HIGH ALTITUDE FOREST COMPOSITION DIVERSITY AND ITS COMPONENT IN A PART OF GANGA CHOTTI AND BEDORI HILLS DISTRICT BAGH. AZAD JAMMU AND KASHMIR, PAKISTAN

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Abstract
The effect of altitude on species diversity and its components was recorded in Ganga Chotti and Bedori Hills District Bagh Azad Jammu and Kashmir during 1999-2000. There were 30 plant communities merged in to four plant associations on the basis of cluster analysis. The highest average species diversity was 2.70 at the base (Alt1700 m) in woodland temperate association. Then the diversity declined. At the top (Altitude 3000 m) species diversity was 1.71, while in monsoon diversity was 2.48 at the base and 1.72 at the top. Average species richness was highest at the base (4.06) then decreased with the increase in altitude. Equitability increases from 1700-3350 m (0.71-1.07) while at the top it decreases (0.77). Species maturity in winter and monsoon was highest at the base and lowest at the top (3000 m).

Keywords: biodiversity, species richness, equitibility, deforestation, overgrazing

1. Introduction

Species diversity is an important character of any vegetation. It not only reflects the health of vegetation but also its productivity. Index of diversity is the measure of complexity of form and function within a community. Its precise measurement leads to understanding of processes involved in the developmental changes and organization of communities (Shaukat et al.1978). Some work on the species diversity has been done by different workers in various part of the world i.e. Adhikari et al. 1991, Franklin and Merlin 1992, West 1993, Planty-Tabbachi et al. 1995, Green andKaufman 1995, Willoughby 1996, Al-Faraj et al. 1997, Raizada et al. 1998, Khan et al. 1999, Townsend et al 2000, Spehn et al 2000, Vujnovic et al. 2002, Hurka and Heinrich, 2004. Similarly, on Kotli Hills diversity was recorded by Malik (2007). The aim of this work was to report recent index of diversity and its components which might be helpful for future botanist engaged in the work of phytosociology.

2. Material and Methods

2.1 Method of Field Data

The flora of the areas was collected in 1999 and 2000, as it is the reflection of the climate of an area. Complete specimen of each of these species were collected in triplicate, dried, preserved and mounted on standard herbarium sheet. The plants were identified with the help of available literature (Nasir and Ali, 1971-1994; Ali and Qaisar 1995-2002) and confirmed at National Herbarium NARC, Islamabad, Pakistan Museum of Natural History, Islamabad and Herbarium Department of Botany University of Karachi. A complete floristic list along with families was complied. Observation on the life form and phenological behaviour were recorded on spot. The voucher specimens were deposited in the Herbarium University of Azad Jammu & Kashmir, Muzaffarabad.

For the calculation of index of diversity total number of species and total number of individuals were recorded in each community. A quadrat of 10*2 m for trees, 5*2 for shrubs and 0.5*0.5 m^2 for herbaceous vegetation were laid systematically. Suitable number of quadrats in each community was 5, 10 and 15.

The Ganga Choti and Bedori hills are situated in District Bagh, AJK and is bounded on North by District Muzaffarabad, on South by District Poonch, on west by Muree (District Rawalpindi) and Hazara (District Abbotabad) and on the east by Occupied Kashmir. It stretches on area of 3,34,26,69 hectare. The area is primarily a mountainous terrain. The population of district is 4,70,000 (GOP, 1996). The highest peak Bedori Hills, which is 3578 m. The Ganga Chotti hills lie between 34° 3′ 50″ to 34° 4′ 50″ North and 73° 44′ 50″ to 73° 47′ 3″ East (Toposheet Number 43f/16) where as Bedori hills lie in between 33° 36′ to 34° 0′ North and 73° 23′ to 74° 9′ East (Topo sheet Number 43K/ 1, see Fig.1).

