A PHYTOSOCIOLOGICAL STUDY OF FOREST AND NON-FOREST VEGETATION OF DISTRICT CHITRAL, HINDUKUSH RANGE OF PAKISTAN

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Abstract

The present study was carried out in Chitral that presents a complex mosaic of trees, herbs and shrubs vegetation with a wide range of vegetation types reflecting local variations in climate, geological history, permafrost, wildlife grazing and human use. Field data on the floristic composition and vegetation structure were collected at 36 sites in the study area between 1200m to 3300m elevation asl. Tree, herb and shrub species were grouped into 19 major vegetation types using importance value index. Among the communities types 10 were of tree communities including 3 monospecific stands, while, 9 communities were of herbs and shrubs. These communities were described in quantitative terms. The results disclosed that many conifer and broad leaved forests were in bad shape due to anthropogenic factors.

Introduction

Pakistan is rich in biodiversity, comprising of different climatic zones with a wide range of plant species. Approximately 6000 plant species often of medicinal and/or commercial importance are found in Pakistan (Nasir & Ali 1972). However**,** the floral diversity is constantly subjected to progressive loss, owing to fragmentation and degradation of natural habitats that leads to the disappearance of countless species (Perveen and Hussain, 2007). Pakistan has five significant mountain systems, i.e. Western Himalayas, Karakoram, Hindukush, Suleiman and Khirthar range. Chitral the high mountainous dry temperate area of the Northern Pakistan lies in Hindukush range. It is one of the magnificent and oldest mountain ranges in the world.

According to Champion *et al*. (1965) the dry temperate forest of Pakistan shows high species diversity. Botanically, as well as zoologically the area forms a distinct ecological realm of its own and possesses enigmatic affinities to Himalayan flora and fauna. In this respect different workers have carried out phytosociological studies and identified various plant communities in different parts of the country, but Chitral was notably neglected in this regard. So far very little is known about the Phytosociology of Chitral (Beg, 1974, Khan, 1978, Alamgir, 2004 and Khan *et al*., 2010). An attempt is made here to identify plant communities, their floristic composition and other phytosociological aspects of forested and non-forested vegetation of District Chitral, Hindukush range of Pakistan. The investigations may be useful in the conservation and management of the forest vegetation in the study area. The major objectives of the present study were

1. To provide a description of the plant communities in the area.
2. To evaluate the compositional and structural relationships that exist in the communities.
3. To disclose the distribution pattern of individual plant species amongst these communities.

Materials and Methods

Field Method

Stand Selection: Field work for this study was carried out during 2006-2009 in various parts and altitudinal zones of Chitral. Thirty six stands of vegetation were sampled on a stratified random sampling design within a variety of representatives of forested and non forested areas contingent upon accessibility and the difficulties of the terrain.

The stands studied were situated at elevations between 1228 to 3300 meter above sea level along River Kunar to the alpine areas. The study area is a narrow valley and fragmented into many small valleys. Major areas studied have been described in Table 1. Stands of forest vegetation were selected to represent least disturbed vegetation. These stands were relatively homogeneous in composition of major tree dominants and general physiognomy and uniform in relation to the prevailing environmental conditions. Most of the stands were of $\geq$ 2 Ha in size.

Table 1. Locations and geographical Ecological characteristics of the sampling sites.

Main Location	Forested area sites	Lat (N)	Long (E)	Elev (m)	Aspect	Slope (°)	Canopy
A- Chitral Gol National Park	1. Gohkshal 1	35.54	71.41	2480	E	22	M
	2. Gohkshal 2	35.53	71.41	2774	S	26	M
	3. Meran 1	35.53	71.46	2479	N	42	O
	4. Quercus zone	35.53	71.46	1920	E	15	O
	5. Ispidiar 1	35.53	71.46	2331	N	20	O
	6. Ispidiar 2	35.53	71.46	2325	W	28	M
	7. Rest House	35.54	71.45	2927	S	32	O
	8. Bronshal	35.52	71.46	2217	NE	38	O
B- Bumburate Kalash	9. Dyimeli	35.41	71.41	2273	SW	24	O
	10. Gambag	35.41	71.41	2073	N	34	O
	11. Sheikh-nandeh	35.41	71.38	2283	NE	62	O
C- Rumbur Kalash	12. Posatum	35.46	71.40	2206	N	45	O
	13. Roomgah	35.46	71.41	2370	S	37	O
D- Birir Kalash	14. Compart 1	35.40	71.45	2125	W	27	M
	15. Compart 2	35.38	71.45	2022	E	48	M
E- Sheshe Kuh Valley	16. Shaheed Bala	35.45	71.40	2344	S	29	M
	17. Madaklasht	35.45	71.41	2775	N	31	C
F- Goline Gol	18. Goline Gol	35.54	71.40	2584	N	17	O
	19 Sarooj Village	35.53	71.39	2764	W	20	O
	20 Sarooj 2	35.54	71.41	2720	SW	18	O
G- Arandu	21. Damair	35.45	71.05	2522	E	38	M
H- Agriate	22. Agriate 1	35.46	71.41	2678	NE	27	O
	23. Agriate 2	35.46	71.41	2504	E	32	O
I- Ziarat Chitral	24. Ziarat 1	35.21	71.48	2900	NW	27	O
	25. Ziarat Mata Khur 1	35.21	71.46	2544	W	34	O
	26. Ziarat Mata Khur 2	35.25	71.46	2450	E	20	O
	27. Ziarat 2	35.25	71.48	2600	N	24	M

