IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 9, Issue 11 Ver. I (Nov. 2016), PP 64-71
www.iosrjournals.org

Change in Forest Attributes, Ground Vegetation and Soil Factors along Altitudinal Gradient in Coniferous Mixed Forest, Pakistan.

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Abstract
Background:*The ecological studies were mostly observational and descriptive in Pakistan but with the passage of time quantitative methods were introduced and vegetation description merged into quantitative studies.The present study describes the vegetation composition of Shinkyari reserved forest, Kaghanvalley.*
Aims and Objectives:*Aims of this study were to determine the pattern of different plants in Coniferous mixed plants and to determine the relative importance of edaphic and topographic factors in moist temperature forest.*
Study Settings: *This study was undertaken by the institute of Pure and Applied Biology, Bahauddin Zakariya University, Multan. Research work was carried out in Shinkyari Forest during March 2013 to October 2013.*
Material and Methods:*The area located in wet temperate forest of lesser Himalayas from 1500 m to 2400 m above sea level. The montaine temperate forest extends in sub-tropical pine forest. The open canopy of the forest was surveyed. Data was analyzed by multivariate analysis including Cluster analysis, ANOVA,Detrended cluster analysis (DCA) and Spearman's Rank correlation coefficient to detect the relationship between altitudinal and environmental factors.*
Results:*During field survey a total of74 species belonging to 41 families were analyzed. Among these families Rosaceae and Ranunculaceae, Polygonaceae, Plantaginaceae were most common. The area was dominated by Conifers with little admixture of deciduous broad leaved trees. There were four associations observed with distinct vegetation and habitat.There was limited species diversity from low to high altitude. The environmental variables such as climatic and edaphic factors also limit the distribution of species. Classification and ordination are able to delimit the plant communities according to their altitude.*
Conclusion:*It was concluded that altitude and soil pH were significantly associated with vegetation variation in moist temperature forest.However further studies must be continued to define the boundaries of these community types.*
Keywords*: Altitudinal gradient, coniferous mixed, forest attributes, ground vegetation,soil factors*.

I. Introduction

Shinkyari forest is characterized by notably moist depressions and cool steep slopes. The conifers with little admixture of deciduous broad leaved species form a complete forest, cover with a good height of 80-150 ft. Among broad leaved species *Quercus, Prunus, Aesculus, Populus*, *Ficus*are of circumpolar distribution. Deciduous shrubby undergrowth such as *Viburnum grandiflorum, Loniceraquinquelocularis* is almost present. The forest area is also occupied by evergreen shrubs including *Sarcococcasaligna, Daphne mucronata, Berberislycium, Indigoferaheterantha*. Among climbers *Hederanepalensis* is frequently occurring species. In Ferns, such as *Adiantumvenustum*, *Dryopterisremosa* constitute good ground cover. In this forest area Rosaceae, Ranunculaceae are conspicuous among all other families. There are also some species with limited distribution.Phytoclimatic investigations on Coniferous forests were attempted on considerable part of moist temperate regions of Western Himalayas Pakistan. Several types of plant communities have been studied along various aspects such as species composition, indicator species and distribution pattern. An extensive work has been done to reveal the relationship between floral communities and environmental gradients, emphasizing mainly on bioclimatic factors, particularly precipitation and temperature.

Mountains are the most important regions of our earth with prominent vegetation zones, based on mainly climate and altitudinal variations along many other collateral factors[1]. Floral vegetation in the Himalayan region is more diverse at low foothills, decreases gradually along with high altitude due to decline in temperature and many other environmental factors. Latest studies reveal that flora is significantly diverse in the center of altitudinal gradient[2].

As vegetation constitutes first trophic level of any ecosystem speciallyin mountainous regions, hence requires proper quantification and documentation both at aggregation and individual level in relation to abiotic environmental variables. In recent years, species diversity, biomass, phytoclimatic diversity, vegetation dynamics, diversity indices are very important topics of ecological study and explained by many workers with reference to biotic interactions, productivity, climate and heterogeneous ecosystems[2,3] and are very important topics for better perception of Ecology and vegetation structure of a particular region[4]. Many countries have been trying to collaborate the quality of species life forms by identifying the indicator species and their abundance in particular area, as well as quantity of plant biodiversity.

