

## TREE DIVERSITY OF REMA-KALENGA WILDLIFE SANCTUARY, BANGLADESH

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### Abstract

Rema-Kalenga Wildlife Sanctuary is one of Bangladesh's richest centers of plant diversity and a natural hill forest in the country. Established in 1982 in the Habiganj district, this protected area covers 1,795 hectares and harbours an exceptional variety of native flora. We identified and recorded a total of 102 angiospermous tree species, comprising 1,400 individuals and belonging to 34 families, from Rema-Kalenga Wildlife Sanctuary. Sixty percent of the tree species were represented by 10 families, while the remaining 40% are distributed across 24 families. The most species-rich family is Euphorbiaceae, with 11 species. Individual counts per species ranged from 1 to 97. *Aporosa dioica* (Kakra) was the most abundant species, represented by 97 individuals, followed by *Dillenia pentagyna* (94), *Artocarpus chaplasha* (78), *Schima wallichii* (76), and *Dipterocarpus turbinatus* (61). The average density of tree individuals per hectare was 295.07. Shannon's species diversity index (H') was 5.6762, and Simpson's concentration of dominance (C) was 0.0285. These values indicate that the sanctuary supports a highly diverse, relatively stable forest community with many nearly equally abundant tree species. Given that several of the more abundant species have economic, medicinal, or environmental significance, it is recommended that such species be incorporated into the forest management plan, particularly in new plantation programs or forest restoration in the area. For rare or endangered species, species distribution mapping and intensified monitoring efforts are also urgently required.

### Introduction

Flora and ethno-botanical aspects of Rema-Kalenga Wildlife Sanctuary have been described in a series of earlier publications (Uddin *et al.*, 1999, 2000, 2001a, 2002, 2003; Uddin *et al.*, 2001b, 2001c, 2001d; Uddin *et al.*, 1999a, 2000a; Uddin and Hassan 2005; Khan *et al.*, 2002). The emphasis of those studies was primarily on floristic inventory, lists of ethno-medicinal plants, and new plant records for Bangladesh. However, with increasing interest in the community organisation of natural forests, research into tree species diversity has become essential (Bazzaz 1975).

Tree species diversity is a fundamental component of total rainforest biodiversity, as trees provide the resources and structural habitat for nearly all other rainforest species (Charles *et al.*, 1998). Adequate knowledge of tree species composition and structure is indispensable for effective forest management, as emphasised by Devi and Yadava (2006), Kunwar and Sharma (2004), Panchal and Pandey (2004), Mijanuddin and Misbahuzzaman (2007), Gentry (1982), and Aryal *et al.* (1999).

Several studies have examined plant species diversity and structural composition in the southern, south-eastern, and central regions of Bangladesh, covering sal, hill, and mangrove forest ecosystems (Nazrul-Islam, 1995; Nazrul-Islam and Hoque, 2001; Alam, 1995; Hossain *et al.*,

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1997; Nath *et al.*, 1998; Mijanuddin and Misbahuzzaman, 2007). However, comparable investigations have been lacking for Rema-Kalenga Wildlife Sanctuary. The objective of the present study is to inventory the tree species of the sanctuary and to assess their abundance, density, and diversity.

## Materials and Methods

### *Study Area*

Rema-Kalenga Wildlife Sanctuary is located in Chunarughat Upazila of Habiganj District, approximately 130 km east-northeast of Dhaka and about 80 km south-southwest of Sylhet city. Geographically, it lies between 24°06' and 24°14' N and 91°34' and 91°41' E, within the Kalenga Forest Range of Habiganj District under the greater Sylhet administrative division (Karim *et al.*, 2024).

Originally gazetted at 1,095 hectares in 1982, the sanctuary was expanded to 1,795.54 ha in 1996 (Canonizado and Rahman, 1998). It is bounded to the east and south by the state of Tripura, India, and is contiguous to the north and west with the Kalenga Range of the Sylhet Forest Division.