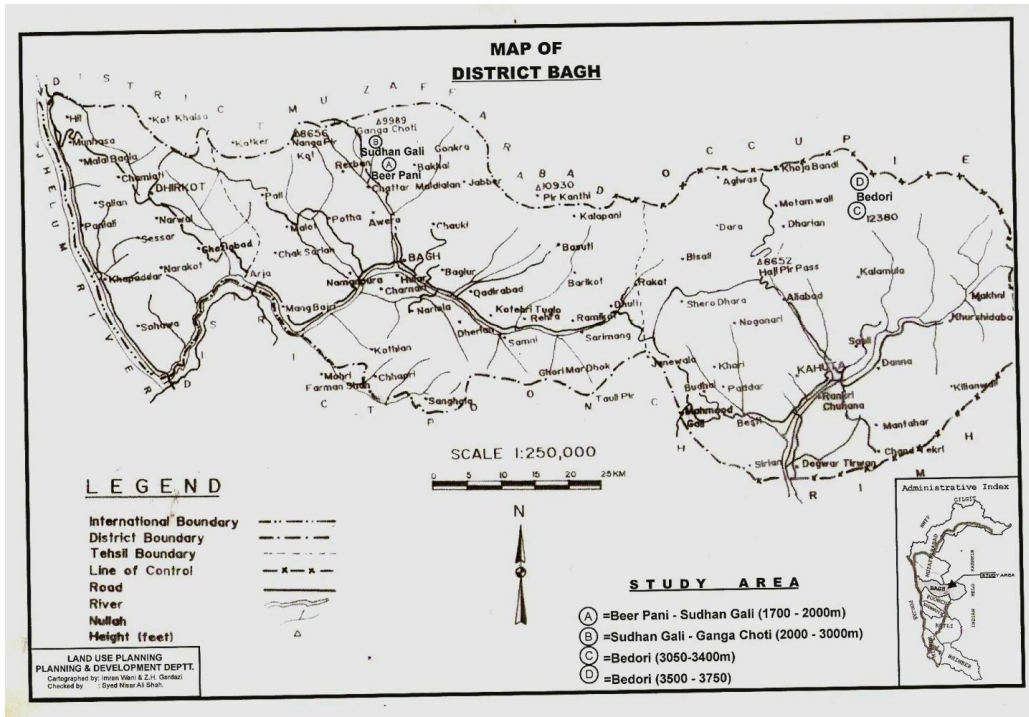

Fig. 1. Location of District Bagh in Pakistan

The area is characterized by subtropical climate in the lower reaches which changes to moist temperate subalpine to alpine type in the upper reaches. The summer is hot in lower altitude and pleasant in upper reaches. The winter is cold. The total annual rainfall is 705.12 mm. The maximum rainfall occurs during the month of June to August having 76-167 mm respectively. November (17.04 mm) October (36.24 mm), November and May generally receive the least rainfall which amounts to 17.04 and 25.2 respectively. Winter precipitation is gentle, steady and regular. It mostly gets absorbed in the soil. The summer rains are heavily torrential and irregular and cause heavy soil erosion. The area above 2000-3700 m receive snowfall from November to April which starts melting at the end of April and is a source of melt water.

The maximum temperature from January to March ranges in between 11-16°C. While the minimum temperature -1.55-3°C during winter. From May to August, the temperature ranges in between 25-29°C, while the minimum temperature lies in between 10-17°C. It decreases and remain between 14-24°C during September. At the same time the minimum temperature also drops from 12°C to less than 1°C. Geologically the area is characterized by Dogra slates and Muree formation (Wadia 1928).

Four plant associations were detected from cluster analysis and DCA which shows that at (1700-2000 m) soil was silt loam to clay loam type and from 2000-3000 m loamy, loamy clay and clay type. Thereafter, at 3000-3400 m soil was sandy clay loam to clay loam. At the top (3500-3750 m) soil was sand, sandy loam and clay loam type. Phosphorus increases from 0.16-2.80 ppm at 1700-3000 m to 0.41-6.43 ppm in woodland alpine association while in shrubland alpine association (3000-4000m) it increases from 1.50-179.63 ppm. Potassium differs from 56-188 ppm at 1700-2000m while in woodland alpine association it was 60-280 ppm at 2000-3000 m. Thereafter from 3000-3750 m potassium decreases from 60-130 ppm.

