International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133; Print ISSN: 2664-7125; Impact Factor: RJIF 5.28
Received: 28-08-2020; Accepted: 14-09-2020; Published: 29-09-2020
Volume 2; Issue 4; 2020; Page No. 31-37

Floristic composition and population characteristic of woody species in community forest of Mawlyngbna, Meghalaya

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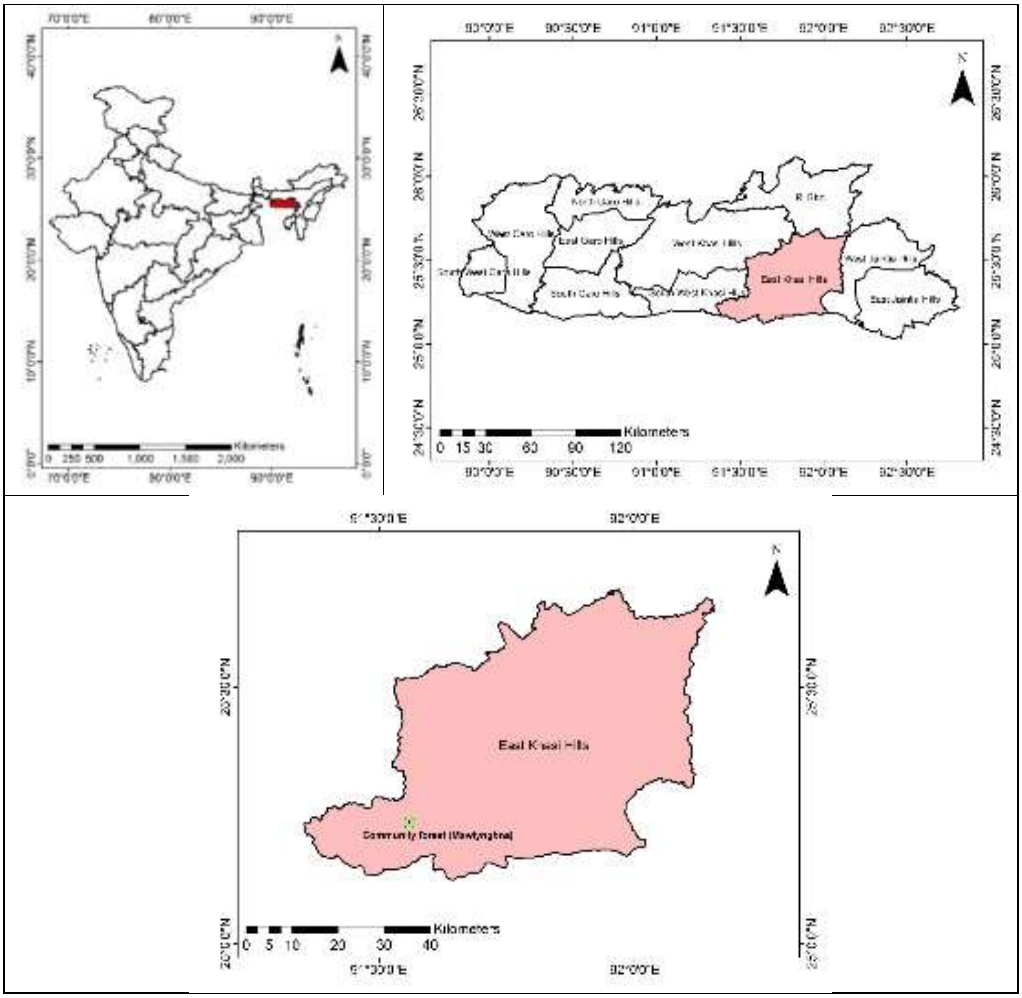
Abstract
Woody species diversity and population characteristics was investigated in Mawlyngbna, East Khasi Hills district, Meghalaya, North East India. The village located in Cherrapunjee- Mawsynram plateau, one of the wettest place on the planet. The study was carried out from January 2018 to December 2018. The woody species was sampled by laying fifty quadrats of $100m^2$ size randomly. During the investigation a total 38 species belonging to 33 genera and 22 families were recorded in the community forest of Mawlyngbna. Lauraceae, Fagaceae, and Euphorbaceae were the dominant families. Species diameter at breast height (dbh) ≥ 5 in the forest were individually counted, numbered and measured and their density per plot and frequency were estimated. Height of each tree were recorded using a rough estimation in all plots and were grouped into three height classes (large tree ≥ 15m, medium tree 8-15m, small tree < 8m).

