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A Surveillance to Evaluate the Diversity, Dominance and Community Structure of Tree Species in Nagrakata Forest Beat of Chalsa Forest Range, West Bengal, India

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ABSTRACT

For better understand of forest ecosystems it is important to study the Phytosociological aspects and diversity pattern of plants in these ecosystems. Phytosociology deals with plant communities, their composition, development, and the relationships between the species within the ecosystem. The structure of a community is determined mainly by the dominating plant species and not by other characteristics. The quantitative characters with reference to density, diversity and frequency distribution could well act as indicators of disturbances that are affecting the various forest types and such studies would help in understanding the threats that are being faced by the forests and would help in deriving conservation policies. The present research is an attempt to assess the phytosociology of tree species in Nagrakata forest beat.

Key words: *Biodiversity, Phytosociology, Quadrate, Dominance, IVI, Community indices.*

INTRODUCTION

Forests are the repositories of natural wealth that support the ecological balance of the earth. They are regarded as one of the most species rich terrestrial ecosystems. They are distinguished from all other terrestrial ecosystems by a very high diversity in many levels (species, life forms, etc). Each forest is also an impotant natural resource that plays several important roles in nature. As a whole it is a repository of biodiversity. The forest biodiversity of the world is now getting depleted alarmingly as a result of various factors like habitat loss, pollution, introduction of exotic species, over exploitation and other anthropogenic activities. Biodiversity is a short form for biological diversity which is to describe the total number, variety and variability of living organisms as well as the diversity of the ecosystem they are living in. Biological diversity implies the variety of living organisms and includes diversity within species, between species and of ecosystems and the ecological processes of which they are a part[1]. It also provides essential services including nutrient cycling, air and water purification, drought mitigation and soil recuperation. It provides the raw materials for medicine, food and house holding things. Thus conserving of forest biodiversity is really a critical task. Measuring of community is one of the central issues in ecological studies because of its importance in devising biodiversity conservation strategies.

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The plant diversity at any site is influenced by species distribution, abundance patterns and the richness of plant species is controlled by a variety of biotic and abiotic parameters[2,3,4].

The community of biodiversity is an assemblage of species population that occurs together in the same place at the same time. Several Ecologists developed several systems of description and classification to analyse the plant community and this aspect of ecology is known as phytosociology. Phytosociology deals with plant communities, their composition, development, and the relationships between the species within the ecosystem. A mixture of species which live in a habitat and are held together by common ecological tolerances, form a community. In a community all the species are not equally important but there are only a few overtopping species which by their bulk and growth modify the habitat and control the growth of other species of the community as these species are called dominants. Thus it can also be said that Phytosociology is the study of plant community structure. The study of plant community implies knowledge of structure and composition of the component species. Stone and Frayer (1935) estimated the combined influence of plant height, basal area, density and number of species on 'complexity index' in the evaluation of vegetation physiognomy[5]. The vegetation complex fluctuates from season to season and year to year. The fluctuation suggests a response by each species population to incoming heat, moisture and light as modified by the vegetation itself[6].

MATERIALS AND METHODS

Description of Study Site

Nagrakata beat is one of the important territorial beat forest. It belongs to Chalsa Forest Range of Jalpaiguri Forest Division, West Bengal, India. This forest beat is located on the undulating plain of Himalayan foothill,which create a great floral and faunal diversity. It is located in close proximity to Chapramari Wildlife Sanctuay. Total area of Nagrakata beat forest is 2148.85 hectors. This beat is located with an average elevation of 65 meters in the Jalpaiguri District of West Bengal. However this beat is also recommended for Sal, Teak and mixed plantation. The soil is fertile in nature and strongly acidic. The temperature ranges from 20^{o}C to 32^{o}C during summer and from 8^{o}C to 22^{o}C during winter. The forest is situated very close to the bank of the river Jaldhaka.