The sanctuary encompasses several hills of varying elevation and intervening low-lying valleys. The highest peak reaches approximately 67 m above mean sea level (Rizvi, 1970). The hills are composed of upper Tertiary rocks in which sandstone predominates, together with siltstones and mudstones, locally altered to slates and shales; sediments are generally well-weathered and sometimes cemented with secondary ironstones (Ahmad, 1970; Stevens, 1986). Soils range from clay loam on level ground to sandy loam on slopes, are moderately acidic (pH below 7), and are generally fertile. Humus accumulation is limited due to rapid decomposition under warm, moist tropical conditions (Ahmad, 1970).

The area experiences a moist tropical climate, with high precipitation from April to September and a relatively dry period from November to March. The forest is of mixed evergreen type, with a rich diversity of lianas, climbers, epiphytes, and parasites, as well as dense understorey vegetation. Small water bodies in the valleys support grasses, sedges, and other aquatic plants. The sanctuary currently faces threats from anthropogenic activities including illegal logging and collection of minor forest products. Detailed information is available in Uddin and Hassan (2005).

Data were collected from 2000 to 2001 using 18 randomly selected line transects, each 300 m long. Sampling points were established at 30 m intervals along each transect. The point-centred quarter method (also known as the point-quarter method; Cottam *et al.*, 1953; Cottam and Curtis, 1956; Krebs, 1989) was employed to record tree species. At each point, two size classes were recorded: trees with cbh greater than 1 m, and trees with circumference at breast height (cbh) between 30 cm and 1 m. A total of 175 sampling points were established, and eight tree individuals were recorded per point. Density of individuals per hectare was calculated following Morisita (1954) and Cottam and Curtis (1956). Species diversity was quantified using Shannon's diversity index ( $H'$ ; Shannon, 1948) and Simpson's concentration of dominance ( $C$ ; Simpson 1949). Most species were identified in the field; where identification was uncertain, voucher specimens were collected and identified at the Dhaka University Herbarium using standard taxonomic literature and comparative herbarium material.

*Note on size threshold:* The 30 cm cbh threshold (approximately 9.5 cm dbh) used in this study differs from the >10 cm dbh standard employed in many comparable tropical forest inventories. This should be borne in mind when interpreting density comparisons with other studies.

## Results and Discussion

A total of 102 angiospermous tree species representing 1,400 individuals and 34 families were recorded across all sample points. Scientific names, local names, family affiliation, and abundance of each species are presented in Table 1. Sixty percent of species are distributed across 10 families, while the remaining 40% are represented by 24 families. The most species-rich family is Euphorbiaceae (11 species), followed by Moraceae (8), Meliaceae (6), Myrtaceae (6), Verbenaceae (6), Anacardiaceae (5), Lauraceae (5), Rubiaceae (5), Fagaceae (4), and Mimosaceae (4). The remaining 24 families are each represented by 1–4 species.

Individual counts per species ranged from 1 to 97. Fifty percent of all individuals were represented by only 12 species, while the remaining 50% were distributed across 90 species, indicating a pattern of high species richness with relatively few dominant species. The 12 most abundant species are: *Aporosa dioica* (97 individuals), *Dillenia pentagyna* (94), *Artocarpus chaplasha* (78), *Schima wallichii* (76), *Dipterocarpus turbinatus* (61), *Lagerstroemia parviflora* (52), *Ilex godajam* (49), *Vitex peduncularis* (49), *Terminalia bellirica* (40), *Syzygium cumini* (36), *Bursera serrata* (35), and *Garcinia pedunculata* (32).

Twenty-one species were represented by a single individual and may be considered locally rare (Table 1). These are: *Albizia lebbek*, *Myristica angustifolia*, *Phoebe lanceolata*, *Cassia nodosa*, *Cassia fistula*, *Chukrasia tabularis*, *Dillenia indica*, *Ficus religiosa*, *Garcinia cowa*, *Aquilaria agallocha*, *Heterophragma adenophyllum*, *Litsea panamonja*, *Macaranga denticulata*, *Macaranga indica*, *Macaranga peltata*, *Maesa indica*, *Neonauclea sessilifolia*, *Syzygium wallichii*, *Terminalia citrina*, *Myristica linifolia*, and *Vitex diversifolia*. The co-occurrence of high species diversity and low density of individual species is a well-documented pattern in tropical forests (Peters, 1994) and is consistent with the present findings. Low-density species in the wild are particularly vulnerable to local extinction.

