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Plant Species Diversity and Endemism at Dihang Dibang Biosphere Reserve and its surroundings, Eastern Himalaya Biodiversity Hotspot

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Abstract - An attempt has been made to give assessment of plant species diversity of primary and secondary forest vegetation types in Dihang Dibang Biosphere Reserve (DDBR), a single biosphere reserve in Eastern Himalaya. It is excellent example of continuous unbroken forest of the Himalaya from subtropics to mountain tundra while surrounding area of southern part cover tropics. In the present study we have analysed seventy three sample plots in different forest types and species diversity indices were calculated, Shannon-Wiener's H¢ species richness, evenness, dominant species, dominant verses species richness, and important value index of Biosphere. The species richness in Subtropical evergreen II forest was found highest 7.21 with 350 numbers of species. Owing to the variation of microenvironment,

diversity values within the same vegetation type vary between the samples from different patches. The study would be a great assistance for biodiversity conservation and planning of newly constructed DDBR and its surroundings.

Keywords - Species Diversity, Endemism, Biosphere Reserve, Eastern Himalaya

INTRODUCTION

The Indian subcontinent, with its rich biodiversity, is one of the 12 mega-diversity centers of the world. The North Eastern hills is one of the biodiversity hotspots of India. It is one of the most important areas in the Indian subcontinent for developing a comprehensive conservation network of all the zones in India; it is perhaps the richest in communities, in species and in endemism.

Northeast India, with its highly humid tropical climate is very remarkable for biodiversity. The region represents the transition zone between Indian, Malayan and Indo-Chinese biogeographic regions, as well as a meeting place of Himalayan elements with that of peninsular South Asia. The biotic groups, mainly composed of tropical, subtropical elements, here mix together with temperate and alpine elements. As a consequence of this, a mosaic of diverse forest types occurs. These are interlaced with subtypes and secondary forests depending upon local conditions. Primary forests of India are disappearing at an alarming rate due to anthropogenic activities and are replaced by forests comprising inferior species or their land use and vegetation pattern changed (Singh, Singh, Roy, and Rao 2002). Understanding of forest processes is necessary for assessment of potential impacts; the amelioration of effects of disturbance, optimization of productivity and rehabilitation of ecosystem (Congdon and Herbohn 1993). Species diversity is generated by species interaction such as competition and niche diversification (Pianka, 1966; Bada 1984).

Two attributes of biodiversity have attracted particular attention from the international conservation community: species richness (the number of species in an area), and endemism (the number of species in that area that occur nowhere else) (Caldecott, Jenkins, Johnson, and

Groombridge 1996). Since these two attributes reflect the complexity, uniqueness and intactness of natural ecosystems, they are believed to indicate overall patterns of biodiversity in a useful way.

The local biodiversity of terrestrial ecosystem in particular forest depends on the complex suit of factors that characterized the habitat individual species. These factors include such component as the species composition, phenological timing, structural complexity and horizontal patterning of the vegetation, which in turn depend on environment and the legacy of disturbance. The dominant plant (i.e. tree in forest) plays a pivotal role of defining the habitats for associated organism providing food and shelter and by regulating the local microenvironment.

Different people have studied the forest vegetation of Arunachal Pradesh and attempted a classification of forest types. (Champion and Seth 1968; Rao 1974; Kaul and Haridasan 1987; Anon 2001), but the DDBR and surroundings is poorly studied for these aspects, The natural conditions and geographical position of DDBR make it a very distinctive region, as it occupies a key position as a bridge between Indo-Malayan and Indo-Chinese region so its floristic composition shows affinities to both Biogeographical region. For these reasons, this paper focuses on species richness and endemism of the DDBR as a whole and its surrounding area.

FRAMEWORK

The Biosphere reserve is situated approximately 94° 21′ 20.25 to 96° 26′ 53.08 east longitude and28° 18′ 26.35 to 29° 29′ 51.92 north latitudes (Fig. 1). It comprises an area of 5112 km^2 in the district of Siang and Dibang valley of Arunachal Pradesh. The area is almost totally forested from swath of subtropics to cold and some parts lies at elevation above the tree line varies from 500 to 6000 meters, altitude, rainfall, and temperature are major factors in determining plant growth. Other factors are varying soils exposure and others microhabitats which include snow peaks and this area feature a very special array of plant s and animals. Tremendous speciation occurs here with over 1500 species of flowering plant expected Due to the steep terrain combined with difficult weather and the lack of communication; the area has a

very sparse human population. The approximately 10,000 people who live here are primarily of the Adi, Buddhist and Mishmi tribes with ten sub tribes.

