STRUCTURAL COMPOSITION AND DISTRIBUTION OF TREE SPECIES OF DUDHPUKURIA-DHOPACHORI WILDLIFE SANCTUARY, CHITTAGONG, BANGLADESH

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Abstract

Structural composition based on diameter and height class distribution of the tree species of Dudhpukuria-Dhopachori Wildlife Sanctuary, Chittagong, Bangladesh was assessed. A total of 183 tree species having ≥ 10 DBH belonging to 125 genera and 48 families was recorded from the study area. Different species were found to dominate in different DBH classes, i.e. *Aporosa wallichii* (4.06%), *Artocarpus chama* (1.54%) and *Dillenia pentagyna* (0.38%) dominated 10 - < 25 cm, 25 - < 40 cm and 40 - < 55 cm DBH, respectively. *Swintonia floribunda* was found in maximum (7 out of 8) number of DBH classes. Both the percentage of tree individuals (73.18%) and number of species (169) were highest in 10-24.5cm DBH range. Similarly, *Dipterocarpus turbinatus* (14.5-24.4m and 24.5-34.4m) and *Swintonia floribunda* (34.5-44.4m and 44.5-54.4m) were dominant in two height ranges each. On the other hand, height range 4.5 - 14.4 m was dominated by *Aporosa wallichii* (4.36%). *Dipterocarpus costatus, Artocarpus chama, Syzygium firmum* and *Bombax insigne* were found in all the height classes. Both the number of tree species and number of individual stems (167 species; 1,684 individuals) were highest in the height range of 4.5-14.4m. The number of species and tree individuals decreased linearly with increasing height. All these indicate that, there was a sustainable natural regeneration and successful recruitment of *Aporosa wallichii, Dipterocarpus turbinatus, Lithocarpus acuminata, Grewia nervosa* and *Artocarpus chama* in Dudhpukuria-Dhopachori Wildlife Sanctuary. *Dipterocarpus turbinatus* was found as dominant species as it constitures maximum (5.56%) percentage of all tree individuals. The findings of the study may be useful for protection, conservation and sustainable management of Dudhpukuria-Dhopachori Wildlife Sanctuary.

***Keywords*:** Dudhpukuria-Dhopachori, DBH and height class, Conservation, *Dipterocarpus turbinatus.*

INTRODUCTION

Bangladesh covers an area of 1.204 million ha of natural forests which are classified into hill forests, Sal forests and mangrove forests of the Sundarbans (Altrell *et al.* 2007). The flora of hill forests of Bangladesh is closely related to Indo-China than any other forests of this region (Das and Alam 2001). An undisturbed natural hill forest of Bangladesh is generally uneven-aged and multi-storied forest (Alam 2008). Clear felling followed by artificial regeneration in the hill forests of Bangladesh caused serious harm to natural regeneration, seedling and sapling establishment, soil fertility, natural forest condition and hence the natural ecosystem (Das 1980, Haque and Alam 1988). In Bangladesh, forest biological resources are severely disturbed and degraded due to rapid population growth, poverty, inappropriate forest management system, over exploitation, energy deficit and lack of motivation regarding biodiversity conservation (Hassan 1995). The overall forest structure is changed by such disturbances (Shaforth *et al.* 2002) which ultimately affects the regeneration and population dynamics (Kwit and Platt 2003). Diameter distribution of trees has been often used to represent forest structure (Khan *et al.* 1987, Newton and Smith 1988). A forest community typically includes a canopy, an understory layer, shrubs and herbs to ground layer, and the forest floor, including roots and soil. The vertical arrangement of vegetation in a forest is as important to many species as the size of the forest itself. It is suggested that vertical stratification of vegetation results in the stratification of food

resources and microclimate, animal communities and each vegetation stratum having its own characteristic fauna (Kimmins 1996).

Knowledge about the tree flora of a country or an area is very important for its sustainable use and future management plan. The trees as key structural components of forest ecosystems, provide timber and non-timber products, and vital ecosystem services. Various research findings have suggested that tree species diversity can be used as a surrogate for overall species diversity in forest ecosystems (SBSTTA 1996, Lammerts van Bueren and Duivenvoorden 1996). Tree diversity is often considered as a good proxy to estimate diversity of other taxonomic groups (Gentry 1988). A clear understanding of forest stands parameters, i.e. DBH class and height class distribution are also important for modeling future wood production of that forests. Motaleb and Hossain (2009) and Nath *et al.* (1997) investigated suitable management system based on diameter class distribution in two natural forests of Bangladesh. Dudhpukuria-Dhopachori declared Wildlife Sanctuary in 2010 and is composed of disturbed and undulated natural forest patches. Hence, this study is conducted to find out the species composition, height and diameter distribution at a class interval of 10 m and 15 cm, respectively in Dudhpukuria-Dhopachori Wildlife Sanctuary, so that management decision for the forest can be facilitated.

MATERIAL AND METHODS

The study was carried out in the Dudhpukuria-Dhopachori Wildlife Sanctuary (between 22°09' and 22°22' north latitude and 92°05' and 92°10' east longitudes) along the borderline of Chittagong, Rangamati and Bandarban districts (Hossain *et al.* 2014). The Wildlife Sanctuary (WS) comprises a portion of the Reserved Forests of Khurusia and Dohazari Forest Ranges under Chittagong (South) Forest Division. The sanctuary comprises with a total area of 4,716.57 ha. The whole wildlife sanctuary area, criss-crossed by numerous creeks, is comprised of hill and hillocks (about 80% of total area) and plain lands (about 20% of total area) covered with forests and grasses. Stratified Random Sample method was applied for the inventory of the tree species. A total of 125 sample plots of 20m × 20m in size were taken from the three blocks (Dudhpukuria- 31 plots, Kamalachori- 31 plots and Dhopachori- 63 plots) randomly to cover a total sample area of 5 ha for the assessment of the tree species diversity. From each quadrat, all the tree species having DBH of ≥10cm were recorded by their name and number. Tree individuals of each species were tallied into DBH classes at 15 cm interval and height classes at 10 m interval. Herbarium specimens were collected and preserved following standard scientific methods. The specimens were identified with the help of taxonomists and comparing with the voucher specimen of the Bangladesh Forest Research Institute and Chittagong University herbaria.

RESULTS AND DISCUSSION

The results revealed that Dudhpukuria-Dhopachori Wildlife Sanctuary harbors 183 tree species belonging to 125 genera and 48 families. The number of tree stems per hectare is 468 (Table 1).

