



## RESEARCH PAPER

## OPEN ACCESS

**Diversity and distribution of tree species in the hills of Chittagong Metropolitan Area, Bangladesh****Md Nezam Uddin, Ohidul Alam\*, Mohammad Main Uddin, ATM Rafiqul Hoque, Khaled Misbahuzzaman***Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong – 4331, Bangladesh***Key words:** Biodiversity; Distribution; Density; Frequency; Important Value Index.

Article published on April 11, 2015

**Abstract**

Chittagong City is surrounded by several hills which were abundant with biodiversity but continuously destroying now due to high population pressure and development. To explore current status of species diversity and distribution, we conducted this study from November, 2013 to October, 2014 in Chittagong Metropolitan Area (CMA). Wherein 780 trees belong to 65 species were recorded from 45 random sample plots amidst 9 selected hills. We took 5 plots (10 m×10 m) from each hill and 28 families were recorded where to the Mimosaceae family is dominated with 12 species. The highest average number of tree individual was detected 3700 ha<sup>-1</sup>, which occurred in the Finley Hill. Contrary, the lowest average number of tree individual was 500 ha<sup>-1</sup> in the Ispahani Hill. Likewise, the highest average Basal Area (BA) was 467.59 cm<sup>2</sup> ha<sup>-1</sup> in Probortok Hill wherein *Swietenia macrophylla* is the dominant species. Contrary, the lowest average BA was 289.53 cm<sup>2</sup> ha<sup>-1</sup> in Batali Hill whereas *Acacia auriculiformis* is the dominant species. The highest average Diameter at Breast Height (DBH) of the trees was identified 24.4 cm in Probortok Hill and the lowest DBH was 17.3 cm in Dhampara Hill. The highest average height of the trees was 16.85 m in Jilapi Hill and the lowest average height of the trees was 12.30 m in Chittagong Railway (CRW) Hill. Amid all the studied species the largest Important Value Index (IVI), Relative Frequency (RF), Relative Density (RD), and Relative Dominance (RDo) were found in *Acacia auriculiformis* viz. 67.44%, 4.30%, 33.94%, and 29.20% subsequently.

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## Introduction

Biological Diversity' or 'Biodiversity' simply means the diversity or variety of flora and fauna which means abundance of different species living within a particular region (CBD, 1992). Contrary, the scientists refer biodiversity as an ecosystem or a natural area made up of a community of plants, animals, and other living beings in a specific physical and chemical environment. Thereto, biodiversity has become one of the most popular topics for discussion of scientific and political issues at different level (Boontawee *et al.*, 1995; Dallmeier *et al.*, 1992). The main concern of biodiversity measurement and conservation is the benefit of social and economic development. Further, each species of vegetation and each creature have a place on the earth and play a vital role in the circle of life. Maintaining a wide diversity of species in each ecosystem is necessary to preserve the web of life that sustains all living beings (Douglas, 1982; GOB, 2004). Apart from, plant diversity is a part of quantitative structure of plant community. Consequently, we can know the Relative Frequency (RF), Relative Density (RD), Relative Dominance (RDo), abundance and Importance Value Index (IVI) of a particular plant in the existing area. The concept of biodiversity is concerned with the total number of species in a community (species richness) and how individuals were distributed amid them (equitability) (Kikkawa, 1986; Hassan, 1995). The diversity of life forms in the biosphere, from the bottom of peak mountain to sea, from deserts to tropical mangroves are so numerous that we have hereto to identify most of them (Shrestha, 1999).