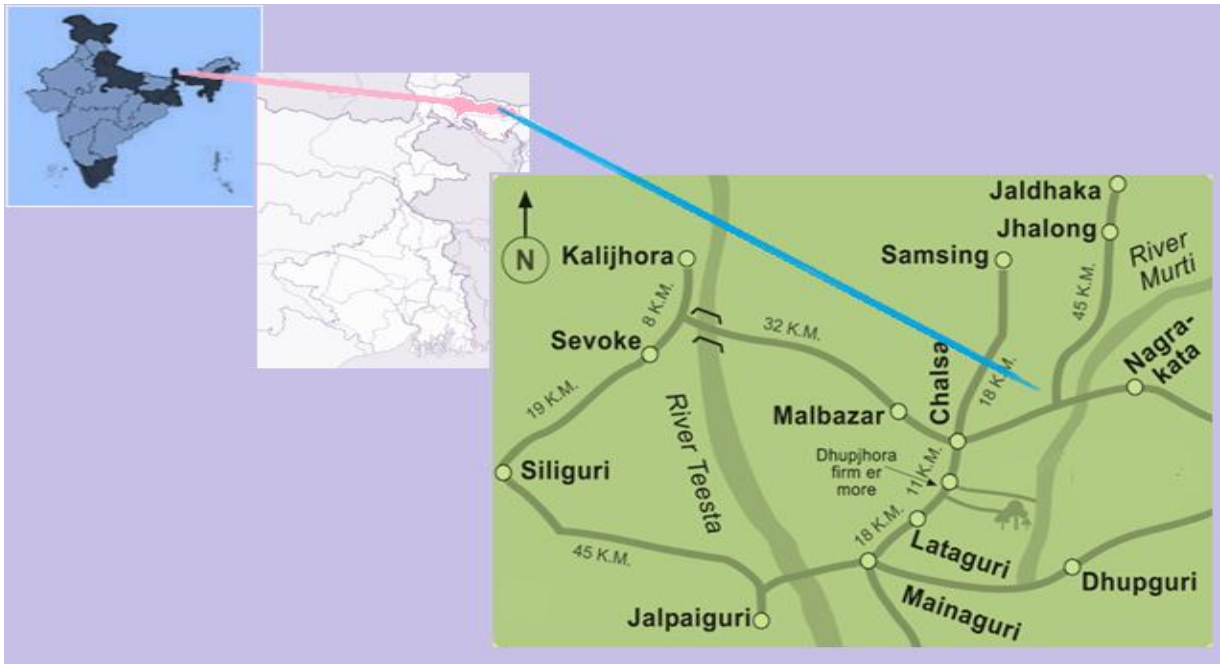


Fig 1: Position of study site

Study of Tree vegetation composition and structure:

For phytosociological studies of tree vegetation in Nagrakata forest beat, the quadrate methods were used. A total of 20 sampling sites distributed over Nagrakata beat representing various categories of natural forests and plantations were selected for vegetation sampling. At each site four quadrates (20 m x 20 m) were laid to quantify various layers. The use of local name of each forest site was adopted from the knowledge of Forest guards. Different topography and altitudes, had different types and levels of disturbance intensity[7,8,9] and the dominant and character species for each of the twenty forest community sites were different. Tree species found within each sampling plot were photographed and identified by their vernacular names (adopted from Range Officer, Beat Officer, Forest Guards and local people) and scientific names using various books, articles and internet In order to analyze the diversity of tree vegetation Frequency, Relative frequency, density and Relative density were calculated. Importance Value Index was calculated by adding Relative frequency Relative density and Relative Basal Area[10,11].

