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Floristic Composition of Fasiakhali Wildlife Sanctuary (FWS), Cox's Bazar, Bangladesh

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Abstract

Fasiakhali Wildlife Sanctuary (FWS) is one of the protected area comprises a significant part of tropical forest in Bangladesh. The pure natural forest patches are being encroached and degraded day by day due to illegal felling by local peoples. A study was conducted during October 2011 to December 2012 to assess the floristic composition of FWS. The study revealed that the sanctuary was dominated by large garjan (*Dipterocarpus turbinatus*) trees followed by co-dominant jam (*Syzygium cumini*). Total 46 plant species belonging to 27 families were recorded where 13 tree species belonging to 11 families are available. Within the plant species, there were also 14 shrub and 19 herb species recorded belonging to 11 families and 9 families respectively. Among these, Poaceae family was the highest number of herb species. The highest Importance Value Index (IVI) was represented for *Dipterocarpus turbinatus* (91.6) followed by *Syzygium cumini* (60.77), *Acacia auriculiformis* (48.8) and *Tectona grandis* (46.11) respectively. Total 6 naturally regenerating tree species were recorded where the highest IVI was represented for *Syzygium cumini* (105.79) followed by *Dipterocarpus turbinatus* (96.98). The outcome of study suggests for the protection, sustainable management, and conservation of the FWS to restore a better quality forest ecosystem with plant diversity.

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Introduction

The diversity of plant life is an essential reinforcement of the forest ecosystems (Sajib *et al.,* 2016).Taxonomy and ecology are two essential tools for assessing biodiversity. Taxonomic revisions play a vital role for monitoring biodiversity and provide information for conservations measures. The diversity of trees is fundamental to total tropical forest biodiversity, because tree provides resources and habitats for almost all other forest species (Huston, 1994; Hossen and Hossain, 2018), but these forests are being destroyed so rapidly that they will mostly disappear within the next century, taking with hundreds of thousands of species into extinction (Hossain *et al.,* 2020). The distribution of the natural forests, plantation forests and the village forests are not uniform throughout the country; the central and the northern highly populated regions have practically very little natural and plantation forests while the least populated areas of the eastern, south-western and southern parts have all the natural and plantation forests (Baten, 1991).

Bangladesh located in the humid tropical region is rich in species diversity and is unique in the diversity of genetic resources compared to its land area. It has about 5700 species of angiosperms and four species of gymnosperms of which some 2260 species are reported from the Chittagong region (Anon, 1992). Khan (1996) reported that there are about 86 timber species, 130 species yielding fiber and 29 medicinal plant species available in the country. The Bangladesh National Herbarium (BNH) prepared a list of 500 medicinal plants. Bamboo resources of 18 taxa, both wild and planted are available in the country (Alam, 1982). There are at least 9 species of rattans, including a recently reported one, along with 12 other palm species (Khan, 1996). Because of geographic location Bangladesh is a good habitat of fauna. In Bangladesh 635 fish species, 36 amphibians, 154 reptiles, 690 birds and 121 species of mammals recorded (Feeroz *et al*., 2012).

In Bangladesh the forest growth performance is very low than other forested countries in the world. Here the estimated average annual forest growth is $2.5 m^3 ha^{-1}$(Islam, 2003). Although there is a low growth rate the forest contributes to the national Gross Domestic Product (GDP) to 3.28% (BBS, 1994).

The supply of various forest products such as timber, poles, fuel wood, bamboo etc. cannot meet the present demand. 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). The annual per capita consumption of timber and fuel wood was estimated to be 0.01 m^3 and 0.08 m^3 respectively, based on a population of 90 million as at 1980 (Byron, 1984). The figure would be less if the present forest production and population were considered.

Materials and methods

Description of the study area

The study site is located in the Fasiakhali Wildlife Sanctuary (FWS). Legally the Wildlife sanctuary declaration occurred in April, 2007 under Bangladesh Wildlife Act, 1974 (IPAC, 2012 a). The FWS was declared as a protected area in 2007 and in 2008 it came under Nishorgo Network. The forest is constituted with natural and plantation forest.

The FWS is under the administration of Fasiakhali Forest Range of Cox's Bazar North Forest Division consisting of two forest beats named Dulahazara and Fasiakhali. It is situated at Chakaria upazilla under Cox's Bazar district. It is about 48 km and 106 km away through Cox's Bazar-Chittagong Highway respectively from Cox's Bazar and Chittagong city. It lies between 21°40′ to 21°45′ North latitude and 92°4′ to 92°8′ East longitude (Hoque *et al.,* 2021).

