

Full Length Research Paper

Biodiversity of plant species in Tehsil Takht-e-Nasrati, Pakistan

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The current study illustrates the proportional description of the biodiversity of plants in Tehsil Takht-e-Nasrati, Pakistan. The highest value (3.097) of species diversity was obtained from southern area in spring, while the lowest value (1.75) was obtained from Jahangeri Banda in winter. The highest value (5.752) of species richness was obtained from Warana in winter, while the lowest value (2.08) was obtained from Sarki Lawager in summer. Furthermore, the highest equitability value (0.957) was obtained from Kiri Dhand in spring, while the lowest equitability value (0.575) was got at Sarki Lawager in winter. The fact that southern Bogara had more species diversity in showed that their vegetation was more stable compared to Jahangeri Banda. This study pointed out that the climatic environment of the region which has privileged conscription of area correlates with the climatic development of the area more than an extensive succession progression and area administration is supposed to be at the heart of the area in order to preserve its diversity.

Key words: Area composition, species diversity, species richness, equitability.

INTRODUCTION

The assortment and changeability of existing organisms along with and the biological difficulties which they encounter is biological diversity. Tropical forests cover up only 7% of the earth's surface and forms part of more than half of the world's species. However, these species are vanishing at an expected annual rate of 0.8 to 2.0% (May and Stumpf, 2000). In India, out of the 86% of the tropical forest area, 54% is dry deciduous, 37% is moist deciduous, while the remaining percentage is wet evergreen or semi evergreen (Kaul and Sharma, 1971).

Tree species diversity in the tropics contrasts considerably from place to place (Pitman et al., 2002). Much attention has been given to tropical forests due to their species richness (Whitmore, 1984), high standing biomass (Bruenig, 1983), and greater productivity (Jordan, 1983). The present study compares the diversity and dominance of sal-dominated moist deciduous forest with that of degraded moist deciduous forest from Achanakmar Wild Life Sanctuary part of Achanakmar-Amankantak - a proposed biosphere reserve. Biodiversity has remained one of the essential ideas of ecology for many years now. However, after the Rio's Earth Summit, it became the most important issue for not only ecologists, but also the whole biological community and environmentalists. As many countries including Pakistan get together to consider the issue of biological diversity, each nation has the formal and heartfelt responsibility to document the species of plants and animals in their particular state, evaluate the biodiversity accurately and develop proper organization policies for protecting the biodiversity which is regularly illustrated as the living

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Abbreviations: GB, Gardi Banda; TK, Tater Khel; AA, Ahmad Abad; WA, Warana; SB, Southern Bogara; NB, Northern Bogara; GK, Gandiri Khattak; KD, Kiri Dhand; JB, Jahangeri Banda; MK, Mona Khel; JS, Jarassi; CH, Chokara; AK, Ambiri Kala; SH, Shawa; SK, Siraj Khel; SD, Shahidan; ZN, Nasratti; TN, Takht-e- Nasrati; KK, Kandu Khel; SA, Shadi Khel; SN, Shnawa; SL, Sarki Lawager.