2.2 Index of diversity

The index of diversity is used for the comparison of the diversity of plant communities in various altitudes. It was calculated after Shannon and Wiener (1949) as follow: the average degree of uncertainty in predicting what species an individual chosen at random from a sample will belong to the species.

$$H= -\Sigma\ p_i \times \ln(p_i)$$

where p_i= Actual number of individual of the one species in a stand

2.3 Species richness

It is the richness of flora of an area. It is an expression of simple ratios between number of species and the square root of the total number of individuals of all the species. The species richness was determined by Margalef (1958)

$$R = S - 1/\ln (n)$$

Where S= total number of species in a community
ln = natural log
n= total number of individual of all species in a community.

2.4 Equitability or Evenness

It is a component of diversity and presents the ratio of the observed diversity to the maximum diversity possible for the same number of species. The equitability components are related to the evenness of allotment of individuals among the species (Peet, 1974).The equitability was determined after Pielou (1975). Equitability= Natural log of expected value from Shannon -Wiener index / Natural log of total species in a community

2.5 Maturity index

Maturity index is an indicator of maturity of stand or community. A value more than 60% indicates maturity of the stand. It was measured by Pichi and Sermolli's (1948) method as follows:

Degree of maturity=frequency values of all species in a stand/ total number of species in a stand

3. Results

In spring average value of index of diversity decreases from 2.70 to 1.66 at 1700-3350 m. In alpine grassland association it increased (Table 1).

Table 1. Diversity and its components recorded by the communities during spring.

Association	Altitude(m)	Diversity	Species Richness	Equitability	Species Maturity
Woodland temperate Association	1700	2.16	3.50	0.69	30.60
	1800	2.96	4.31	0.88	41.78
	1900	2.94	4.92	0.4	41.24
	2000	2.76	3.50	0.87	52.46
	Average	2.70	4.06	0.71	41.52
Woodland Alpine Association	2400	2.67	3.67	0.82	40.13
	2500	2.50	3.90	0.75	37.68
	2600	2.56	3.39	0.83	40.00
	2800	2.53	2.83	0.85	50.17
	2900	2.45	2.97	0.81	34.99
	3000	2.34	2.97	0.79	35.08
	Average	2.51	3.29	0.81	39.67
Shrubland Alpine Association	3050	1.54	1.54	0.86	46.29
	3250	1.64	1.37	1.32	42.49
	3350	1.79	1.78	0.93	32.33
	Average	1.66	1.56	1.07	40.37
Alpine Grassland Association	3505	1.36	0.93	0.84	54.44
	3650	1.82	1.39	0.79	35.83
	3750	1.85	1.07	0.68	28.88
	Average	1.71	1.13	0.77	39.72

The species richness decreased from low altitude to high altitude. Equitability increases from 1700-3350 m and thereafter it decreases. Similarly, species maturity almost remained the same. Index of diversity among communities increased from 1700 to 3000 m. In monsoon average value was 2.27-2.37. It decreased in shrubland alpine association (alt 3050-3350 m). Thereafter, a declining trend was observed in alpine grassland association. Species richness decreased with

increasing altitude from 1700-3750 m from 2.57-1.25in all the four associations. Similarly, equitability increased while moving from low altitude (1700 m) to high altitude (3000 m), but declined to 0.61 at 3750 m. The recorded species maturity show declining tendency while moving from lower (1700 m) to higher altitude (3750 m). It was 51.27 at the base (1700 m), and 31.82 at the top (3750 m, Table 2).

Table 2. Diversity and its components recorded by the communities during monsoon.