FWS is mainly tropical evergreen, semi evergreen and savanna forest. The total forest area is 3217 acres (1302 ha) with consisting 3 blocks, such as Dulahazara block, Ringbong block and Fasiakhali block with areas of 710 acres, 1514 acres and 993 acres respectively. The study area is blessed with diversified flora and fauna and serve the local people at a great extent and their also have contribution in

conserving this forest. In the sanctuary area degraded barren hills occupy 324 ha, plantations 935.2 ha, water bodies 2 ha, settlements 40.5 ha. There were also buffer plantations 192 ha, enrichment plantations 545 ha, others 565 ha (IPAC, 2010).

Plant sample processing and identification

To estimate the plant species composition, the study was conducted in two beats of Fasiakhali Wildlife Sanctuary. Total 20 plots, 10 from each beat were selected by simple random sampling. Each plot size was 20 m × 20 m.

The sample plots were demarcated by measuring tape and the corners of each plot were marked by pegs before starting the enumeration work. Only the tree species of ≥ 5 cm dbh and at least 3m height were counted. Within each plot the number of species, number of stems from each species, height and diameter at breast height (dbh) of each stem were directly counted. From each sample plot of tree species the undergrowth (shrub and herb) species were identified and counted. Each tree, shrub, herb species were identified by its local name from local people. Herbarium was also made to identify the species accurately. Identification was done according to Dey (2006).

Regeneration survey

To study the regeneration status of the Fasiakhali Wildlife Sanctuary, a total of 60 plots each of 1m × 1m in size from two beats were selected randomly. Position of the sample plots were ensured in all aspects and slopes in the beats. Regeneration process through seed originated seedling, coppice and root sucker was recorded from each of the regeneration plot. The numbers of naturally regenerated seedlings were identified, counted and recorded in the field book.

Data processing and analysis

The Frequency, Relative Frequency (RF), Density, Relative Density (RD), Abundance, Relative Abundance (RA), Relative Dominance (RDo) and Importance Value Index (IVI) of each tree species were calculated according to Hossain and Hossain (2014), Hossen *et al.* (2021) and Hossen *et al.* (2019). The data were analyzed with the help of MS excel.

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

$$\text{Relative Density of a species} = \frac{\text{Total number of individuals of a species}}{\text{Total number of individuals of all species}} \times 100$$

$$\text{Relative Dominance of a species} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Frequency of a species} = \frac{\text{Total number of quadrats in which the species occurs}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Frequency of the species}}{\text{Sum of all frequency}} \times 100$$

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

$$\text{Relative Abundance} = \frac{\text{Abundance of the species}}{\text{Total abundance of all species}} \times 100$$

Importance Value Index (IVI) = *Relative Frequency (RF)* + *Relative Density (RD)* + *Relative Dominance (RDo).*

Importance Value Index (IVI) = *Relative Frequency (RF)* + *Relative Density (RD)* + *Relative Abundance (RA).*

$$\text{Basal area} = \pi \times \frac{D^2}{4}$$

Here, D = Diameter at Breast Height (DBH) in centimeter

Π = 3.1416

Results and discussion

Floral diversity abundance of Fasiakhali Wildlife Sanctuary (FWS)

The study revealed that total 46 plant species belonging to 27 families were recorded where 13 tree species belonging to 11 families are available (Table 1) that will be comparable to other national and international records in several natural and mixed forests. Among the tree species, Dipterocarpaceae and Leguminosae family were represented the highest number of tree species. Both the natural and planted tree species were found in the sanctuary.

Within this plant species, there were also 14 shrub and 19 herb species recorded belonging to 11 families and 9 families respectively (Table 2 and Table 3).

Among these, Poaceae family belonging to highest number of herb species.

Table 1. List of tree species found in Fasiakhali Wildlife Sanctuary.

Sl. No.	Local name	Scientific name	Family name
1	Garjan	*Dipterocarpus turbinatus*	Dipterocarpaceae
2	Jam	*Syzygium cumini*	Myrtaceae
3	Akashmoni	*Acacia auriculiformis*	Leguminosae
4	Teak	*Tectona grandis*	Verbenaceae
5	Agar	*Aquilaria agallocha*	Thymelaeaceae
6	Bohera	*Terminalia bellerica*	Combretaceae
7	Batna	*Castanopsis tribuloides*	Fagaceae
8	Krishnachura	*Delonix regia*	Leguminosae
9	Bot	*Ficus benghalensis*	Moraceae
10	Hargaza	*Dillenia pentagyna*	Dilleniaceae
11	Telsur	*Hopea odorata*	Dipterocarpaceae
12	Am	*Mangifera indica*	Anacardiaceae
13	Tejbahal	*Cinnamonum cicidodephne*	Lauraceae