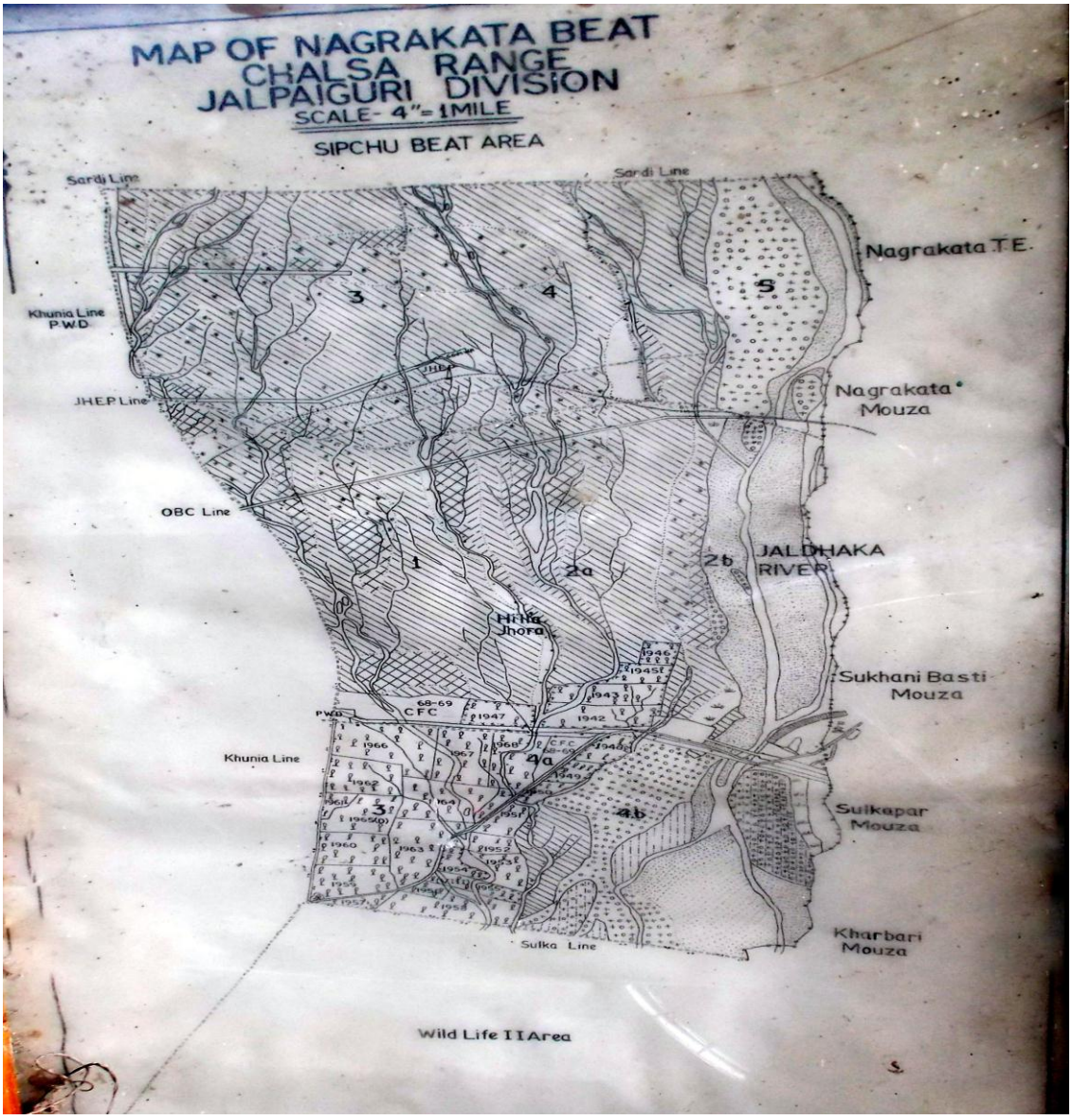


Fig. 2: Beat Map of Nagrakata forest beat (Chalsa Forest Range)

Fig. 3: Different Study sites of Nagrakata Forest Beat (Chalsa Forest Range), West Bengal, India

(a) ***Frequency (%):*** This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{No. of plot in which the species is present}}{\text{Total No. of plots sampled}} \times 100$$

(b) ***Relative Frequency (%):*** The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of the species}}{\text{Frequency of all the species}} \times 100$$

(c) ***Density:*** Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied. Density is calculated by the equation:

$$\text{Density} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots sampled}}$$

(d) ***Relative Density (%):*** Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Density of all the species}} \times 100$$

(e) ***Relative Dominance (%):*** Dominance of a species is determined by the value of the basal area. Relative dominance is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$\text{Basal Area} = \frac{(\text{Circumference at breast height})^2}{12.56}$$

Relative dominance or Relative Basala Area

$$= \frac{\text{Basal Area of the species}}{\text{Basal Area of all the species}} \times 100$$

(f) ***Abundance:*** It is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots in which the species is present}}$$

(g) ***Importance Value Index:*** This index is used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative dominance (Relative Basala Area) are summed up together and this value is designated as the Importance Value Index or IVI of the species.

IVI= Relative Frequency + Relative Density + Relative dominance

Data processing and Phytosociological Analysis:

All the data both spatial and especial collected from different sources has been tabulated and analyzed separately. The data collected were used to compute community indices like

(a) **Species diversity (H')**: Species diversity of different tree species; it was calculated using the Shannon- Weiner Index (Shannon and Weiner, 1963): $(H') = -\sum [(ni / N). \ln (ni / N)]$

Where 'ni' is the IVI of individual species and N is the total IVI of all the species[12].

(b) **Species dominance (Cd)**: Species dominance was calculated following Simpson (Simpson, 1949): $Cd = \Sigma (ni/N)^2$,

where, ni and N are the same as those for Shannon Weiner information function[13].

(c) **Equitability of evenness (e)**: Equitability of evenness refers to the degree of relative dominance of each species in that area. It was calculated according to Pielou (1966) as: Evenness (e) = H'/log S

where, H'= Shannon index, S = number of species[14].

(d) **Species richness (D)**: Species richness was determined by Margalef index (1968) as:

$D=(S-1)/\ln N$.

