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# Community structure of different medicinal plant species in the eastern part of Rajajji national park

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## Abstract

**The present study was aimed to find out the actual status of selected medicinal plant, their relation with other plant species of Rajaji national park and their contribution to make the definite community structure. Several quadrats were laid down to study trees in the different parts of the selected area. On Site 1, three medicinal plant species *Cassia fistula*, *Nyctanthes arbor-tristis*, and *Bauhinia variegata* were found. *Cassia fistula* was also found on Site 2 with *Terminalia arjuna.* Sites 3, 4 and 5 showed the presence of *Syzygium cumini, Terminalia arjuna* and *Emblica officinalis* respectively.**

***Key words: Concentration of Dominance, Diversity Index, Medicinal plant, Phytosociological analysis of trees, Rajaji National Park***

## Introduction

Rajaji National Park spread over an area of 820.42 sq km lies between 29° 51'N latitude and 77° 52'E - 77° 22'E longitude. This park is a magnificent ecosystem nestled in the Shivalik ranges and beginning of the vast Indo-Gangetic plains. Thus, it represents vegetation of several distinct zones and forest types, like riverine forests, broad-leaved mixed forest, scrub land and grassy pasture land.

With the change in environmental conditions, the vegetation cover reflects several changes in its structure, density and composition (Gaur, 1982). The most important structural property of a community is a definite quantitative relationship between abundance and rare species. Most environments of the world support certain associated species which can therefore be characterized as a plant community (Kent and Coker, 1992). The study on floristic composition and phytosociological attributes are useful for comparing one community with the other from season to season and year to year. Each species within a community has large measure of its structural and functional individualism, and has more or less different ecological amplitude and Modality.The Garhwal Himalaya embodies a number of forest types which are found distributed at various altitudes, and soil types (Champion and Seth, 1968; Saxena and Singh, 1982). According to Gaur (1982) although about 60% of the total land on the Himalaya is covered by forest out of which only 10% can be considered as closed forest based on tree canopy and stem density. At the lower altitudes (upto 1,000 m) generally the forests are dominated by *Shorea robusta* along with *Anogeissus latifolia*, Terminalia species and *Adina cordifolia*, whereas *Quercusleuco trichophora, Cedrus deodara* and *Pinus roxburghii* are dominant cover types at higher altitudes between 1,100-2,500 m (Kumar *et al.,* 2004).

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### Study area

The Gohri range of the Rajaji National Park has been selected for the community study of trees. (Figure1). This range is divided into beats and compartments. It has six beats viz., Laxmanjhula (North), Laxmanjhula (South), Kunao, Gohari, Khadri and Bidasani. Out of these five sites i.e, Laxmanjhula North, Laxmanjhula South, Kunao, Gohri North and Gohri South were selected for as the study sites. The climate of Rajaji National Park is like the climatic conditions of plains areas of Uttarakhand. Because of its vicinity to outer Himalayan hills climatic conditions become moderate. It varies from subtropical in the plains to temperate in higher hills.

