Tree Diversity and Community Characteristics of the Subtropical Evergreen Forest in the Buffer and Core Zones of Nokrek Biosphere Reserve, North-east India

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ABSTRACT

The study was conducted in the Nokerek Biosphere Reserve (NBR), Meghalaya to study the diversity and population structure of tree species. Tree species richness (87 species) was high in the core zone than the buffer zone (81 species). A large number of tropical, temperate, and Sino-Himalayan, Burma-Malaysian and Malayan elements as well as primitive families like Annonaceae, Ranunculaceae, Piperaceae, Menispermaceae and Myricaceae and primitive genera like *Myrica* were present in the NBR. The trees were distributed in three distinct strata viz., canopy, sub-canopy and tree-let layers. Canopy layer was composed of 12 and 14 species in the buffer and core zone of NBR, respectively. Sub-canopy and tree-let layers together had the maximum species at both the places. They together had about 85% of the total tree species in the forest.

Lauraceae, Euphorbiaceae, Clusiaceae and Rubiaceae were the dominant families and a large number of families were represented by few species both in core and buffer zones. *Vitex vestita, Castanopsis indica, C. tribuloides* and *Engelhardtia spicata* in the buffer zone, *Castanopsis kurzii, Elaeocarpus lancifolius* and *Derris robusta* in the core zone were among the dominant tree species. Majority (70–75%) of the tree species in the forest showed contagious distribution pattern and had low frequency (<20%). The tree density varied between 1023 and 834 stems ha^{-1} and their basal cover was 33.3 m^2ha^{-1} and 38.8 m^2ha^{-1} in the buffer and core zone stands, respectively. Low values of similarity index and high values of β-diversity index between the stands suggested marked difference in the species composition of communities of buffer and core zones. Shannon diversity index, Margalef species richness index and Pielou evenness index were high in both the stands.

Key words: Nokrek biosphere reserve, tree diversity, tree population structure.

Introduction

The tropical and subtropical forests have attracted the attention of large number of workers all over the world, who have carried out comprehensive studies on their community organization and dynamics, and have estimated species richness, biomass, and productivity (Whitmore, 1984; Valencia *et al.*, 1994; Aiba and Kitayama, 1999). In Asia, these forests occupy much forested area of India and dry areas of Southeast Asia, which have pronounced periodicity of temperature and dry and wet seasons. These forests are best developed in monsoon areas of India, Burma, Thailand and Malaya (Champion, 1936; Puri, 1960). The subtropical evergreen and semi-evergreen forests are very similar to each other. The subtropical forests found in India have been termed as montane subtropical forests by Champion and Seth (1968). They have divided them into southern broad-leaved hill forests and northern wet hill forests because of considerable difference between the two. The latter are distributed up to 2000 m a.s.l. in eastern Himalaya and up to 1600 m a.s.l. on the hills south of Brahmaputra river where annual rainfall is generally over 2000 mm (Champion and Seth, 1968). In these areas there is a noticeable difference between summer and winter temperature and the ground frost is common during December–January.

The subtropical forests found in north-east India are highly fragmented and disturbed by human activities. The undisturbed evergreen forest patches are mainly confined to inaccessible hill slopes and valleys along the banks of rivers and streams. In these forests trees are generally shorter than those found in the lowland tropical rain forests. Stratification is indistinct in the valleys, but it is clear on hills. Epiphytes, tree ferns, mosses and liverworts are abundantly found in the forest. The paper presents data on effect of disturbance on tree diversity, community structure and tree population structure in two stands of subtropical evergreen forest found between 1100 m and 1400 m a.s.l. in East Garo hills district of the state of Meghalaya in north-east India.

Study Site and Methodology

Study site

The present study was conducted in the Nokrek Biospher Reserve (latitude 25°18′ and 25°36′ N, and longitude 90°13′ and 91°37′ E), located in Garo hills districts of Meghalaya during 2000–2002. The topography of the biosphere reserve is variable with an average altitude of about 600 m a.s.l. The highest peak in the biosphere reserve is the Nokrek Peak (1412 m). Two forest stands were selected in the Nokrek Biosphere Reserve (NBR), one each in the core zone (25°27′ N and 90°19′ E, altitude 1425 m a.s.l.) and the buffer zone (25°27′ N and 90°18′ E, altitude 1125 m a.s.l.) of NBR.

The climate of the study site is monsoonic. The temperature, rainfall and humidity vary widely from place to place in the biosphere reserve due to wide variation in topography. Based on the atmospheric condition, the year may be divided into summer (March to mid May), rainy (mid May to September), autumn (October and November) and winter (December to February). The climatic data of the study site was collected from the Coal Department, Garo hills district during the study period as there was no meteorological station within the NBR. The average annual rainfall was 4,300 mm, average mean minimum and maximum temperature was 11°C and 34°C, respectively, and relative humidity ranged from 56% (March) to 77% (August) during the study period.

Methodology

The selected forest stands were sampled by using square quadrats. A total of 30 quadrats of 20 m × 20 m size were sampled for tree (≥15 cm cbh) species, and they were identified with the help of different floras (Kanjilal *et al.*, 1934–40; Balakrishnan, 1981–83; Haridasan and Rao, 1985–87). Herbaria of Botany Department, North-Eastern Hill University and Botanical Survey of India, North-Eastern Circle, Shillong were consulted from time to time for correct identification of the plant species. Family importance value (FIV) was calculated using the formula given by Keel *et al.* (1993). Frequency, density, basal cover and importance value index of tree species were calculated following Misra (1968) and

Mueller-Dombois and Ellenberg (1974). Species-richness and various diversity indices were calculated according to Magurran (1988). Population structure was studied on the basis of girth-class distribution pattern (Khan and Tripathi, 1992).

