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STRUCTURAL ATTRIBUTES, DIVERSITY AND MANAGEMENT OF SOME VAN PANCHAYAT FOREST STANDS OF GARHWAL HIMALAYA

B.S. Bhandari[1], Toseef Riaz[1*] and R.S. Rawat[2]
[1]Department of Botany and microbiology, HNB Garhwal University, Srinagar Garhwal, India
[2]Biodiversity and Climate Change Division, Indian Council of Foresty Research and Education, Dehradun, India
*E-mail: toseefriaz11@gmail.com; Phone no-7006312027

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ABSTRACT

Oak (*Quercus oblongata*) is an important component of mid-altitude ecosystem of the Central Himalaya which are exposed to over-exploitation making conditions favourable for the invasion by light-demanding conifers such as chir-pine (*Pinus roxburghii*). The present study provides information on woody vegetation structure, composition, regeneration and management of four broadleaved forest stands of Garhwal Himalaya managed by Village Panchayat. *Quercus oblongata* was the most important and dominant species in all the stands. Although dominance was shared by a number of species, no single species was found to complete with this climax species. The presence of *Alnus nepalensis* (a nitrogen-fixing species) depicts the poor nitrogen status of these forest stands. High density values and low basal cover suggest that these community forest stands are younger than the natural oak reserve forests of the Central Himalaya. The richness index shows that the seedling strata are ecologically richer than the tree, sapling and/or shrub strata. High richness in the seedling strata is attributed to the low magnitude of biotic interferences in these communities based conserved forest stands. The regeneration potential of *Quercus oblongata* is much higher than the natural oak forests of Central Himalaya managed by the forest department. This supports the view that moderate disturbance regimes are more conducive to satisfactory regeneration of this species. Since the management of these forest stands is looked after by the Village Panchayat, they are introducing some conifers for their vested interests. This may add an additional competition of the broadleaved climax species with conifers as has been witnessed in most of the broadleaved oak forests of this altitudinal range.

***Keywords**:* Van Panchayat, Oak *(Quercus oblongata),* forest regeneration, diversity, management, Garhwal Himalaya.

INTRODUCTION

Garhwal Himalaya exhibits a submontane to alpine climate with a distinctive topography which harbours a variety of forest type. Geology, soils and other abiotic and biotic factors exert influences to a great extent. However, the natural distribution of these forests from the outer hills to inner zone is determined primarily by altitude. The elevational range of 300-2200 m in Central Himalaya represents three vegetational regimes with *Shorea robusta* in the submontane zone (up to 1000 m), *Quercus oblongata* (>1500 m) in the low montane to mid-montane zone, and *Pinus roxburghii* regime between the first two regimes. The altitudinal range between 1000-1800 m in Central Himalaya is densely populated and considered among the problem zones of India (Singh and Singh, 1992), where great scarcity of fodder prevails. Natives depend heavily on these forests to cater for their demands of fodder, fuel, timber, etc. Human influences are selective for certain species such as the multipurpose oak (*Quercus oblongata*). This has resulted in a heavy degradation of oak forests and its associated communities. The over-exploitation of oaks and edaphic conditions have led to the preponderance of conifers such as chir-pine (*Pinus roxburghii*) or mixed oak- conifer communities which remain seral or show succession to the oak climax.

Although ecosystem level studies of Himalayan natural forests are available in the Central Himalaya (Saxena & Singh, 1982; Ralhan *et al.,* 1982; Singh & Singh, 1987; Rikhari *et al.,* 1997; Bhandari and Tiwari, 1997; Bhandari, 2003) studies on the structural attributes and management of community forests are only fragmentary (Negi *et al*., 2008; Hussain *et al*., 2013). The present study too is an additional effort to link these studies with some other community forest stands of Garhwal Himalaya managed by village level institution known as "Van Panchayat". Community forests managed in accordance with Van Panchayat Act is a hybrid of state ownership and community responsibility. For the management of such forests the village level institutions are guided by the Revenue Department with the technical advice of the Forest Department.