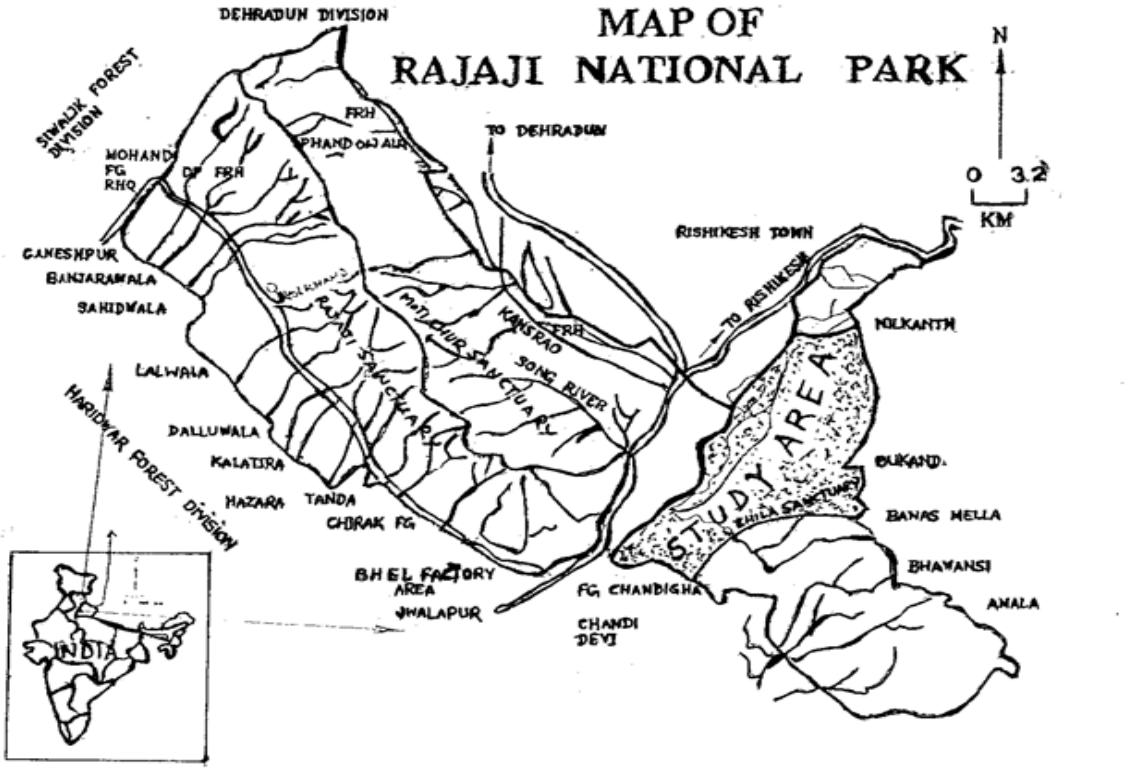


**Fig 1: Location of Study Area**

## Material and methods

The eight medicinal plants were selected for the present study, viz, *Bauhinia variegata* Linn. , *Terminalia arjuna* W. & A., *Tinospora cordifolia* (Willd.) Miers. ex Hk. f. & Thoms., *Datura stramonium* Linn., *Syzygium cumini* (L.) Skeels, *Emblica officinalis* Gaertner, *Nyctanthes arbor-tristis* Linn., *Cassia fistula* Linn. The vegetation analysis of selected study sites in Gohri range of Rajaji National Park was done in summer season. From each selected stand 10 quadrats (each of 10X10 m size) to study tree component) were laid down randomly (Mishra, 1968). Abundance, frequency and density were determined as per Curtis and McIntosh (1950).The relative values and Importance Value Index (IVI) were calculated following Curtis (1959) as follows:

$$Relative\ humidity = \frac{Total\ no.\ of\ occurence\ of\ species}{Total\ no.\ of\ occurence\ of\ all\ species} X\ 100$$

$$Relative\ Density = \frac{Total\ no.\ of\ individuals\ of\ species}{Total\ no.\ of\ individuals\ of\ all\ of\ Species} X\ 100$$

$$Relative\ dominance = \frac{Total\ basal\ cover\ of\ a\ species}{Total\ basal\ cover\ of\ all\ species} X\ 100$$

**IVI =** Relative frequency + Relative density + Relative dominance

The ratio of abundance to frequency (A/F) was used to represent the distributional pattern (Whitford, 1949) of the species i.e., the two dimensional spatial organization or dispersion of population in the community (Greig-Smith, 1983; Pielou, 1966). A/F ratio was used to interpret the distribution pattern of species. This ratio indicates regular distribution if it is $\leq$0.025, random if between 0.025-0.050, and contagious if $\geq$0.050 (Cottam and Curtis, 1956).

Mean Basal Area (MBA) is expressed as $ha^{-1}$ and the TBC as $m^2\ ha^{-1}$.

Basal cover is the proportion of ground surface occupied by a species (Greig-Smith, 1983), which is calculated as follows:

Total Basal Cover (TBC) = Mean Basal Cover of a species X Density of a species

Concentration of dominance (CD) was measured by Simpson's index (Simpson, 1949) for tree, shrub and herb layers on the basis of their density as given below:

$$CD = \sum_{i=1}^{s} (ni/N)^2$$

Where,
ni = Total number of individuals of species i
N = Total number of individuals of all species on that site.