In mountainous region, although many factors contribute for variation in plant biodiversity but altitude has much more effect in shaping and limiting plant communities[5]. The altitude show prominent effect than latitude, as it has major effects on temperature. Temperature gradually decreases along altitudinal gradient. Thus vegetation diversity decreases with high altitude and low temperature. Temperature is not the only dominant factor delimiting vegetation, however elevation, slope and aspect are three main topographic factors that influence the type and distribution pattern of vegetation in hilly areas. Availability of water decreases with the increase of altitude. Thus it limits the number of plants and vegetation diversity. Other edaphic factors such as soil pH, cautions exchange capacity also influence the type of vegetation.

Present study was undertaken to determine the pattern of different plants in Coniferous mixed plants and to determine the relative importance of edaphic and topographic factors in moist temperature forest. Structure of vegetation along altitude, soil attribution, species richness and diversity were also studied.

II. Material and Methods

Shinkyari Reserve Forestis located in Northern Pakistan about 180 km from Islamabad, capital of Pakistan and is a part of Kaghan valley. This valley stretches from 34° 14’ to 35° 11’ North latitudes and 72° 49’ to 74°08’ East longitudes and is part of Himalayan range. The valley has diversity of habitats from steep to lower mountains.The altitude of the study area ranges from 1,508 to 2,419 meters.Topography is sufficiently heterogeneous with varying degrees of slopes ranging from snowcapped upper slopes to dry mid-slopes and bases of slopes. Valley bottom enjoys the moist condition.This topographic sequences is the common feature of all valleys of study area and regulate the distribution of rainfall or snow melt and consequently the completemoisture distribution pattern emerged in the study area.

Sampling and Data Analysis

The study area was surveyed in March to October, 2013. Sampling stands (10 x 10 m) were marked along the altitudinal transect laid between 1500 – 2400 m above sea level (a.s. l). Stands were established randomly to record presence/absence of all the vascular plants including ferns. Cover value of each species was recorded following BraunBlanquet 1935[6] system and then converted in to percentage. Plants were identified in the field and voucher specimens were also gathered along with their complete structure i.e, flowers, stem, leaves etc. The voucher specimens were then identified and classified according to the Flora of Pakistan Nasir& Ali,1972[7] and deposited in M. H. Bukhari Memorial Herbarium, BahauddinZakariya University, Multan (Pakistan). Plant species were arranged according to their genus and family. Life form categories were identified following Raunkiaer’s system[8].Soil samples were obtained from each sample stand. Three replicated samples of the top soil (0 – 5cm) were collected. All the samples were air-dried and sieved through 2mm sieveand then stones and litter were removed. Three replicates of each soil sample analyzed for physical and chemical analysis, following standard procedures[9]. The analysis parameters includedSoil pH, Electrical Conductivity (EC), Sodium/ Potassium Phosphorous, Soil saturation, Carbonates/ Bicarbonates.Environmental variables such as altitude (m. a. s. l.), temperature(^{o}C), humidity(%) were also recorded for each stand using Kestrel, (Japan), Clinometer was used to measure degree of slope, longitude, latitude while location of stands were recorded by Global Positioning System (GPS).Before performing numerical analysis, percent frequency of each species was determined.The floral data of 18 stands containing 74 species was analyzed for species diversity and evenness following Shannon diversity index[10]. Evenness was determined by J= H / LnS.In order to classify the vegetation in to communities cluster analysis was performed on the presence/absence data of all the plant species and stands. Community types were derived using the default option ‘farthest neighbor’ as similarity coefficient. The results obtained from cluster analysis were further confirmed by using correspondence analysis. De-trended correspondence analysis (DCA) was carried out to identify and describe gradients in the species composition. The plant communities were derived from the cluster analysis were plotted (Fig 1) on the two axes of DCA (Axis 1 and 2). In order to determine and describe the relationships between spatial distribution of species and environmental pattern, the score on DCA axis I&II were correlated with the climatic and edaphic variables obtained from the stand data by using Pearson’s co-relation. For classification and ordination of vegetation, Multivariate Statistical Package Analysis (MVSP) was used. The differences between the soil parameters were measured by using one way ANOVA.

III. Result

A total of 74 plants species belonging to 66 genera and 41 families were recorded from Shinkyari reserved forest. Angiosperms dicot plant species contribute major floral vegetation, among these Rosaceae and Ranunculaceae predominate while Polygonaceae and Plantaginaceae contributed sufficient share in plant communities. Asteraceae, Caryophyllaceae and Fabaceae comprise of three species each. Monocots were represented by single family Poaceae with one species. Gymnosperms also had single family (Pinaceae) with three species, while Pteridophytes with two families: Dryopteridaceae and Pteridaceae (Table 1). The study area comprises of diverse life forms, herbs undergrowth contributed 68 %, shrubs 20 %, while trees 12 %. The Conifers were mixed with broad leaved trees such as *Quercusbaloot, Populusciliata, Prunuswallichii, Pyruspashia, Ficusracemosa.* In the Coniferous mixed forest, most common shrubs were*Berberislycium, Indigoferaheterantha, Sarcococcasaligna, Salix daphnoides,* while *Hederanepalensis* was frequently found climber.