Main Location	Non forested area sites	Lat (N)	Long (E)	Elev (m)	Aspect	Slope (°)	Canopy
J- Lowari-Top	28. Lowari	35.24	71.48	3118	W	15	---
K- Chitral Gol National Park	29. Village site	35.52	71.46	1540	E	25	---
	30. Ayun	35.52	71.47	1228	Plain	5	---
	31.Artemesia Zone GNPC	35.56	71.42	2340	E	5	---
	32. Mastuj	36.1	72.17	2351	N	10	---
	33. Booni valley	36.1	72.16	2237	N	10	---
M- Garam Chashma	34. Perabeg	35.59	71.33	2445	E	24	---
	35. Shah Saleem	35.56	71.35	3022	N	12	---
N- Shandur	36. Shandur	36.06	72.35	3338	W	17	---

Key to the acronyms. Lat: Latitude, Long: Longitude, Elev: Elevation, E = East, W = West, N = North, S = South Canopy = O, Open, M= moderate, C= Closed

Collection of Field Data: Elevation was estimated by Altimeter as the average of the higher and lower elevation of the stand, slope was measured by Clinometer, and aspect (direction of exposure) was measured by compass. Global positioning systems (GPS) were used to estimate geographical coordinates. Site description including an estimation of use and impact of grazing, wood cutting, and fodder collection were obtained. Observations and local informal interviews were made to gather relevant information on the nature and extent of land use.

Forested and shrubby vegetation stands were sampled. Each stand was systematically sampled by using 20 quadrats for shrubby and herbaceous plants. Point- centered quarter (PCQ) method of Cottam and Curtis (1956) was used for sampling forest tree species in order to evaluate the quantitative vegetational composition, while a 1.5m diameter circular plots at each PCQ point were used for the understorey vegetation. A total of twenty seven forest stands, and nine herb and shrub stands were sampled. For herb and shrub vegetation 3×3 meter quadrats were employed. The PCQ technique is known to provide reliable overall density and relative density estimates (Grieg-Smith 1983). Franklin (1967) and Mark and Esler (1970) found that this procedure overestimates the true basal area. The criteria for the selection of this technique was that it has been widely and successfully used by various workers in different vegetation inside and outside the country. It is fast, flexible, requires little field labour/computational effort and is easily applied in thick dense forest with rugged topography. Two small cross-pieces were nailed onto the end of a meter long stick (PCQ stick) to define the four quadrants required. The other end of the stick was pointed for insertion into the ground. This simple instrument was easily adjustable on the forest ground. Depending on the topography of the site twenty points were taken at 25 m intervals along a specific direction. However in some cases fewer points with shorter intervals were recorded due to extreme slope or the small area of the stand.

Using a compass and PCQ stick at every point on the transect, the PCQ method was followed. In this way a stratified random sampling (Ogden and Powell 1979) over at least two ha of the area was conducted. This sampling procedure was recommended over systematic and random sampling by Bourdeau (1953) and Orloci (1975). According to Cottam *et al*., (1953) at least thirty PCQ points are required for accurate calculation of individual species density. However, in our case due to homogeneous nature of stands 20 PCQ points were used. In order to increase the sample size for relative density a second nearest tree (Ogden and Powell 1979) was also recorded. The distance was not measured for this tree but dbh was recorded following the method outline of Ahmed (1984).

A species list with a frequency table for understorey plants was made using a circular quadrats (1.5 m diameter) at each PCQ point. In some cases this included tall shrubs and small trees. Lower plants were almost ignored but the widely distributed Pteridophytes were included. Seedling of pine tree species (<10 cm dbh) were enumerated in each plot and the number per hectare for every stand was calculated.

Laboratory procedure

Herbarium Specimens: In the field, voucher specimens of difficult and unidentifiable plants as well as representative species were collected. Over 125 specimens and duplicate samples were pressed, and are deposited in the Laboratory of Plant Ecology and Dendrochronology, Federal Urdu University Herbarium. All specimens were later identified or revised with the help of numerous authorities, flora of Pakistan (Nasir and Ali, 1972) and Herbarium University of Karachi. All specimens thus identified were compi1ed and used in annotating the stand data sheets.

Data analysis: Quantitative information obtained for trees, herbs, shrubs and pine seedlings/saplings was summarized following Mueller-Dombois and Ellenberg (1974) and Ahmed and Shaukat (2012). All point to plant distances were totaled, averaged and the mean points to plant distance were obtained. The mean area of ground surface which was occupied by an individual tree was obtained by taking the square of the mean distance. The vegetation was quantitatively analysed for frequency, relative frequency, density, relative density, density per hectare, cover, relative cover, basal area (BA), basal area m^2 ha^{-1} and Importance value Index (IVI) were calculated following Curtis and McIntosh (1950) and Hussain (1989).

Frequency was ca1cu1ated as a percentage of points at which a species occurred. Relative frequency is the frequency value expressed as a percentage of the sum of the frequency values for all species. Relative dominance is the sum of basal areas of one species as a percentage of the sum of basal areas of all species. According to Brown and Curtis (1952) importance value gives more information about the species than any other single attribute alone and reflects the realistic ecological importance of the species in a stand. Therefore, the relative values of Frequency, Density and Basal area were summed to determine Importance Value Index (IVI) in a particular stand**.** Every species was ranked according to their importance values and the species with the highest importance value in the stand was considered as the dominant species. Communities were named on the basis of the first two dominant species.