Species diversity (H) for each site was determined following Pielou (1966) method using the density data for trees and shrubs as follows:

$$H = -\sum (ni/N) \log_2 (ni/N)$$

Where,
ni and N are same as used for the calculation of concentration of dominance.

## Results and Discussion

### The status of selected medicinal plants on study sites

Among the selected medicinal plants, *Terminalia arjuna* was reported on sites 2, 3 and 4.(table1,2 and 3 respectively). On site 2(table 2) it had the frequency of 80, density of 110 plant $ha^{-1}$,TBC of 4.93 $m^2$ $ha^{-1}$ and IVI of 330.96. On site 3(table 3) the frequency percentage increased with the value of 90 although the density, TBC and IVI were recorded with the values amounting to 410 plant $ha^{-1}$, 16.83 4.93 $m^2$ $ha^{-1}$ and 73.44 respectively. The value of IVI was highest for this site. The lowest value of density (50 plant $ha^{-1}$) was found on site 4(table 4). *Cassia fistula* was observed only on sites 1(table 1) and 2(table 2). Except TBC (2.95 $m^2$ $ha^{-1}$ for site 1 and 3.00 $m^2$ $ha^{-1}$ for site 2) the value of frequency percentage (60), density (100 plant $ha^{-1}$), and IVI (25.71) was higher than site 2 (table 2) for this species. *Nyctanthes arbor-tristis* and *Bauhinia variegata* were recorded on site 1(table 1). The frequencies of both species were equal (30), although the density was recorded higher (80 plant $ha^{-1}$) for *Bauhinia variegata* than *Nyctanthes arbor-tristis.* For *Bauhinia variegata* the value of TBC and IVI were 2.57 $m^2$ $ha^{-1}$ and 17.34 and for *Nyctanthes arbor-tristis* the values were 1.20 $m^2$ $ha^{-1}$ and 10.67 respectively. *Syzygium cumini* and *Emblica officinalis* were restricted only to sites 3 and 5(table 3 and 5 respectively). The frequency and density for these two species were equal (40 % and 60 plant $ha^{-1}$) but for *Syzygium cumini* TBC was quite low (0.01 $m^2$ $ha^{-1}$) as compared to *Emblica officinalis* (1.32 $m^2$ $ha^{-1}$). The value of IVI was found better for *Emblica officinalis* as compared to *Syzygium cumini* (11.46).Among all the sites, Site 1(table 1) was found as the richest site in term of finding maximum selected plants.viz., *Terminalia arjuna,Cassia fistula ,Bauhinia variegate, Nyctanthes arbor-tristis. Tinospora cordifolia* and *Datura stramonium* were not recorded in the samplings from the 5 study sites because the former species is a climber which was not common in the study sites. *Datura stramonium* is a shrub which could not be encountered in the samplings, and moreover, this species grows annually and registers its presence in the study area for a short period. It revealed from the results that the site, Laxmanjhula north was found the most flourishing site as it shelters the maximum (4) medicinal plants. Different climatic factors may favors the diverse nature of plant species. On all the five sites the tree species were observed mostly as randomly distributed .According to Odum (1971) and Dojoz (1972) contagious distribution is the most common pattern in nature. Random distribution is found only in very uniform environment, and regular distribution shows a severe competition between the individuals. Contagious distribution is based upon: (I) local habitats differences (II) daily and seasonal weather conditions, and (III) reproductive processes of the species of that area. Rajwar and Gupta (1992) observed the random and contagious pattern of distribution for most of the tree species in the forests of Garhwal Shivalik hills. They reported *Acacia catechu* as a dominant species in one of their sites of investigation as observed in the present investigation.