MATERIALS AND METHODS

General description of Study Area

Four forest stands, I, II, III and IV, located at 30^0 24`` lat. and $78^0$ 50`` long. in the Tehri district of Garhwal

Himalaya, were selected for the present study. The whole area is mountainous, with an elevation between 1750-1900 m a.s.l.

These forest stands are managed by Village Panchayats of Thella, Garh, Silgaon and Dhargaon villages. During the course of this study, villagers were interviewed to collect information on fuel, fodder and litter harvest from these forest stands. Unlike those living in natural reserve oak forests of Garhwal Himalaya managed by the Forest Department, people are allowed to collect fuel and fodder only once or twice in a season. Besides, care is taken not to lop off big branches. However, they may frequently collect leaf litter for animal bedding and biomanuring. Forest fires from adjacent pine forests often escape to these oak forests; however, local control these spreading fires by making fire lines with the help of Mahila Mangal Dal, Yuvak Mangal Dal and through community participation.

The climate is monsoonic and divisible into three distinct seasons, *viz.,* rainy (June-September), winter (October-February) and mild-summer (mid-March, mid-June). Winters are generally severe and are characterized by one or two snowfalls in the upper reaches.

Geologically the area is covered by quartize metabasites intercalated with slates and carbonates. Besides, the panecontemporaneous basic lava flows, the rocks of the area are largely intruded by tourmaline granites. Structurally the area is traversed by a major NW-SE trending fault called Alaknanda fault and Karanprayag anticline (Kumar & Agarwal 1975). The soil is sand predominating (52.4 - 62.6%) with a low organic carbon (0.87-0.97%) due to regular removal of leaf litter and slightly acidic with pH ranging from 5.2 to 5.8.

Vegetation Analysis

Structural analysis of the forest stands was done using 10x10m quadrats. The number and size of the quadrats were determined by the running mean method (Kershaw, 1973) and species area curve (Misra, 1968). Care was taken to sample the most representative area of each site. Circumference at breast height (cbh) was used to further categorise the trees. In each quadrat, all trees (>31.5cm cbh) and saplings (10.5-12.95 cm cbh) were individually measured at breast height i.e. 1.37m from ground. The individuals of trees with cbh < 10.5 cm were treated as seedlings. Shrubs were considered separately in each quadrat. Ratio of saplings and seedlings with respect to trees was considered as the regeneration potential.

The vegetational data were quantitatively analysed for abundance, density and frequency (Curtis & McIntosh, 1950). The importance Value Index (IVI) was determined as the sum of relative frequency, relative density and relative dominance. The ratio of abundance to frequency (A/F) was used to interpret the distribution pattern of the species. The distribution is considered regular if the ratio is <0.025, random (between 0.025 and 0.05) and contaguous if >0.05 (Curtis and Cottam, 1956).

Richness index (d) was calculated following Odum (1983):

$$d = \frac{S-1}{\log_e N}$$

Where S= number of species, and N= total number of individuals.

Similarity indices between different sites for trees, saplings, seedlings were calculated following Jaccard (1912) on the basis of density. Species diversity (H) was determined by using Shannon-Wiener Information function (Shanon & Wiener, 1963; Pielou, 1977; Sugihara, 1980). Dominance concentration of species was calculated for observation of strongest control of species space of different stands (Simpson, 1949). Following Whittaker (1975), beta-diversity (β) was computed to measure the rate of species change across the stands.

RESULTS AND DISCUSSION

Structure and Dominance

Quercus oblongata was the most important and dominant tree species in all the stands with higher values of density, basal area and Importance Value Index (Table 1-4). Besides *Q. oblongata*, dominance was shared by a number of species, but no other single species was found to compete with this climax species. However, in all the stands, *Pinus roxburghii* was noticed with comparatively higher values of IVI than the other species of the *Quercus oblongata* community forest stands. Saplings and seedling strata are species-rich than trees. Higher species richness in the sapling and seedling strata indicates that only a few species are able to reach maturity depending upon the adaptability of the species to a particular microhabitat. The presence of chir-pine (*Pinus roxburghii*), an early successional species, may be regarded as an indication of a possible replacement of oak (*Quercus oblongata*) in the near future.

