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Phytosociological study of plant species in three tropical dry deciduous forests of Birbhum District, West Bengal, India

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Key words: Phytosociological study, IVI, Dry deciduous forests, Conservation status, Birbhum district.

Abstract

Birbhum district of West Bengal, India harbours floristically important Northern Tropical Dry Deciduous forests and is quite enrich with phytodiversity. But no quantitative analysis of forest structure, its phytosociology and status of the plant species has been carried out in the forest areas of Birbhum district. In this scenario, an attempt has been made to analyze the vegetation structure, composition and diversity of plant species in three forest areas of the district (Illambazar, Chorchor and Ganpur) following standard ecological methods. The importance value index (IVI) of total 486 tree individuals belonging to 20 species has been determined.*Shorearobusta* Gaertn. f. is the dominant tree species showed maximum IVI value in each three forest areas. *Madhuca longifolia* (Koenig) Macbride and *Buchanania lanzan* Spreng. have been identified as the next dominant species in the forest areas. The IVI values of rest 17 tree species were found unsatisfactory. Diameter class of the tree species ranged from 05-10 cm. Here, the Shannon- Weiner index (H') ranged from 0.11- 0.48 in Illambazar forest, 0.08-0.50 in Chorchor forest and 0.18-0.95 in Ganpur forest. In Chorchor and Ganpur forests, the density distribution pattern of tree species showed a typical reverse J-shaped curve and in Illambazar forest, it was found as A-shaped curve. Ground vegetation comprises of species of 6 shrubs, 8 herbs and 12 climbers and saplings of 9 species. This study will provide the baseline information for effective conservation of phytoresources of these three forest areas of Birbhum district.

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Introduction

Tropical and subtropical forests are often referred to as one of the most species-diverse terrestrial ecosystems. Their immense biodiversity generates a variety of natural resources which help to sustain the livelihood of local communities. However, many tropical forests are under great anthropogenic pressure and require proper management measures to maintain the overall biodiversity, productivity and sustainability. Most of these forests are disappearing at alarming rate owing to deforestation for extraction of timber and other forest products (Murphy and Lugo, 1986a; Hare *et al.,* 1997; Raghubanshi and Tripathi, 2009). Murphy and Lugo (1986b) further argued that seasonally dry deciduous forests are the most disturbed and least protected ecosystems on the earth.

Trees form the major structural and functional basis of tropical forest ecosystems (Misra, 1968). Quantitative analysis on tree species diversity in forest ecosystem provides a clear understanding about its floristic status and distribution pattern which ultimately help in conservation and management of biodiversity of the forest ecosystem. Many works have been carried out to understand the vegetation characteristics and its diversity of the tropical forests of India and also other parts of the world (Sahu*et al*., 2012; Murali*et al*., 2003; Hare *et al*., 1997). In this respect, the state of West Bengal in India is remained largely unstudied except a few reports. Bhattacharyaa *et al*. (2003) tried to reconstruct modern vegetation changes in lateritic zone of West Bengal using pollen analysis. Gupta Joshi (2012) gave a very preliminary report on phytosociology of forests in the red laterite zone of West Bengal. Kushwaha and Nandy (2012) studied the community structure and species diversity of two different rainfall regimes of the state West Bengal. A phytosociological study of sacred grove vegetation made from eastern lateritic part of India which includes the district Birbhum also (Manna *et al*., 2013). It has been found that such type of studies poorly explore the phytosociological aspects in the laterite part of West Bengal as well as district Birbhum and those studies are not quite adequate for clear understanding of the forest structure of this zone of West Bengal.

In this scenario, an attempt has been made to analyze the vegetation structure, composition and diversity of dry deciduous forest of the Birbhum district which will help in management and conservation of forest vegetation of this district in future.

Materials and methods

Study area

Birbhum district lies between 23°32'30" and 24°35'00" North latitude and 88°01'40" and 87°05'25" East longitude. The district is a part of lateritic zone of West Bengal. Forest vegetation of Birbhum district as a whole is of Tropical Dry Deciduous type (Champion and Seth, 1968) with a few representative of the evergreen tree species occurring here and there. Total forest area of the Birbhum district is about 159.26 sq km.Many of the forest plants are used as non-timber forest products by tribal people of the district (Rahaman *et al.,* 2008, 2009, 2011). Mainly three forest areas are found in Birbhum district namely Illambazar forest, Chorchor forest and Ganpur forest (Fig.1). Illambazar forest is situated between 23°38′12.5″-25°59′05.3″ latitude and 087°28′49.7″ - 087°35′26.6″ longitude at the elevation of 82.91- 83.51m. Chorchor forest is situated between 24°00′13.00″- 25°59′05.3″ latitude and 087°28′48.2″ - 087°31′00.3″ longitude at the elevation of 113.99 – 141.42 m and Ganpur forest situated between 24°04′37.0″ - 24°04′37.5″ latitude and 087°40′59.1″-087°41′004″ longitude at the elevation 59.74–164.89 m.