Different organizations and educational institutions viz. Forest Department, Forestry and Biological Science Departments of several universities in Bangladesh meantime have undertaken a limited flora and fauna survey, which have given a segmented and partial view of species distribution and their RDo in certain ecosystem (Hossain, 2001; Khan, 1977). However, lately some of the conservation groups, societies and Non-government Organizations (NGO's) are coming forward to evaluate the status of species

and to ascertain if they are endangered or threatened (Anon, 2003). Chittagong is an important city in Bangladesh with full of natural beauty which is surrounded by fertile lands, beautiful countryside's, hills and rivers. Hence, many eminent taxonomists and plant explorers came to Bengal and studied here. Their visit and exploration laid strong foundation of floristic research of ever-green city, Chittagong (Anon, 2003; Anon, 1992). In Bangladesh, the forest growth performance is very low than other forested countries in the world and the estimated average annual forest growth is  $2.5 \text{ m}^3 \text{ ha}^{-1}$  (Islam, 2003). Despite of low growth rate, the forest contributes to the national Gross Domestic Product (GDP) to 3.28% (BBS, 1994). But the supply of various forest products such as timber, poles, fuel wood, bamboo, etc. cannot meet the present demand. Contrary, village forest areas, being one-tenth of the national forest area, supply 70% of saw-logs, 90% of fuel wood and 90% of bamboo consumption of the country (Douglas, 1982; Rahman, 2002). In Chittagong, Chittagong Medical College (CMC) Hill, Probortok Hill, and Finley Hill regions are with high diversity in geological substrates ranging from basic sedimentary strata to acidic metamorphic and granitic strata including patterns of climate and geological history. Thereto, it involves hill uplift, urbanization, and several sequences of hill slopes and recessions which affect biodiversity distribution. All these factors have acted as evolutionary selection forces on the potential floras originating not only from the north but also from the east (Panchlaish), the west (Dampara) and the south (Tigerpass); which have given rise to the floristic diversity that are presence still (Anon, 1992). However, these hills are very important for the existence and sustainability of green environment of Chittagong Metropolitan Area (CMA). If these hills were managed properly, taking reforestation programs annually including protection there would create vast tree species diversity (Anon, 2003; Anon, 1993). In 2003-04 year, the Chittagong Development Authority (CDA) planted some species in the barren hills of CDA boundary. Only a few of them are available now in the plantation area where most of

them are destroyed. This plantation program was not successful because of undeliberate plantation and dearth of appropriate management. Moreover, the tree composition of a few hills (private management authority) is denser than public ones. Therefore, we attempted to detect the differences of tree species composition between under private and public authority management (Hossain, 2001; Hassan, 1995).

Contrary, an ideal country requires about 25% forest coverage landmass but there was a 21% vegetation coverage area in Bangladesh afterwards the liberation war. Unfortunately, it was gradually destroyed mainly by political leaders and corrupted forest department officers. Currently, people are started to realize the importance of forest and biodiversity for conservation and protection of natural environment and ecosystem but it's too late (FRA, 2010; GOB, 2002). Besides, it is not easy to alter any long time formed habit, therefore this malpractice is still continuing indiscriminately. Consequently, forest coverage land has stood 11.1% now (FAO, 2006) and a lot of rare and valuable species have already been extinct from Chittagong and Bangladesh which have great ecological significance. It is a matter of joy that in private owned land floral diversity and density are rising up. Therefore, it has stood urgent appropriate information and strategies to shift all public hills to under private management authority to rehabilitate existing barren hills.

## Materials and methods

### *Study Area Selection*

We selected CMA as study area which is located between 22°22'0"N and 91°48'0"E on the banks of the Karnaphuli River. From all the hills of CMA, we studied 9 hills paradigm Batali Hill, CRW Hill, Dampara Hill, CMC Hill, Probortok Hill, Hatirbangla Hill, Zilapi Hill, Finley Hill, and Ispahani Hill. The fieldwork was conducted over a period of eleven months (November, 2013 to October, 2014).

### *Reconnaissance Survey and Literature Review*

Very beginning of this study, a few reconnaissance field surveys were arranged. Besides, many literatures were reviewed from various published and unpublished sources regarding this study. We also collected relevant information from different authorities and departments regarding to their past and present experiences about the area. Afterwards, reviewing literature and based on reconnaissance survey, we planned structured procedure for directing this unique study.