Diameter (DBH) class distribution of tree species

Percentage distribution of tree individuals in different DBH classes (cm) shows that 73.18% trees belong to DBH class ranges from 10 - <25 cm. On the other hand, DBH range 100-<115 cm was found to represent lowest percentage (0.17%) of trees. Different DBH classes were dominated by different tree species, i.e. DBH range 10 - <25 cm was dominated by *Aporosa wallichii* (4.06%) followed by *Lithocarpus acuminata* (3.76%) and *Dipterocarpus turbinatus* (3.55%); DBH range 25-<40 cm was dominated by *Artocarpus chama* (1.54%) followed by *Dipterocarpus turbinatus* (1.45%) and *Lithocarpus acuminata* (0.86%). Moreover, *Dillenia pentagyna* (0.38%), *Dipterocarpus turbinatus*

(0.26%), *Terminalia bellirica* (0.09%) and *Dipterocarpus costatus* (0.09%) were dominant in 40-<55cm, 55-<70cm, 85-<100cm and 100-<115cm DBH ranges, respectively. *Swintonia floribunda* occurred in higher DBH classes 70 - <85cm and ≥115cm with representation of 0.13% and 0.09% respectively (Table 1).

Table 1. Diameter class distribution of tree species of Dudhpukuria-Dhopachori Wildlife Sanctuary.

No	Scientific name	Percentage distribution of tree species into different diameter classes (cm)								
		10 - <25	25 - <40	40 - <55	55 - <70	70 - <85	85 - <100	100 - <115	≥ 115	Total (%)
1	*Acacia auriculiformis*	0.09	-	-	-	-	-	-	-	0.09
2	*Acacia mangium*	0.09	-	-	-	-	-	-	-	0.09
3	*Acronychia pedunculata*	1.92	0.3	0.04	-	-	-	-	-	2.27
4	*Actinodaphne angustifolia*	0.64	0.09	-	-	-	-	-	-	0.73
5	*Aegle marmelos*	0.09	-	-	-	-	-	-	-	0.09
6	*Aglaia chittagonga*	0.3	0.09	-	-	-	-	-	-	0.38
7	*Aglaia perviridis*	0.17	0.13	-	-	-	-	-	-	0.3
8	*Aglaia spectabilis*	0.04	-	0.04	-	-	0.04	-	-	0.13
9	*Aidia oppositifolia*	0.17	0.04	-	-	-	-	-	-	0.21
10	*Alangium chinense*	0.47	0.21	0.09	-	-	-	-	-	0.77
11	*Albizia chinensis*	0.94	0.09	-	-	-	-	-	-	1.03
12	*Albizia odoratissima*	0.68	0.17	0.09	-	-	-	-	-	0.94
13	*Albizia procera*	0.26	0.13	-	0.04	-	-	-	-	0.43
14	*Alstonia scholaris*	0.3	-	-	-	-	-	-	-	0.3
15	*Anisoptera scaphula*	0.09	0.04	-	-	-	-	-	-	0.13
16	*Anogeissus acuminata*	0.81	0.17	-	-	-	-	-	-	0.98
17	*Antidesma banius*	0.04	-	-	-	-	-	-	-	0.04
18	*Antidesma velutinum*	0.09	-	-	-	-	-	-	-	0.09
19	*Aphanamixis polystachya*	0.56	0.21	0.04	-	-	-	-	-	0.81
20	*Aporosa wallichii*	4.06	0.34	0.04	0.04	0.04	-	-	-	4.53
21	*Aquilaria agallocha*	0.09	-	-	-	-	-	-	-	0.09
22	*Artocarpous heterophyllus*	0.09	0.04	-	-	-	-	-	-	0.13
23	*Artocarpus chama*	2.14	1.54	0.04	0.04	-	-	-	-	3.76
24	*Artocarpus lacucha*	0.68	0.17	0.09	-	-	-	-	-	0.94
25	*Baccaurea ramiflora*	0.04	-	-	-	-	-	-	-	0.04
26	*Berrya cordifolia*	0.09	0.04	0.17	0.04	-	-	-	-	0.34
27	*Bombax insigne*	0.21	0.21	0.09	-	-	-	-	-	0.51
28	*Brassaiopsis glomerulata*	0.04	-	-	-	-	-	-	-	0.04
29	*Bridelia retusa*	0.13	-	-	-	-	-	-	-	0.13
30	*Brownlowia elata*	0.13	0.04	-	-	-	-	-	-	0.17
31	*Butea monosperma*	0.04	-	-	-	-	-	-	-	0.04
32	*Caesalpinia pulcherrima*	-	0.04	-	-	-	-	-	-	0.04
33	*Callicarpa arborea*	1.24	0.21	-	-	-	-	-	-	1.45
34	*Calophyllum polyanthum*	0.04	0.04	0.04	-	-	-	-	-	0.13
35	*Canthium horridum*	0.09	-	-	-	-	-	-	-	0.09
36	*Carallia brachiata*	0.21	-	0.04	-	0.04	-	-	-	0.3
37	*Caryota mitis*	0.51	0.04	-	-	-	-	-	-	0.56
38	*Caryota urens*	0.26	-	-	-	-	-	-	-	0.26
39	*Cassia fistula*	0.13	0.09	-	-	-	-	-	-	0.21
40	*Cassia nodosa*	0.04	-	-	-	-	-	-	-	0.04
41	*Ceriscoides campanulata*	0.09	-	-	-	-	-	-	-	0.09
42	*Chisocheton cumingianus*	0.47	0.21	0.04	0.09	0.09	-	-	-	0.9
43	*Chukrasia tabularis*	0.26	0.56	0.26	-	-	-	-	-	1.07
44	*Cinnamomum iners*	0.13	-	-	-	-	-	-	-	0.13
45	*Cocos nucifera*	0.09	0.04	-	-	-	-	-	-	0.13