The socially valued multipurpose species of the Himalaya are important for fodder and fuel wood and serve a variety of functions as an important component of the mountain ecosystem (Ramakrishnan *et al.,* 1994). They support a rich biodiversity in the ecosystem by improving soil fertility through efficient nutrient cycling and conserving soil moisture, partly through a deepl root system which has biomass uniformity distributed throughout the soil profile. Invasion by chir-pine (*Pinus roxburghii*) causes considerable ecological damage to the oak-forests, making the soil more acidic, adversely affecting the nutrient cycling and soil fertility, and almost forming a monoculture (Ramakrishnan, 1998). In addition, *Pinus roxburghii* is a light-demanding, fire-adapted but fire-promoting species. The surface fires occurring on every two or three years, cause substantial nitrogen losses in the forests (Singh *et al.,* 1984) and nitrogen depletion is one of the major causes of oak replacement in this altitudinal range of Garhwal Himalaya.

Alnus nepalensis (a nitrogen-fixing species) was present in all the strata of stand III. According to Mohan and Puri (1954), the *Alnus* community seems to be an early stage, and due to the fact that these become nitrogen depleted, it is the only species to grow and complete due to its ability to fix nitrogen (Sharma & Ambasht, 1988). Furthermore, local people are introducing some timber and commercial species such as *Pinus roxburghii* and cedar (*Cedrus deodara*) into these forests for their vested interests. This may add an additional competition of the broadleaved climax species with conifers. Thus, proper scientific management skills are need immediately to conserve the biodiversity of these community base conserved forest stands.

Berberis aristata, *Pyracantha crenulata*, *Rhus parviflora* and *Rubus ellipticus* are the common shrub species. Total shrub density among the stands ranged from 266 to 4187 ha[1]. The shrub layers are poorly developed due to either severe competition with saplings and seedlings or to the deep shade in the under canopy environment. Total basal cover across the stands ranged from 16.42 to 40.65 m^2 ha^{-1} and total tree density from 587 to 1983 ha^{-1}. In earlier references, total basal area and density were reported in the ranges of 27-84 m^2 ha^{-1} and 350-1787 plants ha^{-1}, respectively, for various forest stand of Kumaun and Garhwal Himalaya (Saxena & Singh, 1982; Singh & Singh, 1987; Bhandari & Tiwari, 1997; Bhandari, 2003). However, the highest values of density and lower basal area measurements suggest that these community forest stands are younger than other reserve oak forests of the Central Himalaya.

Distribution Pattern and Similarity Indices

Analysis of distribution pattern for different stands and strata indicates that most of the species are distributed contiguously followed by random distribution. However, a small proportion (14.25%) in the tree layer is regularly distributed in site I indicating low rate of disturbances. Sapling layers are either distributed contiguously or randomly (Table 5). Contiguous distribution was the most frequent in the shrub layer of all the stands. Interestingly, in this study the distribution pattern of tree layers did not correspond with the distribution pattern of sapling and seedling layers, in general and shrubs in particular. Similar findings have been reported for Central Himalayan forests by different workers (Saxena & Singh, 1982; Bhandari & Tiwari, 1997). Contiguous distribution in natural vegetation has been reported by Grieg Smith (1957), Kershaw (1973), and Singh and Yadava (1974). Odum (1971) is of the opinion that in natural conditions, the contiguous distribution is most common, due to small but significant variations in the environment. Preponderance of random distribution on site II, III and IV reflects the magnitude of biotic interferences in these forest stands.