Normal Cluster Analysis was used to identify plant associations. Total four associations were recognized. All these four associations show altitudinal and edaphic trends. The vegetation structure of each stand along altitude is indicated in Table 3.

Association A (base of slope) shown in table 3 located at 2129- 2144 (m. a. s. l) with the diverse species richness, comprises of 48 genera and 51 species. This community was characterized by *Aquilegia pubiflora, Aesculusindica, Juglansregia, Lepidiumapetalum, Loniceraquiniquielocularis, Nepheliumlappaceum, Parrotiapersica, Piceasmithiana, Podophyllumemodi, Populusciliata*. These species were altogether absent in other associations.Evergreen tree *Pinuswallichiana* dominated this association among all other trees. *Abiespindrow, Piceasmithiana*, were also found. The Coniferous trees were also mixed by some broad leaved trees such as *Aesculusindica*, *Populusciliata*, while *Juglansregia*was quiet rare.The shrub strata occupied by *Berberislycium, Euphorbia cornigera, Indigoferaheterantha, Paeoniaemodi*, *Salix daphnoides,Menthalongifolia,Rumexhestatus,Rubusellipticus,Loniceraquiniquielocularis, Nepheliumlappaceum, Viburnum grandiflorum*. Among these *Indigoferaheterantha, Viburnum grandiflorum, Paeoniaemodi, Rumexhestatus* were most frequently occurring while *Berberislycium*, *Rubusellipticus*, *Euphorbia cornigera*, were occasionally present. *Loniceraquiniquielocularis, Salix daphnoides, Nepheliumlappaceum,* were rarely found. There was also good ground vegetation (herbs) in this association. Among herb layer*Potentillareptans*, *Ajugaparviflora*, *Gentianaornata*, *Ranunculus laetus, Valerianajatamansi*, *Veronica beccabunga* were abundant in this association.*Androsacerotundifolia, Aquilegia pubiflora, Barbareaintermedia, Euphorbia cornigera, Gerbera gossypina, Geranium wallichianum, Galiumboreale, Lepediumapetalum, Podophyllumemodi, Plantagolanceolata, Stellaria media, Taraxacumofficinale, Trifoliumrepens, Urticadioica, Veronica beccabunga, Viola biflora* were also common.While *Anemone biflora, Carduusnutans, Cerastiumtomentosum, Plantago major, Menthalongifolia, Ranunculus diffusus,* were rarely occurring species.*Dryopterisramosa, Adiantumvenustum* were also abundant fern species in this association. Annual grass *Poaannua* and climber *Hederanepalensis* were less common.

Table 1: Alphabeticallyarranged Families with their species.

	Family	**Name of species**
1.	Asteraceae	*Taraxacumofficinale* (L.)Weber ex F.H. Wigg., *Carduusnutans*L. *Gerbera gossypina*(Royle) Beeauverd
2.	Adiantaceae	*Adiantumvenustum*D.Don.
3.	Araliaceae	*Hederanepalensis*K.Koch
4.	Berberidaceae	*Berberislyceum* Royle.
5.	Buxaceae	*Sarcococcasaligna*(D.Don) Mull.
6.	Brassicaceae	*Capsellabursa –pastoris*(L.) Medik, *Thalspii*spp.,*Lepidiumapetalum*Willd, *Barbariaintermedia*Boreau.
7.	Caryophyllaceae	*Stellariamedia*(L.) Vill, *Cirastiumtomentosum*L, *Silenevulgaris*(Moench) Garcke.
8.	Caprifoliaceae	*Loniceraquiniquielocularis*Hardwicke, *Viburnum grandiflorum*Wall.ex DC.
9.	Dryopteridaceae	*Dryopteris ramose* (C.Hope) C.Chr.
10.	Euphorbiaceae	*Euphorbia cornigera*Boiss.
11.	Fabaceae	*Indigoferaheterantha*Wall, *Trifoliumrepens*L, *Melilotusindicus*(L.) All.
12.	Fagaceae	*Quercusbaloot*Griffith.
13.	Fumariaceae	*Fumariaindica*(Hausskn.)Pugsley.
14.	Geraniaceae	*Geranium wallichianum*D.Don
15.	Gentianaceae	*Gentianaornate* (D. Don) Wall. ExGrised..
16.	Hemamelidaceae	*Parrotiapersica*
17.	Juglandaceae	*Juglansregia*L.
18.	Lamiaceae	*Ajugaparviflora*Bth.,*Menthalongifolia* (L.) L.
19.	Moraceae	*Ficusracemosa*L.
20.	Oxalidaceae	*Oxalis corniculata*L.
21.	Paeoniaceae	*Paeoniaemodi* Wall.
22.	Poaceae	*Poaannua*L.