46	*Crypteronia paniculata*	0.04	0.04	-	-	-	-	-	-	0.09
47	*Cryptocarya amygdalina*	0.26	0.34	0.13	-	-	-	-	-	0.73
48	*Derris robusta*	-	0.04	-	-	-	-	-	-	0.04
49	*Didymosperma gracilis*	0.09	-	-	-	-	-	-	-	0.09
50	*Dillenia indica*	0.04	-	-	-	-	-	-	-	0.04
51	*Dillenia pentagyna*	0.26	0.47	0.38	0.13	-	-	-	-	1.24
52	*Diospyros malabarica*	0.17	0.04	0.04	-	0.04	-	-	-	0.3
53	*Diospyros toposia*	-	-	0.04	-	-	-	-	-	0.04
54	*Dipterocarpus alatus*	0.04	0.09	-	0.04	-	-	0.04	0.04	0.26
55	*Dipterocarpus costatus*	0.51	0.09	-	0.09	0.09	-	0.09	0.09	0.94
56	*Dipterocarpus turbinatus*	3.55	1.45	0.17	0.26	0.09	0.04	-	-	5.56
57	*Discospermum abnorme*	0.04	-	-	-	-	-	-	-	0.04
58	*Drimycarpus racemosus*	0.09	0.04	-	-	-	-	-	-	0.13
59	*Duabanga grandiflora*	0.09	0.13	-	-	-	-	-	-	0.21
60	*Dysoxylum binectariferum*	0.04	0.04	-	-	-	-	-	-	0.09
61	*Dysoxylum excelsum*	0.09	-	-	-	-	-	-	-	0.09
62	*Ehretias errata*	-	0.04	-	-	-	-	-	-	0.04
63	*Elaeocarpus floribundus*	0.17	0.13	-	0.04	0.04	-	-	-	0.38
64	*Elaeocarpus tectorius*	0.34	0.04	0.04	-	0.04	-	-	-	0.47
65	*Elaeocarpus varunua*	0.04	0.04	-	-	-	-	-	-	0.09
66	*Engelhardtia spicata*	-	0.04	-	-	-	-	-	-	0.04
67	*Erythrina fusca*	0.17	0.09	-	0.04	-	-	-	-	0.3
68	*Ficus auriculata*	0.13	0.04	-	-	-	-	-	-	0.17
69	*Ficus benghalensis*	0.04	0.04	-	0.04	0.04	0.04	-	0.04	0.26
70	*Ficus fistulosa*	0.04	-	-	-	-	-	-	-	0.04
71	*Ficus hispida*	0.9	0.09	-	-	-	-	-	-	0.98
72	*Ficus lamponga*	0.04	0.09	0.09	0.09	-	0.04	0.04	-	0.38
73	*Ficus nervosa*	0.13	-	0.09	0.13	0.09	-	-	-	0.43
74	*Ficus racemosa*	0.38	0.04	0.09	-	-	-	-	-	0.51
75	*Ficus semicordata*	0.17	-	-	-	-	-	-	-	0.17
76	*Ficus variegata*	0.9	0.04	0.09	0.04	0.04	-	-	-	1.11
77	*Flacourtia jangomas*	0.04	-	-	-	-	-	-	-	0.04
78	*Garcinia cowa*	0.68	0.43	-	-	-	-	-	-	1.11
79	*Garcinia morella*	0.09	0.04	-	-	-	-	-	-	0.13
80	*Garcinia xanthochymus*	0.09	0.09	0.04	-	-	-	-	-	0.21
81	*Gardenia coronaria*	0.04	-	-	-	-	-	-	-	0.04
82	*Garuga pinnata*	0.9	0.21	0.26	0.09	0.04	-	-	-	1.5
83	*Glochidion lanceolarium*	0.04	-	-	-	-	-	-	-	0.04
84	*Glochidion multiloculare*	0.86	-	-	-	-	-	-	-	0.86
85	*Glochidion velutinum*	0.09	-	-	-	-	-	-	-	0.09
86	*Gluta elegans*	0.34	0.26	0.04	0.09	-	-	-	-	0.73
87	*Glycosmis pentaphylla*	0.04	-	-	-	-	-	-	-	0.04
88	*Gmelina arborea*	0.3	0.09	-	-	-	-	-	-	0.38
89	*Grevillea robusta*	-	-	-	-	0.04	-	-	-	0.04
90	*Grewia nervosa*	3.42	0.6	0.04	0.04	-	-	-	-	4.11
91	*Grewia tiliifolia*	0.13	-	-	-	-	-	-	-	0.13
92	*Haldina cordifolia*	0.13	-	-	-	-	-	-	-	0.13
93	*Harpullia cupanoides*	-	0.04	-	-	-	-	-	-	0.04
94	*Holarrhena antidysenterica*	0.86	-	-	-	-	-	-	-	0.86
95	*Hopea odorata*	0.13	-	-	-	-	-	-	-	0.13
96	*Hydnocarpus laurifolius*	0.9	0.21	-	-	-	-	-	-	1.11
97	*Illex godajam*	0.09	-	-	-	-	-	-	-	0.09
98	*Lagerstroemia macrocarpa*	0.56	-	-	-	-	-	-	-	0.56
99	*Lagerstromia speciosa*	0.26	0.13	-	-	-	-	-	-	0.38

100	*Lannea coromandelica*	0.04	-	-	-	-	-	-	-	0.04
101	*Leea robusta*	-	0.04	-	-	-	-	-	-	0.04
102	*Lepisanthes rubiginosa*	0.04	-	-	-	-	-	-	-	0.04
103	*Licuala peltata*	0.64	0.17	0.04	-	-	-	-	0.04	0.9
104	*Lithocarpus acuminata*	3.76	0.86	0.04	-	-	-	-	-	4.66
105	*Lithocarpus elegans*	0.3	0.17	-	-	-	-	-	-	0.47
106	*Lithocarpus pachyphylla*	0.56	0.13	0.21	0.04	-	-	-	-	0.94
107	*Lithocarpus polystachya*	0.68	0.17	-	-	-	-	-	-	0.86
108	*Litsea glutinosa*	0.47	-	-	-	-	-	-	-	0.47
109	*Macaranga denticulata*	1.03	0.17	-	-	-	-	-	-	1.2
110	*Macaranga indica*	0.13	-	-	-	-	-	-	-	0.13
111	*Macaranga peltata*	0.09	-	-	-	-	-	-	-	0.09
112	*Maesa chisia*	0.04	-	-	-	-	-	-	-	0.04
113	*Maesa indica*	0.43	0.04	-	-	-	-	-	-	0.47
114	*Magifera sylvatica*	0.13	0.09	-	-	0.04	-	-	-	0.26
115	*Mallotus tetracoccus*	0.04	-	-	-	-	-	-	-	0.04
116	*Mangifera indica*	-	0.13	-	-	-	-	-	-	0.13
117	*Michelia bailloni*	-	0.04	-	-	-	-	-	-	0.04
118	*Micromelum minutum*	0.17	-	-	-	-	-	-	-	0.17
119	*Mitragyna diversifolia*	0.81	0.04	-	-	-	-	-	-	0.86
120	*Mitragyna parvifolia*	1.07	0.04	-	-	-	-	-	-	1.11
121	*Mitragyna rotundifolia*	0.26	-	-	-	-	-	-	-	0.26
122	*Myristica linifolia*	0.26	-	-	-	-	-	-	-	0.26
123	*Neolamarckia cadamba*	0.68	-	-	-	-	-	-	-	0.68
124	*Neonauclea sessilifolia*	0.13	-	-	-	-	-	-	-	0.13
125	*Ormosia robusta*	0.04	-	-	-	-	-	-	-	0.04
126	*Oroxylum indicum*	0.38	-	-	-	-	-	-	-	0.38
127	*Pajanelia longifolia*	0.09	-	-	-	-	-	-	-	0.09
128	*Palaquium polyanthum*	0.09	-	0.09	-	-	-	-	-	0.17
129	*Persea bombycina*	0.04	-	-	-	-	-	-	-	0.04
130	*Phoebe lanceolata*	0.04	-	-	-	-	-	-	-	0.04
131	*Phoenix sylvestris*	0.09	0.04	-	-	-	-	-	-	0.13
132	*Phyllanthus emblica*	0.38	0.04	-	-	-	-	-	-	0.43
133	*Phyllanthus reticulatus*	0.04	-	-	-	-	-	-	-	0.04
134	*Picrasma javanica*	0.09	-	-	-	-	-	-	-	0.09
135	*Pithecellobium angulatum*	0.21	0.26	0.04	-	-	-	-	-	0.51
136	*Protium serratum*	2.01	0.47	0.13	-	-	-	-	-	2.61
137	*Psidium guajaba*	0.04	-	-	-	-	-	-	-	0.04
138	*Pterospermum acerifolium*	0.68	0.04	-	-	-	-	-	-	0.73
139	*Pterospermum semisagittatum*	0.77	0.13	0.09	-	-	-	-	-	0.98
140	*Sapium baccatum*	0.26	0.13	0.17	0.04	0.04	-	-	-	0.64
141	*Saprosma ternatum*	0.04	-	-	-	-	-	-	-	0.04
142	*Sarcochlamys pulcherrima*	0.09	-	-	-	-	-	-	-	0.09
143	*Schima wallichii*	1.58	0.51	0.04	0.17	0.09	-	-	-	2.4
144	*Senna siamea*	0.3	0.04	-	0.04	-	-	-	-	0.38
145	*Shorea robusta*	-	0.04	-	-	-	-	-	-	0.04
146	*Siphonodon celastrineus*	0.3	0.04	-	-	-	-	-	-	0.34
147	*Spondias pinnata*	0.64	0.09	-	-	-	-	-	-	0.73
148	*Sterculia foetida*	0.6	0.09	0.09	-	-	-	-	-	0.77
149	*Sterculia hamiltonii*	0.04	-	-	-	-	-	-	-	0.04
150	*Sterculia villosa*	0.38	0.3	-	-	-	-	-	-	0.68
151	*Stereospermum colais*	1.28	0.34	0.34	0.17	-	-	-	-	2.14
152	*Stereospermum suaveolens*	0.38	0.04	-	0.04	-	-	-	-	0.47
153	*Streblus asper*	0.21	0.21	-	-	-	-	-	-	0.43