S = number of species. N= total number of individuals[15].

(e) **Menhinick's index (D_{mm})**: Menhinick's index (Whittaker 1977) is expressed as $D_{mm}=S/\sqrt{N}$, where N is the number of individuals in the sample and S is the species number[16].

(f) **Equitability Index:** The Shannon's equitability Index (Lloyd and Ghelard, 1964) is expressed as (EH)=H/Hmax = H/ln S

(g) **Berger-Parker Dominance Index:** The Berger-Parker Dominance Index is a simple measure of the numerical importance of the most abundant species and is expressed a d=Nmax/N.

N max is the number of individuals in the most abundant species and N is the total number of individuals in the sample. The increase in the value of reciprocal of Berger-Parker Dominance Index reflects the increase in diversity and a reduction in dominance [17].

RESULTS AND DISCUSSION

The forest is more or less homogenous in composition with admixed type of tree species.The vegetation of the studied sites is composed of evergreen vegetation. The disturbance is mainly due to the anthropogenic activities , overgrazing, removal of seeds and seedlings of economically important trees and some other biotic interference. These activities are responsible in converting natural vegetation to semi natural vegetation. An important component of any ecosystem is the species it contains. The study site A total of 32 trees species representing 27 genera and 23 families were recorded within the study site. Among them highest IVI was recorded for *Shorea robusta* Gaertn. (31.58). IVI was also good for *Lagerstromia speciosa Pers.* (19.27), *Terminalia belerica Roxb. (*18.46) and *Sterculia villosa* Roxb. (17.02). The lowest IVI was recorded for *Gynocardia odorata Roxb.* (1.97). IVI was also poor for few species like *Mallotus philippinensis* Muell. and *Dimocarpus longan Lour*. (Table 1). Six to seven plant communities: *Shorea robusta* Gaertn., Lagerstromia speciosa Pers., *Terminalia belerica* Roxb., *Chuckrasia tabularis* A. Juss. *Terminalia tomentosa* Roth. etc were observed as a leading dominant. Their dominance at the forest sites was possibly on account of availability of optimum conditions for their growth.

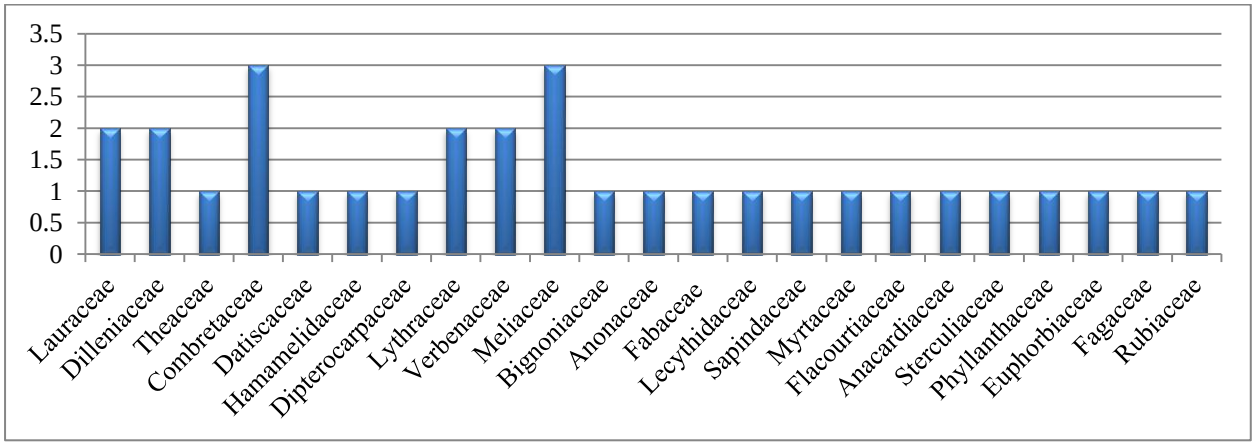
Table. 1: Different Phytosociological values of tree vegetation of Nagrakata Forest Beat