**Table 1. Tree species recorded in Rema-Kalenga Wildlife Sanctuary with scientific names, local names, families, and individual abundance. Species represented by a single individual (rare species) are indicated in the text. Total species: 102 | Total families: 34 | Total individuals: 1,400**

Sl. No.	Scientific Name	Local Name	Family	Abundance
1.	<i>Aporosa dioica</i> (Roxb.) Müll.Arg.	Kakra	Euphorbiaceae	97
2.	<i>Dillenia pentagyna</i> Roxb.	Harganja	Dilleniaceae	94
3.	<i>Artocarpus chaplasha</i> Roxb.	Chamul	Moraceae	78
4.	<i>Schima wallichii</i> (DC.) Korth.	Bonak	Theaceae	76
5.	<i>Dipterocarpus turbinatus</i> Gaertn.f.	Garjon	Dipterocarpaceae	61
6.	<i>Lagerstroemia parviflora</i> Roxb.	Tilajarul	Lythraceae	52
7.	<i>Ilex godajam</i> (Colebr. ex-Wall.) Wall. ex-Hook. f.	Lud	Aquifoliaceae	49
8.	<i>Vitex peduncularis</i> Wall. ex-Schauer	Awal	Verbenaceae	49
9.	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Bohera	Combretaceae	40
10.	<i>Syzygium cumini</i> (L.) Skeels	Kaloram	Myrtaceae	36
11.	<i>Bursera serrata</i> Wall. ex Colebr.	Neul	Burseraceae	35
12.	<i>Garcinia pedunculata</i> Roxb. ex-Buch. -Ham.	Kaoathuti	Clusiaceae	32
13.	<i>Microcos paniculata</i> L.	Aser	Tiliaceae	31
14.	<i>Stereospermum personatum</i> (Hassk.) Chatterjee	Barrenga Awal	Bignoniaceae	29
15.	<i>Lagerstroemia speciosa</i> (L.) Pers.	Jarul	Lythraceae	28
16.	<i>Mitragyna parvifolia</i> (Roxb.) Korth	Kutikadam	Rubiaceae	26

Table 1 contd.