Association	Altitude (m)	Diversity	Species Richness	Equitability	Species Maturity
Woodland temperate Association	1700	2.24	2.61	0.78	47.55
	1800	2.05	2.47	0.82	43.55
	1900	2.30	2.48	0.82	60.23
	2000	2.48	2.74	0.72	53.75
	Average	2.27	2.57	0.78	51.27
Woodland Alpine Association	2400	2.65	3.07	0.90	49.12
	2500	2.59	3.01	0.88	43.68
	2600	2.36	2.53	0.58	43.74
	2800	2.30	2.35	0.87	39.99
	2900	2.38	2.37	0.90	38.09
	3000	1.92	1.42	0.87	54.81
	Average	2.37	2.46	0.83	44.90
Shrubland Alpine Association	3050	1.64	1.37	0.79	42.49
	3250	1.79	1.78	0.77	32.33
	3350	1.36	1.93	0.75	54.44
	Average	1.59	1.69	0.77	43.09
Alpine Grassland Association	3505	1.82	1.39	0.87	35.83
	3650	1.70	1.30	0.70	30.75
	3750	1.63	1.07	0.26	28.88
	Average	1.72	1.25	0.61	31.82

4. Discussion

Species diversity of an area is the reflection of different factors such as overgrazing, deforestation, environmental stress and susceptibility of species to those which lowers the species diversity (Willoughby, 1996). Species diversity is a function of the number of species present in a given area of the evenness with which the individuals are distributed among species. Sai and Misra, 1986 stated that the upper part of his study area on both NE and SW faces had lower species diversity as is evident by the negative correlation with altitude. Nevertheless, the relation was not found significant ($p>0.05$). Similarly Ohsawa et al. (1973) also did not observe any significant relation between species diversity and altitude. Since

the stands on both slopes are almost at the same altitude and have mixed forest, there maximum diversity indicates intermediate succession stage (Adhikari et al. 1991). Species diversity is controlled not only by habitat condition but also by the interaction of the component species (Ohsawa et al. 1973). Low diversity of woody species was reported in forests of Cook Island (Franklin and Merlin 1992). Greenland Kauffman (1995) stated that in ungrazed dry and moist meadow communities had significant lower species richness and diversity as compared with grazed communities. In the most heavily grazed communities, grazing disturbances increased ruderal and competitive ruderal species. They concluded that influence of herbivore on species diversity and evenness vary from one community to another and that basin management recommendation on one component ignores the inherent complexity of riparian ecosystem. It was observed that in spring there was high species diversity in the lower altitudes (1700 m) due to more species while diversity was low at higher altitudes (3000 m) due to few numbers of species. Similarly findings were reported by Colinvaux (1993), Malik et al. (1993) who reported similar findings in Kotli and Bhimber Hills. In spring diversity was positively correlated with species richness and maturity and negatively correlated with equitability while in monsoon species diversity was correlated with species richness, equitability and species maturity. The investigated area is severely overgrazed by local animals such as cow, buffalo, sheep, goats etc which reduced vegetation. The observed low species diversity in the Ganga Chotti is due to deforestation and overgrazing, collection of medicinal plants and quick disappearance of annuals/geophytic and because of cold season of the species. In degraded vegetation few species can compete and complete their life cycle. Thus, those, which require a better habitat in term of shade, light, nutrients and moisture, are usually excluded. In degraded open vegetation sun tolerant or loving species which require low moisture, low humidity might do better. This reduced the species diversity as number of sciophytes reduced and this agrees with Malik et al. (1993) who reported that in degraded vegetation sun tolerant require low moisture and low humidity in the Kotli hills. Dannin (1999) observed that species diversity of eastern desert vegetation increased with increasing the humidity. In our case, overgrazing, deforestation, temperature and erosion may be some of the factors responsible for the observed low species diversity. In some localities very high species diversity was recorded in moist temperate zone of Ganga Chotti Hills. Malik (2001) while reporting vegetation of Dao Khun observed high species diversity in the upper reaches while low diversity at lower altitude Khan et al.(1999) reported low species diversity due to few species and stressful environmental stress. Sharing of limited resources by associating species in proportionally related to the dominance of species, which becomes clear due to low diversity. In our case species diversity was low due to less number of species in higher altitude and high diversity due to high number of species in lower altitude. The diversity of species was high in the tree layer in the middle part (2500-2800 m)