Phytosociological studies were carried out during 2010-12 by laying random quadrates (10 m×10 m for trees, 5 m×5 m for shrubs, climbers, twiners and 1m × 1m for herbs and seedlings) in different sites of the forests of Illambazar, Chorchor and Ganpur. The quadrates for shrubs and herbs were nested inside the bigger quadrates for trees. A total of 0.3 ha forest area was sampled (Illambazar - 0.1 ha, Chorchor forest-0.1

ha, Ganpur forest - 0.1 ha). Structural parameters like frequency, density and basal area have been calculated following standard methodologies (Curtis and McIntosh, 1950).

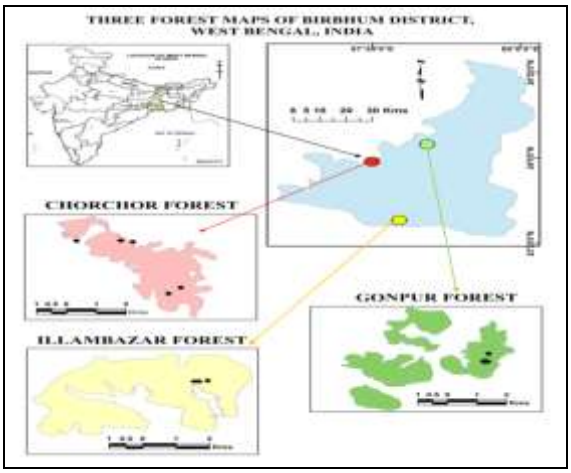

Fig. 1. Forest areas of Birbhum district.

Field sampling

The spatial location (latitude, longitude and altitude) of each quadrate was recorded using a Global Positioning System (GPS). Emphasis has been given to cover different aspects like elevation, rainfall and temperature gradients of the study areas to study overall spectrum of tree species diversity.

Data analysis

The vegetation data recorded from three forest areas were quantitatively analyzed for tree species. To determine the vegetation structure, analytical characters such as frequency, density and basal area were computed for each species in each forest area following standard methods (Curtis and McIntosh, 1950). The Importance value index (IVI) for tree species was calculated by summing up the values of relative frequency, relative density and relative dominance (Curtis, 1959; Mishra, 1968). Population structure of tree species was analyzed across the fixed girth classes. A species area curve was plotted using the new species encountered in each of the subsequent 10m × 10m quadrates measured in terms of hectare for three different forest areas. Density distribution was studied by determining the number of individuals in different size classes starting from 0 – 5 cm to 20 – 25 cm. Diversity index reflects the manner in which abundance is distributed among the different species constituting the community. Species diversity index (H′) was determined for each forest areas from the Shannon-Wiener's information function (Shannon and Weaver, 1963).

Basal area (m^2) = Area occupied at breast height (1.3 m)

Relative density = (Density of the species/Total density of all species) × 100.

Relative frequency =(Frequency of the species /Total frequency of all species) × 100.

Relative dominance =(Basal area of the species/Total basal area for all species) × 100.

Importance Value Index (IVI) = Sum of relative density+ relative frequency + relative dominance.

Species diversity index ($H^/$) was determined by the formula:

$H' = -\Sigma [(ni/N) \log_2 (ni/N)]$

Where, ni= IVI of individual species in that vegetation type, N = IVI of all species

Results and discussion

Floristic composition

A total of 65 species have been recorded from three forest sites which belong to 36 families and 64 genera. Considering individual site it was found that a total of 39 species belonging to 23 families 38 genera accumulated in Illambazar forest (Fig. 2). 34 plant species have been recorded from Chorchor forest belonging to 29 families and 33 genera (Fig. 3). From Ganpur forest, 26 plant species have been recorded that belong to 20 families, 24 genera (Fig. 4).