### *Sampling Methods*

Based on literature review and personal investigation, there are 20 hills in the CMA. From the entire metropolitan area 9 hills were taken under consideration for the study aims for the ease of conducting. The considered hills were under both private and public authority for management. From the 9 hills, 45 simple plots were taken randomly sampling and 5 sample plots from each hill were taken where the plot size were 10m×10m.

### *Field Study Procedure*

We visited selected hills with the vision of taking-out raw data suchlike existing family & species number, species density, DBH, height and basal area. Repeated data was also collected from some sampling units, which was considered important during analysis and final write-up. Moreover, some instruments and helping materials were used for field level data collection such as –

- Measuring tape: One, 50 metals or fiberglass for measuring plots.
- Diameter tape: One, 2 m fiberglass tape for measuring DBH
- Spiegel rela-scope: One for measuring height of the standing tree
- Pegs: For demarcation of sample plots.
- Dao (one kind of cutting instrument)

### *Identification of Specimens*

We are not well expert on this topic. Therefore, at the time of collecting data from sampling plots we found

various species of trees among them a few were unknown to us. However, each unknown tree was identified by its local name under the supervision of experienced guide and in some cases from staffs of IFESCU.

*Data Analysis*

Finally, all the aggregated data was compiled in MS Excel Sheet. Then it was made rearrangement for obtaining desired outputs from this study. Afterwards gathered data were analyzed with the help of MS Excel Sheet version: 2010 and scientific calculator (MS750). The basal area (BA) of the tree was calculated by using the formula given by Chaturvedi and Khanna (1982).

$$BA/tree = \pi \times D^2 / 4$$

Where, D = Diameter at breast height in centimeter

$$\pi = 3.1416$$

**Results and discussion**

*Current Status of Tree Species in Chittagong Metropolitan Area Hills*

Chittagong is known as both commercial capital and green city of Bangladesh. From very beginning of industrialization and urbanization, the undisturbed hills are being dismantled rapidly. Even, little disturbed or undisturbed zones are also continuously losing biodiversity and high population pressure is triggering this unexpected problem. Further, the chief sea port of Bangladesh is located in Chittagong through which more than 80% export and import are performed. Therefore, population pressure and development activities are enhancing day-to-day, consequently forest coverage lands are shrinking including biodiversity. Anyhow, still there are some hills coverage zones though comparatively less than before. The current status of tree species in CMA are explained below –

Chittagong is known as hill tract area in Bangladesh because there are many hills in three districts viz. Chittagong, Bandarban and Fatikchari. But owing-to rapid and haphazard urbanization including high

population growth rate deforestation rate in metropolitan area is topless compared to the Chittagong Hill Tracts (CHTs) area. A few small hills exist within CMA for conserving mutually by different departments or authorities of both local and central governments. Though they are small in size but their importance is very high. Most of them are under private ownership and some hills are conserved by Chittagong Railway (CRW) details information of them is mentioned in (table 1).

**Table 1.** Name of hill, location, and ownership category.

Sl No	Name of Hill	Location	Ownership
01	Probortok Hill	Panchlaish	Private
02	Batali Hill	Dampara	PWD
03	CRW Hill	Tigerpass	CRW
04	Hatirbangla Hill	Tigerpass	CRW
05	Jilapi Hill	Tigerpass	CRW
06	Dampara Hill	Dampara	Private
07	Finley Hill	Chatteshwori	Private
08	CMC Hill	Panchlaish	Govt.
09	Ispahani Hill	Khulshi	Private

(Source: Field survey).