23.	Pinaceae	*Pinuswallichiana*A.B.Jackson, *Abiespindrow*Royle, *Piceasmithiana* (Wall.) Boiss.
24.	Primulaceae	*Androsacerotundifolia*Hardwicke.
25.	Plantaginaceae	*Plantagolanceolata*L, *Plantago major*L, *Veronica beccabunga*L.
26.	Platanaceae	*Platanusorientalis* L.
27.	Polygonaceae	*Rumexhestatus*D.Don, *Rumexdentatus* (Meisn.) Rech. *Rumexacetosa*L.*Rumexnepalensis*Spreng.
28.	Podophyllaceae	*Podophyllumemodi*(Wall.) Royle.
29.	Pteridaceae	*Pteridiumaquilinum*(L.) Kuhn.
30.	Rosaceae	*Cotoneaster microphylla*Hook.f., *Rosa macrophylla*Lindlo, *Rubusellipticus*Smith, *Potentillareptans*L, *Prunuswallichii*Steud, *Pyruspashia* L, *Sorbariatomentosa*(Lindl.)Rehder.
31.	Ranunculaceae	*Ranunculus laetus*(Wall.) Royle, *Ranunculus diffuses* DC, *Calthapalustris* L, *Anemone biflora*DC, *Aquilegia pubiflora*(Wall.) Royle.
32.	Rubiaceae	*Galiumaparine* L, *Galiumboreale* L.
33.	Salicaceae	*Populusciliata* (Wall.) Royle, *Salix daphnoides*
34.	Sapindaceae	*Nepheliumlappaceum*L, *Aesculusindica*Colebar.
35.	Saxifragaceae	*Bergeniaciliate* (How)Sternb.
36.	Scrophulariaceae	*Verbescumthapsus* L.
37.	Solanaceae	*Lyciumdepressum*Stocks.
38.	Thymelaeaceae	*Daphne mucronata*Royle.
39.	Urticaceae	*Urticadioica*L.
40.	Valerianaceae	*Valerianajatamansi*Jones.
41.	Violaceae	*Viola biflora*L.

Table 2: Showing Shannon's Diversity Index, Evenness, Species richness in 18 stands.

Stands	Altitude (m)	Index	Evenness	No. of species
1	2,241	3.401	1.000	30.00
2	2,233	3.258	1.000	26.00
3	2,231	2.996	1.000	20.00
4	2,200	2.890	1.000	18.00
5	2,170	2.773	1.000	16.00
6	2,165	2.708	1.000	15.00
7	2,185	3.091	1.000	22.00
8	2183	3.091	1.000	22.00
9	2178	3.434	1.000	31.00
10	2144	3.401	1.000	30.00
11	2,129	3.091	1.000	22.00
12	2,129	2.639	1.000	14.00
13	2.129	2.833	1.000	17.00
14	1,508	2.890	1.000	18.00
15	2,419	2.398	1.000	11.00
16	2,379	2.485	1.000	12.00
17	2,353	2.485	1.000	12.00
18	1,975	3.178	1.000	24.00

Table 3: List of stands in each association identified by Normal Cluster.

Name of Group	No. of Stands	Name of Stand	Altitude
Association A	5	7,8,9,10,11	2129-2144
Association B	6	1,2,3,4,5,6	2178 – 2241
Association C	4	15,16,17,18	1975- 2353
Associations D	3	12, 13, 14	1508 – 2419