Results

Tree diversity and stratification

A total of 81 and 87 tree species were recorded from the sampled area (1.2 ha) of the buffer zone and core zone of NBR, respectively (Table 1). There were tropical, temperate, and Sino-Himalayan, Burma-Malaysian and Malayan elements in the forest. Besides, taxa belonging to primitive families like Annonaceae, Ranunculaceae, Piperaceae, Menispermaceae, Lauraceae and Myricaceae and primitive genera like *Myrica* were also present in the forest.

The trees were distributed in three distinct strata viz., canopy (>20 m height), sub-canopy (10–20 m) and tree-let (2–10 m) layer. Canopy layer was composed of 12 and 14 species in the buffer and core zone of NBR, respectively. Sub-canopy and tree-let layers together had the maximum species in both the stands. They together had about 85% of the total tree species in the forest. *Elaeocarpus rugosus, Dysoxylum gobara, Engelhardtia spicata* and *Mesua ferrea* in the buffer zone and *Castanopsis tribuloides, Celtis tetranda, D. gobara,* and *Syzygium cuminii* in the core zone were among the dominant canopy tree species of the NBR (Table 1).

The sub-canopy was formed by *Ficus* sp., *Macaranga indica* and *Elaeocarpus lancifolius*. Other species commonly seen in the sub-canopy layer were *Beilshmiedia assamica, Casearia kurzii* and *Echinocarpus murex. Eurya acuminata, Saprosma ternatum* and *Syzygium cuminii* were common species of the tree-let layer of the buffer zone. *Aporusa dioica, Citrus* sp. and *Litsea salicifolia* were common in the tree-let layer of the core zone stands (Table 1).

Lauraceae was the dominant (11 species) family followed by Euphorbiaceae (7 species), Clusiaceae (5 species) and Rubiaceae (4 species) in the buffer zone stands. Seven families were represented by three species, 9 families by two species and rest 16 families were represented by single species. Based on family importance value (FIV), Lauraceae (FIV 37.4) and Euphorbiaceae (FIV 30.2) were the dominant and co-dominant families of the buffer zone. Clusiaceae was replaced by Fagaceae (FIV 21.6) due mainly to higher basal cover. Euphorbiaceae (12 species) was the most species-rich family in the core zone followed by Rutaceae (7 species), Lauraceae and Rubiaceae (5 species each), and Moraceae and Myrtaceae (4 species each). Based on the (FIV), Fabaceae was the dominant family (FIV 43.7), followed by Euphorbiaceae (FIV: 38.7) in the core zone. Dominance-distribution curve of FIV showed that only few families (Lauraceae, Euphorbiaceae, Rutaceae and Rubiaceae) were dominant in both the buffer and core zone forest stands. The large number (25 families) of families were represented by few species and had low FIV values (Fig. 1).

Dominance, distribution pattern and frequency of species

In terms of importance value, *Vitex vestita, Callicarpa arborea, Citrus hystrix,* and *Macaranga indica, Engelhardtia spicata* in the buffer zone, and *Castanopsis kurzii, C. tribuloides, Elaeocarpus lancifolius* and *Dysoxylum gobara* in the core zone were among the dominant tree species (Table 1). Dominance-distribution pattern among the tree species was similar in both the stands i.e. it showed log