154	*Suregada multiflora*	0.04	-	-	-	-	-	-	-	0.04
155	*Swietenia mahagoni*	-	0.04	-	-	-	-	-	-	0.04
156	*Swintonia floribunda*	0.04	0.04	0.09	0.09	0.13	0.04	-	0.09	0.51
157	*Syzygium balsameum*	0.13	0.04	-	-	0.04	-	-	-	0.21
158	*Syzygium claviflorum*	-	-	0.09	-	-	-	-	-	0.09
159	*Syzygium cumini*	0.17	-	-	-	-	-	-	-	0.17
160	*Syzygium cymosum*	0.04	-	-	-	-	-	-	-	0.04
161	*Syzygium firmum*	0.13	0.13	0.13	0.17	0.09	-	-	-	0.64
162	*Syzygium fruticosum*	0.17	0.04	-	-	-	-	-	-	0.21
163	*Syzygium ramosissimum*	0.04	-	0.04	-	-	-	-	-	0.09
164	*Syzygium syzygioides*	0.21	0.09	-	-	-	-	-	-	0.3
165	*Syzygium tetragonum*	0.38	-	-	-	-	-	-	-	0.38
166	*Tamarindus indica*	0.13	-	-	-	-	-	-	-	0.13
167	*Tarenna campaniflora*	1.75	0.09	-	-	-	-	-	-	1.84
168	*Tectona grandis*	3.08	0.13	0.04	0.04	-	-	-	0.04	3.34
169	*Terminalia alata*	0.04	0.09	-	-	-	-	-	-	0.13
170	*Terminalia arjuna*	0.26	0.04	0.13	0.09	-	-	-	-	0.51
171	*Terminalia bellirica*	1.54	0.13	0.3	0.17	0.04	0.09	-	-	2.27
172	*Terminalia chebula*	0.04	0.04	-	0.04	-	-	-	-	0.13
173	*Tetrameles nudiflora*	0.21	0.17	-	-	-	-	-	-	0.38
174	*Toona ciliata*	0.43	0.09	-	-	-	-	-	-	0.51
175	*Trema orientalis*	0.04	-	-	-	-	-	-	-	0.04
176	*Trewia nudiflora*	0.3	0.17	-	-	-	-	-	-	0.47
177	*Vatica lanceaefolia*	-	0.04	-	-	-	-	-	-	0.04
178	*Vitex glabrata*	0.26	-	0.04	-	-	-	-	-	0.3
179	*Vitex peduncularis*	2.31	-	0.04	-	-	-	-	-	2.35
180	*Vitex pinnata*	0.43	0.09	0.04	-	-	-	-	-	0.56
181	*Walsura robusta*	0.09	0.04	-	-	-	-	-	-	0.13
182	*Wrightia arborea*	0.09	0.04	-	-	-	-	-	-	0.13
183	*Zanthoxylum rhetsa*	0.17	0.09	-	-	-	-	-	-	0.26
	Total	**73.18**	**17.45**	**4.88**	**2.48**	**1.2**	**0.3**	**0.17**	**0.34**	**100**

Occurrences of individual tree species at different diameter classes showed that *Swintonia floribunda* occurred in 7 DBH classes among 8 classes, but its representation was only 0.51%. Followed by *S. floribunda*, presence of tree individuals of *D. turbinatus, Terminalia bellirica, D. costatus, Ficus benghalensis* and *F. lamponga* were noticed in maximum 6 DBH classes. It indicates sustainable natural regeneration and successful recruitment of these tree species in the study area. As an individual species, *D. turbinatus* showed maximum (5.56%) occurrence of its individuals followed by *Lithocarpus acuminata* (4.66%), *Aposora wallichii* (4.53%), *Grewia nervosa* (4.11%) and *Artocarpus chama* (3.76%). Distribution of individual stems among different DBH classes, shown in Fig. 1, indicates a reverse J-shaped curve which is typical for most undisturbed tropical forests (Campbell *et al.* 1986; Rankin-de-Merona *et al.* 1992). It depicts progressive decline of tree individuals in larger tree size (DBH) classes with age.

Similarly, the number of tree species reflects a decreasing trend with increasing diameter (Fig. 1). Both the number of species and number of tree individuals were maximum (169 species; 1,711 individuals) in 10-<25 cm DBH range and minimum (3 species; 4 individual stems) in 100- <115 DBH range (Fig. 1). The trend reveals successful recruitment of some pioneer tree species. It also indicates incidence of illegal felling of comparatively mature trees in Wildlife Sanctuary area. Recent strengthening of protection over the forests supposed to increase the higher number of trees in lower size classes.