Keywords: community forest, tree diversity, sub-tropical evergreen forest, species richness

1. Introduction
The structure and function of forest ecosystem is determined by the plant component more than any other living component of the system (Richards 1996) [31]. The plant diversity at any site is influenced by species distribution and abundance patterns (Palit & Chanda 2012) [22]. And the richness of plant species is controlled by a variety of biotic and abiotic parameters (Rannie 1986 [29]. Huston 1994) [8]. Millions of hectares of natural forests have been degraded by logging (Putz *et al*. 2000) [28]. And for agricultural uses (Lenne & Wood 1999) [14]. It is generally considered that human exploitation causes major changes in the biodiversity of these forests, even though research on this subject has been limited and results often controversial (Turner 1996) [37]. Whereas other studies have reported increase in species richness in secondary forests (Kappelle *et al*. 1995) [12].
Agroforestry is often viewed as an alternate land use management system that offers solutions to the problem of land and forest degradation and loss of biodiversity in the tropics (Oke and Odebiyi 2007) [21]. The northeast region of India is considered as one of the richest biodiversity centres of the Indian continent. The Meghalaya state (25°02' to 26°10'N latitude and 89°45' to 92°45' E longitude) in northeast India, comprising the Khasi, Jaintia and Garo hills, covers an area of 22429 km. According to Takhtajan (1988) [34]. It is the centre of origin of angiosperms. Meghalaya, a constituent of Indo-Burma biodiversity hot spot, harbours 3 128 species of angiosperms which include 1,237 endemic species and 53 threatened plant species (Khan *et al*. 1997) [13]. The biodiversity of primary forests of Meghalaya has been studied by workers like Upadhaya (2002) [40]. Jamir and Pandey (2003) [9]. And Tripathi *et al.* (2006). The people of the state have an old age tradition in preserving the forest as part of their culture and religious belief. These forest are biodiversity rich and harbours a great diversity of endangered and rare species of the region. The arecanut agroforests of south Meghalaya, northeast India, are good examples of multistrata agroforestry in which woody species provide products for human use which include fuelwood, food, medicine, spice, latex and timber (Tynsong & Tiwari 2010) [38]. The study was carried out in one of the community forest in Mawlyngbna East Khasi Hills District, Meghalaya. The community forest of the study site is reffered by the locals as Law adong or village restricted forest. Extraction of fuelwood and collection of minor forest products is allowed provided that they get prior permission from the village headman. The objective of this paper was to inventorize the plant diversiy of woody species in village restricted forest located in Mawlyngbna, East khasi hills district, Meghalaya.

2. Study Area
Vegetation diversity for woody species was carried out between Jan 2018 to December 2018 in community forest of Mawlyngbna. The village is located to the south of Meghalaya facing the plains of Bangladesh. The study area is located about 40 km from Mawsynram at an altitude of 889m a.s.l (latitude 25°14´ N, longitude 92°18´) and falls into the Mawsynram –Cherrapunji plateau which is the wettest region on the planet. Agriculture is very limited in the area and in such cases tuber crops are mainly grown. Arecanut, Broomgrass, bay leaf, are such produce which are important in the region. People also collect, process and market a huge amount of non-timber forest products (NTFPs and medicinal and aromatic plants (MAPs) which include *Piper peepuloides, Cinnamomum tamala, Phrynium capitatum,* bamboo shoots, bamboo, honey, nuts from the community forest. The natural vegetation of Meghalaya ranges from tropical evergreen to sub-tropical evergreen forests (Balakrishnan 1981-1983) [3]. The plant species in the forests are distributed in distinct vegetation layers. The important evergreen trees found in the region include: *Cinnamomum tamala*, *Myrica esculenta*, *Sarcosperma griffithii*, and *Syzygium tetragonum*.