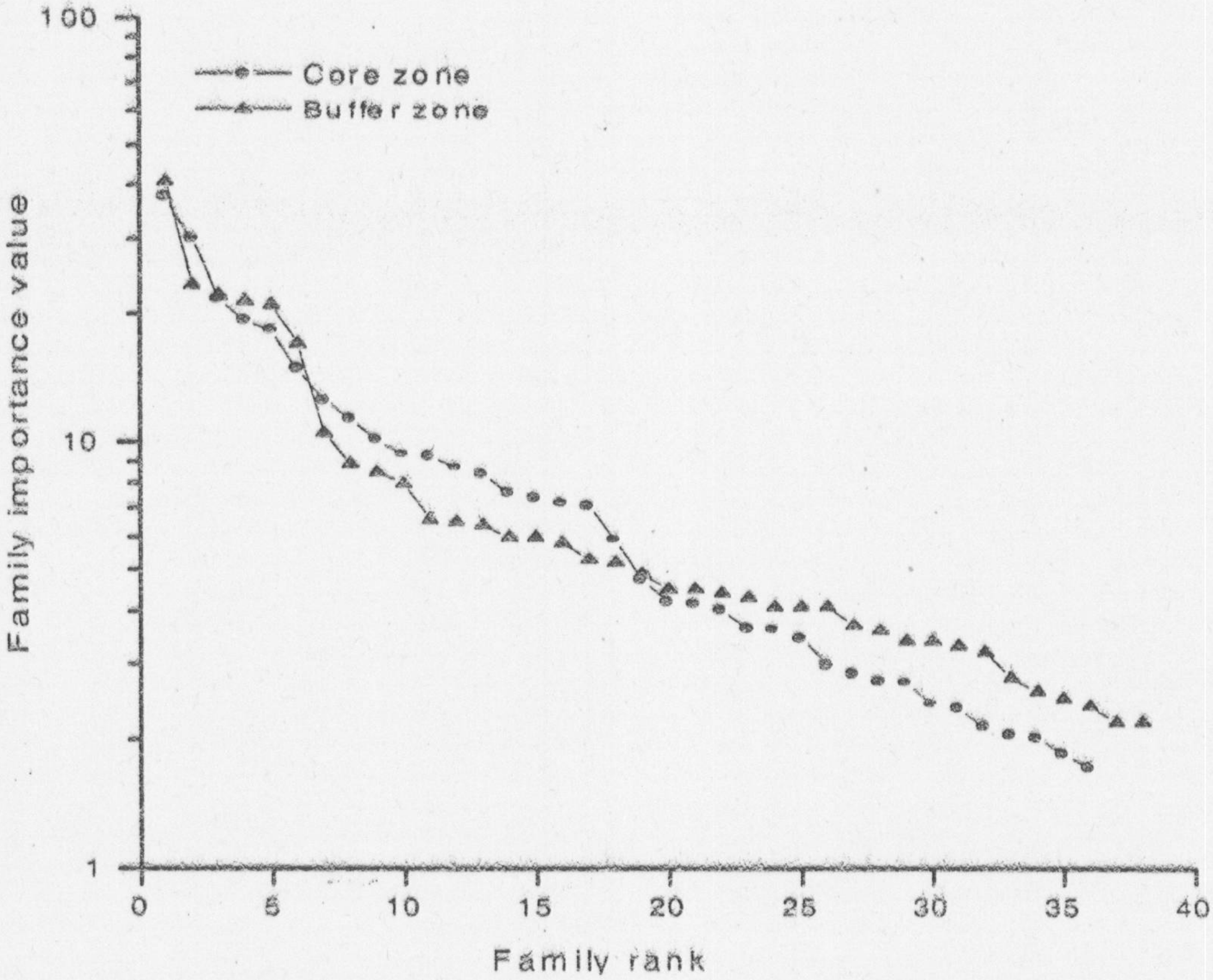

Fig. 1. Dominance-distribution in different families of tree species in the forest stands in core and buffer zones of the Nokrek biosphere reserve.

Table 1. Diversity, density (individual ha^{-1}) and importance value index (IVI) of the tree species recorded in the subtropical forest of the buffer and core zones of Nokrek biosphere reserve

Tree species	Family	Buffer zone		Core zone	
		Density	IVI	Density	IVI
Canopy species					
Albizia chinensis (Osb.) Merr.	Mimosaceae	–	–	14	4.7
Castanopsis tribuloides (Sm.) DC.	Fagaceae	–	–	28	9.5
Casearia kurzii Cl.	Flacourtiaceae	–	–	16	6
Celtis tetrandra Roxb.	Ulmaceae	10	2.7	–	–
Diospyros undulata DC.	Ebenaceae	3	0.9	–	–
Duabunga grandiflora Roxb.ex DC.	Sonneratiaceae	4	1	6	2.7
Dysoxylum gobara Buch.-Ham. Merr.	Meliaceae	10	2.2	18	8.4
Dysoxylum alliarium (Ham.) Balak	Meliaceae	–	–	4	2.8
Dysoxylum binectariferum Hk. f.	Meliaceae	–	–	13	4.7
Elaeocarpus floribundus Bl.	Elaeocarpaceae	10	3.5	–	–
Elaeocarpus rugosus Roxb.	Elaeocarpaceae	17	3.7	–	–
Engelhardtia spicata (Wall.) Kds.	Juglandaceae	27	8.6	–	–
Mesua ferrea Linn.	Clusiaceae	19	5.7	–	–
Paramichelia baillonii Pierre.	Magnoliaceae	–	–	2	0.7
Randia cochinchinensis (Laur.) Merr.	Rubiaceae	7	2.2	–	–
Sapium baccatum Roxb.	Euphorbiaceae	14	3.7	–	–
Schima wallichii (DC.) Korth.	Theaceae	15	4.7	–	–
Syzigium cumini (Linn.) Skeels	Myrtaceae	10	2.2	15	5.7
Syzyzium tetragonum Wall.	Myrtaceae	–	–	3	1
Talauma hodgsonii Hk. f. & Th.	Magnoliaceae	–	–	4	2.1
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	–	–	7	3.1
Terminalia citrina (Gaertn.) Flem.	Combretaceae	–	–	3	1.6