Association B (mild slope) shown in table 3 was distributed at 2178-2241 m. a s. l. In this association 42 species belonging to 40 genera were recorded. The plant species that were not present in any other association include*Bergeniaciliata, Calthapalustris, Lyciumdepressum, Quercusbaloot, Melilotusindicus, Silene vulgaris, Sorbariatomentosa.*Among tree strata *Pinuswallichiana*dominated this association and was associated with broad leaf deciduous tree *Quercusbaloot*. Ever green *Abiespindrow*was also present. There was least shrub diversity in this association than other associations. Most common shrubs included *Berberislycium, Rumexhestatus, Viburnumgrandiflorum, Indigoferaheterantha,Sorbariatomentosa, Rubusellipticus*. While *Rosa macrophylla, Paeoniaemodi, Lyciumdepressum* were present occasionally.Diversity of herbaceous plants constituted greater part of this association. The most frequently found herbs were *Androsacerotundifoila, Geranium wallichianum, Potentillareptans, Plantagolanceolata, Rannunculuslaetus, Taraxacumofficinale, Trifoliumrepens, Valerianajatamansi, Viola biflora.* Other common herbs included in this association were *Ajugaparviflora, Anemone biflora, Bergeniaciliata, Carduusnutans, Calthapalustris, Euphorbia cornigera, Gentianaornata, Gerbera gossypina, Melilotusindicus, Menthalongifolia, Silene vulgaris, Urticadioica. Galiumaparine*, while *Veronica beccabunga* was rare in this association. A climber *Hederanepalensis* was also

present. These species were also mixed by some fern plants such as *Dryopterisramosa, Adiantumvenustum*. Annual grass *Poaannua* was commonly found in open forest regions.

Association C (Upper slope) shown in table 3 was located at 1975-2353 m. a. s. l. Total 32 genera and 35 species were recorded. The divisor species ofthis association identified by Normal Cluster Analysis included *Cotoneastormicrophylla, Daphne mucronata, Ficusracemosa, Oxalis corniculata, Pteridiumaquilinum, Prunuswallichii, Pyruspashia, Rumexacetosa, Rumexdentatus*. The tree strata included in this association was *Pinuswallichiana* along with *Pyruspashia.* While*Prunuswallichii*was rare to see. In the shrub layer, *Daphne mucronata, Sarcococcasaligna, Indigoferaheterantha, Paeoniaemodi, Rosa macrophylla, Berberislycium, Barbariaintermedia, Cotoneaster microphylla*were found. Among these *Daphne mucronata, Sarcococcasaligna, Viburnum grandiflorum*were most frequent.However *Indigoferaheterantha* was occasionally present *Paeoniaemodi, Rosa macrophylla, Berberislycium, Barbariaintermedia, Cotoneaster microphylla*were rare. Ground vegetation was characterized by dominant species *Duchesneaindica, Galiumboreale,* other common herbs *Geranium wallichianum, Oxalis corniculata, Plantagolanceolata, Potentillareptans, Rumexhestatus, Veronica beccabunga* were also found. Annual grass *Poaannua*was commonly occurring species. *Hederanepalensis* was also found.*Galiumaparine, Trifoliumrepens, Taraxacumofficinale, Stellaria media, Rumexdentatus, Rumexnepalensis, Rumexacetosa*were rare in this association.Fern plants *Adiantumvenustum, Dryopterisramosa* were also common.

Association D (upper slope-dry) shown in table 3 was located at 1508-2419 m a. s. l. and comprises of 22 genera with 24 species, with least species diversity than other associations. The characteristic species representing this association were*Fumariaindica, Platanusorientalis, Verbescumthapsus.* There was least trees diversity in this association including *Pinuswallichiana, Platanusorientalis.* Ever green *Pinuswallichiana* was dominant. Deciduous tree *Platanusorientalis* was also seen occasionally. The shrubs found in this association were *Berberislycium, Indigoferaheterantha, Menthalongifolia, Viburnum grandiflorum, Verbescumthapsus.* In shrub undergrowth *Viburnum grandiflorum* was the most frequently found species. *Berberislycium, Indigoferaheterantha, Menthalongifolia*were common in open canopy. However, *Verbescumthapsus* were rare to see.Herbs strata included *Androsacerotundifolia, Plantagolanceolata, Rumexnepalensis, Duchesneaindica, Geranium wallichianum, Ranunculus diffusus, Stellaria media, Trifoliumrepens, Veronica beccabunga, Fumariaindica, Plantago major, Ranunculus laetus, Taraxacumofficinale, Potentillareptans, Viola biflora, Dryopterisramosa, Poaannua.* Among these most frequent herbs *Androsacerotundifolia, Duchesneaindica, Plantagolanceolata, Rumexnepalensis*. Other common species included in this association were *Geranium wallichianum, Ranunculus diffusus, Stellaria media, Trifoliumrepens, Veronica beccabunga*. The rarely found plant species were *Fumariaindica, Plantago major, Ranunculus laetus, Taraxacumofficinale, Potentillareptans, Violabiflora*. Ferns contributed with only single species *Dryopterisramosa.* Annual grass *Poaannua* was also common.