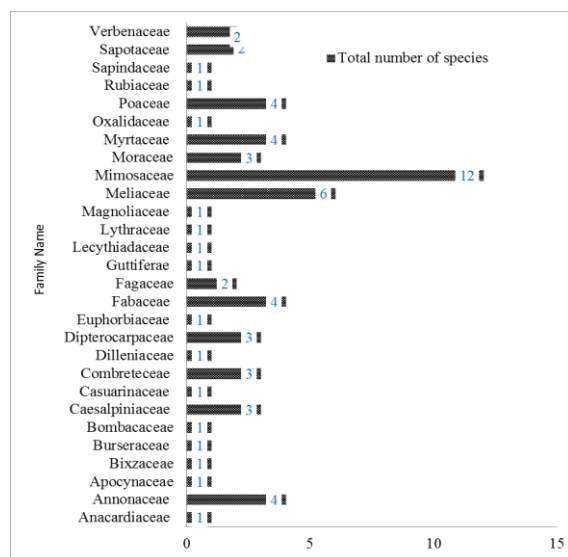
Amidst the existing hills in CMA, there are a lot of timber species stock including herbs and shrubs. Moreover, natural regeneration scenarios were noticed if any area remains undisturbed for a long time. But the motto of this study is to count only tree species not others. Due to private ownership, in a few hills tree species are available hereto but in public ownership it's rare. Then within the surveyed hills of CMA, *Acacia auriculiformis* is the dominant species in most of the hills. Among the 9 hills Acacia is the dominant family in CRW Hill, Hatirbangla Hill, Jilapi Hill, Dampara Hill and CMC Hill. In contrary, Teak is dominant in Batali Hill and Raintree is dominant in Finley Hill. In addition, in Probortok Hill Mahagony is dominant (details in table 2). All other tree species are found within the experimental plots is minor species.

**Table 2.** List of dominant tree species in different hill of CMA.

Sl no	Name of the Hill	Local name	Total tree individuals	Dominated individuals no	Percentage (%)
01	Probortok Hill	Mahagony	110	27	24.55
02	Batali Hill	Teak	85	19	22.35
03	CRW Hill	Acacia	55	21	38.18
04	Hatirbangla Hill	Acacia	60	26	43.33
05	Jilapi Hill	Acacia	35	9	25.71
06	Dampara Hill	Acacia	85	31	38.27
07	Finley Hill	Raintree	185	35	18.92
08	Ispahani Hill	Eucalyptus	25	11	44
09	CMC Hill	Acacia	140	46	32.86

(Source: Field survey).

Within the taken 45 plots from nine hills in CMA, 28 families were identified. The dominant family in CMA was Mimosaceae with 12 species followed by Meliaceae 6, Annonaceae 4, Fabaceae 4, Myrtaceae 4, Poaceae 4, Moraceae 3, Dipterocarpaceae 3, Combretaceae 3, Caesalpiniaceae 3, Fagaceae 2, Sapotaceae 2, Verbenaceae 2 and the remaining families possess merely one species (fig. 1).



**Fig. 1.** Dominant families of tree species in the Hill s of CMA.

However, stems of the trees are very important segment for which people try to cut trees illegally to get livelihood or instant benefits. Normally, all the stems of any study area are not same rather differ from family to

family even from plot to plot. The similar scenarios were also observed amid all the studied stems of trees in this study from 9 selected hills in CMA. The accumulated data is shown in (table 3).

*Diversity of Tree Species in CMA*

The diversity and distribution of individual tree species are not equal in all the studied hills in CMA rather vary from plot to plot within the same hill, and hill to hill within the entire CMA. Hence, this study reveals that the number of individual trees ha<sup>-1</sup> were estimated such as 2000, 1700, 1100, 1200, 700, 1700, 3700, 2800, 500 respectively in Probortok Hill, Batali Hill, CRW Hill, Hatirbangla Hill, Jilapi Hill, Dampara Hill, Finley Hill, CMC Hill, Ispahani Hill in CMA. Therefore, it's stark transparent that individual number of trees are not equal in all the studied hills. Contrary, the highest tree species distribution occurred in Finley Hill (3700 ha<sup>-1</sup>) and the lowest in Ispahani Hill (500 ha<sup>-1</sup>) in the study area (details in table 4).

The percentage distribution of each individual species in different DBH classes is shown in (fig. 2). Most of tree species (27.95%) belongs to DBH class of (25-29.9) cm. The lowest percentage (4.35%) was represented by (0-4.9) cm DBH class and the largest DBH class ( $\geq 30$ ) cm represent by 20.91% individuals only (fig. 1). It was found that the percentage of individuals fluctuated as diameter increased.