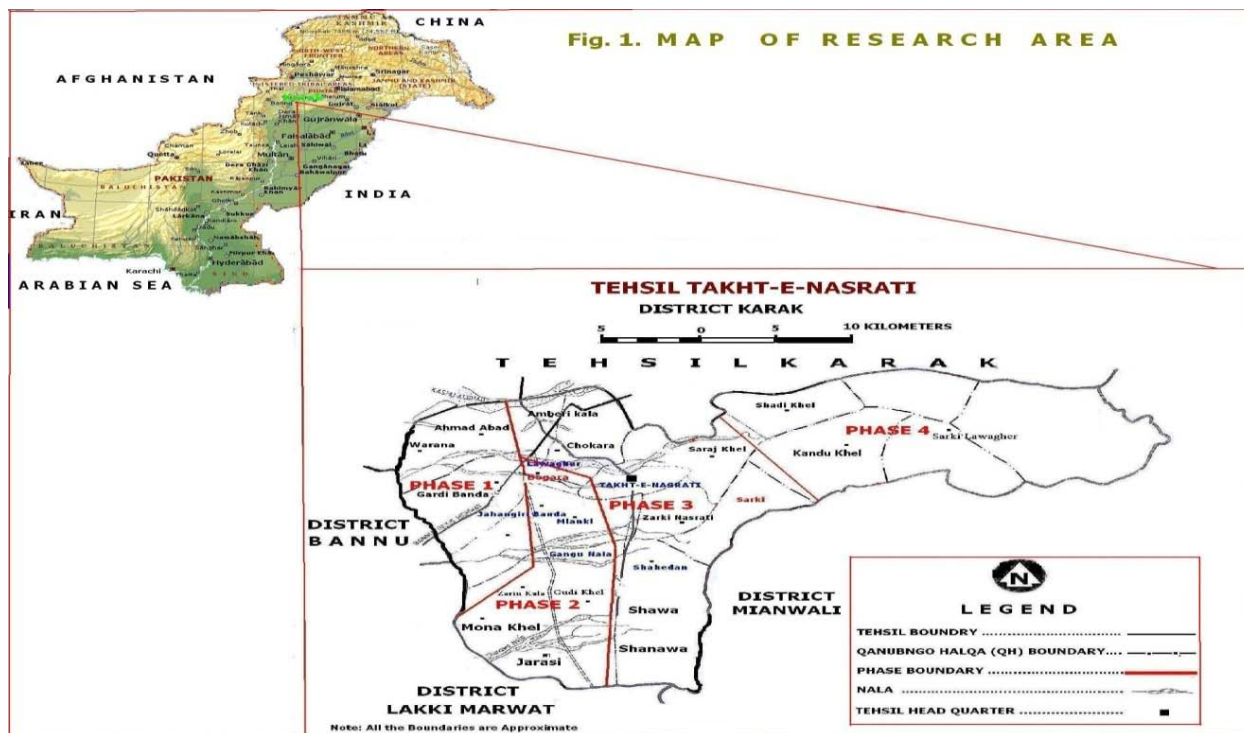


Figure1. Map of Tehsil Takht-e-Nasrati, Karak District, Pakistan.

tradition of creatures.

There are different reasons for which biodiversity is studied. Many species have been eradicated for ornamental and medicinal reasons. The environment has been in an extensively dreadful condition. Pollution load has increased in the area due to industrial expansion and large scale use of pesticides and insecticides in crop growing. Although changing in manner and aspect, diversity has continued to be the essential idea of ecology. A sound essayed outline of spatial and chronological variation in diversity schemed by the early examiners of nature continues to motivate the attitudes of ecologists today. The significant evaluation of location increases the capacity of species diversity. This is chiefly due to the fact that ecologists have proposed a large variety of indices for and forms of assessing diversity. So for the diverse situations, habitations, and locations, the forms of species richness and diversity indices should be used and estimated correctly. The number of different items and their relative frequency is diversity. Many studies have been done on biodiversity changes in different areas of the world (Lovejoy et al., 1986; Diamond et al., 1987; Klein, 1989; Newmark, 1991; Bierregaard et al., 1992; Leigh et al., 1993; Fonseca and Brown, 1994; Kattan et al., 1994; Laurance, 1994; Malcom, 1994; Chittibabu and Parthasarathy, 2000; Cadotte et al., 2002; Liu et al., 2002; Pither and Kellman, 2002; Williams-Linera, 2002; Zhu et al., 2004; Venkateswaran and Parthasarathy, 2005; Arroyo-Rodriguez and Mandujano, 2006; Li et al., 2007; Santos

et al., 2008; Zhu et al., 2010; Khan et al., 2011). Although these studies are related, they are distinct.

The main objective of this research study is to collect, identify, and calculate diversity, species richness, and evenness of plant species in Tehsil Takht-e-Nasrati. Currently, no previous information presented on the biodiversity of this area exists; thus, this is the first work done to confirm the biodiversity of this region.