Table 1



3. Methods

3.1 Floristic composition

The woody vegetation studies was carried out in the community forest of Mawlyngbna between January 2018 to December 2018 and was sampled by randomly laying fifty quadrats of 100m^2 size in the forest. Species diameter at breast height (dbh≥5cm) were counted and measured. Plant species were identified with the help of the Flora of Jowai (Balakrishnan 1981–1983) [3]. The Forest Flora of Meghalaya (Haridasan and Rao 1985–1987) [5]. And the Flora of Assam (Kanjilal *et al.* 1934-1940) [11]. The Herbaria of Botanical Survey of India, Eastern Circle, Shillong and Botany Department, NEHU, Shillong, were consulted for correct identification of plant specimens. The nomenclature of species follows the regional flora. (Balakrishnan 1981-1983 [3]. Haridasan & Rao 1985-1987 [5]. And Kanjilal *et al.* 1934-1940) [11]. The height of stems of each tree species were recorded by rough estimation in the plots and were grouped into three height classes (large tree ≥ 15 m, medium tree 8 - 15 m, small tree < 8 m) and seven dbh classes (5 - 15, 16 - 25, 26 - 35, 36 – 45cm,>46cm).

3.2 Data analysis

Community quantitative parameters such as frequency, density, abundance, basal area (BA), relative frequency, relative density, relative dominance and Importance Value Index (IVI) were calculated (Cottam & Curtis 1956). The density and basal area of each species were determined in different dbh classes according to Mueller-Dombois and Ellenberg (1974) [19]. Shannon- Wiener Index of Diversity (H') (Magurran 1988) [15]. Simpson Index of Dominance (D) (Simpson 1949) [32]. Pielou's Evenness Index (E) (Pielou 1975) [26]. Margalef's index (Margalef 1958) [16]. and Whit ford' index (Whit ford were calculated to analyze species diversity and dominance in the community. The importance value index was calculated by using the formula for tree: IVI = relative frequency + relative density + relative basal area (Misra 1968) [18].

3.3 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:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats studied}}$$

3.4 Frequency (%)

This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. It was studied by sampling the study area at several

places at random and recorded the name of the species that occurred in each sampling units. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which the species occured}}{\text{Number of quadrats in which the species occured}} \text{x100}$$

3.5 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:

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats in which the species occured}}$$

3.6 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 are summed up together and this value is designated as the Importance Value Index or IVI of the species (Curtis, 1959).

3.6.1 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:

$$\text{Relative density} = \frac{\text{Number of individual of the species}}{\text{Number of individuals of all the species}} \text{ X } 100$$

3.6.2 Relative frequency
The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative frequency} = \frac{\text{Number of occurrence of the species}}{\text{Number of occurence of all the species}} \text{ X } 100$$

3.6.3 Relative dominance
Dominance of a species is determined by the value of the basal cover. 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.

$$\text{Relative dominance} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} \text{ X } 100$$

The total basal area was calculated from the sum of the total diameter of immerging stems. In trees the basal area was measured at breast height (1.5m) and by using the formula $\pi r2$

4. Results
4.1 Species richness and distribution pattern
A total of 38 species belonging to 33 genera and 22 families were recorded in 0.5 ha plot in the community forest of Mawlyngbna. Lauraceae, Euphorbaceae and Eleocarpaceae were the dominant families. The trees were distributed into three different strata namely canopy (≥15m height), sub canopy (8-15m height) and under canopy (<8m height). Out of these 3 species were canopy trees (≥15m height), 8 were sub canopy trees (8-15m height) and 27 were under canopy trees (<8m height).

