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SPECIES COMPOSITION AND COMMUNITY STRUCTURE OF SUBTROPICAL FOREST STANDS IN WESTERN HIMALAYAN FOOTHILLS OF KASHMIR

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Abstract

Lesser Himalayan subtropical forests have unique species composition due to diverse climatic and topographic factors which create numerous microhabitats. Phytosociological characteristics, structural attributes and biological spectrum of plant communities in the forests of Himalayan foothills in Kashmir were analyzed. A total of 65 species belonging to 26 plant families were recorded constituting 6 plant communities. Average value of diversity recorded for the communities was 2.44; species richness 4.01; whereas evenness was found to be 0.48. The species data indicated random distribution of species with a hump shaped diversity pattern directly correlated with increasing altitude. *Themeda anathera* was the dominant species with an importance value percentage of 14.7% followed by *Pinus roxburghii* (9.6%), *Mallotus philippenensis* (5.2%), *Malvastrum coromandelianum* (5.1%), *Acacia modesta* (5%), *Olea ferruginea* (3.8%) and *Oxalis corniculata* (3.2%). Vegetation was dominated by Therophytes (30%) and megaphanerophytes (23.3) with dominant leaf spectrum as leptophylls (31.6%). Thirty seven percent plants had medicinal values followed by 31% having fodder values where as 12% used as fuel. Principal component analyses and cluster analyses revealed the association of dominant species with specific sites due to prevailing environmental conditions. The distribution of species in ordination diagrams indicated a continuous change in species composition along the altitudinal gradient. Key stone tree species were subject to immense tree felling resulting in deteriorating changes in forest structure. Visual indicators showed over grazing at all the studied sites evident from the dominance of unpalatable species. Local forest stands demand immediate attention of policy makers as well as forest management so that local diversity and floristic richness could be conserved and rehabilitated.

Key words: Diversity, Biological spectrum, Subtropical forests, Aggregation, Multivariate analysis.

Introduction

Phytosociology deals with composition and development of plant communities, and the relationship between the species. Phytosociological attributes of plant communities reflect the dominance, spatial patterns and biological abundance of vegetation (Ruschel *et al*., 2007; Akhani, 2007). Diversity is the degree of variation in life forms within a given ecosystems. Species richness is the number of different species represented in an ecological community, landscape or region (Ahmed *et al*., 2009). The species richness is affected by the number of individuals as well as heterogeneity of the sample (Kharakwal & Rawat, 2010). Species richness is often used as criterion when assuming the relative conservation values of habitats or landscape (Roy & Behra, 2005; Chandra *et al*., 2010). Biological spectrum of plant species includes life form and leaf spectra which reflect environmental conditions as well as the geography of the habitat; often used to describe and compare vegetation at community level (Oswalt *et al*., 2006; Todoria *et al*., 2010). Variations in climatic and topographic factors influence the microhabitats resulting in diverse species composition in lesser Himalayas. Lower limits of Lesser Himalayan foot hills in the 700-1300m altitudinal range are dominated by *Pinus roxburghii*, *Acacia* and *Olea* forest stands (Ahmad *et al*., 2009; khan *et al*., 2010). Lesser Himalayan Kashmir forests are rich in medicinal flora due to diversified plant habitats (Bibi *et al.,* 2008; Chawla *et al*., 2008). About 80% of the Himalayan people are dependent on traditional indigenous medicines for their basic healthcare (Shinwari, 2010; Timilsina *et al*., 2007). Himalayan forests are facing immense pressure due to rapid socioeconomic transformations in the area correlated with exponential population increase (Durrani *et al*., 2005; Singh *et al*., 2009). Researchers have discussed the forest deterioration in Kashmir valley in recent decades using conventional methods as well as by using satellite imagery (Valdiya, 2002; Shaheen *et al*., 2011). The objectives of the current study were to get the baseline information of subtropical forest stands including structural attributes, Phytosociological characteristics and biological spectrum of plant communities; and assess human dependence on the local forest species.