Tree layers were 40.5 to 75.86% similar among themselves (Table 6). Low similarity between stand I and IV may reflect the striking variation in the micro climate and hence species composition between the stands. Wikum and Wali (1974) and Saxena and Singh (1982), among others, have pointed out significant role of site characteristics in plant distribution and similarity.

Regeneration Potential and Diversity Measurements

The density of the saplings and seedlings of any species may be considered as the regeneration potential of the forest stands. It is interesting in this study that the density of *Quercus oblongata* saplings and seedlings is comparatively much lower than the tree density of this species and reflects the poor regeneration potential of this climax species. However, the regeneration potential of *Q. oblongata* in these community forest stands is relatively much higher than the reserve oak forests of Central Himalaya managed by the Forest Department (Saxena & Singh, 1982; Singh & Singh, 1987; Bhandari & Tiwari, 1997), which supports the hypothesis that moderate disturbance regimes would be more effective to the satisfactory regeneration of this species (Thadani & Ashton, 1995).

The richness index (d) ranged from 9.20 to 10.95, 9.19 to 10.57, 10.62 to 12.03 and from 8.5 to 11.63, respectively, for tree, sapling, seedling and shrub strata of the sites (Table 5). The richness index shows that the seedling strata are ecologically richer than the tree, sapling and/or shrubs. High richness in the seedling strata is the result of proper protection of these community forest stands by the villagers.

Diversity is a combination of two factors, the number of species present, referred to as species richness, and the distribution of individuals among the species, referred to as evenness or equitability. Single species populations are defined as having a diversity of zero, regardless of the index used. Species diversity therefore refers to the variations that exist among the different forms. Diversity indices attempt to incorporate both richness and abundance into a single numerical value. In the present study, the Shannon-Wiener index has been used. The value of species diversity (H') ranged from 0.49 to 1.46, 1.45 to 3.10, 2.93 to 3.22 and 0.90 to 2.16, respectively, for tree, sapling, seedling and shrub strata of the different study sites (Table 5). The diversity indices for the present forest stands compared well with the values ranging between zero to 3.037 for Himalayan forests (Saxena & Singh, 1982). The range of diversity in sapling and seedling layers is higher in the current work than the above reported range. This indicates much diverse as well as even nature of these layers in these forest stands. Loucks (1970) stated that the diversity of species may not necessarily approach maximum in a mature stable stage of succession; it may actually decline as the successional stage reaches maturity. Hence, a high value of diversity but relatively low value of basal cover of sapling and seedling might be an indication that the community is at a stage immediately before the climax stage. Species richness and diversity of the shrub layers has a narrow range in comparison to the other layers of the forest stands. The low values of species richness and diversity may be due to the deep shade under these forests. Whittaker (1972) suggested that the dominance of one stratum may affect the diversity of another stratum.

The values of concentration of dominance for all the layers varied among different stands (Table 5). Highest value (0.8257) was reported for the layer in site IV. Species diversity and dominance concentration are generally inversely related. The values fall in the range reported for other Himalayan forests (Sexena & Singh, 1982; Bankoti *et al.,* 1986; Bhandari & Tiwari, 1997) and for temperate forests (Whittaker, 1965; Risser & Rice, 1971) and are higher that the values reported for tropical forests (Knight, 1975).

The values of beta diversity were 1.87, 1.81, 1.45 and 2.11, respectively for tree, sapling, seedling and shrub layers. A low value of beta diversity indicates that growth forms respond in similar fashion (Adhikari *et al*., 1991). This index has often been used to compare the differences in species composition between habitats and it is suggested that the finer the divisions of a habitat the greater would be the value of beta diversity (Whittaker, 1975).

