Pak. J. Bot., 45(5): 1663-1667, 2013.

ANALYSIS OF VEGETATION PATTERN AND SOIL CHARACTERSTICS OF ASTORE VALLEY GILGIT- BALTISTAN

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Abstract

A survey was conducted to analyse the vegetation pattern and soil characteristics of Astore valley at different altitudes (1250m-4200m) and localities. It was observed that the herbaceous plant species were dominant in the natural habitat, particularly in the alpine and sub-alpine zones. At lower altitude i.e. Bunji and adjacent areas xerophytic and halophytic plant species were found and upper altitudes *i.e.* Deosai, Kalapani and surrounding areas herbaceous plant species were common. Total 668 plant species were recorded from the Astore valley during the survey period (2005-2009). Out of these 631 belonged to naturalized flowering plants, including to 291 genera and 76 families, 4 species of Pteridophytes belonged to two genera and two families while 33 cultivated species belonged to 30 genera and 17 families. The study area was categorized into five ecological zones on the basis of microclimatic conditions and topography. For comparison of vegetation pattern in these zones similarity index and Beta Diversity were calculated. *Seriphidium brevifolium* (Wall. ex DC.) Ling & Y. R. Ling was the most dominant plant species in the study area. The soil was fine to coarse in texture ranging from clay loam to sand and acidic to slightly alkaline in nature, containing considerable amount of calcium carbonate (up to 16 %) and appreciable amount of organic matter(up to 33.094 %). Maximum water holding capacity (21.415-63.179) and pH values (5.35-7.20) were also determined. The amount of organic matter was high; in these habitats and the vegetation was dense. It is concluded that certain edaphic factors, altitudinal variation, soil texture and amount of organic matter are responsible for variation in vegetation.

Introduction

A store is a beautiful valley of Gilgit-Baltistan lying in Northern part of Pakistan between 34.8°-35.8° N latitude and 74.4°-75.2° E longitude. The valley has altitudinal and topographical variation, lower valley parts, Bunji including up to Doain are arid, dry and warm and upper part of the valley i.e., Deosai, Domail, Kalapani, Rupal & Rama etc. are cold and some of the most beautiful places in Pakistan. The valley covers an area of 7222 km^2 (Ali, 1995). It is bounded by Baltistan, in south East, Gilgit East North, Chillas and Azad Kashmir in West.

The valley extends over the major part of the Western Himalayas; it is ranging from sea level to 1200m- (8126m Nanga Parbat). The Himalayas are one of the most representative mountain ranges which have vast alpine vegetation and great varieties of plants. Physiognomically Astore and Nanga Parbat have great altitudinal variation. The lands are deeply cut by rushing hill torrents and rugged topography forming V-shaped valleys. There are many habitats, arid desert plains, temperate conifer forests, sub alpine bushes to alpine meadows and permanent snow covered mountains.

The mountainous topography of the area has extended since the tertiary period when the region was subjected to prolonged orogeny. The mountain chains are aligned parallel to the original geological structure and this distribution depends on the difference of weathering of the rock type. Glaciation has played an important role in producing the rugged topography. Glaciation reached to maximum during the Pleistocene epoch but the ice has since been receded to much higher altitudes. Undisturbed high level river gravels, on the sides of valleys, show that the river has cut several hundred feet since the last orogeny. The main rock types are slate, quartzite, schist, and gneiss (Ahmed & Qadir, 1976). According to Ahmad (1951) whole of northern area falls in sub tropical continental highlands.

The average minimum temperature in winter was 2.8°C and the maximum temperature in summer is 20.8°C. According to last five years metrological data (2004-2008) of Astore & Bunji lower part of the area the hottest month is June with mean monthly maximum temperature of 31.06°C while January is the coldest month with the mean minimum monthly temperature of -4.3°C. Metrological data of upper zones is not available but approximately in winter the minimum temperature falls to-20°C. The summer season is very short lasting from May to August. Relative humidity is much higher in the morning than the evening. The mean monthly precipitation is 33.9mm to 750mm (Anonymous, 1999). In lower altitude of the area it falls as rain and upper zones mostly as snow.