Study area:

Study area lies in district Kotli, in the state of Azad Jammu & Kashmir Pakistan, between longitude 73^o 57’52” East and latitude 33^{o}31’ 12” North. Area falls in the sub-tropical and humid region and shows variation in the climate. The hottest months of the year are June and July, with mean daily maximum temperature 37.3^{o}C and 34.3^{o}C. December and January are the coldest months with mean minimum temperature of 16.2^{o}C and 4.5^{o}C respectively (Rehman, 2007). The average rainfall is 92.5mm with maximum (277.2mm) in July and least in November (15.1mm). The average maximum and minimum relative humidity received by area is 79.8% and 34.3% respectively. Soil is of loam and clay loam types whereas rocks are of Pir-Panjal stone, sand-stone, mud-stone, quartzites, shale-stone and Siwalick type (Pak-Met, 2012; Nazir *et al*., 2012).

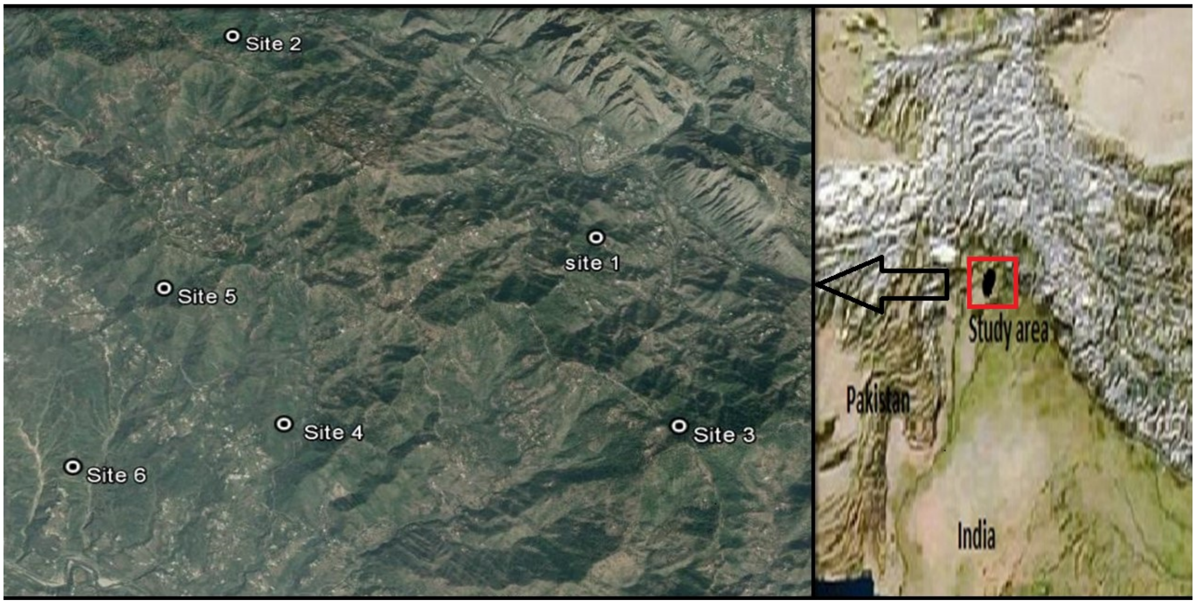

Fig. 1. Location map of study area (right) and Satellite imagery (left) of study sites.

Materials and Methods

Six localities viz: Kurti, Manil, Pagwar Morah, Palahna, Badhana and Barali in an altitudinal range of 600-1300m were selected for phytosociological analysis (Fig. 1). A total of 210 quadrates were laid systematically to get the data with a size of 30×30m for trees, 5×5m for shrubs and 1x1m for herbs. Phytosociological parameters were recorded in each community including density, frequency, cover, importance value index (Cox, 1967); index of diversity, species richness, equitability, species maturity (Shannon-Wienner, 1949; Sorenson, 1948), degree of aggregation, index of similarity (Pichi-Sermolli, 1948); biological spectrum and leaf spectra following standard protocols (Ahmed & Shaukat, 2012; Greig-Smith, 2010; Mueller-Dombois & Ellenberg, 1974). Ethnomedicinal information was obtained from the populations surrounding the forests through questionnaire method. Species data was subjected to ordination techniques including Principal Component Analyses, Detrended Correspondence Analysis and Cluster Analyses (Hill & Gauch, 1980).