CONCLUSIONS

Quercus oblongata has been found to dominate all the species of these community forest stands under the present study managed by the village level institution known as "Van Panchayat". It is noteworthy that the density of these community forest stands is comparatively higher with moderate values of basal cover than other natural oak forests (reserve forests) of Garhwal Himalaya (Bhandari & Tiwari, 1997) managed by the forest department. It indicates that these forest stands are younger than the oak reserved forests with high species diversity and luxuriance. However, oak replacement can occur due to invasion by chir pine (*Pinus roxburghii)*. Further, recurring fires in the pine forests lead to marked nitrogen losses through volatilization, augmenting the nitrogen shortage. Oak has a relatively heavy demand for nitrogen and cannot succeed in nitrogen-poor soil (Singh *et al.,* 1984). Since the management of community forests is looked after by the Village Panchayats, they are planting and introducing *Pinus roxburghii* and *Cedrus deodara* for their vested interests. Thus, *Quercus oblongata*, a late successional and climax species seems to be steadily replaced by *Pinus roxburghii*, an early successional species. This changing scenario is responsible for far-reaching alterations in the natural ecosystems and increasing control of the environment by man, which often create conflicts between his objectives and the natural processes themselves.

Although villagers are conserving the broad-leaved forests in a sustainable manner, yet the community chiefs "*mukhias*" (Sarpanchs) and a handful members who are responsible for the management of community forests, are not educated enough scientifically to develop utilization systems which ensure the stability of the systems. All these reasons can be linked to the lack of awareness of villagers to meet short-term requirements, and poor vision for long-term needs. There is a need for a better understanding the type of existing forest association and ecological factors that maintain forest diversity. Furthermore, there is a strong need for a conservation education programme to inform villagers about the importance and benefits of the evergreen broadleaved community forests through sustainable use of natural resources.

Table 1 : Density (D; plants ha^{-1}), Total Basal Cover (TBC; $m^2\ ha^{-1}$), Importance Value Index (IVI) and A/F of woody species on stand I.

Stratum / Species	D	TBC	IVI	A/F
Tree:				
Ficus semicordata	12.5	0.1592	9.58	0.08
Grewia optiva	12.5	0.1096	9.21	0.08
Myrica esculenta	50	0.5409	25.11	0.08
Pinus roxburghii	62.5	2.008	50.85	0.03
Quercus oblongata	425	10.0455	185.96	0.07
Symplocos paniculata	12.5	0.1019	9.15	0.08
Toona hexandra	12.5	0.2311	10.13	0.08
Sapling:				
Cedrus deodara	12.5	0.0125	7.88	0.08
Ficus semicordata	75	0.2043	39.11	0.05
Grewia optiva	12.5	0.0459	9.14	0.08
Lyonia ovalifolia	37.5	0.0582	24.43	0.03
Myrica esculenta	62.5	0.1289	28.87	0.01
Pinus roxburghii	50	0.1777	27.63	0.08
Quercus dialatata	12.5	0.012	7.89	0.08
Quercus oblongata	575	1.7704	110.94	0.07
Rhododendron arboreum	37.5	0.1233	18.18	0.24
Symplocos paniculata	50	0.1329	25.95	0.08
Seedling:				
Cedrus deodara	37.5	0.0176	13.68	0.06
Ficus semicordata	125	0.0266	21.41	0.2
Ficus racemosa	62.5	0.0007	7.31	0.4
Lyonia ovalifolia	300	0.0546	46.22	0.12
Myrica esculenta	137.5	0.0209	23.97	0.09
Pinus roxburghii	12.5	0.0029	4.87	0.08
Prunus cerasoides	12.5	0.0056	5.6	0.08
Pyrus pashia	225	0.0299	31.71	0.16
Quercus oblongata	387.5	0.0971	69.66	0.06
Rhododendron arboreum	187.5	0.0552	32.91	0.3
Symplocos paniculata	87.5	0.0242	21.84	0.06
Toona hexandra	75	0.0356	20.81	0.12
Shrub:				
Berberis aristata	162.5	0.0036	34.74	0.11
Pyracantha crenulata	187.5	0.017	56.35	0.07
Rhus parviflora	675	0.1649	158.9	0.48
Rubus ellipticus	212.5	0.0069	49.07	0.08

Table 2 : Density (D; plants ha^{-1}), Total Basal Cover (TBC;m^2 ha^{-1}), Importance Value Index (IVI) and A/F of woody species on stand II.