Tetrameles nudiflora R. Br.	Tetrameliaceae	–	–	11	4.2
Sub-canopy layer					
Acacia pruinescens Kurz.	Mimosaceae	–	–	14	3.1
Adinandra griffithii Dyer.	Theaceae	18	4.7	–	–
Aesculus assamica Griff.	Sapindaceae	10	2.5	–	–
Aphania rubra (Roxb.)	Sapindaceae	10	4.1	–	–
Aporusa oblonga Muell.-Arg.	Euphorbiaceae	–	–	8	3.7
Ardisia floribunda Wall.	Myrsinaceae	26	6.8	13	7
Beilshmiedia assamica Meissn.	Lauraceae	3	2.4	3	1.1
Bridelia retusa (Linn.) Spreng.	Euphorbiaceae	27	7.6	–	–
Callicarpa arborea Roxb.	Verbenaceae	20	10.1	3	1
Callicarpa vestita Wall. ex Cl.	Verbenaceae	38	12	–	–
Calophyllum polyanthum Choisy	Clusiaceae	15	4	13	3.4
Carallia brachiata (Lour.) Merr.	Myrtaceae	–	–	2	0.7
Caryota urens Linn.	Arecaceae	7	1.8	14	3.2
Casearia zeylanica (Gaert.) Thw.	Flacourtiaceae	6	1.6	–	–
Castanopsis indica A. DC.	Fagaceae	32	12.7	13	9.7
Castanopsis kurzii (Hance.) Biswas	Fagaceae	–	–	58	28.9
Castanopsis purpurella (Miq.) Bl.	Fagaceae	21	6.1	9	5.6
Cleidion spiciflorum (Burm.) Merr.	Euphorbiaceae	–	–	18	4.9
Derris robusta Roxb ex DC.	Fabaceae	–	–	23	5.2
Diospyros stricta Roxb.	Ebenaceae	–	–	15	7.4
Drimycarpus racemosus (Roxb.) Hk.f.	Anacardiaceae	7	2	10	2.7
Drypetes asamica (Hk. f.) Hoffm.	Euphorbiaceae	8	1.7	–	–
Echinocarpus murex Benth.	Elaeocarpaceae	–	–	8	3.2
Elaeocarpus acuminatus Wall.	Elaeocarpaceae	10	2.5	–	–
Elaeocarpus lancifolius Roxb.	Elaeocarpaceae	–	–	25	11.4

contd....

Table 1 ... *contd.*

Tree species	Family	Buffer zone		Core zone	
		Density	IVI	Density	IVI
Ficus elastica Roxb. ex Horneum.	Moraceae	–	–	18	8.1
Ficus oligodon Miq.	Moraceae	23	6.8	4	1.4
Garcinia cowa Roxb.ex DC.	Clusiaceae	13	3.9	3	1.5
Garcinia pedunculata G. Don.	Clusiaceae	10	3.1	1	0.6
Glochidion acuminatum Muell.-Arg.	Euphorbiaceae	–	–	8	3.3
Ilex venulosa Hk.f.	Aquifoliaceae	–	–	2	0.7
Kydia calycina Roxb.	Malvaceae	–	–	16	5.7
Lindera caudata Benth.	Lauraceae	–	–	2	0.7
Lindera latifolia Hk. f.	Lauraceae	14	4.8	–	–
Litsea cubeba (Lour.) Pers.	Lauraceae	4	1.2	8	1.9
Litsea laeta Wall. ex Nees	Lauraceae	12	3	–	–
Macaranga denticulata (Bl.) Muell.	Euphorbiaceae	–	–	18	4
Macaranga indica Wt.	Euphorbiaceae	19	10.7	–	–
Macropanax undulates Wall.	Araliaceae	9	3.3	14	3.7
Mallotus philippensis (Lam.)	Euphorbiaceae	10	3.4	–	–
Micromelum integerrimum Wt.	Rutaceae	3	0.7	3	0.9
Myrica esculenta Buch.-Ham.	Myricaceae	7	1.9	–	–
Neolitsea cassia (Linn.) Kosterm.	Lauraceae	10	2.5	–	–
Ostodes paniculata Bl.	Euphorbiaceae	14	4.7	–	–
Persea duthiei King. ex Hk. F.	Lauraceae	–	–	25	7.1
Persea gamblei (King. ex Hk. f.)	Lauraceae	23	7.3	5	1.7
Picrasma javanica Bl.	Simaroubaceae	–	–	4	1.1
Polyalthia simiarum Hk. f. & Th.	Annonaceae	8	2.1	–	–
Premna bengalensis Cl.	Verbenaceae	–	–	3	1.2

Prunus nepaulensis (Ser.) Steud.	Rosaceae	15	4.7	–	–
Randia cochinchinensis Lour. Merr.	Rubiaceae	–	–	6	1.9
Randia wallichii Hk. f.	Rubiaceae	–	–	4	1.5
Saprosma ternatum Hk. f.	Rubiaceae	27	6.4	–	–
Sarcosperma arboreum Cl.	Sapotaceae	10	3.7	–	–
Sarcosperma griffithii Cl.	Sapotaceae	3	1	–	–
Sterculia hamiltonii (O. ktz.) Adelb.	Sterculiaceae	23	5.5	4	1.1
Symplocos lucida Thunb.	Symplocaceae	–	–	5	1.6
Symplocos racemosa Roxb.	Symplocaceae	–	–	6	2.1
Syzygium sp.	Myrtaceae	7	2.4	–	–
Syzygium tetragonum (Wt.) Kurz	Myrtaceae	6	1.6	–	–
Turpinia pomifera (Roxb.) DC.	Sapindaceae	4	1	–	–
Tree-let layer					
Antidesma acidum Reitz.	Euphorbiaceae	–	–	8	3.5
Antidesma acuminatum Wall.	Euphorbiaceae	–	–	14	6.7
Aporusa aurea Hk. f.	Euphorbiaceae	–	–	2	0.7
Aporusa dioica (Roxb.) Muell.-Arg.	Euphorbiaceae	–	–	5	2.8
Aralia thomsonii Seem.	Araliaceae	–	–	7	1.8
Ardisia virens Kurz.	Myrsinaceae	7	2.4	–	–
Baccaurea ramiflora Lour.	Euphorbiaceae	8	1.8	11	3.1
Beilshmeidia roxburghiana Nees.	Lauraceae	7	1.9	–	–
Camellia caudata Wall.	Theaceae	–	–	13	4.3
Capparis acutifolia Sm.	Capparidaceae	4	0.8	11	3.3
Cinnamonum pauciflorum Nees.	Lauraceae	11	2.5	–	–
Citrus hystrix DC.	Rutaceae	30	9.2	6	1.5
Daphne involucrata Wall.	Thymeliaceae	–	–	7	2.7
Desmos chinensis Lour.	Annonaceae	12	3.4	–	–
Diospyros kaki Thunb.	Ebenaceae	3	0.6	–	–

contd....