Phytogeographycally Astore valley belongs to Eastern Irano-Turanian sub-region and Sino-Japanese region (It may said to be somewhat ecotonic zone). Saharo-Sindian plant species are also found in lower altitude of the study area. Although it is difficult to define the discrete habitat types and ecological zones of the study area. On the basis of Champion *et al*., (1965), Roberts (1991, 1977), (Dickore & Nuseer (2000), (Mufti & Afzal (2001), Ahmed *et al.,* (2006), Ahmed & Shaukat (2012), other related literature and microclimatic differentiation, Astore valley can be recognized following five altitudinal ranges of vegetation zones. Sub tropical zone (1100m-2000m), dry temperate mountain zone (2000m-2700m), montane zone (2700m-3400m), sub-alpine zone (3400m-3900m) and alpine zone (3900m-4500m).

A number of workers have conducted vegetation surveys in different parts of northern Areas of Pakistan. Champion *et al*., (1965) and Beg (1975) conducted an observational survey and classified various types of forests and vegetational zones on the basis of temperature and altitude. Similar studies were done by Ahmed (1976) who conducted multivariate vegetation analysis of Skardu, Ahmed (1986) described vegetation of foot hills

of Himalaya range in Pakistan. Hussain & Illahi (1991) described ecology and vegetation types of Lesser Himalayan of Pakistan. Ahmed *et al*., (2006) presented phytosociology and structure of Himalayan forests from different climatic zones of Pakistan. Shujaul *et al*., (2011) described the species and community diversity of vascular plants of Naran valley. Such types of studies have been conducted by Shaheen *et al*., (2011) and Ahmad *et al*., (2010, 2011). In the present research work efforts have been made to analyse soil characteristics in detailed and vegetation patterns. The study attempts to provide altitudinal changes in the vegetation of Astore area.

Materials and Methods

Phytosociological survey was conducted of the Astore valley during 2005-2009 in different altitudes, localities and categorized the species diversity in infrequent, abundance; common, rare and very rare. Plant specimen were collected, pressed and brought to Karachi University Herbarium (KUH), dried and mounted in the standard herbarium sheets, identified with the help of Flora of Pakistan and other related literatures. Similarity index was calculated by the following formula: SI= 2Ss / (Sj+Sk) (Sørensen, 1948). Where Ss= Number of shared species in two localities, Sj= Total Number of species in one locality, Sk= Total Number of species in the other locality. Beta Diversity was calculated according to (Whittaker, 1972). BD= Sc/S̃ where Sc= Number of species in a composite sample (Excluding the shared species), S̃= Mean Number of species per locality and BD= Beta Diversity. Soil samples were obtained from twenty four different stands and altitudes at 0-35cm depth through hand tools. These samples were brought to the laboratory in polythene bags and were kept in air for drying. The soil sample were passed through 2mm sieve and subjected to physical and chemical analysis. Soil texture class was determined by feel method. Maximum water holding capacity (MWHC) was calculated by the following formula:-

MWHC = Loss in Weight x100/oven dried weight of soil

Soil pH was determined by direct pH reading meter (Mettler Toledo, MP220). Electric Conductivity (EC) were determined by AGB 1000 (England) conductivity reading meter and total dissolved salts (TDS) were calculated by using the conversion factor (uS/cm x.67/1000) available online resources (www.stevenswater.com, www.daff.qld.gov.au), Calcium carbonate was determined by the method of acid neutralization, as used by Qadir *et al*., (1966). Organic matter was estimated by the method of Jackson (1958). Organic matter was converted in to total organic Carbon by using the conversion factor 1.724 (organic matter/1.724) in accordance with the method of Nelson & Sommers (1996). Vegetation zones were determined on the basis of microclimatic conditions, vegetation distribution pattern, soil topography and elevation from sea level.