Table 1: Distribution of woody species richness (number) in community forest of Mawlyngbna

Growth forms	Community forest of Mawlyngbna
Canopy layer (15- 30 m height)	3
Sub canopy (8-15 m height)	8
Under canopy (<8 m height)	27
Total	38

4.2 Species diversity and dominance
Shannon–wiener's diversity index showed a value of 1.16 whereas Simpson's Dominance Index showed a value of 0.07, Margalef's index a value of 5 and Pielou's evenness index a value of 0.17 in the community forest of Mawlyngbna

Table 2: Summary of plant diversity and community characteristics of woody species (≥5cm dbh) in community forest of Mawlyngbna

Parameters	Values
Sampling Size	0.5
Number of families	22
Number of genera	33
Species richness	38
Density(per ha^{-1})	1530
Basel area (m^2 ha^{-1})	0.08
Diversity indices	Values
Pielou's evenness index	0.17
Shannon diversity index	1.16
Simpson dominance index	0.07
Margalef'index	5

Table 3: Frequency%, Density (number of plants per hectare) and IVI of woody species (≥5cm dbh) in community forest of Mawlyngbna

Scientific names	Family	Frequency	Density	IVI
Castanopsis indica	Fagaceae	100	528.0	47.84
Schima wallichii	Theaceae	100	166.0	24.18
Ostodes peniculata	Euphorbiaceae	50	64.0	10.85
Castanopsis purpurella	Fagaceae	24	28.0	5.03
Syzygium trtragonum	Myrtaceae	26	36.0	5.82
Cinamomum tamala	Lauraceae	26	30.0	5.43
Macaranga sp	Euphorbiaceae	4	4.0	0.79
Betula alnoides	Betulaceae	36	48.0	7.94
Cornus macrophylla	Cornaceae	34	52.0	7.93
Clerodendrum viscum	Verbenaceae	10	12.0	2.12
Lithocarpus elegans	Fagaceae	8	10.0	1.72

Syzygium cumini	Myrtaceae	24	36.0	5.55
Ilex ordorata	Aquifoliaceae	12	14.0	2.52
Styrax serrulatum	Styraceae	20	34.0	4.89
Helicia sp	Hernandiaceae	4	4.0	0.79
Alchornea tiliaefolia	Euphorbiaceae	4	4.0	0.79
Sympholus theaefolia	Symplocaceae	4	4.0	0.79
Melastoma sp	Melastomataceae	4	4.0	0.79
Michelia punduana	Magnoliaceae	8	8.0	1.59
Ardisia sp	Myrsinaceae	4	4.0	0.79
Persea sp	Lauraceae	2	2.0	0.40
Photina cuspidate	Rosaceae	30	32.0	6.09
Myrica esculenta	Myricaceae	24	32.0	5.29
Meyna laxiflora	Rubiaceae	8	8.0	1.59
Eurya sp	Theaceae	14	14.0	2.78
Casseria glomerulata	Flacourtiaceae	6	6.0	1.19
Cinamomum bejolghata	Lauraceae	8	8.0	1.59
Persea parviflora	Lauraceae	4	4.0	0.79
Elaecarpus lancifolius	Elaeocarpaceae	66	140.0	17.95
Osbeckia stellate	Melastomataceae	2	18.0	1.44
Lasianthus sp	Rubiaceae	14	26.0	3.57
Litsea leata(rare)	Lauraceae	6	10.0	1.45
Vaccinium vacciniaceae	Vacciniaceae	12	24.0	3.17
Ilex graffithii	Aquifoliaceae	8	14.0	1.98
Michelia sp.	Magnoliaceae	6	8.0	1.32
Euyya acumynata	Theaceae	12	26.0	3.30
Wendlindia paniculata	Rubiaceae	12	44.0	4.48
Garcinia tinctoria	Clusiaceae	14	24.0	3.44