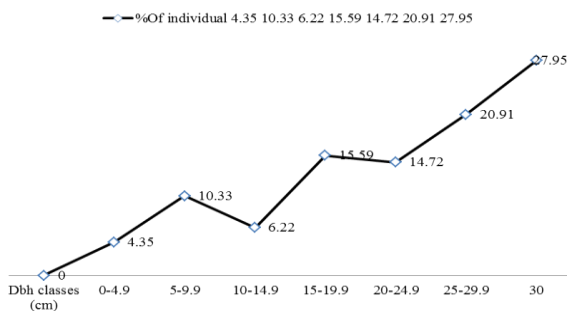
Different DBH classes were noticed dominated by different species. *Acacia auriculiformis* (30.41%) was dominated in (20-24.9) cm DBH class followed by *Swietenia macrophylla* (38.09%) dominant in (25-29.9) cm range, the *Tectona grandis* (45.25%) dominated in range of (20-24.99) cm, *Gmelina arborea* (27.59%) dominated in (10-14.9) cm DBH class followed by *Syzygium fruticosum* (1.15%). *Acacia auriculiformis* (2.99%) was dominated in

DBH classes (10-14.9) cm followed by *Cickrassia tabularis* (34.78%) are dominated in (5-9.9) cm range class each. In DBH class (20-24.9) cm followed by *A. procera* (36.36%) were dominated in the highest DBH class  $\geq 30$  (fig. 2 and table 5) and this range class species are found dominated by *Syzygium grande*, *Artocarpus heterophyllus*, *Artocarpus chaplasha*, *Syzygium cumini*, *Bombax ceiba* and *Dipterocarpus turbinatus*.

**Table 3.** Percentage of stems and family in the study area.

Name of the area	Total No. in all Hill's species	Hill's family	Total No. of stems	No of family	%of stem	% of family
Probortoh Hill			110	14	14.10	50
Batali Hill			85	11	10.89	39.28
CRW Hill			55	8	7.05	28.57
Hatirbangla Hill			60	9	7.69	32.14
Jilapi Hill	780	28	35	7	4.49	25
Dampara Hill			85	11	10.89	39.28
Finley Hill			185	19	23.72	67.85
Ispahani Hill			25	4	3.21	14.28
CMC Hill			140	13	17.95	46.42

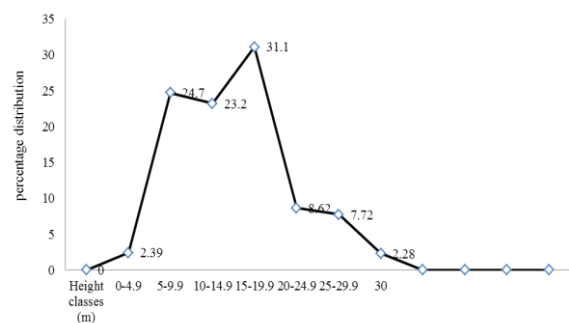
(Source: Field survey).



**Fig. 2.** Percentage distribution of each individual species in different DBH (cm).

Contrary, the percentage distribution of each species in different height classes is shown in (fig. 3). Most of the tree species (31.10%) were belongs to height range (15-19.9) m and the other lowest percentages (2.28%) are in ( $\geq 30$ ) m range. Different height classes were found dominated by different species. *Acacia auriculiformis* (33.11%), *A. lebeck* (33.33%) and *Artocarpus integra* (38.89%) are dominated in the

height class of (10-14.9) m followed by *Gmelina arborea* (41.38%), *Acacia mangium* (77.78%), *A. procera* (35.8%), and *Dalbergia sissoo* (53.33%) while *Gmelina arborea* (41.38%) are dominated in the height class of (15-19.9) m *Eucalyptus camaldulensis* (45.45%) are dominated in more than 30 m height class. Some of *E.citriodora*, *Alstonia scholaris* and *Michelia champaca* also belong to  $\geq 30$  m range (fig. 3 and table 5).



