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Diversity of Shrub Species at Kasar Devi Forest in Kumaun Himalaya

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Abstract

Shrub species diversity was measured in Kasar Devi forest for various altitudinal sites by using different formulae and parameters. Most of the sites were dominated by *Myrsine africana* L. but the site with the greatest diversity was those dominated by other species. Simpson, Shannon Wiener, Mc Intosh (Mc_1 and Mc_2) were highly correlated with each other. There was an inverse relation between dominance concentration and species diversity index. Number of species was positively related with species diversity index.

The term diversity is applied to represent the variability in natural communities (1). The notion of diversity was first introduced by Williams (2) to mean the number of species, also called species richness. Other statistics, such as the total number of species, were strongly affected by the presence of rarities. Lloyd and Ghelardi (3) have defined a notion of evenness, which is in effect a comparison between the diversity as measured by the total number of species, and the diversity as measured by some other statistic. An appropriate notation is the statistics advocated by Whittaker are closely related to Shannon's entropy, and that all three measures are in a sense evaluations of the number of species present in the sample. They differ in their inclination to include or to exclude the relatively rarer species. The most generally appropriate measure of species diversity has been suggested by Whittaker (4) that the number of species per unit area and of the evenness with which the individuals are distributed among the species.

Several indices of diversity have been proposed by a number of workers which are probability measures, the measures of species diversity on the dual concept (5); information measures, which has been discussed in detail by Margaleff (6) and used by several workers (7—9); and distance measures, as proposed by Mc Intosh (10) using the distance between S-species community and the origin represented in an n-dimentional hyperspace where each dimensions refers to the abundance of a particular species.

Present work illustrates the comparison of species diversity for shrub layers at different aspects and altitudes for a forest sampled data. Different parameters and different formulae have been used to calculate the species diversity among the sites. Paper also deals with the various statistical differences among different indices calculated on the basis of various formulae and parameters.

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Study Area and Methods

Site

The present study was carried out in the forest on the Kasar Devi Hill situated in Almora district (29°37′ to 29°38′ N latitude, 79°39′

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Table 1. Density and *IVI* of different forest species of different aspect and altitudes.

Species	Para-meter	South aspect Site 1 1,700 m	Site 2 1,800 m	Site 3 1,900 m	Site 4 1,600 m	Site 5 1,700 m	North aspect Site 6 1,800 m	Site 7 1,900 m	Site 8 1,600 m	Site 9 1,700 m	West aspect Site 10 1,800 m	Site 11 1,900 m	Site 12 2,000 m
Berberis asiatica Roxb.	Density	210.00	92.00		140.00	150.00	40.00	55.00		90.00		125.00	
	IVI	58.80	11.38		40.17	31.37	12.24	29.64		56.99		90.42	
Rubus ellipticus J. E. Smith.	Density	182.50	320.00		610.00	212.50	210.00						
	IVI	63.85	68.03		76.12	30.69	35.38						
R. paniculatus Smith.	Density	102.50	235.00	45.00			60.00						
	IVI	24.45	24.70	39.59			10.23						
Myrsine africana L.	Density	455.00	345.00		672.50	1105.00	1406.25	160.00	110.00	175.00	160.00	210.00	
	IVI	101.61	52.79		102.93	202.46	133.55	122.64	160.79	144.87	124.79	121.83	
Asperagus gracilis Royle.	Density	95.00	280.00	65.00	117.00	261.25			65.00		45.00	60.00	105.00
	IVI	19.94	50.41	68.66	13.85	35.43			63.23		35.88	37.70	107.47
Crataegus crenulata Roxb.	Density	75.00	275.00	110.00	200.00		296.66	95.00		125.00			10.00
	IVI	31.28	92.64	191.70	66.84		108.50	130.42		99.12			116.30
Crotolaria mysorensis Roth.	Density								35.00		125.00		
	IVI								75.95		139.29		
Daphne papyracea Wall.	Density							35.00					
	IVI							17.24					
Sageratia filiformis Roth.	Density												60.00
	IVI												76.21

to 79°41′ E longitude). About 74% of the total forest area is covered by *Pinus roxburghii*, 23% by *Quercus leucotrichophora* and rest of the area covered by other species. Soil is of variable depth. The west aspect of hill is characterized by steep scarps however, south and north is comparatively gentle.