Results

Description of communities: Nineteen plant communities were identified on the basis of species importance value index (IVI) and floristic composition of the stands. Out of these nineteen communities three were monospecific. The communities recognized were as follows:

1. *Cedrus deodara* community (Monospecific)
2. *Juniperus excelsa* community (Monospecific)
3. *Quercus baloot* community (Monospecific)
4. *Cedrus* and *Pinus gerardiana* community
5. *Cedrus* and *Pinus wallichiana* Community
6. *Cedrus* and *Abies pindrow* community
7. *Cedrus* and *Picea smithiana* community
8. *Pinus wallichiana* and *Abies* community
9. *Pinus gerardiana* and *Quercus* community
10. *Juniperus excelsa* and *Betula* community
11. *Juniperus communis* and *Nepeta* community
12. *Micromeria brevifolia* and *Astragalus* community
13. *Tamarix appylla* and *Cynodon* community
14. *Artemisia brevifolia* and *Echinops* community
15. *Artemisia brevifolia* and *Artemisia santolinifolia* community
16. *Artemisia brevifolia* and *Artemisia maritima* community
17. *Rumex hastatus* and *Ranunculus* community
18. *Arenaria griffithii* and *Potentilla arnavatensis* community
19. *Chrysopogon echinulatus* and *Nepeta discolor* community

Monospecific Deodar community: Deodar was recorded as a single dominating species at three locations. These sampling stands were located at the elevation of 2125m to 2900m with 17 to 27º steep slopes. In these monospecific stands deodar density ranges from 100 to 322 individuals ha^{-1} with 7.84 to 76.45 basal area m^2 ha^{-1}. The canopy was mostly open (Table 1). Ten to thirteen non tree species, (understorey vegetation) including seedling of deodar were associated on the forest floor. However poor floristic similarities exist among different stands. A complete list of these species is given in Table 2. However, following were widely spread understorey plants, i.e. *Viola canesens* occupies 70% of the circular plots at Ziarat, *Impatients brachycentra* 30 to 70%, stand (14, 24). *Rumex hastatus*, *Indigofera gerardiana*, *Aconitum laeve*, *Fragaria vesca*, *Urtica dioca* and *Sambucus wightiana* found in 30 to 75% of the plots, while *Rosa webbiana*, *Artemisia maritima*, *Berberis pseudumbellata* were recorded in stand 1 and 18, with 90% frequency.

Monospecific *Juniper* community: Sarooj Goline Gol sampling site (Stand 19) was located on the west facing moderate (20°) slope. Its elevation was 2764 m asl. The stand density ha^{-1} was recorded to be 109 with 9.13 basal area m^2 ha^{-1}. An open forest of *Juniper* is also found mixed with *Pinus gerardiana* and Deodar at elevation above 2600 meter at Gol National Park. Tree size goes on decreased with the increase in elevation, slope, and bareness of surface. However, It immediately adjoins Deodar and *Pinus gerardiana* (Chilghoza) on drier and steep slopes. It was observed that *Juniperus excelsa* is one of the most disturbed gymnospermic trees species of Chitral area due to its multi-purposes use by the local people.

Ten species were recorded from the understory. Among them *Artemisia maritima*, *Artemisia parviflora* were the predominating species with 90% of the plot. *Rosa webbiana*, *Carum bulbocastanum*, with 60% frequency. *Tamarix arceuthoides*, *Rumex hastatus*, *Silene vulgaris*, *Berberis pseudumbellata* and *Verbascum thaspus* with frequency range from 20 to 50 % of the plots. The seedling of *Juniperus excelsa* were recorded very low in number in comparison to other tree species.

Monospecific *Quercus* community: *Quercus baloot* community (Stand 4) was recorded from a conserved area at Gol National Park Chitral. This forest were distributed at the lower parts of the National Park with gentle slope (15°) in the form of a scrub range type extending into main Chitral Gol. In this range it was found almost in the pure form at lower elevation (1920 m) on East exposures. The density ha^{-1} was recorded 256 individual's ha^{-1} with 13.21 m^2 ha^{-1} basal area. *Quercus* were recorded at five locations, out of which it was recorded as first dominant species in one stand, while in other stands it was recorded in association with other coniferous tree species with no leading position (Table 3). It was noted that un decomposed leaves of *Quercus baloot* are mostly

found under the trees with seeds while germination was very poor under the trees as well as in open areas. Signs of browsing and looping can be easily judged.

Table 2. Phytosociological Summarization for the 9 trees species

Species Name	PR	Min[1] IVI	Max[2] IVI	Mean IVI	Min[3] den.	Max[4] den.	Mean Den.	Min[5] B.A	Max[6] B.A	Mean B.A	1st dominance[7]	2nd	3rd
Cedrus deodara	23	8	100	65±4.9	32	502	156±25	7	153	39±7.2	20	2	1
Pinus gerardiana	11	11	69	30±8.9	32	181	80±17.7	4	22	9±1.5	3	8	0
Pinus wallichiana	7	4	67	24±8.9	22	483	106±64	2	90	27±14	1	3	2
Abies pindrow	7	5	38	19±3.9	8	116	37±14	0.76	25	9±3.0	0	4	2
Picea smithiana	6	9	35	21±4.3	4	55	28±8	3	15	7±2.0	0	3	3
Juniperus excelsa	6	3	100	37±18	11	109	43±14	0.28	10	5±1.7	2	0	2
Betula utilis	1	10	10	10±00	2	2	2±00	0.65	0.65	0.65±0	0	1	0
Quercus baloot	5	8	100	33±17	12	256	75±46	0.53	13	4±1.9	1	1	2
Quercus dilitata	5	4	22	14±3.1	7	68	28±10	0.56	2	0.98±.3	0	0	2

Keys: 1. PR=Presence in no. of stands, Minimum important value index 2. Maximum IVI, 3. Minimum density ha^{-1}, 4. Maximum density ha^{-1}, Mínimum Basal area m^2ha^{-1}, 6. Máximum Basal area m^2ha^{-1}, 7. Dominance in stands.