**Fig. 3.** Percentage distribution of each individual species in different Height (m).

**Table 4.** Name of hill, location, ownership, tree individuals (per plot: 10×10 m) and per hectore.

Sl no	Name of the Hill	Location	Ownership	Tree individuals	
				Per plot	per ha
01	Probortok Hill	Panchlaish	Private	22	2200
02	Batali Hill	Dampara	CRW	17	1700
03	CRW Hill	Tigerpass	CRW	11	1100
04	Hatirbangla Hill	Tigerpass	CRW	12	1200
05	Jilapi Hill	Tigerpass	CRW	7	700
06	Dampara Hill	Dampara	Private	17	1700
07	Finley Hill	Chatteshwori	Private	37	3700
08	CMC Hill	Panchlaish	Govt.	28	2800
09	Ispahani Hill	Khulshi	Private	5	500

(Source: Field survey).

**Table 5.** Total number of the individuals including their Average Diameter at Breast Height (cm), Height (m) and Basal Area (cm<sup>2</sup>) per hectare.

Sl no	Name of the Hill	Total individuals	Average DBH (cm)	Average height (m)	Average Basal Area (cm <sup>2</sup> )
01	Probortok Hill	110	24.4	15.95	467.59
02	Batali Hill	85	19.2	16.75	289.53
03	CRW Hill	55	22.7	12.30	404.71
04	Hatirbangla Hill	60	21.9	16.15	376.69
05	Jilapi Hill	35	19.2	16.85	289.53
06	Dampara Hill	85	17.3	13.47	235.06
07	Finley Hill	185	21.9	15.13	376.69
08	Ispahani Hill	25	20.1	12.96	317.32
09	CMC Hill	140	22.8	14.26	408.28

(Source: Field survey).

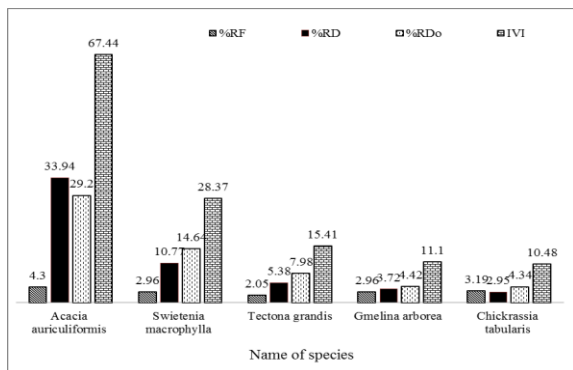
Then tree basal area ha<sup>-1</sup> was determined for the investigated hills. Average BA ha<sup>-1</sup> in CMA were identified like 467.59, 289.53, 404.71, 376.69, 289.53, 235.06, 376.69, 317.32, and 408.28 (cm<sup>2</sup>) in Probortok Hill, Batali Hill, CRW Hill, Hatirbangla Hill, Jilapi Hill, Dampara Hill, Finley Hill, CMC Hill, Ispahani hill subsequently. It is clear that the average BAs of all the surveyed hills are not same rather varies. Amidst the 9 hills BA ha<sup>-1</sup> was the highest in Probortok Hill (467.59 cm<sup>2</sup>) and the lowest in Dampara Hill (235.06 cm<sup>2</sup>) (details in table 5).

#### Quantitative Structure of Tree Species in CMA Hills

The quantitative structure of the tree species of CMA was measured based on the basal area (BA), relative density (RD), relative frequency (RF), relative dominance (RDo), and importance value index (IVI) which are explained below –

Many species were studied throughout this study. Five species among them showed the largest BA viz. *Acacia auriculiformis* (393.8) cm<sup>2</sup>, *Swietenia macrophylla* (358.24) cm<sup>2</sup>, *Tectona grandis* (224.4) cm<sup>2</sup>, *Gmelina arborea* (298.24) cm<sup>2</sup>, *Chickrassia tabularis* (114) cm<sup>2</sup> which were uniformly distributed in all the hills. The details calculated data about the