of altitudinal gradient. It decreased both toward lower and higher altitudes. However, Pinus wallichiana and Abies pindrow forest occupying the middle altitudinal zone had low diversity. In this case, lower (1700 m) and higher altitudinal (3000-3750 m) belts are characterized by severe climate viz, at low altitude temperature was hot with poor rainfall while at higher altitude cold temperature and snow fall restricted the species number to few. It is observed that severe climate keeps the species diversity low, while in the favourable climate with high rainfall and moderate temperature favours the diversification of species. The results are in line with Saxina et al. (1987) who reported that in Kumaun Himalayas the diversity of tree layer was higher, which decreased both at lower and upper altitudes. Similarly, with increasing altitudes the average tree height decreased. Plant diversity is influenced by change in soil type, drainage, nutrient status and elevation (Smith and Smith, 1998). In the present case diversity was also influenced by soil type, nutrient status and elevation in some communities at 1700-2000m here soil was silt-loam to clay loam with 0.16 ppm phosphorus and 56 ppm potassium while at 2000-3000 soil was loamy and clayey with 0.41 ppm phosphorous and 60 ppm potassium which makes the difference with the increase in altitude from 2000-3000 m. Our findings are in line with him. A community that contain a few individuals of many species will have a higher diversity than will a community containing the same number of individual but with most of them confined to a few species, and this is what happened in the present study. Malik et al. (2001) observed that vegetation of Kolti Hills had a lower species diversity in the higher altitude (900 m) and high diversity in the lower altitude (700m) due to low rainfall and high temperature. Diversity is definitely affected by climate which governs the distribution of plants and thus the development of communities and community structure. Townsend et al. (2000) stated that species richness increases as climatic variation decrease. Furthermore, if high productivity is correlated with a wide range of available resources, it leads to an increase in species richness. The species richness was the highest during spring that decreased during monsoon. In spring there was abundance of annuals due to which species diversity increased while in post monsoon season most of the annuals and geophytes disappeared that decreased species richness. The higher value of species richness was recorded for communities of moist temperate habitat, which had relatively optimum climatic condition between lower and higher altitudes. Parthasarathy and Karthikeyan (1997) stated that species richness stand diversity and diversity indices consistently decreased with increasing size class of woody species ranging from 30-180 cm girth. In our case species richness and diversity indices from 30-210 cm girth consistently decreased with increasing size classes of woody species. The present study showed that the vegetation of moist habitats was patchy and aggregated in distribution and this might be the reason that high value for species richness occurred. There were an increase and a decrease in species richness i.e. species richness may be highest at intermediate levels of productivity. In some cases, it has been possible to relate species richness to the spatial heterogeneity of the abiotic

environment. Equitability resource is the analysis of relative abundance of component taxa and is important to land than richness in vegetation (West, 1993). The present study showed that spring communities exhibited more equitability value than monsoon communities. The reason might be that annuals were in abundance during spring season. A higher equitability may result in highly stable environment over a prolonged period of time (Shaukat and Khan, 1979). It appears that high equitability value has significant positive correlation with maturity index. Similarly, Vujnovic et al. (2002) stated that the maximum plant species diversity occurred at intermediate level of disturbance with low level or no disturbance for species richness and diversity index. Species diversity decreased at high level, compared with medium level of disturbance. Low species diversity in undisturbed and lightly grazed quadrat was linked with high abundance of the late succession species. The somewhat higher species richness observed at high altitude disturbed significantly. Higher total species evenness at high disturbance levels was recorded at high levels of disturbance therefore, the higher total species diversity at high level of disturbance resulted from the high evenness of a relatively small number of species. Low species diversity is relatively found in higher altitude where the species number is less and here the plant communities are undisturbed. Planty-Tabacchi et al. (1995) reported maximum exotic species diversity at some intermediate disturbance levels.

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