Research area

Tehsil Takht-e-Nasrati is situated at 32.47° to 33.28° North and 70.30° to 71.30° East. The research area is bounded by Tehsil Karak on the North East, Mianwali District on the East, Lakki Marwat District on the South West, and Tribal area adjoining Bannu District on the West (Figure1). The study spot is semi-arid in nature with hot climatic situation. The total area of Tehsil is about 613.66 Km². The entire area was divided into 22 stands and 4 phases. The stand identification was based on altitude, physiognomic aspects, degradation stage, and floristic composition of the area. Each stand was approximately located at a distance of 100 m. There were 10 replicates in each community/stand. The investigated area lies in summer monsoon region. Phase I was divided into Gardi Banda (GB), Tater Khel (TK), Ahmad Abad (AA), and Warana (WA). It lies 300 to 399 m above the sea level (ASL). Phase II was divided into the Southern Bogara (SB), Northern Bogara (NB), Gandiri

Table 1. Meteorological data of Tehsil Takht-e-Nasrati for the years 2001 to 2010.

Month	Temperature (°C)		Humidity (%)		Rainfall (mm)	Soil temperature (°C) average	Wind speed (km/h)
	Max.	Min.	Max.	Min.			
January	19.18	4.26	75.80	35.24	27.43	7.03	2.9
February	21.69	7.29	77.39	42.23	37.72	9.14	3.2
March	28.20	12.06	75.38	35.23	37.17	13.89	3.5
April	34.74	17.94	66.12	29.42	36.54	19.02	5.2
May	38.32	22.33	59.66	30.73	31.6	21.87	5.4
June	39.50	25.9	59.96	32.89	74.24	25.78	5.5
July	38.44	25.76	73.33	38.76	121.6	26.77	5.2
August	36.66	25.29	75.68	42.61	108.3	26.37	4.1
September	35.47	21.95	77.21	39.29	61.58	23.49	3.7
October	32.33	16.79	71.55	35.51	15.13	20.09	3.5
November	26.71	10.01	71.56	36.66	5.80	14.10	3.2
December	21.93	5.67	75.20	35.90	15.38	8.96	3.1
Mean	31.1	16.27	71.57	36.21	47.71	18.04	4.04

Source: Agricultural Research Farm, Ahmadwala Karak.

Khattak (GK), Kiri Dhand (KD), Jahangeri Banda (JB), Mona Khel (MK), and Jarassi (JS) and lies 400 to 499 m ASL. Phase III which was composed of Chokara (CH), Ambiri Kala (AK), Shawa (SH), Siraj Khel (SK), Shahidan (SD), Zarki Nasratti (ZN), and Takht-e- Nasrati (TN) lies 500 to 599 m ASL. Phase IV was divided into four sites - Kandu Khel (KK), Shadi Khel (SA), Shnawa (SN), and Sarki Lawager (SL). It lies 600 to 800 m ASL. The majority of the area consists of rigged dry hills, rough field areas that are about 323.97 Km² and agriculture land that is about 289.7 km². The main source of revenue for the people is agriculture, which is rain dependent. Although the hills are dry, they are, however, full of valuable minerals like coal, gypsum, uranium, gas, etc. More rain makes available finer crops and vice versa. The major problem of the area is shortage of drinking water, grazing, cutting of plants, and dry seasons. Rainfall is scanty in the area. From the years 2001 to 2010, only 121.6 mm of rainfall was recorded. The area is very hot in summer and very cold in winter. June and July are the hottest months, whereas December and January are the coldest months. It was noticed that in the hottest months, grasses and herbs get out of stock in the area, so the animals feed on every plant in the area. From the years 2001 to 2010, the mean maximum temperature was 39.5°C in the month of the June, whereas the mean minimum temperature was as low as 4.26°C in the month of January (Table 1).