Stratum / Species	D	TBC	IVI	A/F
Tree:				
Albizia julibrissin	12.5	0.3948	8.85	0.08
Ficus semicordata	12.5	0.2587	8.11	0.08
Myrica esculenta	75	0.9171	34.7	0.03
Pinus roxburghii	100	3.3699	50.85	0.04
Pyrus pashia	12.5	0.0459	9.19	0.08
Quercus oblongata	637.5	12.9889	180.92	0.08
Rhododendron arboreum	12.5	0.1218	6.83	0.08
Sapling:				
Albizia julibrissin	12.5	0.1949	4.95	0.08
Ficus semicordata	12.5	0.0374	5.36	0.08
Lyonia ovalifolia	125	0.2356	28.18	0.05
Myrica esculenta	150	0.4178	41.34	0.03
Pinus roxburghii	62.5	0.1871	19.38	0.04
Pyrus pashia	12.5	0.0125	4.79	0.08
Quercus oblongata	1050	3.19	169.47	0.1
Rhododendron arboreum	125	0.2578	21.28	0.2
Symplocos paniculata	12.5	0.0233	5.03	0.08
Seedling:				
Albizia julibrissin	312.5	0.271	17.55	0.02
Cedrus deodara	25	0.0132	4.67	0.16
Ficus semicordata	162.5	0.0068	14.14	0.04
Lyonia ovalifolia	1100	0.1505	64.67	0.14
Myrica esculenta	375	0.0512	26.77	0.09
Pinus roxburghii	112.5	0.0245	15.96	0.03
Pyrus pashia	625	0.0333	33.35	0.08
Quercus oblongata	712.5	0.1703	60.62	0.07
Rhododendron arboreum	400	0.665	31.81	0.07
Symplocos paniculata	325	0.0228	22.56	0.06
Toona hexandra	12.5	0.008	3.49	0.08
Zanthoxylum armatum	25	0.0116	4.4	0.16
Shrub:				
Berberis aristata	362.5	0.007	39.23	0.06
Pyracantha crenulata	45	0.0368	58.55	0.07
Rhamnus virgatus	62.5	0.0031	7.01	0.40
Rhus parviflora	1537.35	0.1292	155.66	0.20
Rubus ellipticus	212.5	0.0077	25.09	0.15

Table 3 : Density (D; plants ha^{-1}), Total Basal Cover (TBC; m^2 ha^{-1}), Importance Value Index (IVI) and A/F of woody species on stand III.

Stratum / Species	D	TBC	IVI	A/F
Tree				
Alnus nepalensis	50	1.6966	26.95	0.04
Glauca spp	17	0.325	10.97	0.06
Myrica esculenta	33	0.4856	21.28	0.03
Pinus roxburghii	17	4.0022	23.57	0.06
Quercus oblongata	983	22.415	206.49	0.14
Rhododendron arboreum	17	0.25	10.71	0.06
Sapling:				
Alnus nepalensis	50	0.1218	6.83	0.08
Carpinus faginea	17	0.1949	4.95	0.08
Cedrus deodara	17	0.0374	5.36	0.08
Myrica esculenta	67	0.2356	28.18	0.05
Quercus oblongata	300	0.4178	41.34	0.03
Rhododendron arboreum	133	0.1871	19.38	0.04
Seedling:				
Alnus nepalensis	100	0.0339	20.99	0.09
Carpinus faginea	467	0.0646	46.83	0.18

Ficus semicordata	17	0.0048	6.06	0.06
Lyonia ovalifolia	633	0.0766	51.72	0.57
Myrica esculenta	333	0.034	33.61	0.13
Pinus roxburghii	483	0.0317	38.42	0.19
Pyrus pashia	233	0.0056	18.25	0.21
Quercus oblongata	67	0.0184	24	0.01
Rhododendron arboreum	433	0.105	60.35	0.09
Shrub:				
Berberis aristata	83	0.0072	142.51	0.3
Rubus ellipticus	150	0.0057	156.63	0.54

Table 4 : Density (D; plants ha^{-1}), Total Basal Cover (TBC; $m^2 ha^{-1}$), Importance Value Index (IVI) and A/F of woody species on stand IV.