Ground flora was composed of 17 species with comparatively low frequencies. *Artemisia maritima* and *Arenaria griffithii* were the predominating species of the ground flora with 60% and 70% frequency respectively. *Hippohae rhamnoides*, *Artemisia parviflora*, *Verbascum thapus, and Pistacia khinjuk* were distributed with 50% frequency. *Astragalus amberstianus*, *Thymus serpyllum*, *Convolvulus arvensis* and *Daphne oleoides* were less abundant species with 30% frequency of the total plots. The lowest frequency (20%) was recorded for *Caragana ambigua*.

***Cedrus* - *Pinus gerardiana* community:** *Cedrus deodara* was the most prominent and widely distributed community of the study area. However, *Pinus gerardiana* was restricted to drier sites of dry temperate area. This association was recorded from ten locations of Chitral (Stand 2, 5, 6, 7,9,10,11,12,13 and15 (Table 3). These stands were recorded at different exposures. At three locations i.e. Gohkshal, Rest house (GNPC) and Birir, the stands were recorded on South exposure while at Ispidiar, Gambag, and Roomgah stands were on North facing slope. However, Ispidiar and Damyli sampling sites were on west facing slope. Some stands (Shehkuh valley, and Posatum) were recorded from extremely steep slope on East exposures while most of the stands were on moderately gentle slope (20°) but extreme steep slope (62°) was recorded from Sheik Nandeh and Bumburate Kalash valley. The elevation range was 2022 to 2479 meter asl. In these stands *Cedrus deodara* occupied 49% to 78% of the important value, while *Pinus gerardiana* showed 16% to 44% of important value.

At Dyimeli Kalash (Stand 9), *Quercus baloot* was associated with 22% of important value with a slight difference in density. *Abies pindrow* was associated as a third dominated species at Gambag Kalash valley, with IVI 16% and density 43 trees ha^{-1}. Its basal area was higher than the co-dominant species. This community had a considerable number of other coniferous and broad leaved species i.e. *Pinus wallichiana*, *Juniperus excelsa*, *Quercus baloot*, and *Quercus dilitata* with low basal area. However, at Ispidiar in Gol National Park on 2325 meter elevation dry temperate species *Juniperus excelsa* appeared with density of 53 individuals ha^{-1} and of basal area 4 m^2 ha^{-1}, though it important value was only 8%.

As far as ground flora is concerned both valleys of Kalash showed similarities. Ground flora had no seedling and sapling of the first two dominant species i.e. *Cedrus deodara* and *Pinus gerardiana*. Both areas showed *Impatients brachycentra*, *Delphinium ajcis*, *Sambucus wightiana*, *Echinops cornigerus*, *Fragria vesca*, *Pedicularia rotundata*, *Pedicularia chitralensis* and *Consolida ambigua* species in common. The area close to rest house at Gol National Park was highly disturbed due to anthropogenic factors. Besides germinating seedling

of *Cedrus* and *Pinus wallichiana*, *Rosa webbiana*, *Artemisia maritima* and *Impatiens brachycentra* were also recorded from ground surface.

***Cedrus - Pinus wallichiana* community:** *Cedrus- Pinus wallichiana* community was recorded from only two locations of the study area. The community was recognized at Bronshal Gol National Park at 2344m, on steep slope (38°), and Shehekuh valley situated comparatively on low elevation (2217m) and (29°) slope. The canopy was moderately closed at Shehekuh valley while it was open at Bronshal. The *Cedrus deodara* was the first dominant species with importance value ranged from 52% to 85% with 275 to 278 trees ha^{-1}.The basal area were recorded in the ranged between 32 to 38 m^2 $ha^{-1.}$ This showed that small size trees of deodar were present in both these stands. The density of *Pinus wallichiana* was 25 in stand 8 whereas 127 in stand 16 with 89 m^2 ha^1 basal area.

Like other communities ground flora of this community also exhibited different floristic composition. However, some dominant non tree species were *Arenaria griffiithii*, *Euphorbia thomosoniana*, *Ormoeterum tuberosum*, which were recorded with 50% frequency in stand 8, while with similar frequency *Rumex hastatus*, *Fragaria vesca*, *Viola canesens*, and *Potentilla biflora* were recorded from stand 16. The dominant species of stand 16 *Cichorium intybus* showed 60% presence. Others species like *Verbascum thapus*, *Ephedra gerardiana*, *Silene vulgaris*, *Sedum multicule*, *Echinops cornigerus*, *Pedicularia chitralensis*, and *Impatiens brachycentra* had low frequency ranging from 20% to 40%. *Echinops cornigerus* was the common species in both stands.