S.No.	Name Of The Plant	Family	A	D	Fr (%)	B A	RD	RF	RBA	IVI
1	*Wrightia tomentosa* Roem. & Schult.	Lauraceae	2.83	0.85	30	734.98	6.64	4.10	2.62	13.36
2	Dillenia pentagyna Roxb.	Dilleniaceae	2.33	0.70	30	725.22	5.47	4.10	2.58	12.15
3	*Schima wallichii* (DC.) Korth.	Theaceae	2.40	0.60	25	961.27	4.69	3.42	3.42	11.53
4	*Terminalia belerica* Roxb.	Combretaceae	1.81	1.00	55	875.61	7.81	7.53	3.12	18.46
5	*Tetrameles nudiflora* R.Br.	Datiscaceae	1.00	0.20	20	306.05	1.56	2.73	1.09	5.29
6	Altingia excelsa Noronha	Hamamelidaceae	2.00	0.60	30	155.89	4.69	4.10	0.55	9.34
7	*Shorea robusta* Gaertn.	Dipterocarpaceae	1.85	0.65	65	4944.31	5.08	8.90	17.60	31.58
8	*Lagerstromia speciosa* Pers.	Lythraceae	2.77	1.25	45	938.49	9.77	6.16	3.34	19.27
9	*Trewia nudiflora* L.	Euphorbiaceae	1.71	0.60	35	725.07	4.69	4.79	2.58	12.06
10	*Terminalia alata* Roth.	Combretaceae	1.88	0.75	40	841.71	5.86	5.48	2.99	14.33
11	*Terminalia tomentosa* Roth.	Combretaceae	1.75	0.35	20	176.92	2.73	2.73	0.62	6.08
12	*Lagerstroemia parviflora* Roxb.	Lythraceae	1.75	0.35	20	110.65	2.73	2.73	0.39	5.85
13	*Gmelina arborea* Roxb.	Verbenaceae	1.86	0.65	35	479.43	5.08	4.79	1.71	11.58
14	*Chuckrasia tabularis* A. Juss.	Meliaceae	1.71	0.60	35	1647.05	4.69	4.79	5.86	15.34
15	*Stereospermum tetragonum* DC.	Bignoniaceae	2.33	0.35	15	1100.15	2.73	2.05	3.92	8.70
16	*Polyalthia simiarum* Benth.	Anonaceae	1.75	0.35	20	471.68	2.73	2.73	1.68	7.14
17	*Bauhinia triandra* Roxb	Fabaceae	2.50	0.25	10	812.18	1.95	1.36	2.89	6.20
18	*Careya arborea* Roxb.	Lecythidaceae	1.66	0.25	15	26.08	1.95	2.05	0.09	4.09
19	*Dimocarpus longan* Lour.	Sapindaceae	2.00	0.10	10	64.66	0.78	1.36	0.23	2.37
20	*Premna mucronata* Roxb.	Verbenaceae	1.00	0.15	15	1244.02	1.17	2.05	4.42	7.64
21	*Dillenia indica* L.	Dilleniaceae	2.00	0.10	5	957.25	0.78	0.68	3.40	4.86
22	*Syzygium cumini* (Linn.) Skeels	Myrtaceae	2.00	0.30	15	592.00	2.34	2.05	2.11	6.50
23	*Gynocardia odorata* Roxb.	Flacourtiaceae	1.00	0.05	10	62.42	0.39	1.36	0.22	1.97
24	*Amoora wallichii* King	Meliaceae	2.00	0.50	25	444.15	3.91	3.42	1.58	8.91
25	*Persea fructifera* Kosterm	Lauraceae	1.00	0.10	20	219.44	0.78	2.73	0.78	4.29
26	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	1.50	0.15	10	911.54	1.17	1.36	3.25	5.78
27	*Sterculia villosa* Roxb.	Sterculiaceae	1.57	0.55	35	2228.44	4.30	4.79	7.93	17.02
28	*Bischofia javanica* Blume	Phyllanthaceae	1.00	0.10	10	602.62	0.78	1.36	2.15	4.29
29	*Mallotus philippinensis* Muell.	Euphorbiaceae	2.00	0.10	10	35.11	0.78	1.36	0.12	2.26
30	*Castanopsis tribuloides* A. DC.	Fagaceae	1.50	0.15	10	2202.68	1.17	1.36	7.84	10.37
31	*Anthocephalus indica* Miq.	Rubiaceae	2.00	0.10	5	1146.49	0.78	0.68	4.08	5.54
32	*Amoora rohituka* W. & A.	Meliaceae	1.00	0.05	5	1345.54	0.39	0.68	4.79	5.86

A= Abundance, D= Density, Fr= Frequency, BA= Basal Area, RD=Relative Density, RF= Relative Frequency, RBA= Relative Basal Area, IVI= Importance Value Index