Sl. No.	Scientific Name	Local Name	Family	Abundance
17.	<i>Artocarpus lakoocha</i> Roxb.	Deoa	Moraceae	25
18.	<i>Quercus gomeziana</i> A.Camus	Batna	Fagaceae	24
19.	<i>Ficus hispida</i> L.f.	Dumur	Moraceae	24
20.	<i>Holarrhena antidysenterica</i> (L.) Wall. ex Decne.	Kurshi	Apocynaceae	21
21.	<i>Garuga pinnata</i> Roxb.	Jeolbhadi	Bursaceae	20
22.	<i>Elaeocarpus floribundus</i> Blume	Belpoi	Elaeocarpaceae	20
23.	<i>Albizia procera</i> (Roxb.) Benth.	Shadakoroi	Mimosaceae	20
24.	<i>Litsea monopetala</i> (Roxb.) Pers.	Huaria	Lauraceae	18
25.	<i>Quercus spicata</i> Sm. (= <i>Lithocarpus elegans</i> (Blume) Hatus.)	Batna	Fagaceae	17
26.	<i>Vitex altissima</i> L.f.	Monawal	Verbenaceae	17
27.	<i>Toona ciliata</i> M.Roem.	Rongi	Meliaceae	15
28.	<i>Hymenodictyon excelsum</i> (Roxb.) Wall.	Pahariathona	Rubiaceae	15
29.	<i>Lannea coromandelica</i> (Houtt.) Merr.	Bhadi	Anacardiaceae	13
30.	<i>Streblus asper</i> Lour.	Sheora	Moraceae	13
31.	<i>Bombax insigne</i> Wall.	Bonshimul	Bombacaceae	12
32.	<i>Syzygium firmum</i> Thwaites	Dhakijam	Myrtaceae	12
33.	<i>Gardenia coronaria</i> Buch.-Ham.	Sitgach	Rubiaceae	12
34.	<i>Oroxylum indicum</i> (L.) Vent.	Thona	Bignoniaceae	11
35.	<i>Aporosa aurea</i> Hook.f.	Lalkakra	Euphorbiaceae	11
36.	<i>Pterospermum acerifolium</i> (L.) Willd.	Moskanda	Sterculiaceae	11
37.	<i>Phyllanthus emblica</i> L.	Amloki	Euphorbiaceae	10
38.	<i>Castanopsis echinocarpa</i> Miq.	Hingra	Fagaceae	10
39.	<i>Aphanamixis polystachya</i> (Wall.) R.N.Parker	Pitraj	Meliaceae	10
40.	<i>Syzygium oblatum</i> (Roxb.) Wall. ex A.M.Cowan & Cowan	Bonjam	Myrtaceae	10
41.	<i>Premna bengalensis</i> C.B.Clarke	Paikkara	Verbenaceae	10
42.	<i>Gmelina arborea</i> Roxb.	Gamari	Verbenaceae	9
43.	<i>Butea monosperma</i> (Lam.) Taub.	Palsah	Fabaceae	9
44.	<i>Mangifera sylvatica</i> Roxb.	Bonam	Anacardiaceae	8
45.	<i>Syzygium fruticosum</i> (Roxb.) DC.	Bhutijam	Myrtaceae	8
46.	<i>Spondias pinnata</i> (L.f.) Kurz	Amra	Anacardiaceae	7
47.	<i>Glochidion multiloculare</i> (Rottler ex Willd.) Voigt	Kesuan	Euphorbiaceae	7
48.	<i>Erythrina fusca</i> Lour.	Mandar	Fabaceae	7
49.	<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	Menda	Lauraceae	7
50.	<i>Callicarpa arborea</i> Roxb.	Bormala	Verbenaceae	7
51.	<i>Holigarna longifolia</i> Roxb.	Jawa	Anacardiaceae	6
52.	<i>Dillenia scabrella</i> (D.Don) Roxb. ex-Wall.	Ekuish	Dilleniaceae	6
53.	<i>Amoora chittagonga</i> (Miq.) Hiern	Rata	Meliaceae	6
54.	<i>Walsura robusta</i> Roxb.	Bonlichu	Meliaceae	6
55.	<i>Anthocephalus chinensis</i> (Lam.) A.Rich. ex Walp.	Kadam	Rubiaceae	6

Table 1 contd.