MATERIALS AND METHODS

The forest vegetation under such geographical and climatic conditions principally consists of lush green tropical, subtropical, temperate coniferous as well broadleaved forests, sub-alpine and alpine forests having unique diversity of plant and animals. The region has very high humidity throughout the year, which supports luxuriant growth of epiphytic plants.

The representative plant species for each of the forest vegetation types referred to in this paper are shown in Table 1.

Assam Valley Tropical Evergreen Forest (1/B/C1) Upper Assam Valley Tropical Evergreen Forest (1B/C2) Sub-Himalayan light alluvial semi- evergreen forest (2B/C1/ISI**)** Sub Himalayan Secondary wet mixed forest (2B/C1/2S3) forest is a kind of tropical rain forest, which, however, differs from tropical lowland evergreen forest in that some of its tree species are deciduous under the monsoon climate, although they do not shed leaves in the same season. Thus it could be categorized as tropical semi-evergreen forest. Assam Valley Tropical Evergreen Forest (1/B/C1) Upper Assam Valley Tropical Evergreen Forest (1B/C2) distributed on the hills from 400 m to 800 m and has a relatively poor species composition and shorter canopy height in comparison with tropical seasonal rain forest. In view of its altitudinal location, it should be labeled as tropical forest.

East Himalayan Moist Deciduous forest (3C3/Bb) is Monsoon forest over limestone and calcareous soil is a kind of deciduous forest developed on limestone. Its canopy trees usually shed their leaves in the dry season, which is consistent with the rhythm of the monsoon climate and makes it a typical representative of tropical monsoon forest.

East Himalayan subtropical wet hill forest (8BC2) and 11B/C1 East Himalayan wet temperate forest is subtropical and temperate forest vegetation, which occurs on the hills and mountains of DDBR ranging between 900 m to 1800 m and 1800 m to 2800 m respectively. In Indian

continental temperate vegetation of forest mainly comprises evergreen tree species of the Fagaceae, Lauraceae, Theaceae, Vacciniaceae and Magnoliaceae, so it is called temperate broad-leaved evergreen forest. The species composition of the Sub tropical evergreen forest in this area is more or less mixed with some tropical semi-evergreen elements and thus it is sometimes called subtropical evergreen II forest.

Cumulative species-area curves were plotted for all forest types sampled by sequential arrangement of plots keeping in view the inaccessible complex terrain, the unpredictable and unfavorable weather conditions, time paucity, manpower etc. A 20 m x 20 m plot for trees (CBH ≥ 15 cm), within which a 5 m x 5 m nested plot at the center for shrubs/saplings (CBH ≥ 5cm) were laid. For herbs/seedlings four 1 m ×1 m plots of which, three were laid at the three out of four corners and one at center of the 20 m × 20 m plot (Roy et al.,1997,1998).

Detailed inventory was done in 73 sample plots covering eight vegetation cover classes for trees, shrubs, seedlings, saplings, epiphytes, climbers and other growth forms including herbs.

Important Value Index **(**IVI) of primary forest was calculated is a statistical quantity, which gives an overall picture of the importance of the species in the plant community. Since the above relative parameters give clues individually, all the parameters are summed up in order to provide the total picture of sociological structure of a species in a community, and called as importance value index (IVI) (Mishra 1969). It thus incorporates three important parameters that are measures of diversity and productivity of every species (Varghese and Menon 1998)

IVI = Relative frequency + Relative dominance (basal area) + Relative density

Species richness can be described as the number of the species in a sample or habitat per unit area. Indices can be generated to bring them to similar scale. The simplest species richness index is based on the total number of species and the total number of individuals in the sample or habitat. Higher the value greater the species richness.

$$Relative\ Density = \frac{Density\ of\ Species}{Sum\ of\ density\ of\ all\ the\ Species} \times 100$$

Density of a species

$$Relative\ Density = \frac{Density\ of\ a\ Species}{Sum\ of\ density\ of\ all\ species} \times 100$$

$$Relative\ Dominance\ = \frac{Basal\ cover\ of\ the\ species}{Total\ stand\ basal\ cover\ of\ all\ the\ species} \times 100$$

Species Diversity —— Shannon-Weaver (1949) information theory Index (H')

Where H is the Index value and 'ni' importance value or number of species and 'N' is total IVI or total number of species in that habitat type. It is also called as Information Index and can also be used to describe the landscape diversity.

$$H` = -\sum_{i=1}^{s}[(\frac{ni}{n})\ln(\frac{ni}{n})]$$

RESULTS AND DISCUSSION

Six (6) major forest types were taken for IVI analysis of tree species. Highest IVI of ten speciese of different forest type are shown in fig.1.