Table 4: percentage distribution of species in Raunkier's frequency classes in community forest of Mawlyngbna

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Raunkier frequency class	A	B	C	D	E
Community forest	67	21	3	3	6

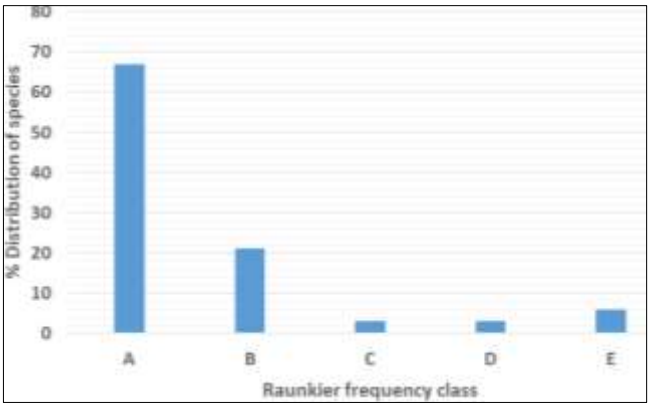


Fig 1: Percentage distribution of species in different classes of Raunkier's Frequency class

Table 5: Percentage distribution of species in showing different dispersion patterns (based on Whitford's index) in community forest of Mawlyngbna

Whitford's index	Regular	Random	Clumped
community forest	8%	20%	72%

Fig 2: Percentage distribution of dispersion of species based on Whitford's Index

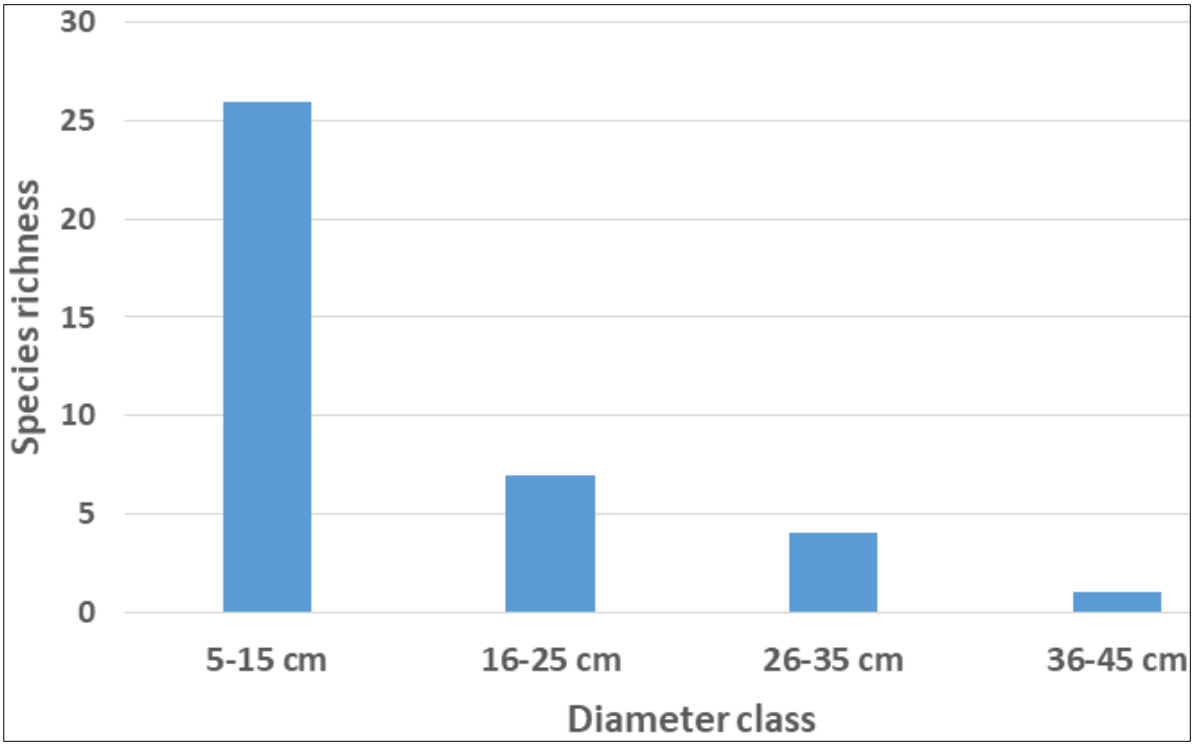
Table 6: Density (individuals/0.5 ha) and Important value index (IVI) of woody species (≥5cm dbh) in community forest of Mawlyngbna