Results

Soil characteristics (Table 2) show that in the study area, 33% of these localities have sandy loam and silty loam soil followed by 16% loam and clay loam. Soil pH was ranging from 5.35 to 7.35; high pH was found in lower altitude 1300-2200m in Ramghat, Doain & Hercho localities. In these localities sparse, scrub and halophytic vegetation was observed such as *Tamarix arceuthoides* Bunge, *Halogeton glomeratus* (M. Bieb.) C.A. Mey., *Salsola tragus* L, *Chenopodium badachschanicum* Tzvelev, *Ceratocarpus arenarius* L., *Rumex hastatus* D.Don., *Andrachne aspera* Spreng. and *Fagonia bruguieri* DC. var. *bruguieri* were observed. While at the upper altitudes 3400-4100m represented mostly dense vegetation of *Bupleurum longicaule* Wall.ex D C., *Anthriscus nemorosa* (M. Bieb.) Spreng., *Leontopodium leontopodinum* (DC.) Hand.-Mazz., *Senecio tibeticus* Hook. f., *Cerastium davuricum* Fisch. ex Spreng., *Carex* spp., *Juncus sphacelatus* Decne., *Poa sinaica* Steud. and *Persicaria vivipara* (L.) Ronse Decr.etc.

Highest amount of maximum water holding capacity (63.179), percentage of organic meter (33.094 %) and calcium carbonate (16 %) were found in soil sample collected from Kalapani Chore Nullah at 3500m elevation, soil texture class was determined as loam in such type of localities dense and carpet vegetation of *Sedum ewersii* Ledeb., *Carex* spp., *Dipsacus inermis* Wall. var. *inermis*, *Trigonella gracilis* Benth., *Aconogonon alpinum* (All.) Schur, *Primula schlagintweitiana* Pax and *Sibbaldia tetrandra* Bunge. was observed. Slight differences were found in the value of salinity from the sample to sample in these localities.

Between 2200-3400m altitudes the soil texture class and other chemical components have minor differences. So the vegetation was complex composed of trees, shrubs, perennial and annual herbs that were found in different patterns in (dense to sparse). Such as *Pinus* spp., *Ephedra* spp., *Carum carvi* L., *Eremurus fuscus* (O. Fedtsch.) Vved., *Achillea millefolium* L., *Cichorium intybus* L., *Artemisia* spp., *Berberis orthobotrys* Bien ex Aitch., *Arnebia* spp., *Pseudomertensia* spp. *Salix* spp. and *Capsella bursa-pastoris* (L.) Medike. etc. *Seriphidium brevifolium* (Wall. ex DC.) Ling & Y. R. Ling was observed as the dominant plant species of the study area followed by *Erigeron acer* L. and *Capsella bursa-pastoris* (L.) Medike.

Distribution pattern of plant species varies in different ecological zones, highest number of plant species (422spp.) were distributed in montane zone followed by (351spp.) in dry temperate mountain zone while lowest number of plant species (65spp.) were distributed in Alpine zone, 214spp. in sub alpine zone and 92 spp. in sub tropical zone Fig. 1.

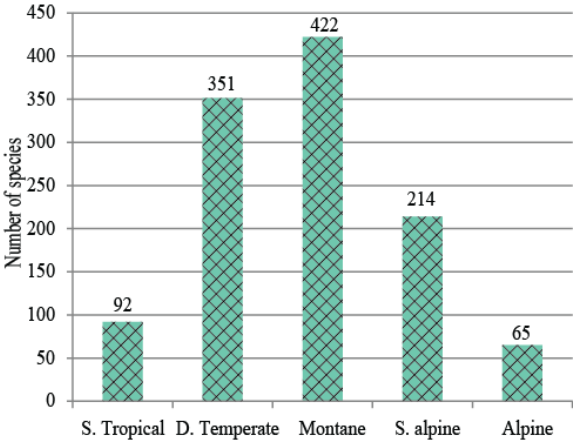

Fig. 1. Number of species distributed in different ecological zones.

The analyzed data show the highest (.57) similarity index in contiguous ecological zones and remarkably lowest (0) in non-contiguous zones (Table 1). In montane and sub alpine zones the value of similarity index is high (0.57) followed by in dry temperate mountain and montane zones (0.51), in sub alpine and alpine zones (0.44) and sub tropical and dry temperate zones (0.24), the lowest value of similarity was zero, in sub tropical and alpine zone, no species found common.