(a) *Mixed moist deciduous*: Only four (4) tree species (*Anthocephalus chinensis* (Lamark.) A.Rich. ex Walp, *Duabanga grandiflora* (Roxb. ex DC.) Walp., *Albizia lebbeck* (L.) Willd., *Terminali amyriocarpa* Heurck&Muell.-Arg) represented 49.22% dominance of the total number of tree recorded from all eight (8) plot laid down in Mix moist deciduous.

(b) *Tropical evergreen*: In tropical evergreen forest, four (4) species(*Altingia excelsa* Nor., *Ficus drupacea* Thunb. *var pubescens* (Roth) Corner, *Kydia glabrescens* Mast.) contribute 63.8% dominance of total four plots.

(c) *Tropical semi-evergreen*: In this forest type total seventy three (73) tree species were recorded in seven plots. Four (4) major dominant species (*Olea dioica* Roxb.,*Vitex glabrata* R.Br., *Litsea salicifolia* (Roxb ex

Nees.) *Celtis tetranda* Roxb.) were contributed 21% dominance in 73 species.

(d) *Subtropical evergreen-I:* seventy-one tree species were recorded in this forest type. Out of these species, most dominate four species (*Trevesia palmata* (Roxb.) Vis, *Quercus lamellosa* Sm., *Saurauia roxburghii* Wall. *Altingia excelsa* Nor) were represent only 17.7% dominance of the total number of recorded nine plots.

(e) *Subtropical evergreen- II*: In subtropical evergreen II forest 350 plant species were recorded, four (4) species (*Olea dioica* Roxb, *Altingia excelsa* Nor., *Bischofia javanica* Bl., *Quercus lamellosa* Sm.) represent 25.2% dominance of total sixty one (61) tree species.

(f) *Temperate broad leaved*: Total six plot were laid down in this forest. Within all six (6) plots a total 63 tree species were recorded. Out of sixty three (63) species (*Vaccinium vacciniaccum* (Roxb.) Scheumer ,*Castanopsis indica* A. DC,. *Schima wallichii* sp wallichiana var khasiana (Dyer) Bloembergen Dyer. *Syzygium tetragona* Wight, *Trema wallichii* Bl,) represented 33.3% dominance.

Species diversity

Table 1 shows the species diversities of plant populations in different forest types. In the tropical forest, the species diversity of single-dominant forest is not consistently lower than that of mixed forest. The highest species diversity occurs in the single-dominant sub tropical evergreen II forest followed by temperate broad leaved, tropical semi-evergreen subtropical evergreen tropical evergreen I forest, and pine. In the subtropical evergreen II forest of DDBR, the large trees of *Olea dioca* usually dominate the emergent layer (Table 1) and build up a relatively humid microenvironment favorable to the growth of plants, especially in the dry season. This forest is distributed at 800 to ± 1500 m altitude, mainly in the wet valleys, frequently with small streams, and on the gentle slopes or rather at terrain. Due to the topography, however, this forest type does not cover a large continuous area and is only found in isolated small patches, and its distribution and species composition are greatly restricted by the local topographical conditions. The emergent are so high that they construct a sparse emergent layer over the canopy. This, on the one hand, increases the depth of the upper strata of the forest, and thus forms

a benign gradient change of environmental transformation from the outside to the inside of the forest. On the other hand, it decreases the density of the canopy under the emergent trees because of its shade, and this creates more heterogeneous microenvironments in the forest, thus allowing the maintenance of a diversified species composition. This may be an important reason why this forest holds so many tree species.

The Shannon-Weaver index of richness was higher in subtropical evergreen-II forests followed by tropical semi-evergreen forest and temperate broad-leaved forest (Fig. 3). It may be due to the fact that Subtropical evergreen II forests and tropical semi-evergreen forest are facing level of disturbance, while tropical semi-evergreen forest has already been subjected to higher amount of human influence leading to loss of biodiversity. Study has found that species richness is high where the biological value is low. It is because high numbers of species of certain families like Pteridaceae, Poaceae, Zinzerbaraceae etc. (Singh ,Singh, Roy and Rao 2002).

As it is well established that vegetation is governed by the factors like, altitude, latitude and aspects. It is observed that the species richness increases up to the temperate zone than decrease subsequently (Fig. 3). The decrease in species richness is from 2500 m and upwards confirms the rule of reduced species number with higher elevation (Colwell and Hurtt 1994). This is probably due to eco-physiological constraints, such as reduced growing period, low temperatures, low energy (Körner, 1999; Brown 2001) and mountain barriers against the closest species pool at the Tibetan plateau the hard boundary (Colwell and Lees 2000). These plants in sub-alpine forests grow in relatively moist habitats close to the limit of tree growth.