Plant species	Family	Growth form	Density	IVI
Castanopsis indica	Fagaceae	Large size tree	528	53.8
Schima wallichii	Theaceae	Large size tree	166	30.1
Ostodes peniculata	Euphorbiaceae	Large size tree	64	13.5
Castanopsis purpurella	Fagaceae	Large size tree	28	8.0
Syzygium trtragonum	Myrtaceae	Medium size tree	36	8.5
Cinamomum tamala	Lauraceae	Medium size tree	30	8.8
Macaranga sp	Euphorbiaceae	Medium size tree	4	11.9
Betula alnoides	Betulaceae	Medium size tree	48	20.8

Cornus macrophylla	Cornaceae	Medium size tree	52	9.5
Clerodendrum viscum	Verbenaceae	Small size	12	2.4
Lithocarpus elegans	Fagaceae	Large size tree	10	5.6
Syzygium cumini	Myrtaceae	Large size tree	36	7.2
Ilex ordorata	Aquifoliaceae	Small size	14	2.8
Styrax serrulatum	Styraceae	Small size	34	6.4
Helicia sp	Hernandiaceae	Medium size tree	4	9.1
Alchornea tiliaefolia	Euphorbiaceae	Small size	4	1.0
Sympholus theaefolia	Symplocaceae	Medium size tree	4	1.0
Melastoma sp	Melastomataceae	Small size	4	1.0
Michelia punduana	Magnoliaceae	Medium size tree	8	2.7
Ardisia sp	Myrsinaceae	Small size	4	1.1
Persea sp	Lauraceae	Medium size tree	2	0.7
Photina cuspidata	Rosaceae	Medium size tree	32	10.3
Myrica esculenta	Myricaceae	Medium size tree	32	16.2
Meyna laxiflora	Rubiaceae	Medium size tree	8	4.3
Eurya sp	Theaceae	Small size	14	3.1
Casseria glomerulata	Flacourtiaceae	Medium size tree	6	3.7
Cinamomum bejolghata	Lauraceae	Large size tree	8	4.4
Persea parviflora	Lauraceae	Medium size tree	4	1.4
Elaecarpus lancifolius	Elaeocarpaceae	Large size tree	140	20.9
Osbeckia stellata	Melastomataceae	Small size	18	1.7
Lasianthus sp	Rubiaceae	Small size	26	3.9
Litsea leata(rare)	Lauraceae	Medium size tree	10	1.9
Vaccinium vacciniaceae	Vacciniaceae	Small size	24	4.0
Ilex graffithii	Aquifoliaceae	Small size tree	14	2.3
Michelia sp.	Magnoliaceae	Medium size tree	8	2.2
Euyya acumynata	Theaceae	Small size	26	3.7
Wendlindia paniculata	Rubiaceae	Small size	44	6.3
Garcinia tinctoria	Clusiaceae	Medium size tree	24	3.8

4.3 Density

The density in the community forest is 1530 individuals' $ha^{-1.}$ At Mawlyngbna, *Castanopsis indica* (225 stem $ha^{-1),}$ *Schima wallichii* (61 stem ha^{-1}) and *Elaecarpus lancifolius* (58 stem ha^{-1}) had the highest density and their density was found out to be 22% of the total stand density. Distribution of species richness in different classes showed high richness in 5-15cm and 16-25 cm dbh classes. Density and basal area of species per hectare was seen to be high in 16-25 cm dbh class