Height class distribution of tree species

Percentage distribution of tree individuals into different height classes shows that smallest growth class, i.e. 4.5-<14.4m height range holds maximum (72.03%) tree individuals, whereas the minimum (0.47%) tree species was represented by the 44.5-<54.4m height range (Table 2). Similar to DBH classes, height classes were dominated by different tree species. *Aporosa wallichii* (4.36%) was dominant in 4.5-<14.4m height range followed by *Lithocarpus acuminata* (3.68%) and *Grewia nervosa* (3.55%). Height range 14.5-<24.4m was dominated by *D. turbinatus* (2.22%) followed by *L. acuminata* (0.98%) and *Stereospermum colais* (0.9%). On the other hand, individuals of *D. turbinatus* was found maximum (0.77%) in 24.5-<34.4m height range followed by *A. chama* (0.38%). *Swintonia floribunda* (0.17%) was found dominant in 34.5-<44.4 m and 44.5-<54.4 height ranges. The overall distribution reflects that the natural environment for sustainable natural regeneration and successful recruitment of *D. turbinatus*, *L. acuminata*, *Grewia nervosa* and *A. chama* was suitable in Dudhpukuria-Dhopachori forests. *Dipterocarpus costatus, Artocarpus chama, Syzygium firmum* and *Bombax insigne* were found in all the height classes (Table 2).

Table 2. Tree species distribution of Dudhpukuria- Dhopachori Wildlife Sanctuary in different height classes.

No.	Scientific name	Distribution (percentage) of tree species in different height class					
		4.5-<14.4	**14.5-<24.4**	**24.5-<34.4**	**34.5-<44.4**	**44.5-<54.4**	**Total**
1	*Acacia auriculiformis*	0.04	0.04	-	-	-	0.09
2	*Acacia mangium*	-	0.09	-	-	-	0.09
3	*Acronychia pedunculata*	1.71	0.56	-	-	-	2.27
4	*Actinodaphne angustifolia*	0.64	0.09	-	-	-	0.73
5	*Aegle marmelos*	0.09	-	-	-	-	0.09
6	*Aglaia chittagonga*	0.30	0.09	-	-	-	0.38
7	*Aglaia perviridis*	0.21	0.04	0.04	-	-	0.30
8	*Aglaia spectabilis*	0.04	0.04	0.04	-	-	0.13
9	*Aidia oppositifolia*	0.17	0.04	-	-	-	0.21
10	*Alangium chinense*	0.51	0.26	-	-	-	0.77
11	*Albizia chinensis*	0.94	0.09	-	-	-	1.03
12	*Albizia odoratissima*	0.64	0.30	-	-	-	0.94
13	*Albizia procera*	0.17	0.21	0.04	-	-	0.43
14	*Alstonia scholaris*	0.30	-	-	-	-	0.30
15	*Anisoptera scaphula*	0.09	0.09	-	-	-	0.17
16	*Anogeissus acuminata*	0.90	0.09	-	-	-	0.98
17	*Antidesma banius*	0.04	-	-	-	-	0.04
18	*Antidesma velutinum*	0.09	-	-	-	-	0.09
19	*Aphanamixis polystachya*	0.64	0.17	-	-	-	0.81
20	*Aporosa wallichii*	4.36	0.17	-	-	-	4.53
21	*Aquilaria agallocha*	0.09	-	-	-	-	0.09
22	*Artocarpous heterophyllus*	0.13	-	-	-	-	0.13
23	*Artocarpus chama*	2.35	0.86	0.38	0.13	0.04	3.76
24	*Artocarpus lacucha*	0.56	0.38	-	-	-	0.94
25	*Baccaurea ramiflora*	0.04	-	-	-	-	0.04
26	*Berrya cordifolia*	-	0.09	0.26	-	-	0.34
27	*Bombax insigne*	0.21	0.13	0.09	0.04	0.04	0.51
28	*Brassaiopsis glomerulata*	0.04	-	-	-	-	0.04
29	*Bridelia retusa*	0.13	-	-	-	-	0.13
30	*Brownlowia elata*	0.13	0.04	-	-	-	0.17
31	*Butea monosperma*	0.04	-	-	-	-	0.04
32	*Caesalpinia pulcherrima*	0.04	-	-	-	-	0.04

33	*Callicarpa arborea*	1.24	0.21	-	-	-	1.45
34	*Calophyllum polyanthum*	-	0.09	-	0.04	-	0.13
35	*Canthium horridum*	0.09	-	-	-	-	0.09
36	*Carallia brachiata*	0.17	0.04	0.09	-	-	0.30
37	*Caryota mitis*	0.56	-	-	-	-	0.56
38	*Caryota urens*	0.26	-	-	-	-	0.26
39	*Cassia fistula*	0.17	0.04	-	-	-	0.21
40	*Cassia nodosa*	0.04	-	-	-	-	0.04
41	*Ceriscoides campanulata*	0.09	-	-	-	-	0.09
42	*Chisocheton cumingianus*	0.47	0.30	0.13	-	-	0.90
43	*Chukrasia tabularis*	0.13	0.81	0.13	-	-	1.07
44	*Cinnamomum iners*	0.13	-	-	-	-	0.13
45	*Cocos nucifera*	0.04	0.09	-	-	-	0.13
46	*Crypteronia paniculata*	-	0.09	-	-	-	0.09
47	*Cryptocarya amygdalina*	0.47	0.26	-	-	-	0.73
48	*Derris robusta*	0.04	-	-	-	-	0.04
49	*Didymosperma gracilis*	0.09	-	-	-	-	0.09
50	*Dillenia indica*	0.04	-	-	-	-	0.04
51	*Dillenia pentagyna*	0.68	0.43	0.13	-	-	1.24
52	*Diospyros malabarica*	0.17	0.09	0.04	-	-	0.30
53	*Diospyros toposia*	-	0.04	-	-	-	0.04
54	*Dipterocarpus alatus*	-	0.13	0.04	0.04	0.04	0.26
55	*Dipterocarpus costatus*	0.51	0.09	0.09	0.13	0.13	0.94
56	*Dipterocarpus turbinatus*	2.48	2.22	0.77	0.09	-	5.56
57	*Discospermum abnorme*	0.04	-	-	-	-	0.04
58	*Drimycarpus racemosus*	0.09	0.04	-	-	-	0.13
59	*Duabanga grandiflora*	0.09	0.13	-	-	-	0.21
60	*Dysoxylum binectariferum*	0.09	-	-	-	-	0.09
61	*Dysoxylum excelsum*	0.09	-	-	-	-	0.09
62	*Ehretia serrata*	-	0.04	-	-	-	0.04
63	*Elaeocarpus floribundus*	0.13	0.26	-	-	-	0.38
64	*Elaeocarpus tectorius*	0.34	0.13	-	-	-	0.47
65	*Elaeocarpus varunua*	-	0.09	-	-	-	0.09
66	*Engelhardtia spicata*	0.04	-	-	-	-	0.04
67	*Erythrina fusca*	0.17	0.13	-	-	-	0.30
68	*Ficus auriculata*	0.17	-	-	-	-	0.17
69	*Ficus benghalensis*	0.09	0.09	0.09	-	-	0.26
70	*Ficus fistulosa*	0.04	-	-	-	-	0.04
71	*Ficus hispida*	0.94	0.04	-	-	-	0.98
72	*Ficus lamponga*	0.17	0.21	-	-	-	0.38
73	*Ficus nervosa*	0.13	0.04	0.21	0.04	-	0.43
74	*Ficus racemosa*	0.38	0.13	-	-	-	0.51
75	*Ficus semicordata*	0.09	0.09	-	-	-	0.17
76	*Ficus variegata*	0.81	0.26	0.04	-	-	1.11
77	*Flacourtia jangomas*	0.04	-	-	-	-	0.04
78	*Garcinia cowa*	0.94	0.17	-	-	-	1.11
79	*Garcinia morella*	0.04	0.09	-	-	-	0.13
80	*Garcinia xanthochymus*	0.04	0.13	-	0.04	-	0.21
81	*Gardenia coronaria*	0.04	-	-	-	-	0.04
82	*Garuga pinnata*	0.81	0.51	0.17	-	-	1.50
83	*Glochidion lanceolarium*	0.04	-	-	-	-	0.04
84	*Glochidion multiloculare*	0.77	0.09	-	-	-	0.86
85	*Glochidion velutinum*	0.09	-	-	-	-	0.09
86	*Gluta elegans*	0.26	0.34	0.13	-	-	0.73