Methods

Phytosociological analysis of the forest shrubs was conducted by using twenty 10×10 m quadrats (11). The vegetational shrubs data were quantitatively analyzed for density according to the formulae given by Curtis and Mc Intosh (12). The relative values of frequency, density and dominance were determined following Philips (13). These quantities were summed up to represent *IVI* of individual species.

Diversity Measures

Simpson's index :

$$D = 1 - \frac{ni\ (ni-1)}{N\ (N-1)}$$

where *ni*, is the number of individuals in species *i* and *N* is the total sample size.

The Shannon-Wiener index :

$$H' - (ni/N)\ \mathrm{Log}\ (ni/N)$$

where *ni* is number of individuals of the *i* th species and *N* the total number of individuals of all species.

Table 2. Shrub species diversity by four indices for two parameters of sampled data.

Aspect	Site	Altitude (m)	Parameter	Diversity index: Simpson's D	Shannon-Wiener's H'	Mc Intosh's Mc_1	Mc Intosh's Mc_2
South	1	1,700	Density	0.7538	0.6880	0.5187	0.5033
			IVI	0.7885	0.7100	0.5629	0.5305
	2	1,800	Density	0.8143	0.7478	0.5829	0.5686
			IVI	0.7883	0.7096	0.5700	0.5372
	3	1,900	Density	0.6236	0.4478	0.4120	0.3798
			IVI	0.5234	0.3868	0.3274	0.3085
North	4	1,600	Density	0.7037	0.5941	0.4665	0.4553
			IVI	0.7505	0.6343	0.5285	0.4981
	5	1,700	Density	0.5462	0.4521	0.3342	0.3262
			IVI	0.5107	0.4283	0.3176	0.2994
	6	1,800	Density	0.4782	0.4128	0.2835	0.2776
			IVI	0.6562	0.5323	0.4370	0.4119
	7	1,900	Density	0.6753	0.5886	0.4515	0.4286
			IVI	0.6327	0.4865	0.4163	0.3924
West	8	1,600	Density	0.6049	0.4343	0.3965	0.3692
			IVI	0.6089	0.4386	0.3934	0.3708
	9	1,700	Density	0.6443	0.4614	0.5545	0.4023
			IVI	0.6257	0.4483	0.4102	0.3866
	10	1,800	Density	0.6046	0.4300	0.3913	0.3999
			IVI	0.5989	0.4234	0.3881	0.3658
	11	1,900	Density	0.5956	0.4282	0.3821	0.3631
			IVI	0.5670	0.4086	0.3614	0.3406
	12	2,000	Density	0.5221	0.3634	0.3316	0.3067
			IVI	0.6590	0.4703	0.4395	0.4142

Mc Intosh diversity :

$$Mc_1=\frac{N-ni^2}{N-N}$$

where N is the total number of individuals and ni is the number of species i.

$$Mc_2=1-\frac{ni^2}{N}$$

Mc_2 is used in comparisons, when the sample size is held constant. For variable sample size Mc_1 is to be preferred.

Concentration of dominance :

$$Cd=\frac{s}{i=1\ (Ni/N)^2}$$

where s is number of species in the collection, Ni is the proportion of individual belonging to the ith species and N is the total number of individuals of the stand.

Results and Discussion

Across all sites *Myrsine africana*, *Rubus eliptícus* and *Asperagus gracilis* were the dominant species, contributing 12—50% of total shrubs vegetation. The shrub species did not show any trend in density and *IVI* with respect to aspect and altitude. The *IVI* of *Myrsine africana* was greater at all altitudes and aspects except at 1,800 m south and 1,900 m north where, the *IVI* of *Cretagus crenulata* was greater. All other species show less *IVI* value compared to these species across all aspects and altitudes (Table 1).

Table 3. Coefficient correlation (r) values and regression parameters between the different indices of diversity. All the values are significant at $P<0.01$. *D*, Density ; *IVI*, Importance value index.

	Shannon-Wiener's (H')		Mc Intosh's (Mc_1)		Mc Intosh's (Mc_2)	
	D	*IVI*	D	*IVI*	D	*IVI*
Simpson's (*D*)						
(r) values	0.923	0.948	0.914	0.998	0.996	0.998
Intercept	−0.229	−0.248	−0.130	−0.154	−0.147	−0.145
Slope	1.162	1.174	0.880	0.908	0.861	0.855
Shannon-Wiener's (H')						
(r) values			0.778	0.960	0.942	0.954
Intercept			0.126	0.072	0.070	0.071
Slope			0.595	0.702	0.647	0.660
Mc Intosh's (Mc_1)						
(r) values					0.902	0.998
Intercept					0.051	0.001
Slope					0.810	0.940

Shannon Wiener index (H'), Simpson index (D), Mc Intosh species diversity (Mc_1 and Mc_2) were computed with density and *IVI* values (Table 2). These indices calculated on above parameters were positively related with each other ($P<0.001$) (Table 3).

