**, **40**, 1999, pp.247-260.
[20] C.V. Chittibabu, N. Parthasarathy, *Attenuated tree species diversity in humanimpacted tropical evergreen forest sites at Kolli hills, Eastern Ghats, India,* **Biodiversity and Conservation, 9**, 2000, pp. 1493-1519.
[21] R. Sukumar, H.S. Dattaraja, H.S. Suresh, N.V. Joshi, *Long- time monitoring of vegetation in tropical deciduous forest in Mudumalai, southern India,* **Current Science, 62**, 1992, pp. 608-616.
[22] R. Sagar, A.S. Raghubanshi, J.S. Singh, *Tree species composition, dispersion, and diversity along a disturbance gradient in a dry tropical forest region of India*. **Forest Ecology and Management, 186**, 2003, pp. 61-71.

[23] A. Alemnew, D. Teketay, Y. Yemshaw, S. Edwards, *Diversity and status of regeneration of woody plants on the peninsula of Zegie, northwestern Ethiopia,* **Tropical Ecology**, **48**(1), 2007, pp. 37- 49.

[24] R. Kanade, M. Tadwalkar, C. Kushalappa, A. Patwardhan, *Vegetation omposition and woody species diversity at Chandoli National Park, northern WesternGhats, India.* **Current Science, 95**(5), 2008, pp. 637-646.

[25] C. Pitchairamu, K. Muthuchelian, N. Siva, *Floristic inventory and Quantitative vegegation analysis of Tropical Dry Deciduous forest in Piranmalai Forest, Eastern Ghats, Tamil Nadu,* **Ethnobotanical Leaflets, 12,** 2008 pp. 204-216.

[26] C. Elouard, J.P. Pascal, R. Pelissier, F. Houllier, M. Durand, S. Arajay, M.A. Monitoring, C. Gimaret Carpentier, *Monitoring the structure and dynamics of a dense moist evegreen forest in the Western Ghats,* **Tropical Ecology, 38**, 1997, pp. 193-214.

[27] B.K. Vasanthraj, K.R. Chandrashekar, *Analysis of the structure of Charmady reserve forest,* **Tropical Ecology**, **47**(2), 2006, pp. 279-290.

[28] S.M. Sundarapandian, P.S. Swamy, *Forest ecosystem structure and composition along an altitudinal gradient in the Western Ghats, South India,* **Journal of Tropical Forest Science, 12,** 2000, pp.104-123.

[29] N. Parthasarathy, V. Kinhal, L.P. Kumar, *Plant species diversity and human impacts in the tropical wet evergreen forest of Southern Western Ghats,* **Indo-French Workshop on Tropical Forest Ecosystems: Natural Functioning and Anthropogenic Impact, French Institute,** Pondicherry,1992.

[30] S. Itow, *Species diversity of equatorial insular forest on Ponape and Kosrae, Micronesia.* **Ecological Research, 1,** 1986, pp. 223-227.

[31] D.G. Campbell, J.L. Stone, A. Rosas Jr, *A comparison of the phytosociology and dynamics of three floodplain (Varzea) forest of known ages, Rio Jurua, western Brazilian Amazon,* **Botanical Journal of the Linnean Society, 108**, 1992, pp. 231-237.

[32] P.S. Roy, Singh Sarnam, M.C. Porwal, *Characterization of Ecological parameters in Tropical forest community - A Remote Sensing approach*, **Journal of Indian Society of Remote Sensing**, **21**(30), 1993, pp.127-149.

[33] R. Ali, *The effect of introduced herbivores on vegetation in the Andaman Islands*, **Current Science,** 86, 2004, pp. 1103-1112.

[34] A. Heaney, J. Proctor, *Preliminary studies of forest structure and floristic on Volcan Barva, Costa Rica,* **Journal Tropical Ecology, 6**, 1990, pp. 307-320.

[35] F. Bongers, D. Engelen, H. Klinge, *Phytomass structure of natural plant communities on spodosols in southern Venezuela: the Bana woodland*, **Vegetation**, **63**, 1985, pp. 13-34.

[36] S. Khadar Basha, *Diversity, Quantification and Conservation of Tree Resources of Nallamalais, Andhra Pradesh*, **Ph.D. Thesis,** Sri Krishnadevaraya University, Anantapur, 2009.

[37] M.V. Suresh Babu, *Plant Biodiversity Assessment of Seshachalam Hill Ranges, Andhra Pradesh, India***, Ph.D. Thesis**. Sri Krishnadevaraya University, Anantapur, 2010.

[38] N. Parthasarathy, *Tree diversity and distribution in undisturbed and human- impacted sites of tropical wet evergreen forest in Southern Western Ghats, India*, **Biodiversity and Conservation**, **8**, 1999, pp.1365-1381.

[39] M.T. Nascimento, J. Proctor, W.A. Haber, *Forest structure, floristic composition of Neotropical cloud forest, Monte Verde, Costa Rica*, **Journal of Tropical Ecology**, **11**, 1997, pp**.** 481- 495.

[40] N. Manokaran, J.V. La Frankie Jr, R. Ismail, *Structure and composition of the Dipterocarpaceae in a lowland rain forest in peninsular Malaysia*, **Proceedings of the Fourth Round Table Conference of Dipterocarps**, (Editors: I. Soerianegara, S.S. Rjitrosomo, R.C. Umaly and I. Umboh), 1991, pp. 317-331.

[41] J.S. Denslow, *Disturbance and diversity in tropical rain forest: the density effect*, **Ecological Applications, 5**, 1995, pp. 962-968.
[42] R. Sagar, J.S. Singh, *Structure, diversity and regeneration of tropical dry deciduous forest of northern India*, **Biodiversity and Conservation, 14**, 2005, pp. 935-959.

Received: February 08, 2018
Accepted: October 28, 2018