Plant endemism

Studies have focused predominantly on determining patterns of endemism at global and regional scales (Major 1988; Cowling 1983). More recently, awareness of the 278 looming biodiversity crisis (Myers 1990) has emphasized the need for studies of local floras in order to identify areas of botanical importance. Procedures implemented in reserve selection exercises incorporate data relating to endemism and rarity (Terborgh and Winter 1983; Rebelo 1994). Successful

management of designated reserves requires knowledge of endemic and threatened plants to ensure their preservation (Kruckeberg and Rabinowitz 1985).

In DDBR, total eighty-eight endemic species were recorded (Table 2) and are included under 40 families. Species richness was predominantly attributed to five plant families (i.e., Rubiaceae, ,Acanthaceae,Ericaceae, Zingiberaceae, Liliaceae), which accounted for 32.9% (29 species) of the total number of endemic species recorded (Table 4), in which, Subtropical evergreen II forest showed the high degree of endemism, which is followed by subtropical evergreen-I and temperate broad-leaved forest. The ratio of endemism of families to species is found to be 1:2.2, Endemism indicates that the flora of these forests is very different and peculiar than the flora of other forest.

The total number of taxa in different forest types were analysed for their number of species, genera and family (Table 1). The result indicates that higher species richness and high endemism with some endangered plant species (Table 3) is found in subtropical evergreen-II forest, thus subtropical evergreen-II forest has great ecological importance. Earlier it was treated as subtropical evergreen forest, and this study has been able to bring about the differences but probably due to disturbances its species composition has changed which comprises species of semi-evergreen and evergreen in nature.

CONCLUSION

Dihang Dibang Biosphere Reserve consists of species diversity from tropical to alpine. There are variations in the plant species diversity between deferent samples of the same forest type, especially when the samples are taken from the ecotone or near the edges of forests. This depends greatly on the microenvironment of the forests. The subtropical evergreen II forests of DDBR is found in secluded patches are unique. It has a very high and sparse canopy structure. This leads to the extension of under storey space and a very heterogeneous microclimate that permits development of a species-rich under storey and maintains high species diversity in regional context.

Species diversity of DDBR is increased from tropical to temperate, but in between, unique microenvironment supports the patches

of Semi-evergreen and subtropical evergreen II which, have high species diversity with high endemism. The sites investigated have a high percentage of species endemism. The number of species with small population sizes, especially the species represented by only one individual, has a close association to the species diversity values. These species are key components in the composition of species diversity of the local forest vegetation.

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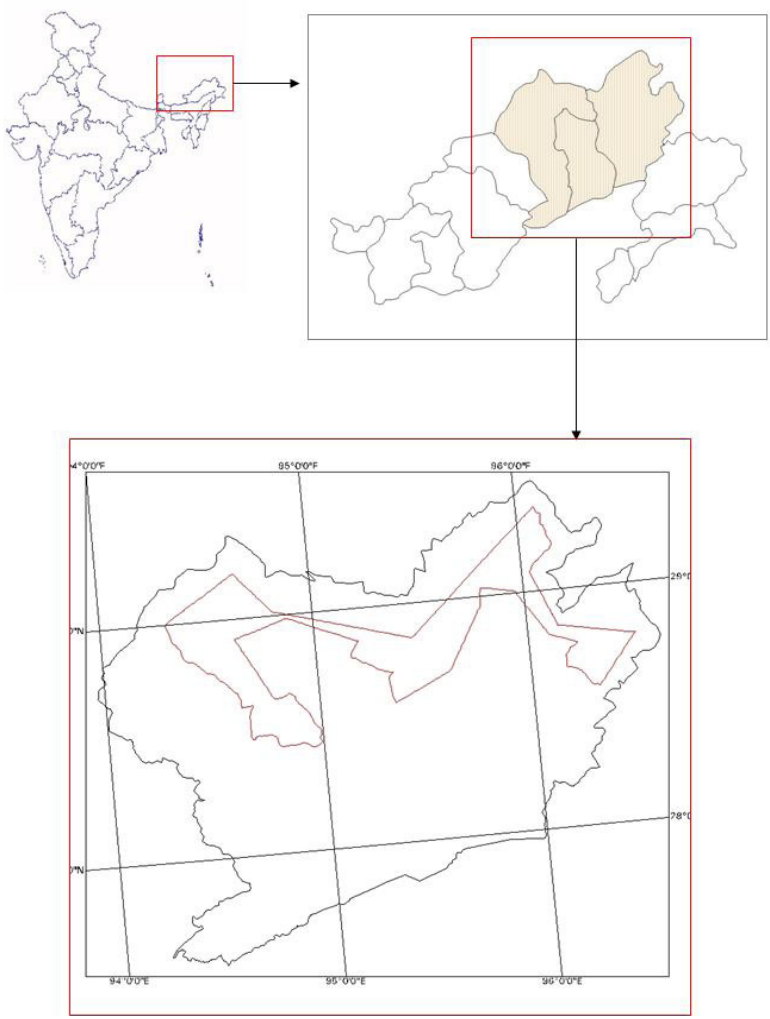