The conentration of dominance (*Cd*) weights species with a large density by acquiring the proportion contributed by each species, and the Shannon Wiener index weights rare species since each proportion of a contributing species is multiplied by the log of its contribution. The highest diversity index H' (0.748), lowest *Cd* (0.186) and lower species diversity H' (0.413), highest *Cd* (0.522) were noted at site 2 and 6 (1,800 m south and north), respectively. The other diversity indices, such as D, Mc_1 and Mc_2 also showed a similar trend. Dominance varied considerably among communities (Table 4).

There existed a significant positive correlation between number of species and Shannon Wiener and Simpson indices according to : $Y=0.18+0.082\ X$; $r=0.820$ $P<0.01$; and $Y=0.45+0.45\ X$; $r=00.57$, $P<0.05$ (Fig. 1). The relation between number of species and concentration of dominance were inverse according to : $Y=0.55-0.05X$; $r=0.570$, $P<0.05$ (Fig. 1). Shannon Wiener and Simpson indices both were inversely related with concentration of dominance according to : $Y=0.740-0.741\ X$; $r=-0.931$, $P<0.01$ and $Y=1.00-0.998X$; $r=0.990$, $P<0.01$ (Fig. 1). The Shannon Wiener index is used as a diversity index because it is dimensionless and combines the variety and equitability components. However, this may obscure the individual behavior of the two components since an increase in the equitability relative abundance may contract a decrease in species number. This index increased

Table 4. Concentration of dominance calculated on the basis of density and *IVI*.

Aspects	Site	Altitude (m)	Density	*IVI*
South	1	1700	0.2468	0.2205
	2	1800	0.1861	0.3057
	3	1900	0.3791	0.4783
North	4	1600	0.2967	0.2519
	5	1700	0.4540	0.4910
	6	1800	0.5220	0.3459
	7	1900	0.3266	0.3693
West	8	1600	0.3980	0.3959
	9	1700	0.3573	0.3763
	10	1800	0.3972	0.4030
	11	1900	0.4059	0.4348
	12	2000	0.4808	0.3422

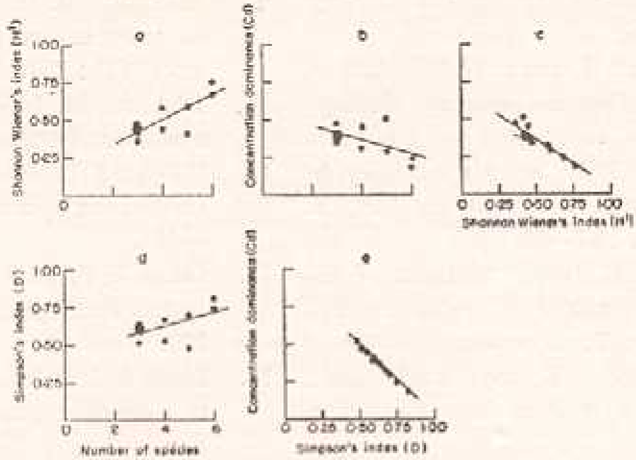

Figure 1. Correlations between number of species and Simpson's index and Shannon Wiener's index (a, d); and between concentration dominance and these indices (b, c, e).

with an increase in number of species (Fig. 1). The number of species across the site ranged between 3 to 7.

Some workers have advocated that diversity be measured by some term for productivity or biomass rather than density (14—16). They argue that these are better measures of the biological contribution of each species and, more practically, circumvent the difficulty of defining an individual. Productivity as a rate measurement in forest is difficult to measure. Odum (17) and Singh and Misra (18) in grasslands and Patten (19) in planktonic communities demonstrated that high biomass is associated with high diversity. Mc Naughton (20) found low diversity related to high productivity in California grasslands, and Whittaker (14) showed that high diversity does not always accompany high biomass.

We have used the density values for the measurement of diversity. We did not find any relation between density and species diversity in shrub communities. Thus increase or decrease in density value is not associated with an increase or decrease in diversity of shrub layer of Kumaun Himalayan forests.

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