***Cedrus deodar – Abies* community:** This community was recorded at Ziarat Mata Khur, West and East facing slopes on a moderate ridge at 2678m elevation. In Agriate it was on North East facing steep slope at about 2500m elevation. The importance value of *Cedrus deodara* ranged between 50% to 74%. The high density (78 ha^{-1}) and low basal area (25 m^2ha^{-1}) were recorded from Agriate, while lowest (37 ha^{-1}) density and high basal area ($31m_2ha^{-1}$) were recorded from Ziarat Mata Khur. Beside these two dominant species, other associated tree species were quite common in each area. In all three locations *Picea smithiana*, was recorded as other associate species. A slight difference was observed in the important value (IVI). The results demonstrated that at Agriate although the density ha^{-1} of *Picea smithiana* was greater than that of *Abies pindrow*, but on the basis of important value the community were named as *Cedrus- Abies* community. Similar situation was also observed in Ziarat Mata Knur (Stand 26). The importance values, density ha^{-1} and basal area were observed to be the same for both the species (Table 3).

Ground flora in the above three locations was also quite similar, and 18, 9 and 16 species were recorded, respectively. Many species were observed to be common in these three stands, including *Viola canesens*, *Aconitum laeve*, *Urtica dioica*, *Geranium rotundifolium*, *Aconitum chasmanthus*, *Oxalis corniculata*, *Dryopteris odontoloma*, *Rumex hastatus*, *Indigofera gerardiana*, and *Fragaria vesca*. *Viola canescens* was the dominant species with 70% frequency. Other species were recorded with 20% to 50% frequency range.

***Cedrus deodar – Picea* community:** This community was recorded from three different locations i.e. Arandu, Agriate, and Ziarat, (Stand, 21, 23, 27). In first two stands it was recorded from East facing slope. In Arandu it was on East facing steep slope (38°) on 2522m elevation, while at Agriate and Ziarat it was recorded from 24 to 27° on East and North facing slope s with elevation ranging between 2678 to 2600 meter (Table 1). At first location co-dominant species *Picea smithiana*, has 16% importance value, while at the same location *Abies pindrow* was also associated with similar quantity but low basal area. These species showed 30% to 35% of importance value at second and third location of the study area. The density ha^{-1} was recorded 151 ha^{-1} at Ziarat while 91 and 99 at Arandu and Agriate simultaneously. A slight change was observed in basal area at these three locations. Basal area values were recorded in the range between 28 to 36 m^2 ha^{-1}.

Ground flora was composed of 11 species in first two locations, while 16 species were recorded from stand 27. At Ziarat *Fragaria vesca*, *Viola canescens*, *Urtica dioica*, *Tribulus terrestris*, *Geranium rotundifolium*, and *Aconitum chasmanthus* were dominant species in the ground flora. These plants were recorded with 30% to 60% of the circular plots. *Fragaria vesca*, *Oxalis corniculata*, *Indigofera gerardiana*, *Rumex hastatus*, and *Rumex dentatus* are common in Ziarat and Agriate area. Arandu sampling site indicated quite different understorey species composition in which *Polygonum amplexicaule*, *Rumex napalensis*, *Sambucus wightiana*, *Plecanthrus rugosus*, *Habenaria aitchisonii*, *Berberis lycium* were recorded in 20 to 60% of the plots of the ground vegetation.

***Pinus wallichiana – Abies* community:** Madaklasht sampling site lies on North facing slope on 2775 meter elevation in Sheshe Kuh valley. Canopy was closed at this locations and plant to plant distances were relatively smaller. *Pinus wallichiana* was the first dominant species with 67% importance value, while *Abies pindrow* showed 25% importance value. The total stand density ha^{-1} was recorded as $631ha^{-1}$ out of which *Pinus wallichiana* had 483 individuals with 73 m^2 ha^{-1} basal area. The results indicated that 116 individuals ha^{-1} of *Abies pindrow* were recorded with 25 m^2 ha^{-1} basal area. *Cedrus deodara* was the associated tree species in this

community with 32 tree ha^{-1}, and 7 basal area m^2 ha^{-1}. In stand 11 and 15 *Pinus wallichiana* was recorded in low quantity.

The ground flora showed poor floristic composition. *Impatients bicolor, Viola canescens, Fragaria vesca* were observed as the dominant species with 60% frequency. *Urtica dioica, Potentilla biflora, Rumex nepalensis, Pedicularis chitralensis, Virburnum cotinifolium* and *Rumex hastatus* were recorded with 20 to 40% frequency range.

***Pinus gerardiana – Quercus* community:** *Pinus gerardiana- Quercus* community was observed growing on North and Southern slopes. In some places *Pinus gerardiana* was observed in pure form, but generally it was found mixed with *Quercus* at 2479m elevation in the study area. The trees had more than one stem, low branching pattern but capable of attaining considerable girth. It appears to be adequately suited specie under existing climatic regime, steep terrain and edaphic conditions of the sampling site. Among the tree species 69% importance value was obtained by the first dominant species while *Quercus baloot* was recorded with 31% of importance value. The density of *Pinus gerardiana* was recorded 191 individuals' ha^{-1} with basal area 12 m^2 ha^{-1}. The co-dominant species were recorded with 70 individual ha^{-1} and 7 basal areas m^2 ha^{-1} in this community.