Stratum / Species	D	TBC	IVI	A/F
Tree:				
Albizia julibrissin	16.67	0.234	8.17	0.05
Lyonia ovalifolia	16.67	0.1533	7.94	0.06
Myrica esculenta	33.33	0.8169	17.33	0.03
Pinus roxburghii	116.67	4.0087	50.6	0.02
Quercus oblongata	1800	29.994	215.95	0.18
Sapling:				
Ficussemicordata	50	0.0935	16.41	0.04
Lyonia ovalifolia	66.67	0.0642	22.43	0.03
Myrica esculenta	100	0.2822	23.75	0.09
Pinus roxburghii	150	0.3539	34.15	0.06
Quercus oblongata	1100	3.809	187.54	0.11
Rhododendron arboreum	50	0.0605	15.7	0.04
Seedling:				
Albizia julibrissin	16.67	0.9056	4.14	0.06
Ficus semicordata	116.67	5.3485	16.68	0.05
Lyonia ovalifolia	916.67	25.1628	60.49	0.36
Myrica esculenta	183.33	8.8553	19.41	0.16
Pinus roxburghii	183.33	1.2005	22.08	0.03
Prunus cerasoides	50	0.1856	64.33	0.18
Pyrus pashia	433.33	3.8484	36.33	0.04
Quercus oblongata	500	21.11	50.63	0.07
Rhododendron arboreum	416.67	15.87	38.56	0.17
Symplocos paniculata	566.67	9.41	45.54	0.06
Shrub:				
Berberis aristata	66.67	1.1927	127.62	0.24
Rubus ellipticus	100	9.108	172.07	0.09

Table 5 : Distribution pattern (%), richness index (d), species diversity (H) and concentration of dominance of tree, sapling and shrub strata for different community forest stands.

Stand	Stratum	Regular	Random	Contiguous	d	H	CD
I	Tree	14.28	-	87.72	9.2	1.4568	0.5437
	Sapling	-	20	80	9.85	3.1002	0.1272
	Seedling	-	-	100	10.62	3.1033	0.1393
	Shrub	-	-	100	10.3	1.8165	0.3532
II	Tree	-	28.57	71.43	9.75	1.3428	0.5681
	Sapling	-	33.33	66.67	10.5	1.7011	0.4754
	Seedling	-	16.66	83.34	12.03	3.222	0.15663
	Shrub	-	14.29	85.71	11.63	2.161	0.2968
III	Tree	-	33.33	66.67	10.12	0.7884	0.0031
	Sapling	-	33.33	66.67	9.19	0.1982	0.3371
	Seedling	11.11	-	88.89	11.43	2.9286	0.1601
	Shrub	-	-	100	8.05	0.902	0.4306
IV	Tree	-	50.00	50	10.95	0.4936	0.8275
	Sapling	-	50.00	50	10.57	1.4471	0.5442
	Seedling	-	27.27	72.73	11.84	3.0236	0.144
	Shrub	-	-	100	9.42	1.5562	0.3313

Table 6 : Similarity indices for different strata and stands.

Stand / Stratum	I	II	III	IV
I				
Tree	100	75.86	53.04	40.59
Sapling	100	79.95	83.21	84.45
Seedling	100	53.53	42.87	55.17
Shrub	100	56.9	30.49	17.13
II				
Tree	-	100	70.72	55.05
Sapling	-	100	45.84	87.15
Seedling	-	100	47.33	77.77
Shrub	-	100	13.54	8.66
III				
Tree	-	-	100	66.64
Sapling	-	-	100	39.7
Seedling	-	-	100	53.89
Shrub	-	-	100	35.11

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