**Table1. Phytosociological analysis of trees on site 1 (Laxmanjhula North)**

| Botanical Name | Frequency (%) | Density (plant ha$^{-1}$) | TBC (m$^2$ ha-$^1$) | IVI | A/F Ratio |
|---|---|---|---|---|---|
| *Holoptelea integrifolia* (Roxb.) Planch. | 80 | 270 | 17.72 | 70.56 | 0.042 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 80 | 310 | 8.65 | 57.61 | 0.048 |
| *Adina cordifolia* (Roxb.) Hook. f. ex Brandis | 70 | 140 | 10.14 | 44.01 | 0.029 |
| *Terminalia arjuna* (Roxb.ex.DC.) W. & A. | 60 | 100 | 6.71 | 32.47 | 0.028 |
| *Cassia fistula* Linn. | 60 | 100 | 2.95 | 25.71 | 0.028 |
| *Drypetes roxburghii* (Wallich) Hurusawa | 40 | 70 | 4.49 | 21.97 | 0.044 |
| *Naringi crenulata* (Roxb.) Nicols. | 50 | 90 | 1.16 | 19.66 | 0.036 |
| *Bauhinia variegata* Linn. | 30 | 80 | 2.57 | 17.34 | 0.089 |
| *Nyctanthes arbor-tristis*Linn. | 30 | 30 | 1.20 | 10.67 | 0.033 |

**Table2. Phytosociological analysis of trees on site 2 (Laxmanjhula South)**

| Botanical Name | Frequency (%) | Density (plant ha$^{-1}$) | TBC (m$^2$ ha-$^1$) | IVI | A/F Ratio |
|---|---|---|---|---|---|
| *Holoptelea integrifolia* (Roxb.) Planch. | 80 | 310 | 20.48 | 81.98 | 0.048 |
| *Adina cordifolia* (Roxb.) Hook. f. ex Brandis | 50 | 70 | 10.64 | 35.46 | 0.028 |
| *Terminalia arjuna* (Roxb.ex.DC.) W. & A. | 60 | 110 | 4.93 | 30.96 | 0.031 |
| *Naringi crenulata* (Roxb.) Nicols. | 70 | 130 | 2.15 | 29.83 | 0.027 |
| *Aegle marmelos* (L.) Correa. | 50 | 90 | 3.36 | 24.31 | 0.036 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 50 | 90 | 2.28 | 22.36 | 0.036 |
| *Cassia fistula* L. | 50 | 70 | 3.00 | 21.73 | 0.028 |
| *Terminalia chebula*Retz. | 50 | 50 | 3.24 | 20.24 | 0.020 |
| *Drypetes roxburghii* (Wallich) Hurusawa | 30 | 60 | 3.86 | 18.47 | 0.067 |
| *Alstonia scholaris* (L.) R.Br. | 30 | 60 | 1.73 | 14.65 | 0.067 |

**Table3. Phytosociological analysis of trees on site 3 (Kunao North)**

| Botanical Name | Frequency (%) | Density (plant ha$^{-1}$) | TBC (m$^2$ ha-$^1$) | IVI | A/F Ratio |
|---|---|---|---|---|---|
| *Terminalia arjuna* (Roxb.ex.DC.) W. & A. | 90 | 410 | 16.83 | 73.44 | 0.051 |
| *Dalbergia sissoo* Roxb. | 90 | 160 | 10.50 | 44.41 | 0.020 |
| *Acacia catechu* (L.f.) Willd. | 70 | 150 | 4.74 | 31.00 | 0.031 |
| *Adina cordifolia* (Roxb.) Hook. f. ex Brandis | 40 | 80 | 10.14 | 29.15 | 0.050 |
| *Holoptelea integrifolia* (Roxb.) Planch. | 60 | 100 | 6.90 | 28.94 | 0.028 |
| *Drypetes roxburghii*(Wallich) Hurusawa | 50 | 110 | 5.99 | 26.52 | 0.044 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 60 | 120 | 2.64 | 23.66 | 0.033 |
| *Alstonia scholaris* (L.) R.Br. | 40 | 70 | 3.36 | 17.56 | 0.044 |
| *Naringi crenulata* (Roxb.) Nicols. | 40 | 60 | 1.52 | 13.87 | 0.038 |
| *Syzygium cumini* (L.) Skeels | 40 | 60 | 0.01 | 11.46 | 0.038 |