Environmental Variables:

In this study work, climatic and edaphic variables such as pH, Altitude, relative humidity, Sodium, Carbonates, showed the major differences between all the plant associations (A, B, C, D). However, pH value is most important than any other variable. Amount of carbonates show high F-value after pH. However other variables such as temperature and magnetic effect have small F- value. The F- value of each variable represents the effect of a particular variable in determining plant communities.The sampling area belonging to Association D (Table 4) showed higher pH value (7.38) as compared to sampling site from association A (6.34). These results indicate altitudinal trend in soil pH, which shows gradual increase with increasing altitude, from acidic soils to alkaline. Similarly, Sodium, Potassium, Phosphorus, Carbonates and Relative humidity also increase with increasing elevation. While Electrical conductivity, and Bicarbonates, soil saturation decreased by increasing altitude(Table 5).

Table 4: Mean values and Standard Deviation of Soil parameters and Environmental parameters for four Associations delineated by Cluster Analysis.

Sr. No.	Variables		A	B	C	D	F Value	P Value
1	Electric Conductivity (mqeL-1)	Mean	2.5440	2.1000	2.4600	1.9300	3.77	0.036
		S.D	0.3488	0.0000	0.2078	0.5159		
1	pH	Mean	6.34	6.1	6.5667	7.3800	11.50	0.0000
		S.D	0.0894	0.0000	0.2309	0.7210		
2	Phosphorus, P (ppm)	Mean	0.25480	0.266	0.23800	0.24875	0.90	0.464
		S.D	0.03708	0.02113	0.02078	0.01162		
3	Potassium, K (%)	Mean	1.2880	1.1517	1.2300	2.0275	6.56	0.005
		S.D	0.0179	0.0631	0.0173	0.6998		
4	Sodium, Na (%)	Mean	9.696	9.800	4.287	9.150	1.62	0.231
		S.D	5.152	0.0000	6.680	1.915		
5	Carbonates,	Mean	2.3900	2.2467	2.4067	2.6000	7.89	0.003

	CO_3 (%)	S.D	0.0831	0.1261	0.0058	0.1534		
6	Bicarbonates, HCO_3 (ppm)	Mean	21.44	9.80	22.60	11.45	1.67	0.219
		S.D	19.32	0.00	8.62	1.11		
7	Soil saturation (%)	Mean	36.312	36.247	35.203	32.820	2.54	0.099
		S.D	2.837	2.107	0.676	1.756		
8	Relative Humidity (%)	Mean	28.960	34.183	27.600	33.050	3.01	0.066
		S.D	1.270	3.722	0.964	6.333		
9	Heat Index (C^0)	Mean	25.460	26.050	26.633	23.750	o.72	0.557
		S.D	0.336	2.007	5.865	2.985		
10	Magnetic Effect	Mean	138.8	189.7	226.3	142.5	0.55	0.655
		S.D	98.8	103.6	123.3	120.7		
11	Temperature (C^0)	Mean	26.680	26.800	27.733	25.225	0.58	0.640
		S.D	0.217	1.705	4.996	3.153		
12	Altitude (m)	Mean	2135.0	2181.2	2102.0	2380.8	1.54	0.247
		S.D	8.2	62.8	514.8	28.4		

Table 5: Showing ANOVA for all variables among four plant communities classified by Normal Cluster Analysis.

Sr. No.	Environmental variables	DF	SS	MS	F	P
1.	Altitude (m. a. s. l)	3	182743	60914	1.54	0.247
2.	Temperature (C^0)	3	11.67	3.89	0.58	0.640
3.	Magnetic effect	3	19709	6570	0.55	0.655
4.	Relative Humidity (%)	3	130.5	43.5	3.01	0.066
5.	Soil Moisture (%)	3	35.11	11.70	2.54	0.099
6.	Heat Index	3	17.91	5.97	0.72	0.557
7.	pH	3	4.184	1.395	11.50	0.0000
8.	E.C (meqL-1)	3	1.1087	0.3696	3.77	0.036
9.	Sodium (%)	3	71.5	23.8	1.62	0.231
10.	Potassium (ppm)	3	2.094	0.698	6.56	0.005
11.	Phosphorus (ppm)	3	0.001743	0.0000581	0.90	0.464
12.	Carbonates (ppm)	3	0.3005	0.1002	7.89	0.003
13.	Bicarbonates (%)	3	588	196	1.67	0.219