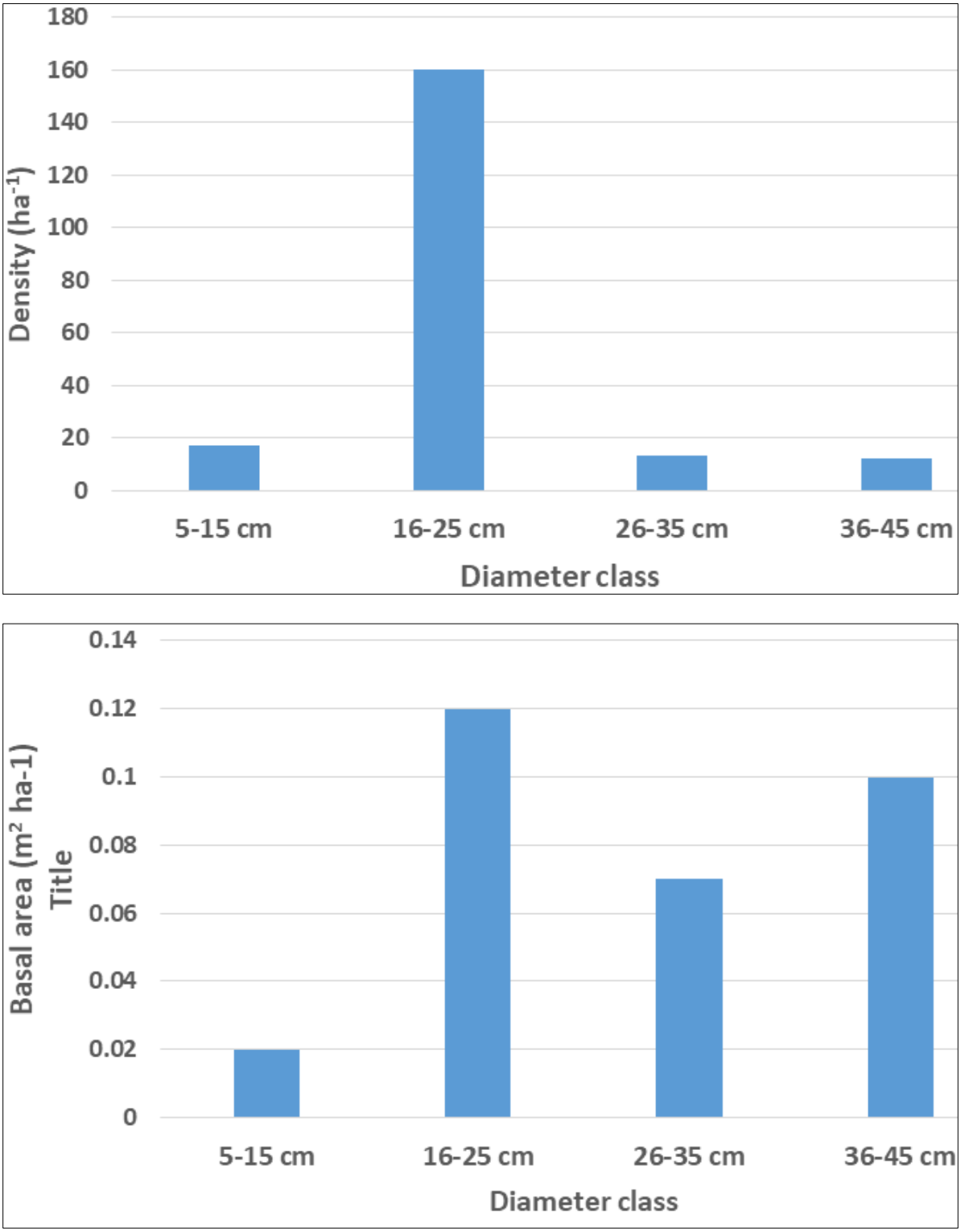


Fig 3: Distribution of species richness, density and basal area in different diameter class in the community forest of Mawlyngbna