**Table4. Phytosociological analysis of trees on site 4 (Kunao South)**

| Botanical Name | Frequency (%) | Density (plant ha$^{-1}$) | TBC (m$^2$ ha-$^1$) | IVI | A/F Ratio |
|---|---|---|---|---|---|
| *Holoptelea integrifolia* (Roxb.) Planch. | 90 | 260 | 18.84 | 78.99 | 0.032 |
| *Terminalia chebula*Retz. | 70 | 160 | 10.34 | 49.53 | 0.033 |
| *Adina cordifolia* (Roxb.) Hook. f. ex Brandis | 80 | 100 | 9.24 | 43.21 | 0.016 |
| *Terminalia arjuna* (Roxb.ex.DC.) W. & A. | 50 | 90 | 6.81 | 31.76 | 0.036 |
| *Drypetes roxburghii* (Wallich) Hurusawa | 50 | 80 | 5.82 | 28.99 | 0.032 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 60 | 100 | 2.43 | 27.49 | 0.028 |
| *Aegle marmelos* (L.) Correa. | 50 | 70 | 2.68 | 22.57 | 0.028 |
| *Alstonia scholaris* (L.) R.Br. | 30 | 60 | 2.77 | 17.47 | 0.067 |

**Table5. Phytosociological analysis of trees on site 5 (Gohri)**

| Botanical Name | Frequency (%) | Density (plant ha$^{-1}$) | TBC (m$^2$ ha-$^1$) | IVI | A/F Ratio |
|---|---|---|---|---|---|
| *Shorea robusta*Roxb.exGaertner f. | 70 | 140 | 14.28 | 44.99 | 0.029 |
| *Bombax ceiba* L. | 70 | 160 | 5.98 | 34.45 | 0.033 |
| *Drypetes roxburghii* (Wallich) Hurusawa | 60 | 110 | 7.41 | 30.50 | 0.031 |
| *Holoptelea integrifolia* (Roxb.) Planch. | 60 | 110 | 7.17 | 30.14 | 0.031 |
| *Adina cordifolia* (Roxb.) Hook. f. ex Brandis | 50 | 80 | 9.94 | 29.95 | 0.032 |
| *Casearia elliptica* Willd. | 60 | 110 | 6.03 | 28.45 | 0.031 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 70 | 130 | 2.91 | 27.21 | 0.027 |
| *Sapium insigne* (Royle) Benth. ex Trimen | 50 | 80 | 8.06 | 27.17 | 0.032 |
| *Moringa oleifera* Lam. | 50 | 70 | 2.09 | 17.42 | 0.028 |
| *Erythrina suberosa* Roxb. | 40 | 70 | 2.18 | 15.94 | 0.044 |
| *Emblica officinalis* Gaertner | 40 | 60 | 1.32 | 13.77 | 0.038 |

Preponderance of the contagious distribution by shrub species in a forest of Kumaun Himalaya was reported by Ralhan *et al.* (1982) and Tiwari (1982). Odum (1971) stated that in natural conditions contagious distribution reflects magnitude of biotic interference such as grazing and lopping in the natural forest stands. The general preponderance of contagious vegetation has been reported by several workers (Greig-Smith, 1983; Kershaw, 1973; Singh and Yadav 1974).The number of tree species varied from 8 to 11 for different sites of the study sites. Maximum number of the tree species belonged to the site 5 (Gohri) while the minimum number was observed on site 4 (Kunao South). In a sub-tropical forest, Kumar *et al.* (2005) recorded the number of tree species varying from 11 to 12. Total plant species diversity for the forest of the present study (all study sites) was 19 for tree species .They found that for tree species the diversity was 19.In the present study *Holoptelea integrifolia* was recorded as the most dominant tree species on three sites with the values of frequency (80-90), TBC (17.72-20.48 m$^2$ ha$^{-1}$) and IVI (70.56-81.98). The results of the study by Nath*et al.* (1991) are supportive for the present investigation with the values of frequency