BA is shown in (table 6). Then, RF is very important for counting the biodiversity availability in any hilly regions. The five species with the highest RFs were *Acacia auriculiformis* (4.30%), *Swietenia macrophylla* (2.96%), *Tectona grandis* (2.05%), *Gmelina arborea* (2.96%), *Chickrassia tabularis* (3.31%) which were equally distributed in all studied hills. The distribution of the highest five RF species is shown in (fig. 4) and (table 7). Similarly, the five species with the highest RD were *Acacia auriculiformis* (33.94%), *Swietenia macrophylla* (10.77%), *Tectona grandis* (5.38%), *Gmelina arborea* (3.72%), *Chickrassia tabularis* (2.95%) which were uniformly allocated in all hills. The distribution of the highest five RD species are presented in (fig. 4) and (table 7).



**Fig. 4.** %RF, %RD, %RDo and IVI of five dominant species in study area.

**Table 6.** Basal area in cm<sup>2</sup> of five highest species.

Name of the species	Basal Area (cm <sup>2</sup> )
<i>Acacia auriculiformis</i>	393.8
<i>Swietenia macrophylla</i>	358.24
<i>Tectona grandis</i>	224.4
<i>Gmelina arborea</i>	298.24
<i>Chickrassia tabularis</i>	114

(Source: Field survey).

Then amid all the species studied, the five species with the highest RDo were *Acacia auriculiformis* (29.92%), *Swietenia macrophylla* (14.64%), *Tectona grandis* (7.98%), and *Gmelina arborea* (4.42%), *Chickrassia tabularis* (4.34%) which were also equally distributed in all the hills. The allocation of the

highest five RDo species are revealed in (fig. 4) and (table 7). Thereto, the five species those represented the largest IVI amidst all, were *Acacia auriculiformis* (67.44%), *Swietenia macrophylla* (28.37%), *Tectona grandis* (15.41%), *Gmelina arborea* (11.1%), *Chickrassia tabularis* (10.48%) which were uniformly allocated in all the hills. Similarly, the distribution of the highest five largest IVI species are shown in (table 7) and (fig. 4).

**Table 7.** RF %, %RD, %RDo and IVI of five dominant species.

Name of the species	RF%	%RD	%RDo	IVI
<i>Acacia auriculiformis</i>	4.30	33.94	29.20	67.44
<i>Swietenia macrophylla</i>	2.96	10.77	14.64	28.37
<i>Tectona grandis</i>	2.05	5.38	7.98	15.41
<i>Gmelina arborea</i>	2.96	3.72	4.42	11.1
<i>Chickrassia tabularis</i>	3.19	2.95	4.34	10.48

### Discussions

The quantitative structure of the tree species in the study area was based on density, BA, RD, RF, RDo and IVI. The tree density (stems ha<sup>-1</sup>) of the study area was found 2800 (CMC Hill) which is higher compared to 560 reported from a study conducted in Fasiakhali Reserve Forest, Cox'sbazar North Forest Division or within the range of 430-1120. This proves that the hills those are managed by private authority properly their density is higher comparing to the hills where human interference is maximum. The species with the highest density (stems ha<sup>-1</sup>) was Mahagoy followed by Teak most of the tree planted in the study area. Among them only *Ficus bengalensis* are naturally growing tree species. The BA of the study area was found 393.8 cm<sup>2</sup> which is very lower compared to 55.23 m<sup>2</sup>/ha reported by Nath *et al.* (2000) from a study of Sitapahar Reserve Forest or 27.96 m<sup>2</sup>/ha from a study conducted in Fasiakhali Forest Reserve, Cox'sBazar North Forest Division. It may be due to proper management, the species with the biggest BA was *Acacia auriculiformis* followed by *Swietenia macrophylla*.