Fig. 1. Location map of Dihang Dibang Biosphere Reserve

Table 1. Species richness and dominant family of different forest type of DDBR

Forest type	Family	Genera	Number of species	Dominant Family	Shannon Weaver Index
Sub tropical evergreen-II	103	226	350	Zinzerbaraceae, Rubiaceae, Pteridaceae, Poaceae	7.19
Tropical semi-evergreen	100	298	300	Fagaceae, Rubiaceae. Athyriaceae	6.49
Temperate broad leaved	74	129	150	Fagaceae, Polypodiaceae, Lauraceae, Vacciniaceae	6.31
Abandoned *jhum*	87	110	178	Urticaceae, Elaeocarpaceae, Lauraceae, Melestomaceae	5.92
Sub tropical evergreen-I	104	214	308	Urticaceae, Hamamelidaceae, Euphorbeaceae, Fagaceae	5.13
Tropical evergreen	44	79	106	Hamamelidae, Urticaceae, Anthyraceae, Moraceae	5.11
Degraded forest	81	93	121	Urticaceae, Poaceae, Lauraceae, Rosaceae	4.97

Continuation of Table 1

Temperate coniferous	97	73	110	Pinaceae, Ericaceae, Rosaceae, Poaceae	4.95
Pine	36	59	63	Fabaceae, Pinaceae, Orchidaceae, Polypodiaceae	4.95
Riverain forest	49	63	75	Mimosaceae, Hamionitidaceae, Piperaceae, Urticaceae	4.69
Mixed moist deciduous	46	63	90	Thelypteridaceae, Sonneratiaceae, Moraceae,	4.46
Rhododendron scrub	11	22	29	Ericaceae, Vacciniacesae, Primulacae, Asteraceae	3.59
Alpine	10	20	25	Poaceae, Primulacae, Asteraceae	3.50
Bamboo	9	15	20	Poaceae, Athyriaceae, Zinzerbaraceae,	3.19
Grassland	8	15	19	Poaceae, Ericaceae, Asteraceae, Rosaceae	2.93
Hollock	5	10	15	Dipterocarpaceae, Athrriaceae, Rubiaceae	2.67

Table 2: Endemic plants in Eastern Himalaya (Encountered in DDBR and Surroundings)