5. Discussion

The community forest of Mawlyngbna are multi layered sub-tropical evergreen forest comprising of large trees, medium trees and small trees. The canopy, sub-canopy and undercanopy layers were composed of large (15 - 30 m height), middle-sized (8 - 15 m height) and small (< 8 m height) trees, respectively. High species richness of the sub-and under-canopy layers is due to the presence of individuals of canopy species, which are either young or whose growth was arrested due to heavy shade by the overhead canopy (Jamir *et al*. 2006) [10]. Similar observation has been reported by Upadhaya *et al*. (2003) [41]. From two sub-tropical humid forests of Jaintia Hills district of Meghalaya and Quigley & Platt (2003). High species richness in the natural forest is because of the geographical locations of north-eastern region at

the influence of Indo-Malayan and Indo Chinese biogeographical region and protection by the people over a long period of time. Species richness in the community forests is comparable to tropical semi-evergreen forest of Western Ghats, India, with 107 tree species (Kanade *et al*. 2008) and other sub-tropical humid forests of Meghalaya ranging from 133 (Mishra *et al*. 2005) [17]. To 159 (Upadhaya *et al*. 2003) [41].

The Shannon weiner diversity index is comparatively less than that reported by Tynsong (2011) from natural forest of south Meghalaya and Upadhya *et al* (2003) and Mishra *et al*. (2005) [17]. The low Shannon weiner diversity value of the forest indicates that the ecological structure is less complex (Odum 1971) [20]. Small sampling size and disturbance impact may also be one of the factor for the low value of diversity index (Tripathi and Khongjee 2010) [36].

Lauraceae and Euphorbiaceae were the dominant and co-dominant woody species families in the studied community forest. This results is similar to that of Upadhaya *et al*. (2003) [41]. And Mishra *et al*. (2005) [17]. who also recorded Lauraceae and Euphorbiaceae as dominant and co-dominant families in the sub-tropical humid forests of Meghalaya. The density distribution of woody species, the community forests are similar to evergreen forests of southern India (Parthasarathy and Sethi 1997) [23]. And Western Ghats (Ayyappan and Parthasarathy 1999) [24].

Since the majority of the species was contagiously distributed and frequency class A was dominant, indicating that the community forest were highly heterogeneous and patchy in terms of species distribution. Poore (1968) [27]. Ashton (1969) [2]. And Herwitz (1981) [6]. Have described tropical rain forests as highly patchy communities, primarily due to gap phase dynamics. Clumping of individuals of the same species is often clearly related to gap formation and dispersal mechanism of the species. Armesto *et al*. (1986) [1]. Compared the dispersion pattern of trees in tropical and temperate climates in different parts of the world and concluded that clumping was characteristic of forest in which formation of canopy gaps was the chief source of disturbance. Hubbell (1979) [7]. In dry tropical forest, observed that all species were either clumped or randomly dispersed, with rare species more clumped than common species. The species represented by one or two individuals in the study plot have been considered as rare species. The number of individuals of such species is probably kept low by a combination of unfavourable regeneration conditions, lack of appropriate habitat, or both (Hubbell 1979) [7].

Abundance of young individuals in the forest, a characteristic feature of vegetation on moist and infertile soil (Coomes and Grubb 2000) [11]. Indicates a slow rate of seedling and sapling growth in the understorey and a relatively low rate of seedling mortality. This may also be due to tree-fall gaps having a varied micro environmental variability (Rao *et al*. 1997) [30]. Which might have favoured the tree species having different regeneration requirements (Phillips *et al*. 1994) [25].

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