MATERIALS AND METHODS

Data collection

The data used throughout the study were collected through quadrat

technique from Tehsil Takht-e-Nasrati, Khyber Pakhtunkhwa, Pakistan from the years 2009 to 2010 by regular assessment in winter, spring, and summer. On the basis of species characteristics, the proper size of the quadrat for trees (10×10 m), shrubs (5×5 m), and herbs (1×1 m) was given. A combination of systematic and random quadrats was used as it gives better results. Thus, at low altitudes quadrats were laid systematically, while in hilly sites, they were laid randomly. The distance between two adjacent stands was approximately 100 m. Species diversity, species richness, and species evenness were determined through standard methods.

Dimension of species diversity

Species diversity is the assortment of diverse kinds of individuals in a region. In this study, it was calculated according to the recommendation made by Shannon-Wiener (1949). The value of Shannon diversity frequently falls between 1.5 and 3.5 and only seldom exceeds 4.5. The index of diversity is used for the relationship of the diversity of plant communities at a chosen altitude. Shannon diversity is the most common functional index used for matching up the diversity in assorted habitations. This expression is:

$$H' = - (1)$$

Where, p_i is the proportion of individuals

$$H = - \sum P_i - \ln P_i$$

$$P_i = n_i/N$$

Where, H is the value of Shannon and Wiener index, P_i is the proportion species, $\ln P_i$ is the natural logarithm of p_i , n_i is real number of individual of the one species in stand and N is the total of individual of all species present in that stand.

Capacity of species richness

The wealth of flora in a specific region shows the species richness

Table 2. Diversity parameters of the phase I of Tehsil Takht-e-Nasrati.

Stand	Species diversity				Species richness				Equitability			
	Spring	Summer	Winter	Mean	Spring	Summer	Winter	Mean	Spring	Summer	Winter	Mean
GB	2.908	2.46	2.394	2.587	4.397	2.54	4.651	3.863	0.927	0.91	0.735	0.857
TK	2.446	2.36	2.055	2.287	3.242	2.3	3.949	3.164	0.863	0.89	0.665	0.806
AA	2.774	2.63	2.676	2.693	3.894	3.11	4.723	3.909	0.911	0.91	0.831	0.884
WA	2.7	2.57	2.689	2.653	3.797	2.9	5.752	4.15	0.901	0.91	0.776	0.862
Mean	2.707	2.505	2.454	2.555	3.832	2.712	4.769	3.771	0.901	0.905	0.752	0.852

of that region. The species richness was definite like that of Margalef (1958). This mode of evaluating the species richness of diverse samples drawn from diverse habitats is simple.

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

Where, R is species richness, S is summation of the species in a community and \ln is the natural log.

Extent of equitability or evenness

This has to do with the likelihood of having the same number of species in a section of diversity and presenting the ratio of the observed diversity near the maximum diversity. The equitability mechanism is related to the evenness of allocation of individuals among the species (Peet, 1974). The equitability was determined by using Pielou's method (1966) which is as follows:

$$E = \ln H / \ln S$$

Where, E is equitability; $\ln H$ is Natural log of expected value from Shannon-Wiener Index; $\ln S$ is Natural log of total species in a community; and S is the number of species in the community.

RESULTS

One hundred and sixty-one plant species were sampled from the area, where 25 were monocotyledonous and 136 were dicotyledonous species all belonging to 52 families. Out of these 161 plant species, 23 were trees, 23 were shrubs, 103 were herbs, nine were grasses, and three were parasite species. Poaceae was the most dominant with 17 species followed by Asteraceae and Papilionaceae both of which had 13 species each and Solanaceae which had 8 species. Amaranthaceae and Brassicaceae had seven species each. Cucurbitaceae and Lamiaceae had 6 species each. Convolvulaceae, Liliaceae, and Mimosaceae each had five species. Euphorbiaceae and Malvaceae had four species each. Each of Boraginaceae, Cappariaceae, Chenopodiaceae, Rhamnaceae, Verbenaceae, and Zygophyllaceae had three species. Apiaceae, Asclepiadaceae, Cyperaceae, Fumaraceae, Moraceae, Myrtaceae, Orobanchaceae, Plantaginaceae, Polygonaceae, and Tamaricaceae had two species each. The remaining 23 families, that is, Aizoaceae,

Apocynaceae, Cactaceae, Caryophyllaceae, Ceasalpiniaceae, Celastraceae, Geraniaceae, Meliaceae, Menispermaceae, Nyctaginaceae, Oxalidaceae, Palmae, Pedaliaceae, Primulaceae, Punicaceae, Ranunculaceae, Rosaceae, Salvadoraceae, Sapindaceae, Sapotaceae, Scrophulariaceae, Tiliaceae, and Vitaceae had a single species each (Khan et al., 2011).