IV. Gradient Analysis

Detrended Corresponding Analysis (DCA) was used for indirect gradient analysis for the total data set obtained from study area. There is higher significant effect of altitude in species variation, and was confirmed by Pearson's Rank Correlation along the DCA scores of Axis I (table 5). There is significant positive correlation ($r_{=}$ 0.672) between Axis 1 DCA score and altitude. These results reveal that main ordination is along altitudinal gradient from base to top. The sampling sites with smaller score occupied left side in ordination belong to an association (A) with lower altitude and characterized by the presence of *Aquilegia pubiflora, Aesculusindica, Juglansregia, Lepidiumapetalum, Capsella bursa, Loniceraquiniquielocularis, Parrotiapersica, Nepheliumlappaceum, Piceasmithiana, Podophyllumemodi, Populusciliata,Thalspii*spp. The sampling stands with moderate values in ordination belong to an association (B) in mid of slope and are characterized by *Bergeniaciliata, Calthapalustris, Quercusbaloot, Silene vulgaris, Sorbariatomentosa.* The sample stands with high scores occupied the right hand side in ordination diagram. These stands belong to associations (C, D) with higher altitude where *Cotoneastormicrophylla, Daphne mucronata, Ficusracemosa, Oxalis corniculata, Pteridiumaquilinum, Prunuswallichii, Pyruspashia, Rumexdentatus, Fumariaindica, Platanusorientalis, Verbescum Thapsus* were characteristic species.

The relationship between DCA score and environmental variables revealed that there is significant positive correlation between soil pH and altitude along Axis I (Table 5). Soil pH increases with increasing altitude. These results suggested that association D at higher altitude tends to have basic pH, while association A at lower altitude has acidic pH. Beside soil pH, Carbonates show significant positive correlation along Axis I. There is more accumulation of Carbonates with the increase of altitude. It shows that associationD (higher altitude) have more soil carbonates than association A (lower altitude). Altitude, pH and Carbonates play important role in shaping plant communities along Axis I. Sodium availability in sample sites showed negative significant correlation with Axis II. This suggested that association A with lower altitude have more Sodium content than association D with higher altitude.

Table 6: Spearman's Rank Correlation Coefficients between DCA Axis I and II score, climatic variables, soil parameters, and diversity indices for Altitudinal transect in Study area (Shinkyari).

Correlation of Environmental variables with DCA axis. Significance indicated as * P < 0.01 and **P < 0.001.				
Factors	**Axis 1**		**Axis 2**	
	Coefficient	**Significance**	**Coefficient**	**Significance**
Climatic variables				
Altitude (m. a. s. l)	0.672	**	0.041	NS
Temperature (C^0)	0.037	NS	0.453	NS
Magnetic effect	0.031	NS	0.116	NS
Heat Index	0.029	NS	0.408	*
Soil Moisture(%)	-0.212	NS	-0.212	NS
Relative Humidity(%)	0.021	NS	-0.467	*
Soil Parameters				
pH	0.445	*	-0.002	NS
E.C (meqL-l)	-0.199	NS	0.263	NS
Sodium (%)	-0.212	NS	-0.412	*
Potassium (ppm)	0.311	NS	-0.214	NS
Phosphorus (ppm)	-0.212	NS	-0.062	NS
Carbonates(ppm)	0.428	*	-0.006	NS
Bicarbonates(%)	-0.138	NS	0.249	NS

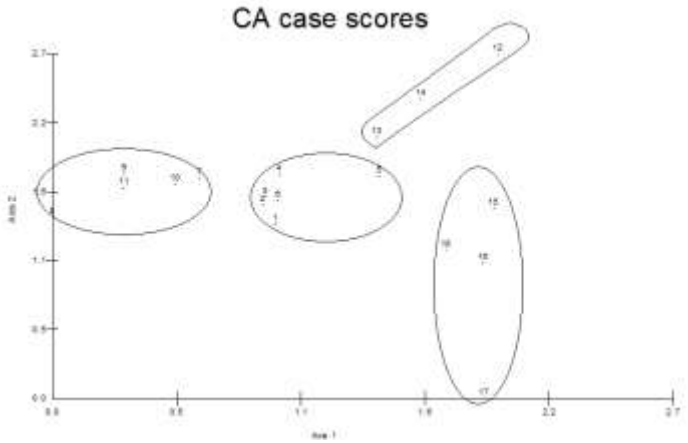

Fig. I: Decorana axis I and II plot showing 18 stands from Shinkyari reserved (study area), indicating four associations delineated by Normal Cluster Analysis.