Table 1 ... *contd.*

Tree species	Family	Buffer zone		Core zone	
		Density	IVI	Density	IVI
Diospyros toposia Ham.	Ebenaceae	4	1.1	–	–
Euonymus lawsonii Cl. & Pr.	Celastraceae	10	2.6	7	2
Eurya acuminata DC.	Theaceae	4	1.2	–	–
Ficus elmeri Merr.	Moraceae	17	5.8	3	1
Ficus nervosa Heyne. ex Roth.	Moraceae	–	–	7	3.1
Garcinia lancifolia (G. Don.) Roxb.	Clusiaceae	26	6.7	–	–
Glochidion assamicum Hk. f.	Euphorbiaceae	3	0.8	3	1
Glycosmis arborea (Roxb.) DC.	Rutaceae	–	–	9	3.9
Helicia excelsa Bl.	Proteaceae	19	4	–	–
Helicia nilagirica Bedd.	Proteaceae	10	2.5	–	–
Litsea lancifolia Roxb. ex Nees.	Lauraceae	11	3.2	14	2.8
Litsea salicifolia Roxb. ex Nees.	Lauraceae	13	4.1	14	5.7
Maesa indica (Roxb.) Wall.	Myrsinaceae	13	5.3	14	4.5
Oriocnide frutescens Thunb.	Urticaceae	–	–	1	0.4
Oriocnide integrifolia (Gaud.) Miq.	Urticaceae	2	0.5	4	1.5
Phoebe lanceolata (Nees.) Nees	Lauraceae	15	4.6	19	4.3
Photinia notoniana Wt. & Arn.	Rosaceae	12	3.1	–	–
Prunus undulata Buch.-Ham.	Rosaceae	11	3.8	–	–
Psychotria denticulata Wall.	Rubiaceae	–	–	4	1.1
Psychotria symplocifolia Kurz.	Rubiaceae	10	3.1	20	6.7
Rhus acuminata DC.	Anacardiaceae	–	–	3	1.4
Saurauia nepaulensis DC.	Saurauiaceae	8	3.8	2	0.5
Saurauia roxburghii Wall.	Saurauiaceae	–	–	1	0.4
Skimmia laureola (DC.) Sieb.	Rutaceae	–	–	3	0.7
Sterculia hamiltonii (O.) Ktze.	Sterculiaceae			2	0.7

Sterculia roxburghii Wall.	Sterculiaceae	–	–	1	0.4
Symplocos paniculata Thunb.	Symplocaceae	–	–	20	8.2
Syzyzium formosum Wall.	Myrtaceae	–	–	4	1.6
Trevesia palmata (Roxb.) Vis.	Araliaceae	2	0.4	–	–
Vatica lanceaefolia Bl.	Sapindaceae	–	–	16	5.4
Vernonia volkameriifolia DC.	Asteraceae	6	1.6	–	–
Viburnum coriaceum Bl.	Caprifoliaceae	11	3	–	–
Viburnum odoratissimum Ker.	Caprifoliaceae	–	–	3	0.8
Viburnum simonsii Hk. f. & Th.	Caprifoliaceae	–	–	2	0.7
Zizyphus mauritiana Lamk.	Rhamnaceae	–	–	2	0.5
Zizyphus rugosa Lamk.	Rhamnaceae	–	–	3	1.3

normal distribution pattern (Fig. 2), signifying high equitability and low dominance in the community.

Majority (70–75%) of the tree species in the forest were contagiously distributed. Out of 81 and 87 tree species, only 4–12 species showed regular distribution (Tripathi, 2002). Greater proportion of contagiously distributed tree species made the forest community highly patchy in nature. In both the stands majority of tree species (54% to 62%) had low frequency (<20%) (Fig. 3). *Saprosma ternatum*, *Macaranga indica*, *Citrus hystrix*, and *Castanopsis indica* in the buffer zone and *Syzygium cuminii*, *Elaeocarpus lancifolius*, *Glycosmis arborea*, *Dysoxylum binectaeriferum* and *C. kurzii* in the core zone were among the frequently found tree species in the community.

Stand density, basal cover and diversity indices

The tree density was 1023 and 834 stems ha^{-1} in the buffer and core zone stands, respectively. The basal cover in the buffer zone