Phase I

During summer, the highest values of diversity index (2.63) and species richness (3.11) were obtained from Ahmad Abad. In the same season, the highest equitability value (0.91) was found to be similar in all the areas except Tater Khel (0.89). In winter, the highest values of diversity index (2.689) and species richness (5.752) were obtained from Warana, while the highest equitability value (0.831) was obtained from Ahmad Abad. At spring, the highest values of diversity index (2.908), species richness (4.397), and equitability (0.927) were obtained from Gardi Banda (Table 2).

Phase II

In summer, the highest values of diversity index (2.79) and species richness (3.85) were found in southern Bogara, while the highest equitability value (0.89) was found at Jarassi. During winter, the highest values of diversity index (2.708) and species richness (5.241) were obtained from southern Bogara, whereas the highest equitability value (0.822) was obtained from Jarassi. In spring, the highest values of diversity index (3.097) and species richness (5.634) were obtained from southern Bogara, while the highest equitability value (0.957) was obtained at Kiri Dhand (Table 3).

Phase III

In summer, the highest values of diversity index (2.8) and species richness (3.73) were obtained from Siraj khel, while the highest equitability value (0.91) was obtained from Shawa. In winter, the highest values of diversity index, species richness, and equitability, (2.825), (4.255), and (0.901), respectively, were obtained from Zarki

Table 3. Diversity parameters of the phase II of Tehsil Takht-e-Nasrati.

Stand	Species diversity				Species richness				Equitability			
	Spring	Summer	Winter	Mean	Spring	Summer	Winter	Mean	Spring	Summer	Winter	Mean
SB	3.097	2.79	2.708	2.865	5.634	3.85	5.241	4.908	0.911	0.88	0.796	0.862
NB	2.865	2.46	2.148	2.491	4.609	2.87	3.652	3.71	0.902	0.84	0.706	0.816
GK	2.619	2.44	2.008	2.356	3.445	2.85	3.006	3.1	0.924	0.86	0.709	0.831
KD	2.866	2.55	2.527	2.648	4.027	3.17	3.852	3.683	0.957	0.87	0.817	0.881
JB	2.552	2.46	1.75	2.254	3.292	3.22	3.473	3.328	0.901	0.81	0.575	0.762
MK	2.431	2.4	2.405	2.412	3.202	2.78	3.884	3.289	0.858	0.85	0.778	0.829
JS	2.696	2.63	2.678	2.668	3.551	3.45	4.873	3.958	0.933	0.89	0.822	0.882
Mean	2.732	2.533	2.318	2.528	3.966	3.17	3.997	3.711	0.912	0.857	0.743	0.838

Table 4. Diversity parameters of the phase III of Tehsil Takht-e-Nasrati.

Stand	Species diversity				Species richness				Equitability			
	Spring	Summer	Winter	Mean	Spring	Summer	Winter	mean	Spring	Summer	Winter	Mean
CH	2.43	1.95	2.249	2.21	3.67	2.92	3.771	3.454	0.826	0.68	0.739	0.748
AK	2.607	2.11	2.261	2.326	3.547	2.79	3.417	3.251	0.885	0.74	0.768	0.798
SH	2.373	2.34	2.363	2.359	3.053	2.99	3.139	3.061	0.856	0.81	0.818	0.828
SK	2.637	2.8	2.742	2.726	3.753	3.73	4.03	3.838	0.88	0.89	0.875	0.882
SD	2.433	2.27	2.19	2.298	2.745	2.61	2.723	2.693	0.899	0.84	0.809	0.849
ZN	2.899	2.65	2.825	2.791	3.917	3.48	4.255	3.884	0.952	0.89	0.901	0.914
TN	2.331	2.27	2.297	2.299	2.735	2.2	2.458	2.464	0.883	0.91	0.895	0.896
Mean	2.53	2.341	2.418	2.43	3.345	2.96	3.399	3.235	0.883	0.823	0.829	0.845

Table 5. Diversity parameters of the phase IV of Tehsil Takht-e-Nasrati.