V. Discussion

The study area was charecterized by conifers mixed with variety of broad leaved trees, such as *Quercusbaloot*, *Aesculusindica*, *Juglansregia*, *Prunuswallichii*, *Pyruspashia*, *Parrotiapersica.* Conifers contributed three species, *Pinuswallichiana, Abiespindrow*, *Piceasmithiana.* The most common shrubs in the study area included, *Viburnum grandiflorum, Sarcococcasaligna, Berberislycium, Indigoferaheterantha, Thalspii*spp., *Sorbariatomentosa*, *Daphne mucronata*. However *Duchesneaindica*, *Galiumboreale*, *Geranium wallichianum*, *Rumexnepalensis*, *Plantagolanceolata*, *Viola biflora*, *Gentianaornata*, *Trifoliumrepens,* were common herbs in the study area. These observations suggested that the forest under investigation may be classified as mixed coniferous forest rather than a pure crop.In current study a total of 74 plants species belonging to 66 genera and 41 families were recorded from Shinkyari reserved forest. Similar work was done by Shehzadi*et. al*. during 2009 in Ayubia National Park District Abbotabad. In that study a total of 80 samples were obtained containing 180 species. There was great difference in terms species compared with current study[11]. Total four plant communities were obtained by using Normal Cluster Analysis. These communities were plotted on ordination diagram (Fig 1). This ordination revealed in some way the environmental effects on species distribution pattern. The DCA scores of Axis I by Normal Cluster Analysis indicated the overriding importance of altitude in determining the species distribution and assemblage. These findings are not surprising but agreed with Champion, *et al*. and Dasti, *et al*[12,13].Beside the altitude, soil pH also showed a significant correlation with altitude. DCA scores along Axis I revealed that soil pH increases with the increase in elevation. The sampling sites with low elevation (association A) have acidic soil pH, while the higher elevation zone (association D) with alkaline pH soils. Amount of carbonates also show significant positive correlation with altitude along first ordination axis. Accumulation of carbonates results in alkaline pH, thus pH also increases with increase in amount of carbonates.It is clear that altitude plays major role in ordination and species distribution pattern. Other soil factors such as soil pH and amount of Carbonates also have distinct effect. The results are in

agreement with the study that presented the association of edaphic factors with distribution of various species. The rank of factors is also almost similar as pH > altitude > tree density > bulk density > phosphorus > calcium + Mg > porosity > texture[11].According to the tree models, carbonates and organic carbon in the topsoil were affected by different factors such as the pattern of SIC controlled by climate, soil physical and chemical properties (pH, Soil moisture etc.) while for SOC biotic and climatic factors were predominant. Vegetation type, AGB, BGB and LM are major drivers of the SOC[14]. As a result of global changes, the temperature, precipitation, nitrogen availability has been altered[15], these changes are most likely to have great impact on soil carbon.

Importance of altitude as an environmental factor affecting plant species association is not surprising, considering its close correlation with rainfall and redistribution of rainfall water[13,16,17]. There were distinct vegetation differences between low and high altitude. Lower altitudes (association A, B) were characterized by*Aquilegia pubiflora, Aesculusindica, Juglansregia,Lepidiumapetalum, Capsella bursa, Loniceraquiniquielocularis, Parrotiapersica, Nepheliumlappaceum, Piceasmithiana, Podophyllumemodi, Populusciliata,Thalspii*spp.At mid of slope (association B) *Bergeniaciliata,Calthapalustris,Quercusbaloot,Silenevulgaris,Sorbariatomentosa*were confined. *Cotoneastormicrophylla,Daphne mucronata, Ficusracemosa, Oxalis corniculata, Pteridiumaquilinum, Prunuswallichii, Pyruspashia,Verbescumthapsus, Rumexdentatus* were confined to higher altitude (association C, D), however resultsare not comparable with the study that identified five communities i.e. A-E[11].In short these results suggested that the narrow range of environmental conditions led to the limitation of species along altitudinal gradient. The distribution pattern of species along altitudinal gradient support individualistic hypothesis of different communities formation. This hypothesis revealed that the distribution pattern of a particular species is determined by its ability to compete, reproduce and survive successfully in challenging environment.

VI. Conclusion

As four communities were identified with their respective habitats (A, B, C, D) by Normal Cluster Analysis and Ordination, however further studies must be continued to define the boundaries of these community types. All these communities represent distinct vegetation pattern along with their environmental conditions, i.e lower altitude with dense vegetation while limited species in upper altitudes. Altitude and soil pH are significantly associated with vegetation variation in moist temperature forest.

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