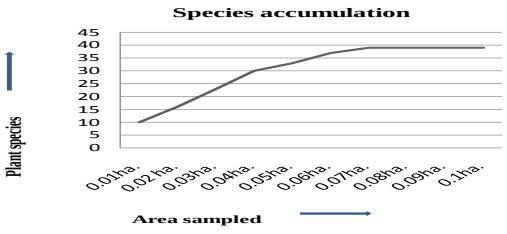

Fig. 2. Species area curve for Illambazar forest.

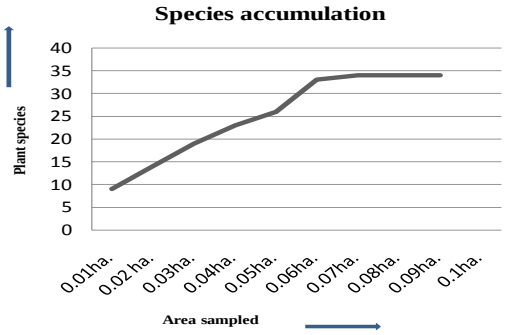

Fig. 3. Species area curve for Chorchor forest.

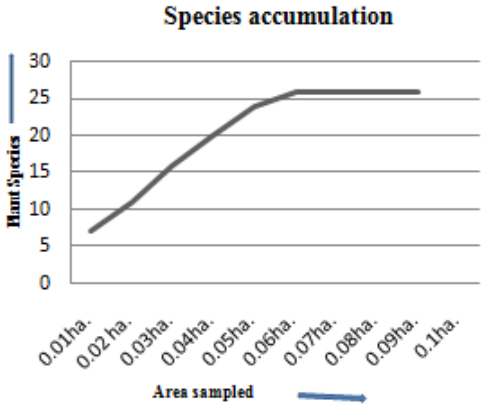

Fig. 4. Species area curve for Ganpur forest.

From the species area curve of all the three sites it is found that with the increasing sampled area the accumulation of species increased means that the tropical deciduous forest are rich with plant diversity. In other tropical dry deciduous forest of India it is also found that large sampled area showing large number of species. Altogether 57 species recorded in the dry deciduous forests of Eastern Ghats (Sahu *et al.*, 2012), 93 species recorded in Rajasthan (Kumar *et al.*, 2010) and 46-133 species were recorded in Karnataka (Sukumar*et al.*, 1992; Murali *et al.*, 2003; Krishnamurthy *et al.*, 2010).

IVI of tree species

The IVI (Importance value index) of 20 tree species have been done in all three forest areas of the district and it has been found that *S. Robusta* Gaertn. f. is dominant tree species having maximum IVI value in each three forest areas like 208.5 in Ganpur forest, 158.60 in Illambazar forest and 144.67 in Chorchor forest (Table 1). *Madhuca longifolia* (Koenig) Macbride and *Buchanania lanzan* Spreng. have been identified as the next dominant species with their IVI values of 31.01- 53.14 and 26.79 -79, respectively (Table1). The IVI value for rest 17 tree species ranges from 2.84 -24.97 which highlights their poor status in all those three forest areas studied. It has been observed that the frequency, density and growth of those 17 tree species are not satisfactory in the forest areas. The tree species with very poor IVI value (2.84 - 24.97) are *Careya arborea* Roxb., *Flacourtia jungomas* Raeusch., *Lannea coromandelica* (Houtt.) Merrill. *Semecarpus anacardium* L.f., *Terminalia bellirica* (Gaertn.) Roxb., *Morinda citrifolia* L., *Oroxylum indicum* L., etc.

Table 1. IVI value for tree species in three forest areas.

Name of the tree species	IVI (Illambazar forest)	IVI (Chorchor forest)	IVI (Ganpur forest)
Shorea robusta Gaertn.f.	158.60	144.67	208.5
Madhuca longifolia (Koenig) Macbride	53.14	6.34	31.01
Buchnania lanzan Spreng.	26.09	79	9.88
Soymida febrifuga (Roxb.) A. Juss.	4.26	8.66	14.34
Lannea coromandelica (Houtt.) Merr.	19.98	X	X
Semecarpus anacardium L.f.	9.08	24.97	4.841
Holarrhena antidysenterica Wall. ex G.Don.	12.49	X	X
Careya arborea Roxb.	6.43	X	X
Azadirachta indica A. Juss.	2.92	X	X
Flacourtia jangomas Raeusch.	2.92	X	X
Acacia auriculiformis A. Cunn. ex Benth.	2.84	3.93	X
Diospyros melanoxylon Roxb.	X	23.66	X
Dillenia pentagyna Roxb.	X	4.22	X
Streblus asper	X	3.93	X