Stand	Species diversity				Species richness				Equitability			
	Spring	Summer	Winter	Mean	Spring	Summer	Winter	Mean	Spring	Summer	Winter	Mean
KK	2.626	2.34	2.502	2.489	3.578	2.72	3.102	3.133	0.892	0.85	0.866	0.869
SA	2.757	2.72	2.553	2.677	4.008	3.22	3.666	3.631	0.879	0.91	0.838	0.876
SN	2.705	2.7	2.695	2.7	3.722	3.55	3.829	3.7	0.919	0.92	0.915	0.918
SL	2.42	2.2	2.136	2.252	3.053	2.08	2.373	2.502	0.893	0.92	0.859	0.891
mean	2.627	2.49	2.472	2.53	3.59	2.893	3.243	3.242	0.896	0.9	0.869	0.888

Nasratti. In spring, the highest values of diversity index (2.899), species richness (3.917), and equitability (0.952) were obtained from Zarki Nasratti (Table 4).

index (2.757) and species richness (4.008) were obtained from Shadi Khel, while the highest equitability value (0.919) was obtained from Sarki Lawager (Table 5).

Phase IV

In summer, the highest values of diversity index (2.72) and species richness (3.55) were obtained from Shadi Khel and Sarki Lawager respectively. In the same season, the highest equitability value (0.92) was obtained from both Shnawa and Sarki Lawager. In winter, the highest values of diversity index (2.695), species richness (3.829), and equitability (0.915) were obtained from Sarki Lawager. During spring, the highest values of diversity

DISCUSSION

The difference in plants found in a particular region is considered as biodiversity. During this research, four phases which were divided into 22 sites throughout three seasons were assessed for species diversity, species richness, and equitability in Takht-e-nasrati by using quadrat method. Diversity index, species richness, and equitability are a measure of the biodiversity of a group of organisms in an area. The highest value (3.097) of

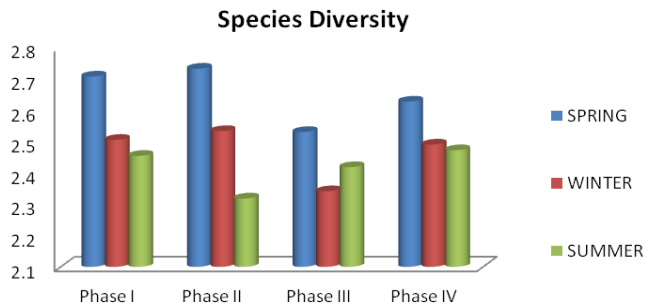


Figure 2. Species diversity in different seasons.

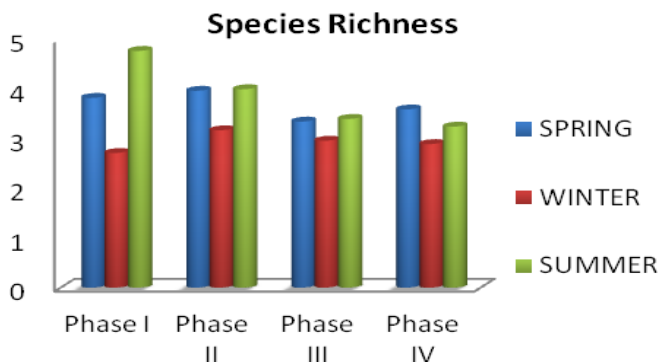


Figure 3. Species richness in different season.