Pinus gerardiana (locally called Chilghoza Pine) is generally regarded as a gregarious tree, but in the study area it was found in the form of an open forest type with scattered individuals. It was noted that low precipitation and plucking of cones to obtain edible seeds for commercial purposes appear to be the most common causes of its scattered distribution. It was recurrently overlapped with *Quercus baloot* leading to gradual extermination. In the study area, *Pinus gerardiana* was found as a moderate sized evergreen and a highly branched tree. It was found to attain a girth of 1.8 to 2.5 meter and a height of 8 to 12 meter. Animal grazing is inimical to reproductive potential of *Pinus gerardiana*. A total of 14 species were recorded in the circular plot study. *Lonicera quinquelocularis*, *Rosa webbiana*, *Artemisia maritima*, *Artemisia parviflora*, *Pistacia khinjuk* and *Fraxinus xanthoxyloides* were the predominating species having 50% to 70% presences of the stand. *Hippohae rhamnoides, Astragalus anisacanthus, Daphne oleoides, Caragana ambigua,* and *Prunus elurnea* were recorded with 20% to 40% frequency. Two grasses, *Thymus serpyllum* and *Andropogon* sp. were also presented with 30% frequency.

***Juniperus – Betula* community:** Sarooj village is located in Goline Gol valley at 2720 m asl. This unique community was recorded on South west exposure of this sampling site on moderate (18°) slope. *Juniperus excelsa* showed 89% importance value with density of 43 individual ha^{-1} and basal areas 10 m^2 ha^{-1}. The co-dominant species *Betula utilis* showed low (11%) importance value, density (2 Individuals ha^{-1}) and 0.65 m^2 ha^{-1} basal area. These values were very low due to anthropogenic factor like lopping, cutting of branches for fuel purposes, and Timber. Sapling and seedling of *Juniperus excelsa* and *Betula utilis* were not recorded.

This community also showed very poor floristic composition. A total of ten species were recorded out of which *Artemisia maritima*, and *Artemisia parviflora* were the dominated species with 90% frequency of the total circular plots. Two species *Rosa webbiana, Carum bulbocastanum* were recorded with 60% frequency. *Tamarix arceuthoides, Rumex dentatus, Rumex hastatus, Verbscum thaspus* and *Silene vulgaris* with 20% to 50% frequency range.

The present paper also incorporated the herb shrub communities that were presented in Table 3. In this group nine plant communities were included which are discussed below:

***Juniperus communis* - *Nepeta* community:** This community was present at an elevation of 3118 meter at Lowari top. The community prevailed on West exposure with moderate (15°) slope (Table 1). *Juniperus communis* was the dominant species and found in a prostrate form. The IVI of *Juniperus* was recorded 68% while *Nepeta clakei* was the associated species of the community with 19% IVI. The density ha^{-1} of *Juniperus* was 7260 with 34848m cover ha^{-1} while the *Nepeta* was recorded with 3388 individual ha^{-1} and with 1452m cover ha^{-1}. Two other species *Astragalus chitralensis* and *Nepeta erecta* were recorded with low frequency and density ha^{-1} (Table 3).

***Micromeria brevifolia* - *Astragalus* community:** In this community the first three dominant species *Micromeria, Astragalus* and *Artemisia maritima* had almost similar (18.8% to 19.8%) importance value. *Rumex hastatus, Nepeta cataria, Datura stramonium* and *Capparis spinosa* species were respectively next species in the order of importance value. The density of the first and second dominant species was 555 and 554, while cover ha^{-1} was 244 and 144m respectively. Highest density ha^{-1} (1444) and cover ha^{-1} (4733) was recorded for *Rumex hastatus*, however due to low importance value it was not considered as the dominant species. Other species of this sampling site were *Verbascum thaspus, Salvia rhytidea, Poeonia emodi,* and *Convolvulus arvensis* with low density and cover h^{-1}. The community showed no floristic similarity with other communities of the study area.

Table 3. Community analysis of herb, shrubs of Chitral

Non forest communities	PR	Stand No	Location	Aspect	Elevation (m)	Slope (^{o})
Juniperus communis & Nepeta clarkei	1	28	Lowari top	W	3118	15
Micromeria biflora & Astragalus chlorstachys	1	29	Village site (GNPC)	E	1540	25
Tamarix appylla & Cynodon dactylon	1	30	Ayun	Plain	1228	5
Artemisia brevifolia & Econops prionolepis	1	31	Artemisia steps (GNPC)	E	2340	5
Artemisia brevifolia & Artemisia santolinifolia	1	32	Mastuj valley	N	2351	10
Artemisia brevifolia & Artemisia maritima	1	33	Buni valley	N	2237	10
Rumex hastatus & Ranunculus muricatus	1	34	Perabeg	E	2445	24
Arenaria griffiithii & Potentilla arnavatensis	1	35	Shah Saleem	N	3022	12
Chrysopogon echinulatus & Nepeta discolor	1	36	Shandur	W	3338	17

***Tamarix appylla – Cynodon dactylon* community:** This community was sampled from the plain area of Ayun Chitral town at lower elevation 1228 meter along the river Kunar. *Tamarix aphylla* and *Cynodon dactylon* were the major dominant species with 42% and 8% IVI. The IVI of other species were in the range of 2 to 6%. *Tamarix aphylla* was recorded as the dominant species with 6277 individuals' ha^{-1} and 17333m cover ha^{-1}. This community showed the richest floristic composition of the sampling area. Eighteen species representing three Pteridophytes species *Equisetum arvensis*, *Marsilea minuta* and *Adiantum capillus veneris,* were reported in cluster form in water under *Tamarix* (Table 3.1). Two grasses namely *Cynodon dactylon*, and *Chrysopogon echinulatus*, were also observed. Five species i.e. *Rumex hastatus*, *Mentha longifolia*, *Micromeria biflora*, *Ranunculus muricatus*, and *Datura stramonium* were recorded in common with other communities.