About 66 plant species were found from a 2-Hector (ha) sample area in Idgaon Reserve Forest of the Cox's Bazar North Forest Division that was recorded by Hossain (2001). Khan (1990) made an exploratory survey in Chunati Wildlife Sanctuary and found 477 plant species. The current study figures are also comparable with studies in the neighboring countries like India and Nepal. For instance Webb and Sah (2003) enlisted 152 species (49 trees, 45 shrubs, 16 climbers and 42 herbs) from the central Terai, whereas Timilsina *et al.* (2007) counted 131 species (28 trees, 10 shrubs, 6 climbers and 87 herbs) from the western Terai of Nepal. Pandey and Shukla (2003) found 208 species (93 trees, 50 shrubs, 34 climbers and 31 herbs) in the eastern Terai and Shankar (2001) examined 87 species (>10 cm dbh) in the Darjiling, Terai of India. Swampy *et al.* (2000) listed 82 species (48 trees, 10 shrubs, 8 climbers and 16 herbs) from 250-400 m altitude and moist deciduous forest in the Western Ghat of India.

Table 2. List of shrub species found in Fasiakhali Wildlife Sanctuary.

Sl. No.	Local name	Scientific name	Family name
1	Shiailla	*Blyxa octandra*	Hydrocharitaceae
2	Ekjoda	*Ixora acuminata*	Rubiaceae
3	Tit begun	*Solanum torvum*	Solanaceae
4	Putti gula	*Melastoma malabathricum*	Melastomataceae
5	Guicha lata	*Calycopteris floribunda*	Combretaceae
6	Verbenaceae	*Lantana camara*	Verbenaceae
7	Vaat	*Clerodendrum viscosum*	Verbenaceae
8	Juta salpani	*Desmodium pulchellum*	Leguminosae
9	Knathaalmari	*Artabotrys uncinatus*	Annonaceae
10	Madannacha	*Actinodaphne angustifolia*	Lauraceae
11	Akkasu keda	*Alangium salvifolium*	Alangiaceae
12	Kanta begun	*Solanum sisymbrifolium*	Solanaceae
13	Silchari	*Mussaenda corymbosa*	Rubiaceae
14	Assar gula	*Grewia nervosa*	Tiliaceae

Phytosociological characters of the tree species

Importance Value Index of the tree species of a forest indicates their importance as a member of the community (Felfili *et al*., 2000) and finally their dominance. The study found that the highest Importance Value Index (IVI) were found for *Dipterocarpus turbinatus* (91.6) followed by *Syzygium cumini* (60.77), *Acacia auriculiformis* (48.77) and *Tectona grandis* (46.11) (Table 4 and Fig. 1) respectively.

Table 3. List of herb species found in Fasiakhali Wildlife Sanctuary.

Sl. No.	Local name	Scientific name	Family name
1	Tiatui	*Costus speciosus*	Costaceae
2	Kashful	*Saccharum spontaneum*	Poaceae
3	Ram kola	*Musa ornate*	Musaceae
4	Asamlata	*Eupatorium odoratum*	Asteraceae
5	Topa pana	*Pistia stratiotes*	Araceae
6	Kachuri pana	*Eichhornia crassipes*	Pontederiaceae
7	Pahari ada	*Alpinia conchigera*	Zingiberaceae
8	Jharuful	*Thysanolaena maxima*	Poaceae
9	Thankuni	*Centella asiatica*	Apiaceae
10	Prem kanta	*Chrysopogon aciculatus*	Poaceae
11	Durba grass	*Cynodon dactylon*	Poaceae
12	Sungrass	*Imperata cylindrica*	Poaceae
13	Dongkolos	*Leucas indica*	Lamiaceae
14	Nal	*Arundo donax*	Poaceae
15	Kanta kanchu	*Lasia spinosa*	Araceae
16	Tokma	*Hyptis Suaveolens*	Lamiaceae
17	Jharuphul	*Thysanolaena maxima*	Poaceae
18	Deotara	*Alpinia malaccensis*	Zingiberaceae
19	Panee kachu	*Monochoria vaginalis*	Pontederiaceae

Table 4. Phytosociological characters of the tree species in Fasiakhali Wildlife Sanctuary (FWS).