Species Name	Family	Forest Type
Acanthus leucostachyus Wall	Acanthaceae	TEV
Agapetes griffithii C.B. Clarke	Vacciniaceae	PINE
Agapetes incurvata (Griff) Sleumer	Vacciniaceae	PINE
Agapetes parishii C.B. Clarke	Vacciniaceae	TBL
Amomum linguiforme Benth.	Zingiberaceae	TSEV
Anisadenia pubescens Griff.	Linaceae	PINE
Aquilaria malaccencis Lamk.	Thymelaeceae	TEV, STE
Ardisia pedunculosa Wall.	Myrsinaceae	TBL
Arundinaria intermedia Munro	Poaceae	BAMB
Bambusa balcooa Roxb.	Poaceae	TSEV, TEV, AJ,STE II
Bambusa tulda Roxb.	Poaceae	TSEV, TEV, AJ,STE II
Begonia rex Putzeys	Begoniaceae	TSEV, TEV, AJ,STE II
Begonia sikkimensis A.DC.	Begoniaceae	TSEV, TEV, STE II
Brassaiopsis mitis C.B. Clarke.	Araliaceae	TSEV, MMD, TEV, STE
Bulbophyllum reptens Lindl.	Orchidaceae	STE
Calamus gracilis Roxb.	Arecaceae	TEV, STE, STE II
Cautleya robusta Baker	Zingiberaceae	STE
Cephalotaxus griffithii Hook.f.	Cephalotaxaceae	STE, TBL, TCF
Chirita oblongifolia (Roxb.) Sinclair	Gesneriaceae	MMD, STE, AJ, RVN
Coelogyne fuscescens Lindl.	Orchidaceae	STE
Coffea jenkinsii Hook. f	Rubiaceae	STE
Coptis teeta Wall.	Ranunculaceae	MMD, TBL, TCF
Cryptocarya andersonii King.	Lauraceae	STE
Dendrobium spathaceum Lindl.	Orchidaceae	PINE
Dracaena petiolata Hook. f.	Liliaceae	
Elatostema griffithii (Wedd.) Hook.f.	Urticaceae	TSEV, STE,STE II
Elatostema sikkimensis C.B. Clarke	Urticaceae	STE
Euonymous echinatus Wall. exRoxb.	Celastraceae	TSEV
Globba multiflora Wall.	Zingiberaceae	TEV, TBL
Globba pauciflora King	Zingiberaceae	TSEV, STE
Hedychium venustum Wt.	Zingiberaceae	TSEV,AJ
Hoya lobbii Hook.f.	Asclepiadaceae	STE
Hoya lobbii Hook.f.	Asclepiadaceae	
Ilex embelioides Hook. f. &Thoms.	Aquifoliaceae	PINE
Indofevillea khasiana Chatterjee	Cucurbitaceae	MMD
Jasminum listeri King & Gage	Oleaceae	
Justicia vasculosa Wall.	Acanthaceae	STE,STE II
Litsea membranifolia Hook. f	Lauraceae	TBL
Musa velutina Wendl. & Drude	Musaceae	TEV
Ophiorhiza fasciculata D. Don	Rubiaceae	AJ
Ophiorhiza oppositifolia Hook. f.	Rubiaceae	TSEV,TBL

Oxyspora vagans Wall.	Melastomaceae	TSEV, TEV, STE, AJM,STE II
Pavetta subcapitata DC.	Rubiaceae	AJ
Persea gammieana (King ex Hook.f.) Kost.	Lauraceae	TSEV
Persea globularia Kosterm.	Lauraceae	STE
Phoebe cooperiana U.N.Kanjilal ex A.Das.	Lauraceae	TSEV,TEV,STE II,AJM,STE
Pholidota articulata Lindl.	Orchidaceae	STE
Pilea ternifolia Wedd.	Urticaceae	TEV,STE
Piper griffithi C.DC.	Piperaceae	TBL
Piper petiolatum Hook.f.	Piperaceae	TSEV,TEV
Polygala tricholopha Chodat	Polygalaceae	STE
Polygonatum brevistylum Baker	Liliaceae	STE
Polygonatum griffithii Baker	Liliaceae	BAMB
Premna bengalensis Cl.	Verbenaceae	TSEV,TEV,STE,AJM
Primula malacoides Franch	Primulaceae	TBL
Psychotria adenophylla Wall.	Rubiaceae	TSEV,TBL,STE II
Psychotria silhetensis Hook.f.	Rubiaceae	TBL,AJ
Rhamnus procumbens Edgew.	Rhamnaceae	TBL
Rhaphidophora glauca Schott.	Araceae	TSEV,TEV,STE,AJM,TCF
Rhaphidophora hookeri Schott.	Araceae	TEV,STE
Rhaphidophora lancifolia Schott	Araceae	TEV,STE
Rhododendron arboreum Sm.	Ericaceae	TBL,TCF,BAMB
Rhododendron campanulatum D.Don.	Ericaceae	RDN,TCF
Rhododendron campylocarpum Hook. f.	Ericaceae	TBL.TCF,RDN
Rhododendron edgeworthii Hook. f	Ericaceae	GRA
Rhododendron grande Wight	Ericaceae	TBL
Rhododendron wightii Hook. f.	Ericaceae	TCF,RDN
Rhynchotechium vestitum Hook.f. & Thoms.	Gesneriaceae	AJ
Rubia sikkimensis Kurz.	Rubiaceae	TBL
Rubus burmanicus Hook f	Rosaceae	BAMB,RDN
Rubus lucens Focke	Rosaceae	TEV,STE,AJM
Rubus rosaefolius Sm.	Rosaceae	
Sapium eugeniae folium Buch.-Ham.	Euphorbiceae	TSEV,TBL,AJ
Sarcospermum arboreum Benth.	Sapotaceae	TSEV,STE,PINE
Schima wallichii sp. wallichiana var khasiana (Dyer) Bloembergen Dyer.	Theaceae	TSEV,TEV,STE,TBLAJM
Shorea assamica Dyer.	Dipterocarpaceae	TSEV,MMD,TEV,STE,AJ
Smilax glaucophylla Klotz.	Liliaceae	TSEV,TBL,STE II
Smilax rigida Wall. ex *Kunth var myrtillus* (DC.) T. Koyana	Liliaceae	TSEV,MMD,STE,TBL,AJ
Strobilanthes discolor T. Anders.	Acanthaceae	TSEV,TEV,STE,PINE
Strobilanthes extensus Nees	Acanthaceae	PINE
Strobilanthes geniculatus C.B. Clarke	Acanthaceae	MMD
Strobilanthes secundus T. Anders.	Acanthaceae	AJ
Tetrastigma dubium (Laws.) Planch.	Vitaceae	MMD,STE
Thladiantha hookeri C.B. Clarke	Cucurbitaceae	STE