Sl. No.	Scientific Name	Local Name	Family	Abundance
56.	<i>Lophopetalum fimbriatum</i> Wight	Rokton	Celastraceae	5
57.	<i>Albizia odoratissima</i> (L.f.) Benth.	Shirishkoro i	Mimosaceae	5
58.	<i>Syzygium operculatum</i> (Roxb.) Nied.	Panijam	Myrtaceae	5
59.	<i>Ziziphus rugosa</i> Lam.	Bonboroi	Rhamnaceae	5
60.	<i>Alstonia scholaris</i> (L.) R.Br.	Chaitan	Apocynaceae	4
61.	<i>Bischofia javanica</i> Blume	Kanjalbhad i	Euphorbiaceae	4
62.	<i>Engelhardtia spicata</i> Lesch. ex-Blume	Zalna	Juglandaceae	4
63.	<i>Ficus benghalensis</i> L.	Bot	Moraceae	4
64.	<i>Sterculia colorata</i> Roxb.	Naichaudal	Sterculiaceae	4
65.	<i>Tetrameles nudiflora</i> R.Br.	Tundul	Datisceae	3
66.	<i>Elaeocarpus robustus</i> Roxb.	Jolpai	Elaeocarpaceae	3
67.	<i>Antidesma ghaesembilla</i> Gaertn.	Chukka	Euphorbiaceae	3
68.	<i>Baccaurea ramiflora</i> Lour.	Bhubi	Euphorbiaceae	3
69.	<i>Dehaasia kurzii</i> King ex Hook.f.	Modo	Lauraceae	3
70.	<i>Careya arborea</i> Roxb.	Biripata	Lecythidaceae	3
71.	<i>Ficus racemosa</i> L.	Jagdumur	Moraceae	3
72.	<i>Myristica linifolia</i> Roxb.	-	Myristicaceae	3
73.	<i>Pterospermum semisagittatum</i> Buch. -Ham. ex Roxb.	Bonachard	Sterculiaceae	3
74.	<i>Vitex pubescens</i> Vahl	Seliawal	Verbenaceae	3
75.	<i>Semicarpus anacardium</i> L.f.	Bhela	Anacardiaceae	2
76.	<i>Garcinia xanthochymus</i> Hook.f. ex T.Anderson	Dephal	Clusiaceae	2
77.	<i>Shorea robusta</i> Roxb. ex Gaertn.f.	Sal	Dipterocarpaceae	2
78.	<i>Castanopsis indica</i> (Roxb. ex Lindl.) A. DC.	Hinguri	Fagaceae	2
79.	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	Bajna	Rutaceae	2
80.	<i>Albizia lucida</i> (Jacques) Benth.	Kalakoroi	Mimosaceae	2
81.	<i>Ficus glomerata</i> Roxb.	Kakdumu	Moraceae	2
82.	<i>Sterculia villosa</i> Roxb.	Udal	Sterculiaceae	2
83.	<i>Vitex diversifolia</i> Blume (= <i>Vitex heterophylla</i> Roxb.)	Badruk	Verbenaceae	2
84.	<i>Heterophragma adenophyllum</i> (Wall. ex G.Don) Seem.	-	Bignoniaceae	1
85.	<i>Cassia nodosa</i> Buch. -Ham. ex Roxb.	Bandarlathi	Caesalpinaceae	1
86.	<i>Cassia fistula</i> L.	Sonalu	Caesalpinaceae	1
87.	<i>Garcinia cowa</i> Roxb. ex-DC.	Kao	Clusiaceae	1
88.	<i>Terminalia citrina</i> (Gaertn.) Roxb. ex-Fleming	Horitoki	Combretaceae	1
89.	<i>Dillenia indica</i> L.	Chalta	Dilleniaceae	1
90.	<i>Macaranga denticulata</i> (Blume) Müll.Arg.	Bura	Euphorbiaceae	1
91.	<i>Macaranga indica</i> Wight	Gulile	Euphorbiaceae	1
92.	<i>Macaranga peltata</i> (Roxb.) Müll.Arg.	Bura	Euphorbiaceae	1
93.	<i>Phoebe lanceolata</i> (Nees) Nees	-	Lauraceae	1
94.	<i>Litsea panamonja</i> (Buch.-Ham.) Hook.f.	Naori	Lauraceae	1

**Table 1 contd.**

Sl. No.	Scientific Name	Local Name	Family	Abundance
95.	<i>Chukrasia tabularis</i> A.Juss.	Chicrash	Meliaceae	1
96.	<i>Albizia lebbbeck</i> (L.) Benth.	Shilkoroi	Mimosaceae	1
97.	<i>Ficus religiosa</i> L.	Ashwathobot	Moraceae	1
98.	<i>Myristica angustifolia</i> Roxb.	-	Myristicaceae	1
99.	<i>Maesa indica</i> (Roxb.) Sweet	-	Myrsinaceae	1
100.	<i>Syzygium wallichii</i> (Wight) Walp.	Nolijam	Myrtaceae	1
101.	<i>Neonauclea sessilifolia</i> (Roxb.) Merr.	-	Rubiaceae	1
102.	<i>Aquilaria agallocha</i> Roxb.	Agar	Thymelaeaceae	1