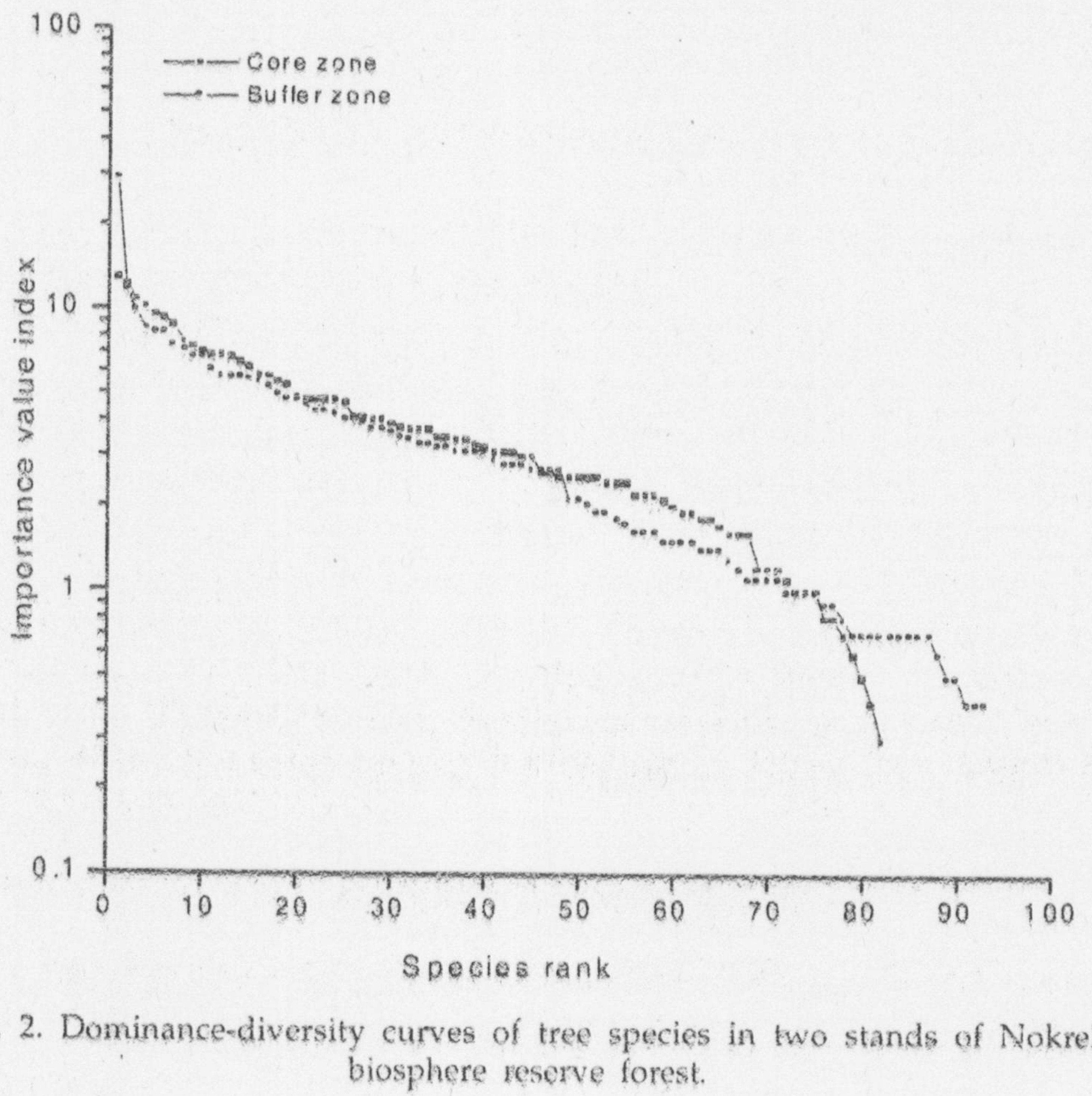

Fig. 2. Dominance-diversity curves of tree species in two stands of Nokrek biosphere reserve forest.