Trachelospermum lucidum (D. Don.) K. Schum.	Apocynaceae	TEV,STE
Trichodesma khasianum C.B. Clarke	Boraginaceae	TSEV,STE II
Vaccinium venosum Wight	Vacciniaceae	TCF
Wallichii densiflora Mart	Arecaceae	TSEV,MMD,STE II,AJ

Table 3. IUCN status of species found in DDBR

Species	IUCN status	Family	Habit	Forest type
Aconitum ferox. Wall. *ex Seringe*	Vulnerable	Ranunculaceae	Herb	TBL, RDN, Fir
Begonia hatacoa Buch.-Ham. ex D.Don	Rare	Begoniaceae	Herb	TSEV, STE II,STE
Coptis teeta Wall.	Vulnerable	Ranunculaceae	Herb	MMD, TBL, TCF
Livistona jenkinsiana Griff.		Arecaceae	Tree	TSEV, TEV, STE, STE II, AJHU

Table 4. Number of endemic plants found in different families in DDBR

Number of Endemic	Families
7	Rubiaceae
6	Acanthaceae
6	Ericaceae
5	Lauraceae
5	Liliaceae
5	Zingiberaceae
4	Orchidaceae
4	Vacciniaceae
3	Araceae
3	Poaceae
3	Rosaceae

3	Urticaceae
2	Arecaceae
2	Asclepiadaceae
2	Begoniaceae
2	Cucurbitaceae
2	Gesneriaceae
2	Piperaceae
1	Apocynaceae
1	Aquifoliaceae
1	Araliaceae
1	Boraginaceae
1	Celastraceae
1	Cephalotaxaceae
1	Dipterocarpaceae
1	Euphorbiceae
1	Linaceae
1	Melastomaceae
1	Musaceae
1	Myrsinaceae
1	Oleaceae
1	Polygalaceae
1	Primulaceae
1	Ranunculaceae
1	Rhamnaceae
1	Sapotaceae
1	Theaceae
1	Thymelaeceae
1	Verbenaceae
1	Vitaceae