Sl. No.	Scientific name	Average number of stem/ha	Average Height (m)	Average DBH (cm)	RD (%)	RF (%)	RDo (%)	IVI
1	*Dipterocarpus turbinatus*	213.75	13.39	22.23	30	29.54	32.06	91.6
2	*Syzygium cumini*	107.5	11.72	27.81	15.09	20.45	25.23	60.77
3	*Acacia auriculiformis*	223.75	10.16	7.44	31.4	13.64	3.76	48.8
4	*Tectona grandis*	78.75	12.19	31.49	11.05	11.36	23.70	46.11
5	*Aquilaria agallocha*	33.75	4.5	22.5	4.73	2.27	5.19	12.19
6	*Terminalia bellerica*	41.25	4.49	5.27	5.78	2.27	0.35	8.4
7	*Castanopsis tribuloides*	5	9.14	19.1	0.7	6.82	0.55	8.07
8	*Delonix regia*	1.25	21	120	0.18	2.27	5.46	7.91
9	*Ficus benghalensis*	1.25	9	60	0.18	2.27	1.37	3.82
10	*Dillenia pentagyna*	1.25	9	50	0.18	2.27	0.95	3.4
11	*Hopea odorata*	1.25	9	45	0.18	2.27	0.77	3.22
12	*Mangifera indica*	2.5	7.5	20	0.35	2.27	0.30	2.92
13	*Cinnamonum cicidodephne*	1.25	10.7	28.65	0.18	2.27	0.31	2.76
Total		712.5			100	100	100	300

From IVI, it was shown that the highest Relative Density (RD) occupied by *Acacia auriculiformis* (31.4%), followed by *Dipterocarpus turbinatus* (30%), *Syzygium cumini* (15.09%) and *Tectona grandis* (11.05%) respectively (Table 4). On the other hand, the highest Relative Frequency (RF) was represented for *Dipterocarpus turbinatus* (29.54%) followed by *Syzygium cumini* (20.45%), *Acacia auriculiformis* (13.64%) and *Tectona grandis* (11.36%) respectively. And, the last parameter is Relative Dominance (RDo) that highest covered by *Dipterocarpus turbinatus* (32.06%) followed by

Syzygium cumini (25.23%) and *Tectona grandis* (23.70%) respectively (Table 4). The study also confirmed that Fasiakhali Wildlife Sanctuary was famous for its evergreen Garjan forest. After considering all ecological parameters like as RD, RF, RDo and IVI, it was ensured that *Dipterocarpus turbinatus* was the single dominant tree species of Fasiakhali Wildlife Sanctuary (Table 4).

Table 5. Regenerating tree species found in Fasiakhali Wildlife Sanctuary (FWS).

Sl. No.	Local name	Scientific name	Family name
1.	Garjan	*Dipterocarpus turbinatus*	Dipterocarpaceae
2.	Jam	*Syzygium cumini*	Myrtaceae
3.	Akashmoni	*Acacia auriculiformis*	Leguminosae
4.	Batna	*Castanopsis tribuloides*	Fagaceae
5.	Telsur	*Hopea odorata*	Dipterocarpaceae
6.	Tejbahal	*Cinnamonum cicidodephne*	Lauraceae

Regeneration status of tree species in Fasiakhali Wildlife Sanctuary (FWS)

The weather and soil of Fasiakhali Wildlife Sanctuary is favorable for natural regeneration. The study found that total 6 tree species belonging to 5 families were recorded to regenerate naturally in the study area (Table 5). Dipterocarpaceae family were covered the highest number of tree species diversity. According to Rahman (2011), about 33 different regenerating tree species were found in Chunati Wildlife Sanctuary; Dulahazara Safari Park and Sitakunda Eco-Park were 36 and 54 respectively. Comparing the previous study, there was less number of regenerating tree species in the study area because of human interference (Table 5).

Table 6. Phytosociological characters of the regenerating tree species in Fasiakhali Wildlife Sanctuary.

Sl. No.	Scientific name	Average number of seedlings/ha	RD (%)	RF (%)	RA (%)	IVI
1	*Syzygium cumini*	19000	40.57	48.42	16.8	105.79
2	*Dipterocarpus turbinatus*	18666.67	39.86	32.63	24.49	96.98
3	*Castanopsis tribuloides*	7166.67	15.30	11.58	26.51	53.39
4	*Hopea odorata*	1166.67	2.49	4.21	11.86	18.56
5	*Cinnamonum cicidodephne*	666.67	1.42	2.10	13.56	17.08
6	*Acacia auriculiformis*	166.67	0.36	1.05	6.78	8.19
Total		46833.35	100	100	100	300

Phytosociological characters of regenerating tree species

The study found that the highest IVI of regenerating tree species in Fasiakhali Wildlife Sanctuary was enumerated for *Syzygium cumini* (105.79) followed by *Dipterocarpus turbinatus* (96.98) (Table 6). The IVI indicates that *Syzygium cumini* was the dominant regenerating tree species in the study area. But it was highly interfered by human and cattle in pole stage.