(53.85), TBC (6.57 $m^2$ $ha^{-1}$) and IVI (52.87) which was much lower than present findings. Kumar *et al.* (2005) have also found *Holoptelea integrifolia* to be the dominant tree species with the values of frequency (84), TBC (10.218 $m^2$ $ha^{-1}$) and IVI (91.13). On the basis of IVI the dominance of the species in the forests was explained. For the tree sites *Holoptelea integrifolia* was found to be dominant on three sites (sites 1, 2 and 4), whereas site 3 was dominated by *Terminalia arjuna*, and site 5 by *Shorea robusta*. In the present investigation the total density of trees for all the sites ranged from 920 to 1320 plants $ha^{-1}$ .The highest density (1320 plant $ha^{-1}$) for the tree species was observed on site 3 (Kunao North).Tropical forests show a great range in density values. Bandhu (1970) and Singh (1974) reported a range of density values from 640 to 1020 trees $ha^{-1}$in a *Shorea robusta* forest. Rajwar and Gupta (1992) reported values for density ranging from 4.92 to 56.8 trees $ha^{-1}$ in deciduous forests of Garhwal Shivalik hills. Singh and Misra (1978) in a forest of Chandra Prabha Sanctuary in India recorded a range of density values from 9.4 to 11.7 trees 100 $m^{-2}$, the higher limit of which was less than present study.For mixed forests in north-eastern U.P. plains, Singh and Mishra (1978) reported tree density of 936-1174 plants $ha^{-1}$ and basal area of 15.12-17.99 $m^2$ $ha^{-1}$. Singh (1981) reported tree density of 1130 plants $ha^{-1}$ and TBC as high as 80 $m^2$ $ha^{-1}$ in hilly sub-tropical humid forests of Meghalaya.