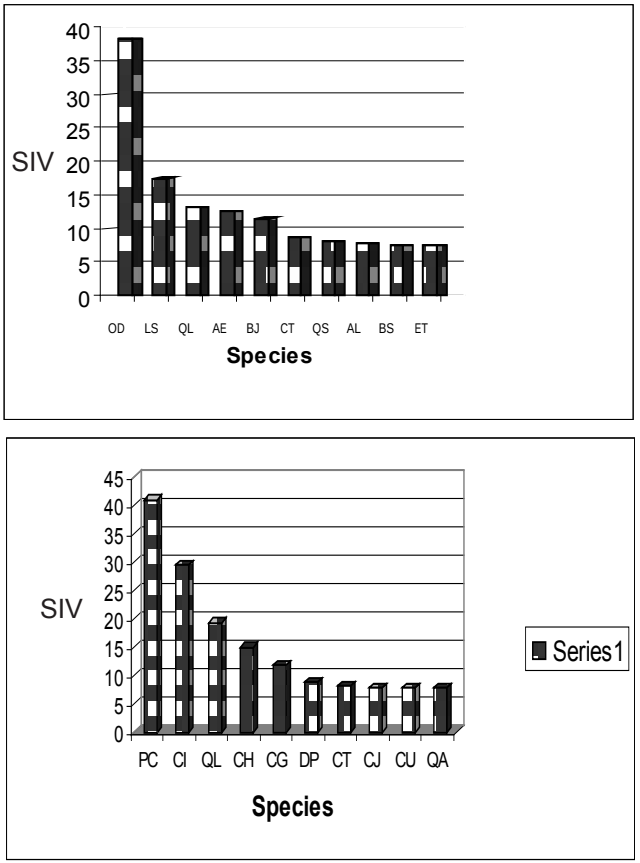

Fig. 2. Species Importance Value (SIV) of different forest type of DDBR

PC (*Phoebe cooperiana* U.N. Kanjilal ex A. Das.), CI (*Castanopsis indica* A. DC.), QL (*Quercus lamellosa* Sm.), CH (*Castanopsis hystrix* A. DC.), CG (*Cephalotaxus griffithii*), DP (Hook.f. *Dillenia pentagyna* Roxb.), CT (*Castanopsis tribuloides* A DC.), CJ (*Cleidionjavanicum* Bl.), CU (*Camellia caudata* Wall.), QA (*Quercus acuminata* Roxb.), AE (*Altingia excelsa* Nor.), FD (*Ficus drupacea* Thunb. *var pubescens* (Roth) Corner), PB (*Premna bengalensis* Cl.), KG (*Kydia glabrescens* Mast.), FH (*Ficus hispida* L.), EL (*Eleutherococcus trifoliatus* (L.) Hu), AC (*Anthocephalus chinensis* (Lamark.)A.Rich. ex Walp.), SA (*Sapindus attenuata* Ham.), UL (*Urena lobata* L. *var. glauca* (Bl.) Borssum), GL (*Glochidion lancae*

olarium Dalz.), OD (*Olea dioica* Roxb.), LS (*Lagerstroemia speciosa* (L.)Pers.), QL (*Quercus lamellosa* Sm.), BJ (*Bischofia javanica* Bl.), AL (*Artocarpus lakoocha* Roxb.) BS (*Baccaurea sapida* (Roxb.) Muell.-Arg.), ET (*Elaeocarpus tectorius* (Lour.) Poiret), DG (*Duabanga grandiflora* (Roxb. ex DC.) Walp.), AL (*Albizia lebbeck* (L.) Willd.), TM (*Terminalia myriocarpa* Heurck & Muell.-Arg.), PA (*Pterospermum acerifolium* Willd.), AH (*Aglaia hiernii* Visw & Ranach.), TC (*Toon aciliata* M. Roem.), HF (*Heteropanax fragans* (Roxb.)Seem.), SR (*Saurauia roxburghii* Wall.), TP (Trevesiapalmata (Roxb.) Vis.), QL (*Quercus lamellosa* Sm.), DA (*Dysoxylum allium* (Buch.-Hum)Balak.), CT (*Castanopsis tribuloides* A DC.), BC (*Betula cylindro stachys* Wall).

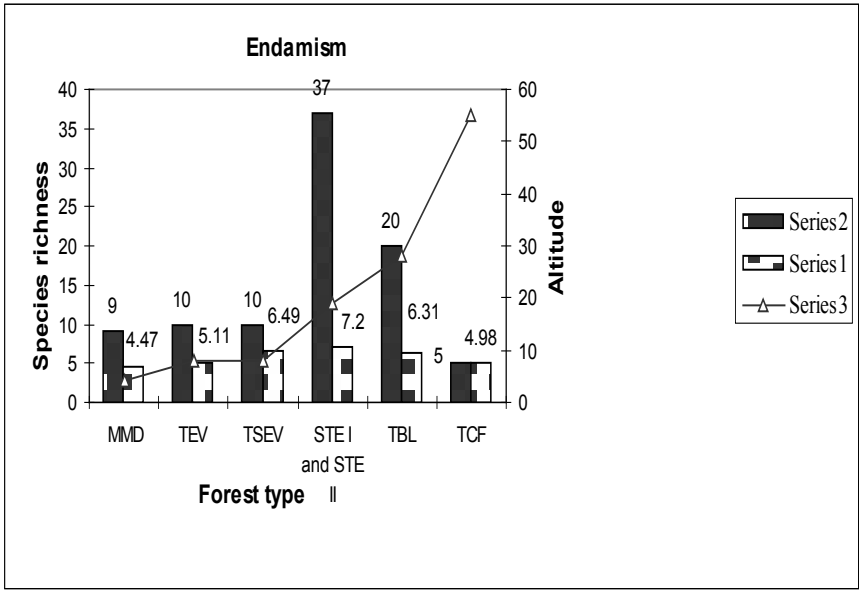

Fig. 3. Graph showing relationship of endemism, species richness and altitude (MMD: Mixed moist deciduous, TEV: Tropical Evergreen, TSEV: Tropical Smievrgreen, STE Sub Tropical Evergreen, TBL: Tropical Broad Leaved, TCF: Temperate Conifer))