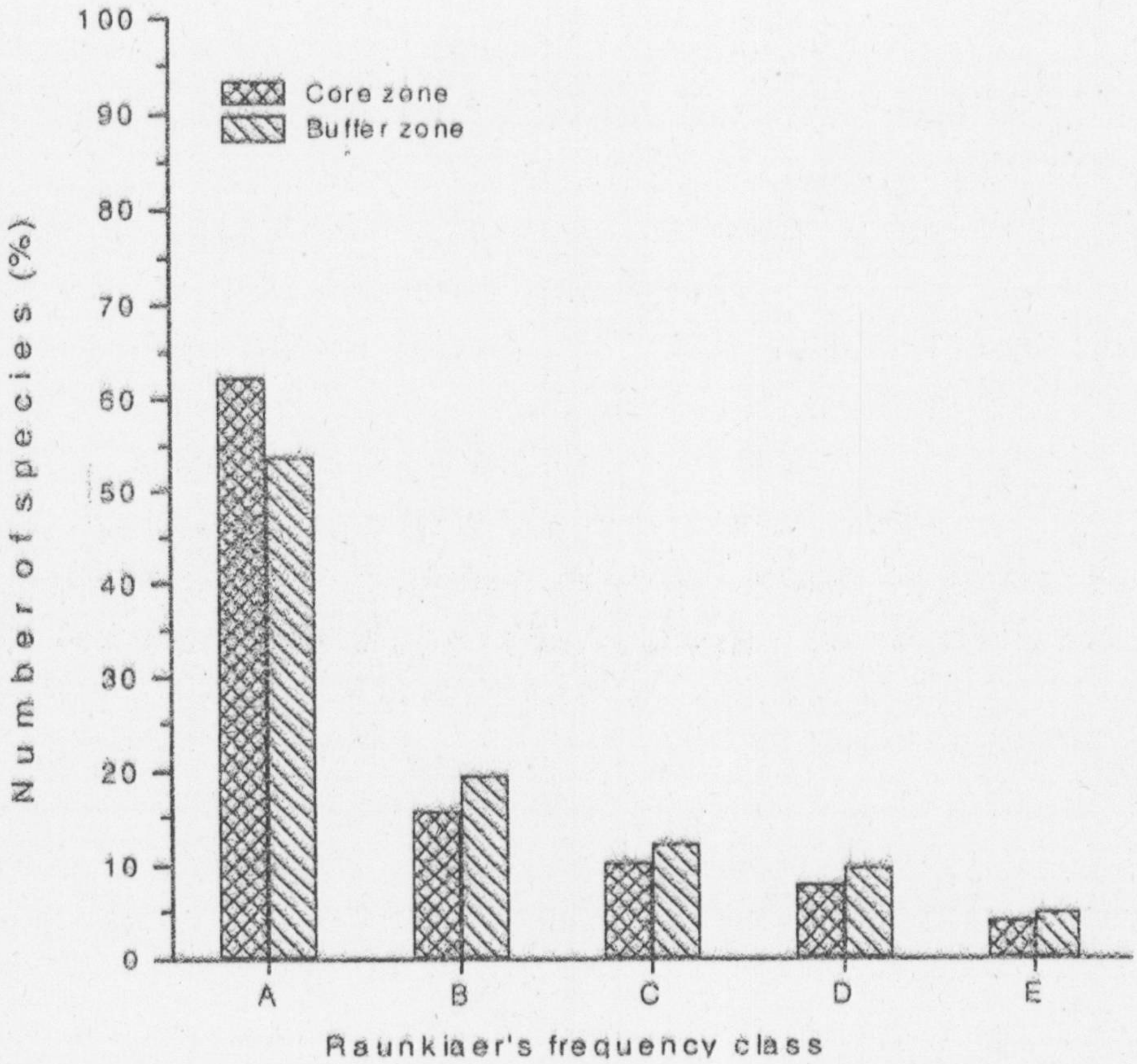

Fig. 3. Distribution of tree species in different frequency classes in two stands of the subtropical evergreen forest.

forest stand was 33.3 m^2 ha^{-1} and 38.8 m^2 ha^{-1} in the core zone forest stand (Table 2). In terms of density, *Callicarpa vestita*, *Castanopsis indica*, *Citrus hystrix* and *Engelhardtia spicata* in the buffer zone and *C. kurzii*, *Elaeocarpus lancifolius*, *Persea duthiei* and *C. tribuloides* in the core zone were dominant tree species.

Sorensen's index of similarity for trees between the two stands was about 17% and Whittaker's β-diversity was 0.80%. Low similarity index and high β-diversity index between the stands suggest marked difference in the species composition of the stands (Tripathi, 2002). But Shannon diversity index, Margalef species richness index and Pielou evenness index were high and Simpson dominance index was low in both the stands (Table 2).

Distribution of stand density in different girth classes revealed that trees of lower girth (15–55 cm cbh) accounted for 62% and 70% of the total stand density in the core and buffer zone forest stands. Trees beyond >95 cm girth class accounted for only 5% and 7% of the total stand density in the buffer and core zones, respectively (Fig. 4a). Distribution of basal cover in different girth classes

Table 2. Tree species characteristics in the forest stands in the buffer and core zones of Nokrek biosphere reserve, Meghalaya

Variables	Buffer zone	Core zone
Area sampled (ha)	1.2	1.2
Density ha^{-1}	1023	834
Basal cover (m^2 ha^{-1})	33.3	38.8
Species richness	82	93
Number of genera	63	65
Number of families	36	39
Shannon diversity index	4.2	4.2
Margalef species richness index	11.7	13.7
Pielou evenness index	0.95	0.92
Simpson dominance index	0.02	0.02

showed a reverse trend, that is, trees of higher girth classes, though less in number, contributed maximum (36%) basal cover in the core zone followed by individuals of middle girth class (55–95 cm cbh). In the buffer zone stand, middle girth classes contributed maximum (42%) to the basal cover followed by trees of higher girth classes (Fig. 4b).

Discussion

The floristic composition and community characteristics of the subtropical forest on one hand show similarity to the comparable sites elsewhere in the world and on the other hand exhibit dissimilarity in other attributes. For instance, Gentry (1988) have reported 300 tree species from 1-hectare area and Valencia *et al.*, (1994) have reported 473 tree (>5 cm dbh) species from 1-hectare area of Amazonian forest. Compared to these values tree species (82–93 species) richness of present study sites is very low. The values are comparable with those of seasonal dry evergreen forest of Thailand (76–100 species from 1 ha, Bunyavezchewin 1999) and Gamma gallery forest (87 species from 1 ha, Felfili and Maria, 1995).

The families' dominance in the NBR forest stands was similar to Pasoh reserve forest (Manokaran *et al.*, 1991) and tropical evergreen forest of Western Ghats where Lauraceae, Moraceae, Euphorbiaceae and Rubiaceae are reported to be the dominant families. Majority of species in both the forest stands had low frequency and showed contagious/clumped distribution, therefore, making the community highly heterogeneous and patchy. Several