Name of the tree species	IVI (Illambazar forest)	IVI (Chorchor forest)	IVI (Ganpur forest)
Lour.			
Terminalia bellirica (Gaertn.) Roxb.	X	X	11.83
Morinda citrifolia L.	X	X	4.92
Terminalia cuneata Roth.	X	X	4.84
Oroxylum indicum (L.) Vent.	X	X	4.7
Anacardium occidentale L.	X	X	5.18
Pterocarpus marsupium Roxb.	4.84	X	X

X= Not found in the sampled areas.

Vegetation structure and tree species diversity index

Average tree density is low in Chorchor forest (**549.52** N ha-1) as compared to Illambazar (**979.65** N ha^{-1}) and Ganpur (**873.345** N ha^{-1}) (Table 2). Mean tree density of 276 – 980 stems ha-1 has been reported from other tropical dry forests of India with preferred diameter classes ranging from 20 – 50 cm and above (Sahu *et al.*, 2007, 2012; Bhadra *et al.*, 2010; Krishnamurthy *et al.*, 2010; Kumar *et al.*, 2010). Total 486 tree individuals of 20 species were enumerated in three study sites covering the area of 0.3 ha. It is found that only 24 out of total 486 individuals in all three forest sites exceeded 20 cm diameter. The diameter class of most of the tree species ranges from 05 - 10 cm in all the study sites. In Illambazar forest 30 number of stems recorded with 05 - 10 cm diameter. In Chorchor forest, number of stems with same diameter (05 -10 cm) recorded is 89. The number of tree individuals of similar diameter recorded from Ganpur forest is 93. Such a higher density of smaller sized tree individuals observed in two forest areas of the district highlights the lower age of the trees and regenerating type of forest (Gupta Joshi, 2012).

The basal area of tree species was found variable among three forest areas studied. In Illambazar forest, total basal area of tree species is 33.21899 m^2ha^{-1}. It is 8.859118m^2ha^{-1} in Chorchor forest and 10.962 m^2ha^{-1} in Ganpur forest. The basal area values of this study are similar to those values reported earlier for dry deciduous forests of western India (5.9 to 19.31m^2ha^{-1}) and are also comparable with the values for dry forests recorded from the regions other than India, 17 to 40 m^2ha^{-1} (Murphy and Lugo, 1986b).

Table 2. Population size and tree diversity in three forest areas.

Parameter	Illambazar forest	Chorchor forest	Ganpur forest
Number of families	8	8	7
Number of species	11	9	10
Tree density (no ha^{-1})	979.65	549.52	873.345
Total basal area (m^2ha^{-1})	33.21899	8.859118	10.962

The diversity index is generally higher for tropical forests. For Indian forests the diversity index ranges from 0.8 to 4.1 (Parthasarthy *et al.*, 1992; Visalakshi, 1995). In present study, the Shannon-Weiner index (H') ranges from 0.11- 0.48 in Illambazar forest, 0.08- 0.50 in Chorchor forest and 0.18 - 0.95 in Ganpur forest. Thus, the diversity value (Shannon-Weiner index) of tree species obtained here in the present study is nearer to the lower range of diversity value reported from the Indian tropical forests. As compare to the other tropical forests, this low species diversity value of all three forest areas in the district Birbhum may be due to extraction of timber and non-timber forest products, and some other anthro-pogenic activities (Singh *et al.*, 1985; Rasingam and Parthasarathy, 2009; Shukla, 2009; Tripathi and Singh, 2009; Krishnamurthy *et al.*, 2010; Sahu *et al.*, 2012).

Density distribution pattern of tree species in the three sites

The diameter density distribution of trees across different density classes have been recorded in all three forest sites. In Chorchor forest and Ganpur forest, diameter density distribution pattern of tree

species reveals a typical reverse J-shaped curve (Fig. 6 and Fig.7) which indicates that these two forest areas are of regenerating nature with an evolving or expanding population. Such type of reverse J-shaped distribution curve has been observed in other tropical dry forests from India like Eastern Ghats, Karnataka (Krishnamurthy *et al.,* 2010; Sahu *et al.*, 2012). In Illambazar forest, slightly A-shaped curve was found (Fig.5) indicating it as nearly mature type of forest. In some other tropical deciduous forests like forests of Western and Southern India, A-shaped density distribution curve suggested the medium age of the respective forests (Vishalakshi, 1995; Parthasarthy and Sethi, 1997; Ayyappan and Parthasarathy, 1999; Kumar *et al.*, 2010).