The study area was found floristically diverse having 65 tree species compare to other similar studies of Hossain *et al.* (1997); Biswas (2001) and Rahaman (2002) in Cox's Bazar and Chittagong regions who reported the presence of 86, 66, and 77 tree species respectively. But a forest stock (density, BA, frequency) of the study area is very poor compare to other studies viz. Nath *et al.* (2000) in different hills of Bangladesh and other countries. The IVI was found higher for *Acacia auriculiformis* (67.42%) followed by *Swietenia macrophylla* (20.89), *Tectona grandis* (11.86%), *Gmelina arborea* (4.73) and *Chickrassia tabularis* (4.61). Here, dominant species is *Acacia auriculiformis* may be due to large scale plantation within experimental area. Another study shows that *Holarrhena antidysenterica* was the dominant tree species in both zones (disturbed: 28.5 and less disturbed: 31.59). Then according to Nath (2003), it was observed that *Holarrhena antidysenterica* had the highest IVI at the Southern (IVI: 24.40) and Western (IVI: 23.77) aspect and also at the top hill (IVI: 20.20) and at the midhill (IVI: 18.23), it had the second highest IVI. It was also found that in the natural forest, *Holarrhena antidysenterica* (IVI: 25.60), *Sterlospermum chelonoides* (IVI: 20.40) occupied the second and third highest IVI whereas at present study, both species had the first and third highest IVI (31.59 & 16.62) respectively in the less disturbed zone. In the enrichment plantation area (mixed with natural and planted species), *Sterlospermum chelonoides* (IVI: 19.23) and *Holarrhena antidysenterica* (IVI: 16.10) followed the highest and second highest IVI whereas in the disturbed zone of the present study, *Holarrhena antidysenterica*, *Sterlospermum chelonoides* showed the maximum IVI. However these differences are mostly linked to the sampling design and the number of plots observed.

However, the present study shows a good condition of forest in respect to tree diameter class distribution. It shows average moderate distribution of tree diameter class positive curve where 27.95% tree is in (25-29.9) cm diameter class which may be due to proper and

private management. While previous study showed that the diameter class distribution of trees (> 6 cm DBH) revealed that with an increase of diameter classes, the total number of species decreased. Most of the species were found at the lowest diameter class (6-11) cm in all plots. *Garuga pinnata* had the highest DBH which was one of the dominant tree species too. In the less disturbed zone, *Albizia procera* showed the highest DBH but IVI of the species was low because it had low frequency and density (number ha<sup>-1</sup>). It was found that less species are available with high diameter ranges in the disturbed zone while there are some species with high diameter classes in the less disturbed zone, due to poor accessibility. Al-Amin *et al.* (2005) reported that most of the species of a deforested area (Bamerchara and Danerchara in reserve forest of Jaldi beat under Jaldi range, Chittagong Forest Division) of Bangladesh were in the lowest diameter range. The study revealed that there is significance difference in the density and BA amid different forest categories particularly between plantation forestry. From the study it is stark clear that in most of the hills *Acacia auriculiformis*, *Acacia mahagony*, teak, gamar and chickrassi were dominant comparing to other species.

### Conclusion

Biodiversity plays a great role in conserving natural forest environment and ecosystems. But by-virtue-of poverty and lack of knowledge among mass people, biodiversity is continuously destroying in developing countries without any consideration for future generation. However, appropriate management of plant species can keep a good contribution in conservation of biodiversity in hills. This study reveals that Chittagong has a unique location for the conservation of biodiversity but it's mutating due to rapid and haphazard urbanization. Amid all the hills 65 species were recorded under 28 families where *Acacia* was the dominant family. In addition, it was found that tree composition was more in privately managed hills comparison to others. With the vision of protecting city environment and to keep sustainable development, the importance of hills

conservation with a diverse composition of tree is unavoidable.

### Acknowledgement

We would like to thank A.S.M. Riduanul Haque who supported to analysis all the aggregated data from field. Then, special thanks go to Rimana Islam Papry and Abnti Paul who accompanied with us to collect field level data. This research was done as partial fulfillment of Postgraduate Degree (thesis).

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