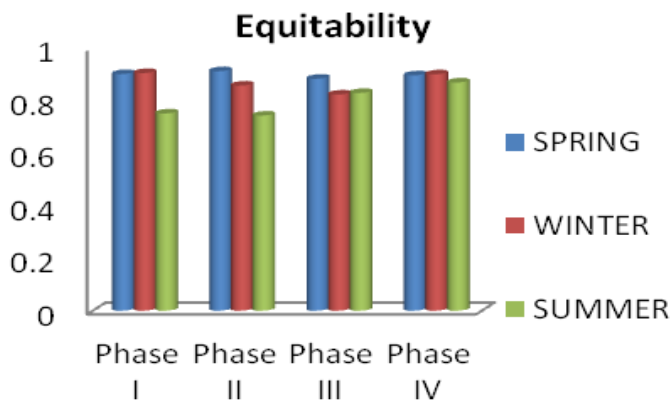


Figure 4. Equitability in different seasons.

species diversity was obtained from southern Bogara at spring, while the lowest value (1.75) was obtained from Jahangeri Banda in winter (Figure 2). The highest value (5.752) of species richness was obtained from Warana in winter, while the lowest value (2.08) was obtained from Sarki Lawager in summer (Figure 3). The highest equitability value (0.957) was obtained from Kiri Dhand at spring, while the lowest value (0.575) was obtained from Sarki Lawager in winter (Figure 4).

Species richness is the total number of species present in



Figure 5. Area habitually cultivated with gram and wheat.

a given region, whereas diversity is related to how individuals are scattered amongst the species. In fact, it seems that nearly all quantitative measures of diversity are a combination of two components: species richness and evenness, where evenness describes how equally individuals are distributed amongst the species. From the present study, it was shown that during spring the species diversity increased in all the phases, while in summer, the species diversity decreased in all the phases except Phase III where the species diversity decreased in winter.

A small number of the majority of receptive species are primarily misplaced as native plants are crowded out by invasive species. As the quantity of invasive plants rises, species diversity decreases. Due to the small number of native plants and due to the fact that the diversity of species is not similar from group to group and from region to region species, diversity decreases. In other words, species diversity increases when some environments are more assorted than others. The most diverse area was southern Bogara which at spring season had the highest value (3.097) of species diversity. The most diverse habitat is healthiest. The weakest habitat was found in Jahangeri Banda during winter, having the lowest species diversity (1.75). The highest species diversity which was recorded in southern Bogara showed that their vegetation was more stable when compared with Jahangeri Banda.

In spring, most of the communities could not bring out their animals for grazing on the agriculture fields because these were plain areas and the community cultivated gram and wheat habitually in the areas; therefore the species richness increased during spring seasons in phases I and II (Figure 5). In phases III and IV, the species richness was typically comparable in all seasons since the part was hilly and the majority of the society brings their animals to the hills. The occupation of the



Figure 6. Hilly area commonly used as grassland.

populace in this region was domestic animals trade; for that reason, the people use these hills as common grassland in all seasons (Figure 6). With regard to biological diversity, items are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses species, genes, diverse ecosystems and their virtual abundance (OTA, 1987). One characteristic attribute of multi-species populations is diversity, which also, is probably one of the most misused and incorrectly evaluated attributes. Perhaps the commonest misconception is that species richness and diversity are synonymous. In Phases I and IV, equitability was high during winter, while in phases II and III, equitability was high during spring. Equitability was diverse in different areas due to the physiography of the region. Equitability was high at the lowest and highest zones, while it was low at the lowest and highest zones.

Conclusion

The range of diversity measures (species diversity, species richness, and evenness) available helps greatly

in evaluating the biodiversity of an entire habitat. This study pointed out that the climatic environment of the region which has privileged conscription of area correlates with the climatic development of the area more than an extensive succession progression and area administration is supposed to be at the heart of the area in order to preserve its diversity. So, biological diversity can be defined as the assortment and changeability of existing organisms and the biological difficulties which these organisms encounter.

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