Discussion

Composition and distribution status of plant communities was found to depend on soil components and other environmental factors including, climate, topography, geology and altitudinal range. Astore Valley consists of rugged topography and complex vegetation pattern. Out of 24 soil samples 33% of soil samples have physically sandy loam and silty loam followed by 16% loam and clay loam in texture classes. Soil pH was ranged from 5.35-7.20, high pH value was found in soil sample collected from lower altitude 1300-2200m in Ramghat, Doain and adjacent localities. Highest amount of maximum water holding capacity (63.179), percentage of organic matter (33.094%) and % of calcium carbonate (16%) found in soil sample collected from Kalapani Chore Nullah at 3500m elevation, soil texture class determined as loam in these habitats dense and carpet vegetation were observed. Slight differences were found in the value of salinity in these soil samples and the value varied from sample to sample. Singh (1986) said that in those plant communities which had a higher percentage of soil organic matter, the water holding capacity of soil was consequently increased due to the colloidal nature of the organic matter. According to Aubert (1960) considerable amount of calcium carbonate, low amount of organic matter is a characteristics feature of an arid zone soils. Pakistani soils are extremely low in organic matter (Ladha *et al*., 1996; Zia *et al*., 1998; Bhatti, 1999; Aslam *et al*., 2000).

Highest number (422 spp.) of plant species were distributed in the middle (montane zone), in this zone favorable climatic conditions like moisture, sunlight, organic matter, soil topography and MWHC were available for the plant communities to establish in the natural habitat and lowest number (65 spp.) of species found in alpine zone which may be due to unfavorable climatic conditions *i.e.* short period of flowering season due to late snow melting and low temperature. Species diversity was optimum at the middle altitudes as compared to lower and high altitudes mainly due to xeric condition and grazing pressure. Such type of species distribution phenomenon has also been observed in other mountainous ecosystems (Nogues *et al*., 2008).

All species of alpine zone were herbaceous in nature likewise *Bupleurum longicaule* Wall. ex D C., *Anthriscus nemorosa* (M. Bieb.) Spreng., *Leontopodium leontopodinum* (DC.) Hand.-Mazz., *Senecio tibeticus* Hook. f., *Cerastium davuricum* Fisch. ex Spreng., *Carex* spp., *Juncus sphacelatus* Decne., *Poa sinaica* Steud. and *Persicaria vivipara* (L.) Ronse Decr.etc. While in Sub tropical zone halophytic vegetation e.g. *Tamarix arceuthoides* Bunge, *Halogeton glomeratus* (M. Bieb.) Ledeb. and *Salsola kali* subsp. *Tragus* (L.) Celak. etc. were distributed where low amount of organic matter and high value of soil pH was found, these localities were observed as rigid and arid topographically and the value of maximum water holding capacity was low (20.833). In Dry Temperate Mountain and Montane zone mixed plant communities were distributed e.g. *Pinus wallichiana* A. B. Jackson, *Pinus gerardiana* Wall.ex Lamb., *Abies pindrow* Royle, *Juniperus communis* L., *Pistacia khinjuk* Stocks, *Bunium persicum* (Boiss.) B.Fedtsch., *Artemisia gmelinii* Weber ex Stechm. *Seriphidium brevifolium* (Wall. ex DC.) Ling & Y. R. Ling *Galinsoga parviflora* Cav., *Pseudomertensia multkioides* (Royle ex Benth.) Kazmi, *Capsella bursa-pastoris* (L.) Medik., *Malcolmia intermedia* C. A. Mey., *Silene vulgaris* (Moench) Garcke, *Nepeta discolor* Royle ex Benth., *Astragalus rhizanthus* subsp. *candolleanus* (Benth.) Podlech. *Cotoneaster gilgitensis* Kultz. and *Rosa webbiana* Wall. ex Royle etc. were commonly found. In these vegetation zones the *Seriphidium brevifolium* (Wall. ex DC.) Ling & Y. R. Ling is a dominant species; it was due to grazing pressure on herbaceous species.

Table 1. Similarity Index and Beta diversity of species between different ecological zones.

Localities pairs	Shared species	SI	BD
Sub tropical and dry temperate mountain zone	54	0.24	1.76
Dry temperate mountain and montane zone	199	0.51	1.49
Montane and sub alpine zone	182	0.57	1.43
Sub alpine and alpine zone	62	044	56
Sub tropical and montane zone	9	0.04	1.96
Dry temperate mountain and sub alpine zone	38	0.13	1.87
Montane and alpine zone	42	0.17	1.83
Sub tropical and sub alpine zone	1	0.006	1.99
Dry temperate mountain and alpine zone	8	0.038	1.96
Sub tropical and alpine zone	0	0.00	2.00
Over all Beta Diversity of all the five ecological zones	595	-	2.40

Abbreviation: SI= Similarity index, BD= Beta diversity

Table 2. Soil characteristics of different localities of study area.