Table 2: Different index values of tree vegetation of Nagrakata Forest Beat

S. No.	Name Of The Plant	Shannon Index (H)	Species dominance	Evenness	A/F index
1	*Wrightia tomentosa* Roem. & Schult.	0.141	0.0021	0.094	0.095
2	Dillenia pentagyna Roxb.	0.128	0.0016	0.085	0.077
3	*Schima wallichii* (DC.) Korth.	0.105	0.0009	0.070	0.096
4	*Terminalia belerica* Roxb.	0.168	0.0036	0.112	0.032
5	*Tetrameles nudiflora* R.Br.	0.072	0.0032	0.048	0.050
6	*Altingia excelsa* Noronha	0.110	0.0010	0.073	0.066
7	*Shorea robusta* Gaertn.	0.239	0.0116	0.159	0.052
8	*Lagerstromia speciosa* Pers.	0.168	0.0036	0.112	0.062
9	*Trewia nudiflora* L.	0.128	0.0016	0.085	0.048
10	*Terminalia alata* Roth.	0.129	0.0242	0.086	0.047
11	*Terminalia tomentosa* Roth.	0.078	0.0004	0.052	0.087
12	*Lagerstroemia parviflora* Roxb.	0.320	0.0004	0.213	0.087
13	*Gmelina arborea* Roxb.	0.105	0.0009	0.070	0.053
14	*Chuckrasia tabularis* A. Juss.	0.149	0.0025	0.099	0.048
15	*Stereospermum tetragonum* DC.	0.078	0.0004	0.052	0.049
16	*Polyalthia simiarum* Benth.	0.096	0.0006	0.064	0.087
17	*Bauhinia triandra* Roxb	0.078	0.0004	0.052	0.250
18	*Careya arborea* Roxb.	0.027	0.0002	0.036	0.066
19	*Dimocarpus longan* Lour.	0.034	0.0001	0.002	0.200
20	*Premna mucronata* Roxb.	0.348	0.0676	0.232	0.066
21	*Dillenia indica* L.	0.661	0.0002	0.440	0.400
22	*Syzygium cumini* (Linn.) Skeels	0.083	0.0004	0.553	0.133
23	*Gynocardia odorata* Roxb.	0.162	0.0044	0.108	0.100
24	*Amoora wallichii* King	0.105	0.0009	0.070	0.080
25	*Persea fructifera* Kosterm	0.059	0.0002	0.039	0.050
26	*Lannea coromandelica* (Houtt.) Merr.	0.075	0.0003	0.050	0.150
27	*Sterculia villosa* Roxb.	0.312	0.3433	0.390	0.044
28	*Bischofia javanica* Blume	0.062	0.0002	0.004	0.100
29	*Mallotus philippinensis* Muell.	0.037	0.0013	0.024	0.200
30	*Castanopsis tribuloides* A. DC.	0.117	0.0012	0.078	0.150
31	*Anthocephalus indica* Miq.	0.075	0.0004	0.050	0.400
32	*Amoora rohituka* W. & A.	0.078	0.0004	0.0052	0.200