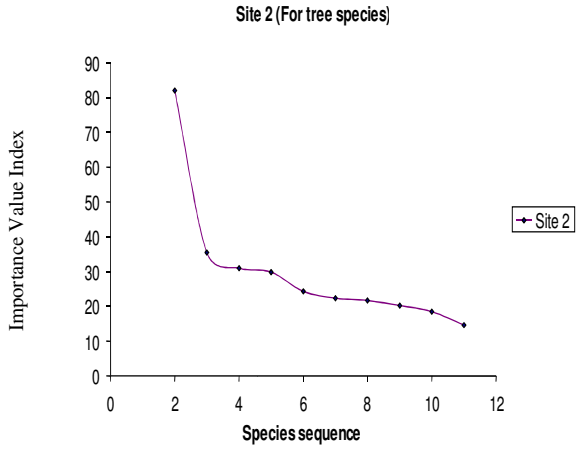


**Fig. 3 Dominance-diversity curve for trees on Site 2**


**Fig. 4 Dominance-diversity curve for trees on Site 3**


**Fig. 2 Dominance-diversity curve for trees on Site1**

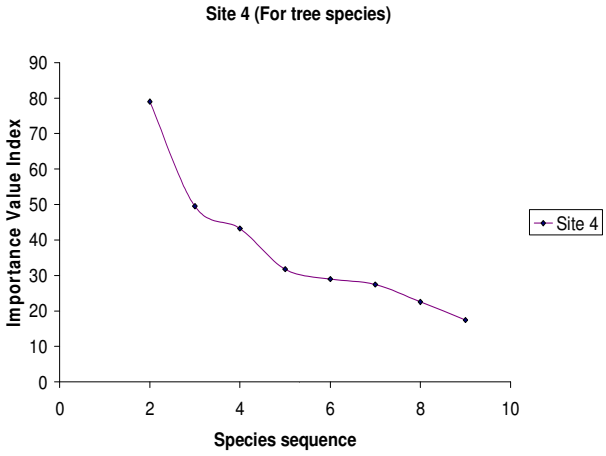


**Fig.5 Dominance-diversity curve for trees on Site 4**

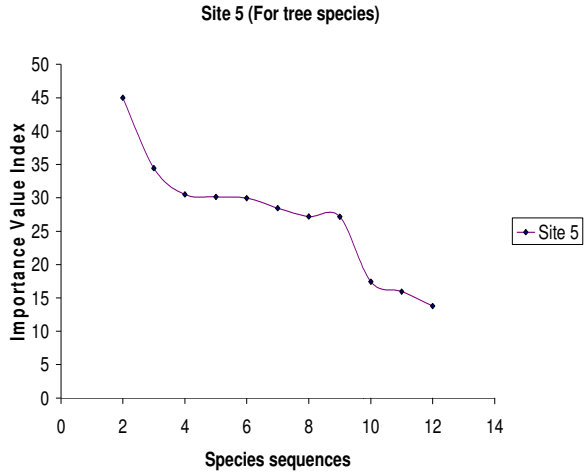


**Fig.6. Dominance-diversity curve for trees on Site 5**

In the present study, the value of basal cover of trees ranged from 1.20 to 20.48 $m^2$ $ha^{-1}$.Singh *et al.* (1981) have reported very high basal cover values for tree species on tropical rain forest of Silent Valley, India (10277 $cm^2$ 100 $m^{-2}$). Pant (1987) noticed TBC values ranging from 470 to 7210 $cm^2$ 100 $m^{-2}$ in the Garhwal Himalaya. Nayak *et al.* (1991) reported TBC values ranging from 7468.20 to 9584.30 $cm^2$ 100 $m^{-2}$ for trees in a forest at Gopeshwar in Garhwal Himalaya.The observation of Nayak *et al.* (1991) also supports the findings of present investigation. They reported *Acacia catechu* as a dominant species in one of their sites as observed in the present investigation. The range of TBC values reported by them was 0.032-14.43 $m^2$ $ha^{-1}$ whose higher limit was lower than the results of present study (0.01-20.48 $m^2$ $ha^{-1}$), whereas, the range of density values as observed in the present study was higher (30-270 plant $ha^{-1}$) than those of the values reported by them (5.12-104.70 plant $ha^{-1}$). In the present study, among all the sites the highest TBC was observed on site 5 and minimum on site 1 for tree species.Kumar *et al.* (2004) recorded the concentration of dominance (CD) value of 2.766 for tree species and 0.135-0.154 for shrub species. These values fall within the range reported for Himalayan forests (Ralhan *et al.* 1982; Saxena and Singh 1982). Among the tree species, the highest value of CD (0.1616) on site 1(table 6) indicates that the dominance was acquired by a few species. The CD values varied from 0.0093 to 0.1609 for rest of the four sites which indicates that in contrast to site 1, dominance was shared by several tree species. These values are lower than that for the temperate forests (0.10-0.99) observed by Whittakar (1965) and Ralhan *et al.* (1982). The values reported by Rout and Gupta (1989) for the mixed forests (0.18-0.19) are comparable to the average value (0.06) reported for tropical forests by Knight (1975). Tropical forests indicate higher diversity (H) as calculated by Knight (1975) for young (5.06) and old stands (5.40) at Barro Colorado Island, Panama. The species diversity for trees among all the sites was maximum (1.210) on site 5(table 6) and minimum (0.898) on the site 4(table 6).

**Table 6. Analysis of Concentration of Dominance (CD) and Diversity Index (H)**

| Sites/ Species | CD | H |
|---|---|---|
| **Trees** | | |
| Site 1 | 0.1616 | 1.020 |
| Site 2 | 0.1487 | 1.037 |
| Site 3 | 0.1556 | 1.131 |
| Site 4 | 0.1609 | 0.898 |
| Site 5 | 0.0993 | 1.210 |

The highest diversity index seems to be due to greater equitability of distribution. The values of diversity for Himalayan forests ranged from 0 to 3.037 for tree species (Saxena, 1979; Ralhan *et al.*, 1982; Pant 1987;).Tropical forests indicate higher diversity as calculated by Singh *et al.* (1981) for Silent Valley forest of India (3.52 to 4.15). Saxena (1993) reported diversity values ranging from 1.098 to 1.223. Iorkar and Totey (2001) reported diversity values for tree species ranging from 1.009 to 1.210, for shrubs 0.691 to 1.022, and for herbs 1.006 to 1.206 for Naregoan National Park, Maharastra to tropical region.High species diversity index has been shown as an indication of maturity in the ecosystem (Margalef, 1963; Odum, 1969). Low species diversity on site 4 (0.898, table 6) may be due to low species richness as a result of elimination of some species through competition. Nath *et al.* (1991) also reported similar results of species diversity for the tree species in their study ranging from 1.167-1.293.

## Conclusion

It can be concluded from the above investigation that some particular zones of Rajaji National park are engaged to enhance the rich diversity of medicinal plants although some are restricted only to specific plant communities. Laxhmanjhula North was found to be most suitable place for the rich diversity of medicinal plants. The rich diversity and abundance of medicinal plant for a region reveals the high productivity as well as a moderate environment to nourish them as well as most of the other plant species. Although every site was encountered by selected medicinal plants and the whole region of selected area was lavish in term of nutrient content due to the presence of these plants. The low value of IVI of selected medicinal plant as compared to other plant species explained the low tendency of dominance over other plants.

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