The mean density of trees with  $cbh > 30$  cm was 295.07 individuals per hectare across the three sampling sites (Table 2). Considerable variation was observed among sites (212.21, 281.34, and 391.67 individuals/ha respectively), which may reflect habitat heterogeneity within the sanctuary, including differences in topography, soil type, and disturbance history (Ahammed *et al.*, 2026; Deuri *et al.*, 2025). This spatial variation also warrants further investigation (da Silva Santos *et al.* 2026). Howard and Valerio (1992) estimated 283 individuals/ha of  $dbh > 10$  cm in a well-stocked natural forest in Costa Rica, while Aryal *et al.* (1999) recorded 382 stems/ha in Royal Bardia National Park, Nepal, and Hossain *et al.* (1997) calculated 369 stems/ha for trees  $> 10$  cm  $dbh$  in Bamu Reserve Forest, Bangladesh. It should be noted that comparisons with studies using a  $dbh$  threshold of  $> 10$  cm must be treated with caution, as the present study used a  $cbh$  threshold of  $> 30$  cm (approximately 9.5 cm  $dbh$ ), which is not strictly equivalent.

**Table 2. Density of individual trees with  $cbh > 30$  cm per hectare across sampling sites in Rema-Kalenga Wildlife Sanctuary.**

Measurement	Site 1	Site 2	Site 3
Average density / ha ( $cbh > 30$ cm)	212.21	281.34	391.67

Overall mean: 295.07 individuals/ha

Shannon's diversity index ( $H'$ ) for the sanctuary was 5.6762 (Table 3), indicating a highly diverse forest community with many nearly equally abundant species. This value is consistent with the range reported by Knight (1975) for tropical forests ( $H'$  values of 5.4–5.6). It considerably exceeds values reported for Garhwal Himalayan forests (2.52–2.84; Joshi and Tiwari, 1990), Simla forests in Himachal Pradesh (1.75–2.45; Singh *et al.*, 1991), *Pinus roxburghii* forests in Kumaon Himalaya (0–0.965; Saxena and Singh, 1982), and temperate forests in Oklahoma (2.0–3.0; Monk, 1967; Risser and Rice, 1971). Such elevated diversity may reflect the heterogeneous habitats within the sanctuary, which support a wide range of species adapted to different microenvironmental conditions.

**Table 3. Species diversity index and concentration of dominance for trees in Rema-Kalenga Wildlife Sanctuary.**

Index	Value
Shannon's Diversity Index ( $H'$ )	5.6762
Simpson's Concentration of Dominance (C)	0.0285

The Simpson's concentration of dominance ( $C = 0.0285$ ) was low, confirming the absence of strong dominance by any single species and further corroborating the high overall diversity of the community. Diversity and dominance are known to be inversely related; forests with high species diversity typically exhibit low dominance values (Narayan *et al.*, 1994). The present value is lower than those reported for Garhwal (0.15–0.22; Joshi and Tiwari, 1990) and Simla (0.21–0.35; Singh *et al.*, 1991) forests, and is broadly consistent with Knight (1975) value of 0.06 for tropical forests, though somewhat lower.

Economically and ecologically important abundant species include the timber-yielding *Dipterocarpus turbinatus*, *Artocarpus chaplasha*, and *Vitex peduncularis*. Many other species in the sanctuary have timber, medicinal, or environmental value (Khan *et al.*, 2002). These species should be prioritised in the forest management plan for this area. For locally rare species—particularly those represented by a single individual—detailed distribution mapping and intensified monitoring are urgently recommended to prevent local extinction.

### Conclusions

Based on the tree species abundance, density, diversity, and dominance, it can be concluded that tree species diversity in Rema-Kalenga Wildlife Sanctuary is relatively high. The sanctuary represents a still well-stocked natural forest harbouring many nearly equally abundant species, characteristics of tropical mixed evergreen forests. Key management recommendations include: (1) incorporation of economically, medicinally, and environmentally important abundant species into the formal forest management plan; (2) urgent preparation of distribution maps and initiation of increased monitoring for all 21 species recorded as singletons; and (3) continued floristic monitoring to detect changes in community composition given ongoing anthropogenic pressures.

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