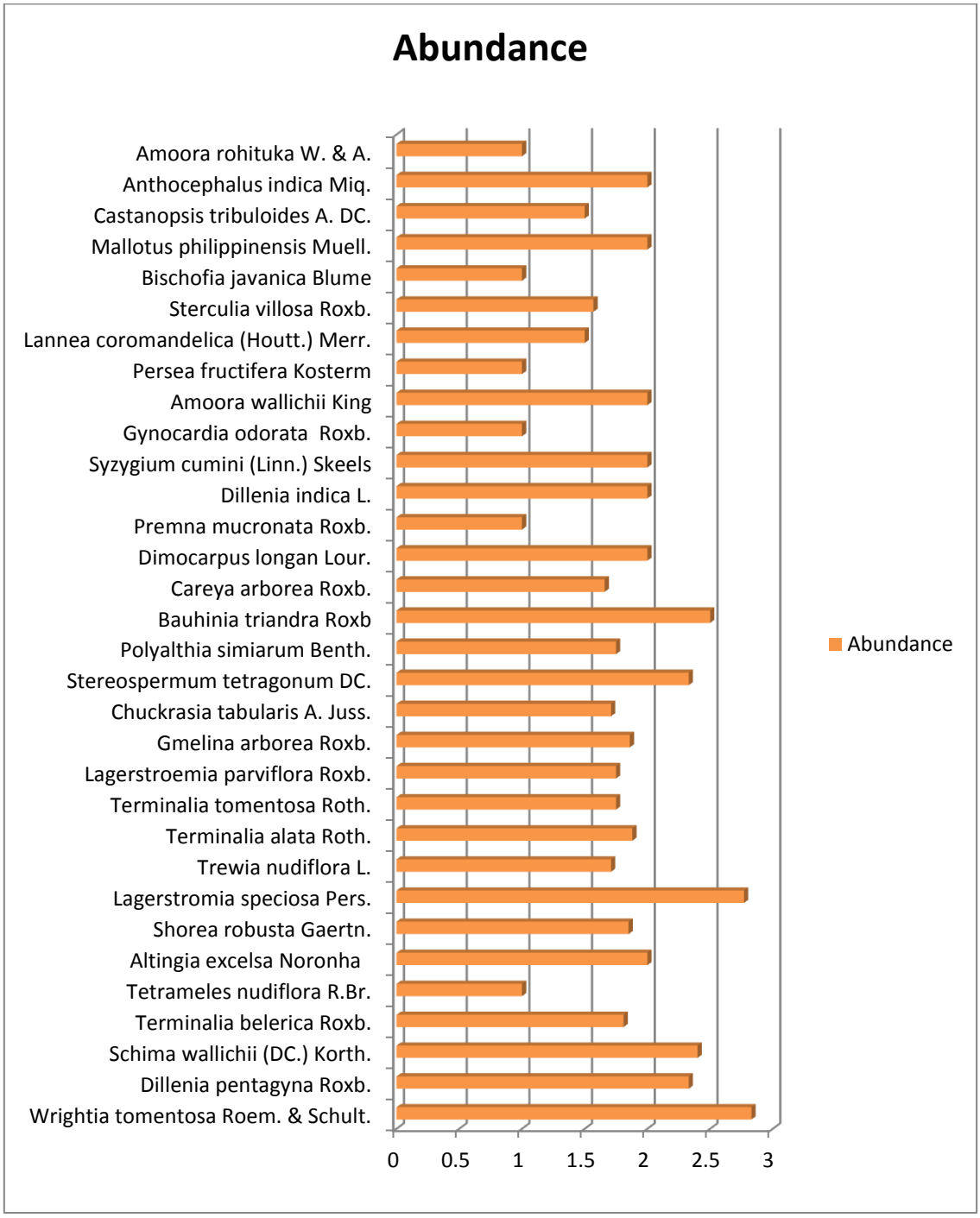
Graph 1: Total number of Families with Genera

Eight diversity indices used were used to analyse the status of this forest. Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. Simpson's dominance index was very less than 1, which showed that the sites were not dominated by single species. On the contrary a few species dominate the forest. The primary conclusion is that there is low grazing pressure and moderate human impact on normal distribution of tree species which may cause reduction in tree community in next few decades in the

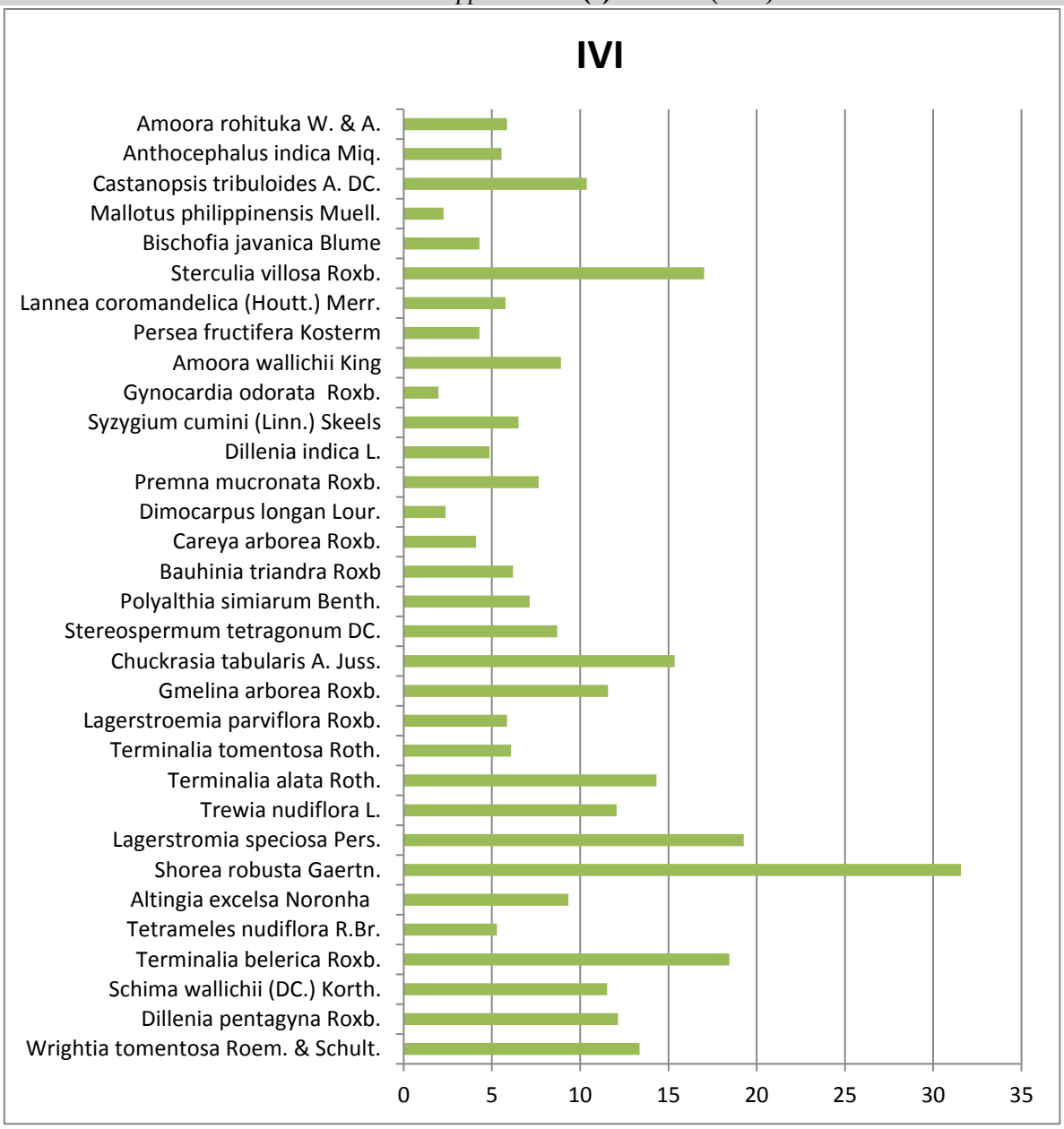
forest ecosystem. Both the Menhinick's index and Margalef's index measure richness of species in the ecosystem.