***Artemisia brevifolia- Echinops* community:** *Artemisia* colonies or carpets were present between *Pinus gerardiana* and *C. deodara* zone covering a large area on East facing slope with 2340 m elevation at Gol National Park. These areas may be due to cutting of Forest because there are still some large diameter sized trees of *Cedrus deodara*, and *Pinus gerardiana* or may be due to exposure to sun light. *Artemisia brevifolia*, (IVI=71) and *Echinops* (IVI=12) were recorded as the leading species with 35222 individual ha^{-1} and 38000m cover ha^{-1} from the sampling site. *Lonicera quinquelocularis* and *Arenaria griffiithii* (Cushion plant) are associated species with this community which is the common plant in alpine meadows of the study area.

***Artemisia brevifolia- Artemisia santolinifolia* community:** This community was reported from Mastuj valley (Stand 32) at 2351m elevation and (10°) slope. The dominated species of the stand were *Artemisia brevifolia*, *Artemisia santolinifolia, Iris aitchisonii* and *Plantago major*. Some new species were also recorded in this community which was not found in other communities, i.e. *Peganum harmala*, *Rheum australe*, *Prangos pubularia*, and *Impatiens bicolor*. *Artemisia brevifolia* has 6222 individual ha^{-1}, while *Artemisia santolinifolia* was obtained with 2888 individual ha^{-1}. Cover ha^{-1} of both species were recorded 10667m and 4222m simultaneously.

***Artemisia brevifolia - Artemisia maritima* community:** For site description (Buni), refer to Table (3). A total of four plant species were obtained from this community. *Artemisia brevifolia*, (IVI=47), *Artemisia maritima*, (IVI=32) were the dominant species with 18666 individual ha^{-1} and 5711 cover ha^{-1} while the co-dominant species with10888 plants ha^{-1} and 3444 cover ha^{-1}. *Rumex hastatus* and *Swertia petiolata* were recorded with low frequency and density ha^{-1}.

R*umex hastatus* - *Ranannculus* community: The area was dominated by *Rumex hastatus* (IVI=20), *Ranunculus muricatus* (IVI=17), *Plectranthus rugosus* (IVI=13). The density ha^{-1} was 10889 and 8333 cover ha^{-1} were recoded of the first dominant specie while the co-dominant species *Ranunculus muricatus* had 7222 individual ha^{-1} with 8333m cover ha^{-1}.The community had poor floristic similarity with other stands of the study

area. *Phlomis cashmeriana*, *Agrostis canina*, *Scutellaria nuristanica*, *Lagotis globosa*, and *Linaria nuristanica* are new species recorded from this community.

Arenaria griffiithii - Potentilla arnavatensis **community:** Shah Saleem area is located on North facing Slope at 3022m elevation next to Gram Chasma. Alpine plants *Arenaria griffiithii* (IVI=29), *Potentilla arnavatensis* (IVI=25), *Anemone rupicola* (IVI=19), *Rumex alpinus* (IVI=12) were the dominated species of the sampling site. This area is adjacent to Afghanistan border so a new species *Inula afghanica* is recorded from this stand. Among all species *Arenaria griffithii* was the leading species with 7556 individual ha^{-1} and 10222m cover $ha^{-1.}$ *Potentilla arnavatensis* was the co-dominant species which showed high density 6444 individuals with 8666 cover ha^{-1} of the stand. Among the other associated species four species were observed in common with stand 36 (Table 3.1).

Chrysopogon echinulatus- Nepeta discolor **community:** The community was recorded from Shandur (3338 m) elevation on west facing slope. A total of seven species were recorded from the sampling site. *Chrysopogon echinulatus* and *Nepeta discolor* were recorded with highest 31% and 13% importance values. The density ha^{-1} of *Chrysopogon* was recorded 12556 with 14000 cover ha^{-1}, while *Nepeta* showed 4888 individuals ha^{-1} with 3556 cover ha^{-1}. Among the other associated species *Potentilla arnavatensis*, *Arenaria griffiithii*, and *Rumex alpinus* were the common alpine plants recorded in this community. *Euphrasia schlagintweitii* and *Phlomis bracteosa* were observed unique species with low frequency. These species were not observed from the rest of the 35 stands.

Discussions

In the present study, thirty six stands were sampled, which included angiospermic (shrubby and herbaceous) as well as gymnospermic trees. The vegetation of the study area was composed of 9 tree species (>10 cm dbh) and 112 herbs and shrubs. The tree species were distributed among 5 taxonomic families. The most commonly represented family was Pinaceae (6 species), followed by Fagaceae (1 genus, 2 species). Family Betulaceae was represented by one species only. The tree species rich family was Pinaceae which constituted 90% of the total tree species in the forest of the study area**.** It was also observed that among the tree species gymnosperms were abundant compared to angiosperms but in the herbaceous and shrubby vegetation angiosperms were more plentiful.