87	*Glycosmis pentaphylla*	0.04	-	-	-	-	0.04
88	*Gmelina arborea*	0.38	-	-	-	-	0.38
89	*Grevillea robusta*	-	-	0.04	-	-	0.04
90	*Grewia nervosa*	3.55	0.56	-	-	-	4.11
91	*Grewia tiliifolia*	0.13	-	-	-	-	0.13
92	*Haldina cordifolia*	0.13	-	-	-	-	0.13
93	*Harpullia cupanoides*	-	0.04	-	-	-	0.04
94	*Holarrhena antidysenterica*	0.81	0.04	-	-	-	0.86
95	*Hopea odorata*	0.13	-	-	-	-	0.13
96	*Hydnocarpus laurifolius*	0.86	0.26	-	-	-	1.11
97	*Illex godajam*	0.09	-	-	-	-	0.09
98	*Lagerstroemia macrocarpa*	0.51	0.04	-	-	-	0.56
99	*Lagerstromia speciosa*	0.21	0.17	-	-	-	0.38
100	*Lannea coromandelica*	0.04	-	-	-	-	0.04
101	*Leea robusta*	0.04	-	-	-	-	0.04
102	*Lepisanthes rubiginosa*	0.04	-	-	-	-	0.04
103	*Licuala peltata*	0.43	0.38	0.09	-	-	0.90
104	*Lithocarpus acuminata*	3.68	0.98	-	-	-	4.66
105	*Lithocarpus elegans*	0.04	0.43	-	-	-	0.47
106	*Lithocarpus pachyphylla*	0.64	0.26	0.04	-	-	0.94
107	*Lithocarpus polystachya*	0.81	0.04	-	-	-	0.86
108	*Litsea glutinosa*	0.47	-	-	-	-	0.47
109	*Macaranga denticulata*	1.11	0.09	-	-	-	1.20
110	*Macaranga indica*	0.09	0.04	-	-	-	0.13
111	*Macaranga peltata*	0.09	-	-	-	-	0.09
112	*Maesa chisia*	0.04	-	-	-	-	0.04
113	*Maesa indica*	0.43	0.04	-	-	-	0.47
114	*Mangifera sylvatica*	0.13	0.09	0.04	-	-	0.26
115	*Mallotus tetracoccus*	0.04	-	-	-	-	0.04
116	*Mangifera indica*	0.04	0.09	-	-	-	0.13
117	*Michelia bailloni*	-	-	0.04	-	-	0.04
118	*Micromelum minutum*	0.17	-	-	-	-	0.17
119	*Mitragyna diversifolia*	0.77	0.09	-	-	-	0.86
120	*Mitragyna parvifolia*	1.03	0.09	-	-	-	1.11
121	*Mitragyna rotundifolia*	0.26	-	-	-	-	0.26
122	*Myristica linifolia*	0.26	-	-	-	-	0.26
123	*Neolamarckia cadamba*	0.60	0.09	-	-	-	0.68
124	*Neonauclea sessilifolia*	0.13	-	-	-	-	0.13
125	*Ormosia robusta*	0.04	-	-	-	-	0.04
126	*Oroxylum indicum*	0.38	-	-	-	-	0.38
127	*Pajanelia longifolia*	0.04	0.04	-	-	-	0.09
128	*Palaquium polyanthum*	0.09	0.04	-	-	-	0.13
129	*Persea bombycina*	0.04	-	-	-	-	0.04
130	*Phoebe lanceolata*	0.04	-	-	-	-	0.04
131	*Phoenix sylvestris*	0.09	0.04	-	-	-	0.13
132	*Phyllanthus emblica*	0.43	-	-	-	-	0.43
133	*Phyllanthus reticulatus*	0.04	-	-	-	-	0.04
134	*Picrasma javanica*	0.09	-	-	-	-	0.09
135	*Pithecellobium angulatum*	0.26	0.26	-	-	-	0.51
136	*Protium serratum*	2.31	0.30	-	-	-	2.61
137	*Psidium guajaba*	0.04	-	-	-	-	0.04
138	*Pterospermum acerifolium*	0.68	0.04	-	-	-	0.73
139	*Pterospermum semisagittatum*	0.73	0.26	-	-	-	0.98
140	*Sapium baccatum*	0.34	0.30	-	-	-	0.64