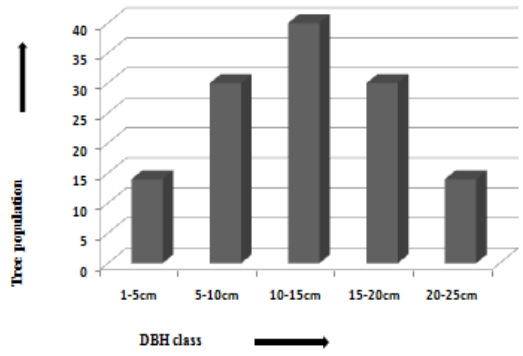

Fig. 5. Density distribution pattern in Illambazar forest.

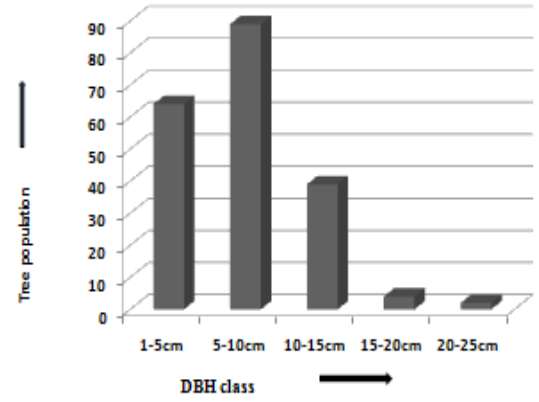

Fig. 6. Density distribution pattern in Chorchor forest.

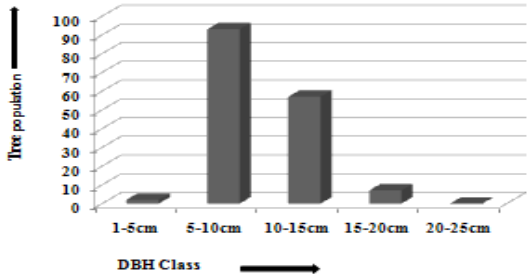

Fig.7. Density distribution pattern in Ganpur forest.

Frequency and density of herbs, shrubs and climbers

Studies on frequency and density of herbs, shrubs and climbers of three forest areas in the district showed that 7 species of climbers, 4 species of shrubs and 5 species of herbs are rare in the study area (Table 3, 4). The rare climbers namely *Aristolochia indica* L., *Cassitha filiformis* L., *Celastrus paniculatus* Willd., *Dioscorea bulbifera* L., *Erycibe paniculata* Roxb.,*Tylophora indica* (Burm. f.), *Combretum roxburghii* Spreng. are found in the area with very poor frequency (10 - 60%) and low density (80 – 440 n ha^{-1}). Harvest pressure and habitat destruction may be the factors for their very low population density as it was reported that *A. indica, C. paniculatus, D. bulbifera* are used as herbal medicine by the local people in the study areas (Rahaman *et al.,* 2008, 2009, 2011). They also need a proper attention of conservation effort. The rare shrubs namely *Woodfordia fruticosa* (L.) Kurz., *Coffea benghalensis* Heyne ex Willd., *Pavetta indica* L., *Carissa spinarum* L., etc. have also been found with very poor frequency (10-30%) and poor density (80-330 n ha^{-1}) in the forest areas. The herbs like *Curculigo orchioides* Gaertn., *Eulophia explanata* Lindl., *Barleria prionitis* L., *Crotalaria prostrate* Rottl., etc. have been found in all three forest areas studied with low frequency (10 - 40%) and very poor density (1 - 11 n m^{-2}). Indiscriminate collection of root of some of these herbs from the forest areas may be one of the major causes for their low population density, as it has been reported that *C. orchioides*, *E. explanata*, etc. are regularly being harvested from the forest areas as root drug by the local herbalists (Rahaman and Pradhan, 2011).

Table 3. Phytosociological characteristics of shrub layer in three forest areas.