Table 3: Different Community indices of tree vegetation of Nagrakata Forest Beat.

Community indices	Value
Species diversity (H')	4.527
Species dominance (Cd)	0.4801
Equitability of evenness (e)	3.018
Species richness (d)	5.586
Menhinick's index (D_{mm})	0.124
Equitability Index	0.152
Berger-Parker Dominance Index	0.0032



Graph 2: Abundance of the tree species of Nagrakata beat forest



Graph 3: IVI of tree species in Nagrakata beat forest

CONCLUSION

The paper reflects the phytosociological characters of tree vegetation of Nagrakata Beat of Chalsa Forest Range in Jalpaiguri forest division, West Bengal, India. The vegetation of the Nagrakata forest beat is composed of mosses,ferns, native grasses, sedges, climbers, shrubs and trees. All these species are well adapted to this habitat and can tolerate in low and adequate moistened environment. Here Diversity index of tree species was found as 4.527, where as dominance index(Cd) was observed as 0.4801. Both the indices reflect that the forest patch is rich in tree vegetation and tree diversity. The study revealed that the forest is totally a mixed forest. The present investigation also revealed some interesting phytosociological findings about the tree vegetation of the forest. Instead of one species a few species had high value of abundance. *Wrightia tomentosa* Roem. & Schult. had recorded as the most abundant tree of the forest (2.83). However the Abundance value was also good for Lagerstromia speciosa Pers. (2.77), *Bauhinia triandra* Roxb (2.50) and *Schima wallichii* (DC.) Korth. (2.40). Another important fact is that such abundant plants did not have much basal area.The maximum

relative basal area was recorded for *Shorea robusta* Gaertn.(17.60) but its abundance value was comparatively less (1.85). Species with highest Importance value index (Table 1) were observed for *Shorea robusta* Gaertn (31.58), Lagerstromia speciosa Pers.(19.27), *Terminalia belerica* Roxb. (18.46). Importance value index were lowest for *Gynocardia odorata* Roxb. (1.97). The high IVI of a species indicated its dominance and ecological success, its good power of regeneration and greater ecological amplitude. Since *Shorea robusta* Gaertn showed the maximum IVI values at all sites and therefore, emerged as dominant species of the ecosystem. The higher value of IVI for some tree species indicates that a number of tree species dominate the forest beat and all the available resources are being utilized by that species and left over are being trapped by another species as the competitors, associates and other organisms.

The study suggested to the followers for the study of soil seed bank and allelopathic interactions among the tree speies as well as other plants and microbes in the forest beat.It is also suggested for the study of successive pattern of the plant communities in the forest beats.

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