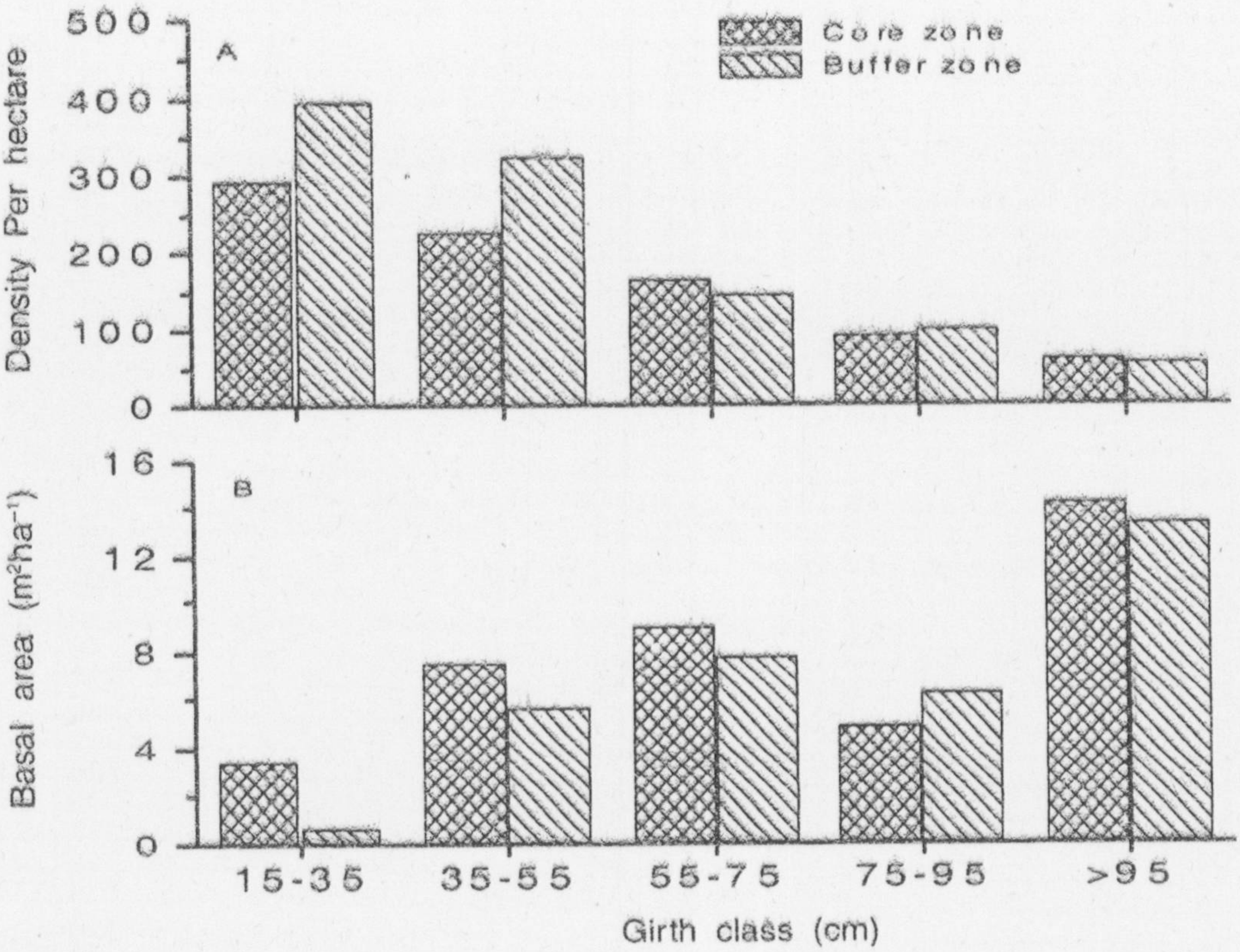

Fig 4. Distribution of density (A) and basal cover (B) in different girth classes in the core and buffer zone forest stands of Nokrek biosphere reserve.

factors contribute to the clumped distribution of species, notable among them are insufficient mode of seed dispersal (Richards, 1996) and gap formation due to natural disturbance (Armesto *et al.*, 1986). The lognormal dominance-distribution curves, as found in the stands of present study, signify equitability and stability of the community (Magurran, 1988). It also indicates the maturity and complexity of the community.

The stand density of tree species in buffer zone was comparatively higher than the core zone stand primarily due to presence of large number of young individuals. The tree density at the present study sites is comparable to the values reported by Pelissier and Riera (1993) from French Guyana (1168 stem ha^{-1}), Parthasarathy and Karthikeyan (1997) from Thirumanikkuzhi tropical evergreen forest, Western Ghats (974 stem ha^{-1}), Bunyavezchewin (1999) from seasonal dry evergreen forest, Thailand (1168 stem ha^{-1}), and Upadhaya *et al.* (2003) from subtropical evergreen forest, Jaintia hills (938–1476 stem ha^{-1}).

The undisturbed core zone had higher basal cover than the moderately disturbed stand of buffer zone of the biosphere reserve, primarily due to presence of large number of old trees in the stand. The tree basal cover is comparable with the results reported by Campbell *et al.*(1986) from Terrafirme (27.6–32 $m^2 ha^{-1}$), Campbell *et al.* (1992) from Brazilian Amazon (25.5–27 $m^2 ha^{-1}$), Valencia *et al.* (1994) from Amazonian rainforest (29.1 $m^2 ha^{-1}$), Pascal and Pelissier (1996) from tropical evergreen forest, Uppangala (39.7 $m^2 ha^{-1}$) and Bunyavejchewin (1999) from seasonal dry evergreen forest of Thailand (29.1 $m^2 ha^{-1}$).

The subtropical forest in the buffer zone of the biosphere reserve is subjected to human disturbances in the form of shifting cultivation and mining of coal and limestone. The changes in species composition and community charateristics observed in the buffer zone are therefore attributed to the disturbances caused due to these activities.

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