Plant species in shrub layer	ILLAMBAZAR		CHORCHOR		GANPUR	
	Frequency (%)	Density (nm^{-2})	Frequency (%)	Density (nm^{-2})	Frequency (%)	Density (nm^{-2})
Smilax ovalifolia Roxb.	60	360	20	120	40	160
Dioscorea alata L.	40	200	30	200	X	X
Gymnema sylvestre (Retz) R.Br. ex Schult.	20	200	20	120	X	X
Erycibe paniculata Roxb.	20	160	60	400	10	120
Tylophora indica (Burm.f.) Merrill	10	160	X	X	X	X
Ichnocarpus frutescens R.Br.	30	120	40	480	40	440
Aristolochia indica L.	20	120	20	120	30	120
Pavetta indica L.	30	120	40	12	30	320
Carissa spinarum L.	20	80	20	160	30	160
Hemidesmus indicus R.Br.	20	80	30	280	20	120
Lygodium pinnatifidum (L.) Sw.	20	80	20	80	X	X
Cassytha filiformis L.	20	80	20	240	X	X
Cajanus scarabaeoides (L.) Thouars	10	80	X	X	20	80
Dioscorea bulbifera L.	20	80	20	80	10	80
Celastrus paniculatus Willd.	10	80	20	120	20	80
Meyna laxiflora Robyns	20	80	X	X	10	80
Asparagus racemosus Willd.	10	40	30	200	X	X
Combretum roxburghii Spreng.	10	40	20	120	30	280
Casearia elliptica Willd.	10	40	X	X	X	X
Symplocos recemosa Roxb.	10	40	X	X	X	X
Ampelocissus latifolia (Roxb.) Planch.	X	X	10	80	X	X
Dendropthoe falcata (L.f.) Ettingsh.	X	X	10	40	X	X
Woodfordia fruticosa (L.) Kurz.	X	X	10	10	X	X
Coffea benghalensis Heyne ex Willd.	X	X	40	12	X	X

X= Not found in the sampled areas.

Table 4. Phytosociological characteristics of ground layer in three forest areas.

Plant species in ground layer	ILLAMBAZAR		CHORCHOR		GANPUR	
	Frequency (%)	Density (nm^{-2})	Frequency (%)	Density (nm^{-2})	Frequency (%)	Density (nm^{-2})
Vernonia cinerea Less.	40	4	X	X	X	X
Crotalaria prostrata Rottl.	10	2	X	X	X	X
Desmodium triflorum (L.) DC.	10	1	20	3	X	X
Eulophia explanata Lindl.	10	1	X	X	X	X
Curculigo orchioides Gaertn.	10	1	X	X	X	X
Ochna jabotapita L.	30	5	X	X	30	11
Elephantopus scaber L.	X	X	20	4	X	X
Andrographis paniculata (Burm.f.) Wall. ex Nees	X	X	20	3	X	X
Glochidion multiloculare (Rottler ex Willd.) Voigt	X	X	20	2	X	X
*Barleria prionitis*L.	X	X	10	2	X	X
Borreria articularis (L. f.) Willd.	X	X	20	2	X	X

X= Not found in the sampled areas.

Conclusion

From this study it is concluded that present status of the tree species in three forest areas of Birbhum district is not satisfactory. Among the three forest sites, two sites show reverse J-shaped curve and in another site, A-shaped curve was found. Reverse J-shaped curve observed in Chorchor and Ganpur forest areas which indicates their regenerating type where immature, young tree individuals are found in large number. A-shaped curve of Illambazar forest indicates quite mature age of this forest with comparatively greater number of mature tree

individuals. The diversity value of tree species in all the three forest areas studied is very poor in comparison to other dry deciduous forests of India. Only 20 tree species have been recorded from the study areas. Among which, only 3 species showed satisfactory IVI value. The IVI value of rest 17 tree species is not good at all. Similar condition was found in case of herbs, shrubs and climbers in all these forest areas studied. Many of the herbs, shrubs and climbers have been found in the study areas with their very poor population density. This low population density and poor tree species diversity with immature tree individuals in three forest areas studied may be due to regular extraction of timber and non-timber forest products, grazing, lopping, surface burning and some other anthropogenic activities. Indiscriminate collection of root of some of the herbs for medicinal uses from the forest areas may be one of the major causes for their low population density.

Considering over all phytosociological status of the three forest areas of Birbhum district, it is recommended that immediate steps should be taken for conservation of rare plant species, along with a special care for growth of immature tree species growing in these forest areas. Awareness should be created among the local people regarding sustainable harvest of plant wealth and its importance in conservation of forest phyto-resources.

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