141	*Saprosma ternatum*	0.04	-	-	-	-	0.04
142	*Sarcochlamys pulcherrima*	0.09	-	-	-	-	0.09
143	*Schima wallichii*	1.54	0.73	0.13	-	-	2.40
144	*Senna siamea*	0.26	0.13	-	-	-	0.38
145	*Shorea robusta*	-	-	-	0.04	-	0.04
146	*Siphonodon celastrineus*	0.26	0.09	-	-	-	0.34
147	*Spondias pinnata*	0.56	0.17	-	-	-	0.73
148	*Sterculia foetida*	0.60	0.17	-	-	-	0.77
149	*Sterculia hamiltonii*	0.04	-	-	-	-	0.04
150	*Sterculia villosa*	0.43	0.26	-	-	-	0.68
151	*Stereospermum colais*	1.07	0.90	0.17	-	-	2.14
152	*Steteospermum suaveolens*	0.34	0.13	-	-	-	0.47
153	*Streblus asper*	0.38	0.04	-	-	-	0.43
154	*Suregada multiflora*	-	0.04	-	-	-	0.04
155	*Swietenia mahagoni*	0.04	-	-	-	-	0.04
156	*Swintonia floribunda*	0.04	-	0.13	0.17	0.17	0.51
157	*Syzygium balsameum*	0.09	0.13	-	-	-	0.21
158	*Syzygium claviflorum*	-	-	0.09	-	-	0.09
159	*Syzygium cumini*	0.13	0.04	-	-	-	0.17
160	*Syzygium cymosum*	-	0.04	-	-	-	0.04
161	*Syzygium firmum*	0.09	0.21	0.21	0.13	-	0.64
162	*Syzygium fruticosum*	0.17	0.04	-	-	-	0.21
163	*Syzygium ramosissimum*	0.04	-	0.04	-	-	0.09
164	*Syzygium syzygioides*	0.21	0.09	-	-	-	0.30
165	*Syzygium tetragonum*	0.34	0.04	-	-	-	0.38
166	*Tamarindus indica*	0.09	0.04	-	-	-	0.13
167	*Tarenna campaniflora*	1.67	0.17	-	-	-	1.84
168	*Tectona grandis*	3.17	0.17	-	-	-	3.34
169	*Terminalia alata*	0.04	0.09	-	-	-	0.13
170	*Terminalia arjuna*	0.26	0.26	-	-	-	0.51
171	*Terminalia bellirica*	1.37	0.81	0.04	0.04	-	2.27
172	*Terminalia chebula*	0.09	0.04	-	-	-	0.13
173	*Tetrameles nudiflora*	0.17	0.17	0.04	-	-	0.38
174	*Toona ciliata*	0.38	0.13	-	-	-	0.51
175	*Trema orientalis*	0.04	-	-	-	-	0.04
176	*Trewia nudiflora*	0.30	0.17	-	-	-	0.47
177	*Vatica lanceaefolia*	-	-	0.04	-	-	0.04
178	*Vitex glabrata*	0.26	0.04	-	-	-	0.30
179	*Vitex peduncularis*	2.22	0.13	-	-	-	2.35
180	*Vitex pinnata*	0.47	0.09	-	-	-	0.56
181	*Walsura robusta*	0.13	-	-	-	-	0.13
182	*Wrightia arborea*	0.09	0.04	-	-	-	0.13
183	*Zanthoxylum rhetsa*	0.17	0.09	-	-	-	0.26
	Total	**72.03**	**22.54**	**4.06**	**0.94**	**0.43**	**100.00**

Distribution of tree individuals among different height classes depicted a reverse J-shaped curve which indicates presence of stable population structure or good regeneration status as of a typical natural forest. Patterns of height (m) class distribution designate general trends of population dynamics and recruitment process to the maximum species. The number of species and individuals decreased regularly with increasing total height (Fig. 2). These were also highest (167 species; 1,684 individuals) in the height range of 4.5-<14.4m whereas 44.5-<54.4m height range showed lowest number of tree species and individuals (Fig. 2).

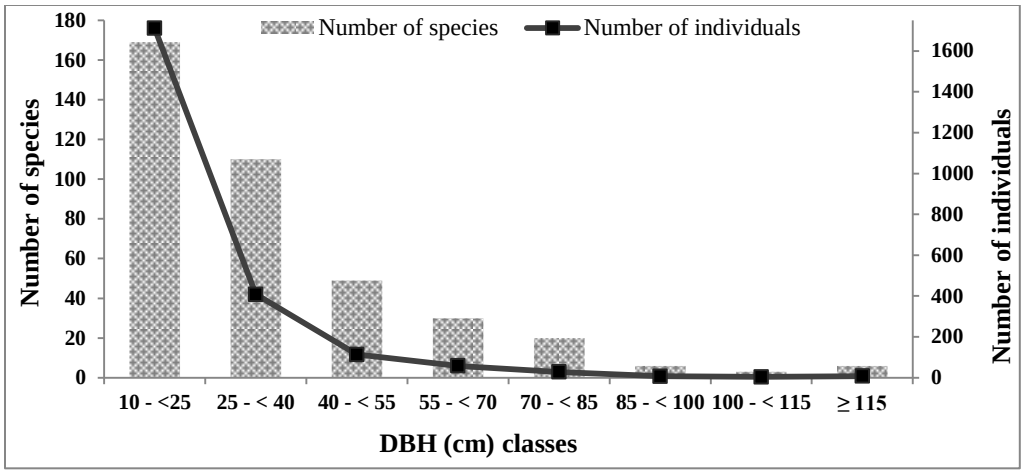

Fig. 1. Distribution of tree species and individuals in different DBH (cm) classes of Dudhpukuria-Dhopachori Wildlife Sanctuary.

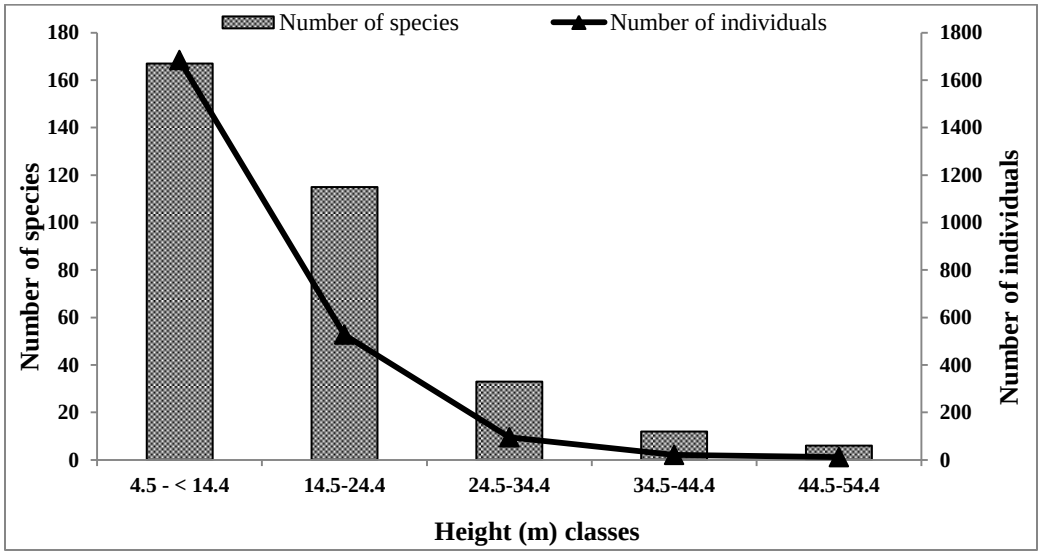

Fig. 2. Distribution of tree species and individuals in different height (m) classes of Dudhpukuria-Dhopachori Wildlife Sanctuary.