S. No.	Locality	Altitude	S TC	pH	E.C. u S/cm	TDS mg^{-L}	MWHC	% O.M	%T.O.C. gm	% $CaCO_3$
01	Deosai	4100m	Clay loam	5.90	904	.60	23.633	11.983	6.95	6
02	Deosai shoser	4000m	Silty loam	6.00	798	.53	57.662	25.651	14.88	7
03	Kamri top	4000m	Clay loam	6.25	766	.51	39.578	7.142	4.14	3
04	Kamri top	4100m	Silty loam	6.25	786	.52	38.948	14.139	8.20	7
05	Kala Pani Waitari	3300m	Loam	6.15	634	.42	39.617	10.337	5.99	5
06	KalaPani Mamodass	3400m	Silty loam	5.35	1174	.78	49.286	14.712	8.53	5
07	Kala Pani	3300m	Loam	5.85	994	.63	44.431	11.111	6.44	3
08	Kala Pani	3300m	Loam	6.05	1022	.68	44.115	7.853	4.55	4
09	Kala Pani Jone Dup	3400m	Clay loam	6.10	877	.58	38.056	11.375	6.59	2
10	Kala Pani Chore Nullah	3500m	Loam	6.25	978	.65	63.179	33.094	19.19	16
11	Kala Pani Chore Nullah	3500m	Silty loam	6.45	663	.42	38.244	6.832	3.96	1
12	Rama near Rest house	3000m	Sandy clay loam	6.50	775	.50	31.947	4.066	2.35	4
13	Dangat	2400m	Sandy loam	6.55	543	.36	23.051	4.761	2.76	1
14	Dangat	2400m	Sandy clay loam	6.45	985	.65	23.774	1.121	0.65	2
15	Dangat	2400m	Sandy loam	6.75	707	.47	21.415	1.322	0.76	2
16	Peerjot	2550m	Clay loam	6.70	882	.59	43.540	1.898	1.10	2
17	Gorikot	2300m	Sandy clay loam	6.95	755	.50	25.192	0.716	0.41	4
18	Gorikot	2300m	Sandy loam	6.90	672	.45	23.688	0.102	0.05	1
19	Eidgah	2300m	Silty loam	6.85	604	.40	45.177	4.166	2.41	3
20	Turpey	2200m	Silty loam	6.90	701	.46	27.868	2.062	1.19	2
21	Hercho	2200m	Silty loam	7.10	567	.36	23.872	1.422	0.82	1
22	Doain	2000m	Silty loam	7.10	755	.50	36.890	2.185	1.26	3
23	Bunji Dass	1400m	Sandy loam	7.35	954	.63	20.833	1.538	0.89	2.
24	Ramghat	1300m	Sandy clay loam	7.20	1054	.70	21.470	2.962	1.71	4

*Abbreviation: STC= Soil texture class, EC= Electric conductivity, TDS= Total dissolved salts, MWHC = Maximum water holding capacity, OM = Organic matter, uS/cm = Microsiemens / centimeter, T. O. C. =Total organic carbon

The measurement of similarity shows the highest similarity in contiguous ecological zones and lowest in non-contiguous zones. In montane and sub alpine zones the value of similarity index is high followed by in dry temperate mountain and montane zones. The lowest value of similarity was zero, in Sub tropical and Alpine zone as none of the species was common, due to the extremely contrast environmental factor.

During the study it was observed that the plant communities are highly disturbed due to overgrazing, expansion of cultivated fields and forest cutting for local and commercial purposes. Phytosociological studies and soil characters can be helpful to understand the plant communities and help in future planning for plantation in the disturbed localities.

Acknowledgement

This paper is a part of Ph.D. dissertation of the first author. Chairman Department of Botany is acknowledged for providing laboratory facilities and WWF-Pakistan is also acknowledged for providing financial assistance.

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(Received for publication 2 December 2011)