The study was also revealed that the Relative Density was found highest for *Syzygium cumini* (40.57%) followed by *Dipterocarpus turbinatus* (39.86%) and *Castanopsis tribuloides* (15.30%). It indicates that most of the area was occupied by *Syzygium cumini* seedlings. At the same time, the highest Relative Frequency was also found for *Syzygium cumini* (48.42%) followed by *Dipterocarpus turbinatus* (32.63%) and *Castanopsis tribuloides* (11.58%).

It indicates that *Syzygium cumini was* mostly uniform over the area. On the other hand, the highest Relative Abundance was enumerated for *Castanopsis tribuloides* (26.51%) followed by *Dipterocarpus turbinatus* (24.49%) and *Syzygium cumini* (16.8%) respectively (Table 6). It indicates that *Castanopsis tribuloides* was most abundant than other two.

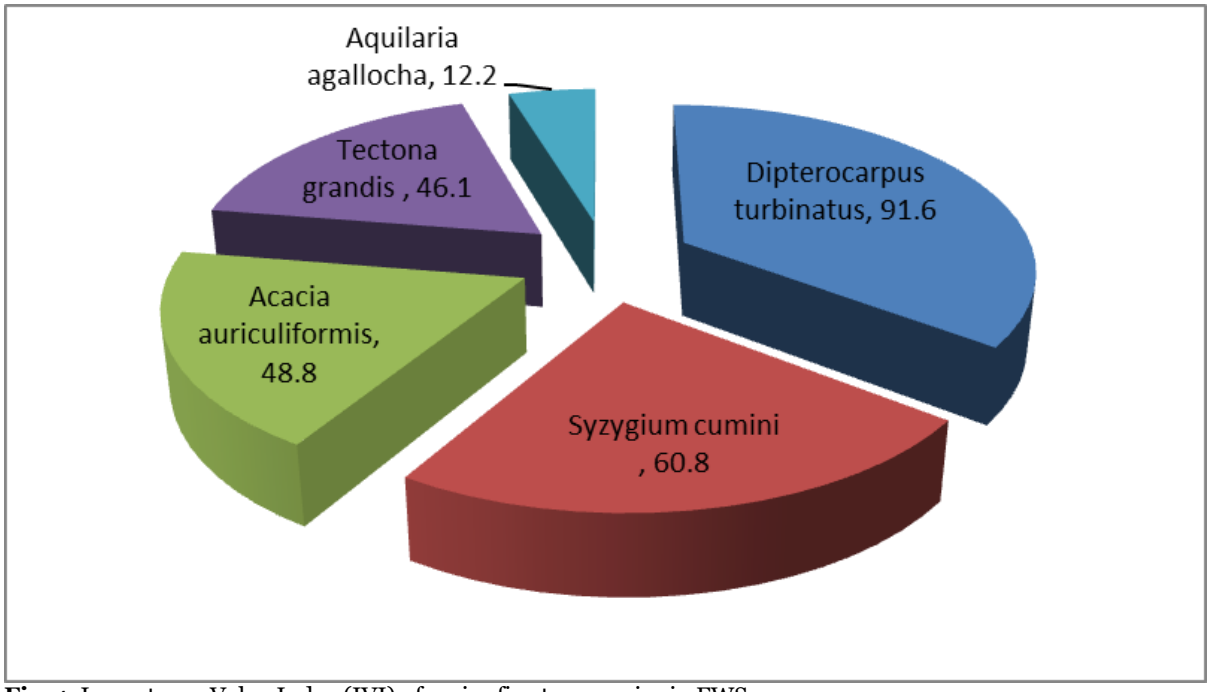

Fig. 1. Importance Value Index (IVI) of major five tree species in FWS.

Conclusion

It is concluded that Fasiakhali Wildlife Sanctuary is full of biodiversity, but its resources reducing day by day through unwise uses. The surrounding people destruct the forest for their livelihood. They depend fully or partially on forest. If it continued, one day the sanctuary will be totally damaged. To preserve the famous Garjan tree in plantation program, species priority for Garjan is needed. The present findings also provide valuable information about plant species composition, phytosociological characters which will be helpful for the future conservation and developing a conservation management plan of this FWS. This study also documented the available plant species before their disappearance due to the continuing interferences and illegal felling in the Wildlife Sanctuary. If it is possible to protect the Wildlife Sanctuary with effective measures of diverting the forest dependent people towards non-forest related livelihood alternatives or reducing dependency on the forest, there will be a greater possibility of this forest to restore a better quality forest ecosystem with plant diversity.

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