Since importance value shows the relative ecological importance, conspicuousness or dominance of each species in a stand (Brown and Curtis 1952). Therefore, it is a good index for summarizing vegetation characteristics, ranking species for the purpose of management and conservation practices. It reflects the degree of relative dominance and abundance of a given species in relation to other species in the area (Kent and Coker, 1992). Based on the importance value (IVI) a total of 19 plant communities including 10 forest tree species communities and 9 non forested herb, shrubs communities were recorded. Among these 19 communities three communities were monospecific i.e. at four locations *Cedrus deodara* was recorded while in one stand *Juniperus excelsa* and *Quercus baloot* (broad leaved species) were recorded as a single dominating species. The monospecific communities have also been reported by other workers from moist and dry temperate areas of the countries (Ahmed, 1988; Ahmed *et al*., 2006; Wahab *et al*., 2008; Ahmed *et al*., 2009; Khan *et al*., 2010 and Siddiqui *et al*., 2009; 2010).

These variety of plant communities indicated that the though the area is very rugged with steep mountains, yet it harbors diversified flora, a number of conifers, broad leaved tree species, herbs and shrubs providing a habitats and breading ground to different wild life. It is worthwhile to mention that among the plant communities *Cedrus deodara* was recorded from 14 stands in pure form or an association with other conifers on a wide area of the district showing extensive distribution. These stands are distributed mainly in dry temperate areas; however, pure deodar stands were also recorded in moist temperate areas, showing wide ecological amplitude of this species (Ahmed *et al*., 2006; Ahmed *et al*., 2011).

The results revealed that in most cases the co-dominant species of a particular community type was also prominent in other community types and much overlap in species composition exists. This situation corresponds well with that found by Ahmed (1984) for Kauri forest New Zealand. If the density was taken into account the most abundant tree species in the study area is *Cedrus deodara* with an average 156 individuals ha^{-1} with 39 m^2 ha^{-1} basal area, followed by *Pinus wallichiana* with an average 106 individuals ha^{-1} with basal area of 27 m^2 ha^{-1}. The species with the lowest density was *Betula utilis* with an average of 2 individuals ha^{-1} and 0.65 basal area m^2 ha^{-1} followed by *Quercus dilitata, Quercus baloot* and *Juniperus excelsa*. The low values of density/ha of these species are possibly due to biotic interference. These extreme disturbances due to anthropogenic factors were also reported by Zarif (2004), Rehman (2003-2005) Alamgir (2004) and Khan *et al.*, (2010).

Pinus gerardiana is an important conifer species of the study area but its scattered distribution in the present study may also be due to plucking of its cones to obtain edible seeds for commercial purposes while extraction of fuelwood also appears to be an important factor responsible for its random thinning and consequently cause of its scattered distribution. According to Zarif (2004) and Rehman (2003-2005) this species have extremely exploited for seed extraction during the last 20 years while Khan *et al*.,(2010) stated that this species is recurrently overlapped with *Quercus baloot* leading to gradual extermination.

Artemisia is a large, diverse and economically important genus of the family Asteraceae. It has more than 500 species. Out of these 38 species are found in different parts of Pakistan which are popularly used among Pakistani people as food, ornaments, fumigants and medicines (Hayat *et al* 2009; Hussain *et al*; 2004; 2007; Siraj *et al*., 2006; Ikramullah *et al*., 2007; Ali and Qaiser 2009). Chitral Gol National Park (CGNP) has a large area above *Quercus baloot* zone which is almost covered by *Artemisia* species. Tree species have been removed through various activities from these *Artemisia* steppe zone. The over dominance of the genus may be due to the allelopathic effects of the genus. This view is supported by the findings of Pareto (1985) and Tan *et al*., (1998), who stated that many species of genus *Artemisia* are economically important as medicines, food, forage, ornamental or soil stabilizers in disturbed habitats, while some taxa are toxic or allergenic and some other are invasive weeds which render the harvest difficult. The other possible reason may be the steppe climate, moderate precipitation and excessive exposure to sunlight in the park. This view is strengthened by the statement of Erdtman (1969) and El-Moslimany (1990) who advocated *Artemisia* as an indicator of steppe climate and moderate precipitation. However, the species of *Artemisia* and *Rosa webbiana* are predominant and are suitable for harvesting in district Chitral for fuel and medicinal products.

Vegetation covering an area has a definite structure and composition developed as a result of long term interaction with biotic and abiotic factors, and any change in the status of these factors disturbs the floristic composition of the forest (Mekonnen, 2006). In many stands ground flora showed poor floristic composition, possibly due to differences in local factors, microclimatic conditions or degree of disturbance. This statement is supported by the findings of Beg (1974); Khan (1978); Ahmed *et al*., (2009), Siddiqui *et al*., (2009) and Khan *et al.*, (2010). Functionally, vegetation is an organized and an integrated whole than the individual species and possess properties which is not necessarily found in the species themselves (Greig-Smith 1964; 1983). This implies that vegetation is a holistic system by itself and it is the most obvious feature of earth's surface that forms the immediate environment of human beings along with his domestic animals.

The present study also covers the vegetation of Chitral Gol National Park (CGNP) that plays a major role for the rehabilitation of vegetation, because illegal cutting of trees by local people for different activities like fuel wood, construction and impact of domestic animals such as goats, sheep and others have minimized greatly after the declaration of the area as a Park and restricting the entry of domestic animals in the park area.

It can be concluded that all the vegetation types under study registered comparatively poor floristic composition related to the total area of the district. This valuable resource needs to be conserved, protected and managed sustainably.

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