Height – Diameter Relationship

Both the tree height and diameter at breast height (DBH) show that maximum number of species and individual stems are decreasing with height and diameter growth (Fig. 3). The typical distribution of tree species of Dudhpukuria-Dhopachori Wildlife Sanctuary is a bit different in comparison to tropical forests. The numbers of mature tree individuals are decreasing because of illegal felling, firewood collection and occurrence of incendiary fire during dry season. Silvicultural treatments for stand improvement are crucial for further growth and development of each species. Quantitative characteristics of trees are crucial for forest management planning. Predicting stand structure and overall status in diameter or height class distribution is of great interest to forest managers for predicting the evaluation of forest resources and scheduling the future silvicultural treatments (Nanos and Montero 2002). As revealed in the results, there is an unevenness of age of the trees in the Dudhpukuria-Dhopachori Wildlife Sanctuary. Trees were distributed in different size classes. The unevenness of age and structure is made by nature. So, estimation of tree distribution in diameter classes can be used as a

model (Sheykholeslami *et al*. 2011) to manage similar other stands of uneven-aged high forests of Bangladesh. Height (m) and DBH (cm) relationship (r^2=0.603) indicates that silvicultural treatments are essential for the appropriate growth and development of the tree species of the forest.

The earlier research findings of similar studies reported that maximum number of species (51 species) and tree stem individuals (200 individuals) were found to occur within DBH range of 20 - <30 cm and 10 -< 20 cm, respectively in Sitapahar Reserve Forest, Chittagong, Bangladesh (Nath *et al*. 1997). The authors also observed that different species dominate different DBH classes and *D. turbinatus* consisting 16.77% of all individuals was most dominant species. Motaleb and Hossain (2009) found that DBH range 20 - <30 cm possess both maximum number of species (58 species) and maximum (465 stems /ha) tree individuals in Tankawati Natural Forest Reserve of Chittagong (South) Forest Division, Bangladesh. The highest percentage (29.69%) of trees was also occupied by 20-<30cm DBH class in this forest along with 1,305 stems per hectare. Ahmed and Haque (1993) reported number of stems (257 stems/ha) showing highest (30.53%) presence in 30-39cm DBH class and lowest (1.32%) in 80-89cm DBH range from the natural forests of Bangladesh. In comparison to the above studies, Dudhpukuria-Dhopachori Wildlife Sanctuary possesses a typical trend of population structure, distribution and recruitment processes of the species. Some species have higher number of individuals in the first DBH classes (10-<25cm) demonstrates their potential regeneration of potentials. Other species possess either no or poor number of individuals in the lowest DBH classes suggesting that they have poor regeneration status and should be prioritized for conservation. Regular diameter distribution should be maintained by enhancing natural regeneration and protection from the stand point of wood utilization, species diversity and maximizing the multiple functions of forest.

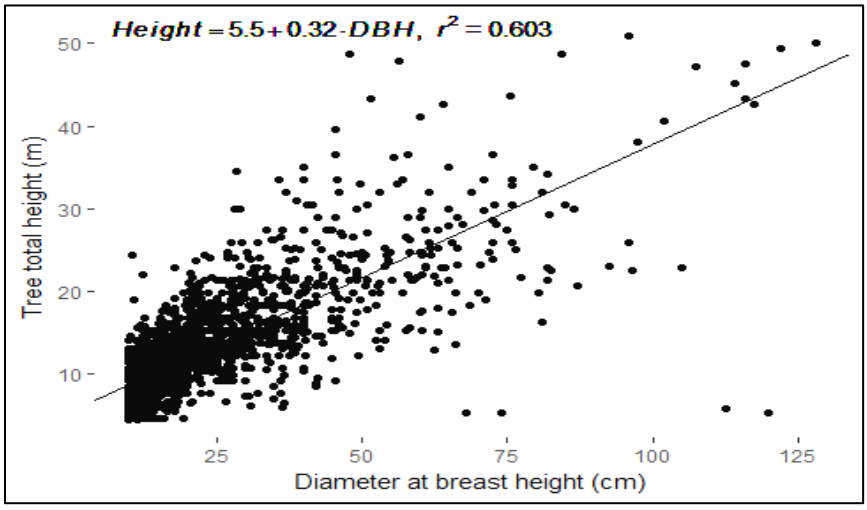

Fig. 3. Height and diameter relationship of the recorded trees in Dudhpukuria-Dhopachari WS.

Bhuju and Yonzon (2009) studied height classes of *Shorea robusta*, *Schima wallichii*, *Terminalia alata* in a dynamic landscape of the Churiya, eastern Nepal, where, all the three species were found in highest frequency within 4-10 m height range. The height class distribution shows existence of a well vertically stratified natural forest in Dudhpukuria-Dhopachori Wildlife Sanctuary. *D. turbinatus*, *S. floribunda*, *D. alatus*, *D. costatus*, *Artocarpus chama*, *Syzygium firmum*, *Bombax insigne*, *Terminalia bellirica* dominated the upper canopy. *Lithocarpus acuminata*, *Ficus variegata*, *Elaeocarpus floribundus*, *Dillenia pentagyna*, *Artocarpus lacucha*, *Acronychia pedunculata*, *Grewia nervosa*, *Hydnocarpus laurifolius*, *Macaranga denticulata*, *Mitragyna parvifolia*, *Protium serratum*, *Schima*

wallichii, Stereospermum colais, Tarenna campaniflora, Vitex peduncularis appeared as the predominant tree species in the study. The forest of this region is known as "Garjan (Bangali name of *Dipterocarpus* spp.) forest" because, *Dipterocarpus* spp. were most dominant in this forest. Severe deforestation, over-exploitation and human settlement at the adjacent forest areas in the past decades caused population decrease of dominant trees in the upper canopy. But, after declaring the area as Wildlife Sanctuary, protection status of this forest is enhanced and co-management programs are in operation with the local people. Extraction of forest resources is in a reducing trend. The results of the study suggest continuation of protection activities so that a better stratified natural forest development is ensured with proficient tree population in each stratum.

The tree species richness, density, population structure and recruitment of trees in Dudhpukuria-Dhopachori Wildlife Sanctuary are far richer than the other natural forests of Bangladesh. The regeneration status of the trees could be further enhanced by strengthening the present protection measures and awareness. Findings of the present study may help the authority of the protected area in prioritizing species specific conservation programs and adopting selective system of timber extraction (if any in future) from the Dudhpukuria-Dhopachori Wildlife Sanctuary.

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