Results

A total of 65 species belonging to 26 plant families were recorded from the investigated area. The major contributors of local flora included Poaceae (8 spp.) followed by Asteraceae (6 spp.) and Euphorbiaceae (4 spp.). Fabaceae, Malvaceae and Amaranthaceae had 3 species each where as Acanthaceae, Lamiaceae, Cyperaceae and Rosaceae were represented by 2 species each. The remaining Families had single representative (Table 1). *Themeda anathera* was the dominant species with an importance value percentage of 14.7% followed by *Pinus roxburghii* (9.6%), *Mallotus philippensis* (5.2%), *Malvastrum coromendelianum* (5.1%), *Acacia modesta* (5%) and *Olea ferrugenia* (3.8%). Therophyte (30%) was dominant life form in the area followed by megaphanerophytes (23.3%), hemicryptophytes (20%), nanophenerophytes (13.3%), geophytes (6.6%); Chameophytes and Lianas (3.3%) each. The dominant leaf spectrum was leptophyll (31.6%), followed by microphylls and nanophylls (28.3% each), and mesophylls (11.6%) (Table 1). Average value of diversity recorded for the communities was 2.44; species richness 4.01; whereas evenness was found to be 0.48 (Table 2).

Pinus-*Themeda*-*Mallotus* community was harbored at an elevation of 850m from Manil hills at 73˚53 5.316 East longitude and 33˚32 9.925 North latitude. Community comprised of 28 species. The dominant species were *Pinus roxburghii*, with an IVI value of (59.2) followed by *Themeda anathera,* (45.2) and *Mallotus philippensis* (41.2). Co-dominant species were *Sida cordata, Lespedeza juncea, Heteropogon contortus, Malvastrum coromendelianum* and *Stellaria media*. The recorded values of diversity index in the community were 2.5; species richness, 4.8; evenness, 0.44; and maturity index was 16.42%. Results for aggregation showed that 10.7% species were regular, 39% were aggregated, 25% were intermediate and 25% were unity.

Themeda-*Olea*-*Adiantum* community was present in Badhana hills Kurti at an elevation of 975m, at 73˚53 5.316 East longitude and 33˚32 9.925 North latitude. Community comprised of 29 species. Dominant species were *Themeda anathera* at an elevation of 675m *Olea ferruginea* (33.1) and *Adiantum incisum* (27.3). The co-dominant species were *Parthenium hysterophorus, Adatoda zeylanica* and *Dicanthium annulatum* whereas *Sida cordata, Acacia modesta* and *Flacourtia indica* were the associated components. The recorded values of diversity index in the community were 0.56; species richness, 4.72; evenness, 0.44; and maturity index was 25%. Results for aggregation showed that 27.5% species were regular, 37.9% were aggregated, 25% were intermediate and 20.6% were unity (Tables 2, 3).

Table 1. Species composition and biological spectrum of the identified plant communities.

S. No.	Name of species	Family	Life form	Leaf spectra	IVI %age
1.	*Acacia arabica* (Lam) Willd.	Mimosaceae	Mp	N	5.0
2.	*Acacia modesta* Wall.	Leguminoceae	Mp	L	0.2
3.	*Achyranthus aspera* Var.	Amaranthaceae	Th	N	1.5
4.	*Adatoda zeylonica* Nees.	Acanthaceae	Np	Me	1.3
5.	*Adiantum incisum* Forssk.	Pteridaceae	G	Mi	1.8
6.	*Ailanthus altisima* (Mill) Swingle.	Simaroubaceae	Mp	N	0.6
7.	*Ajuga bracteosa* Wall.	Lamiaceae	Ch	Mi	0.2
8.	*Amaranthus viridus* L.	Amaranthaceae	Th	L	0.1
9.	*Aristida adscensionis* L.	Poaceae	Th	L	0.0
10.	*Artemisia scoparia* Wald & kit.	Asteraceae	H	N	1.0
11.	*Asparagus gracillus* Royle.	Poaceae	Np	L	0.2
12.	*Berberis lyceum* Royle.	Berberidaceae	Mp	Mi	0.1
13.	*Boerhavia procumbens* Banks ex Roxb	Myrsinaceae	H	N	2.3
14.	*Brachiaria reptans* (L.) Gardner and Hubbard.	Poaceae	Th	L	1.0
15.	*Carissca opaca* Stapf ex Haines.	Apocynaceae	Np	Mi	1.5
16.	*Casia fistula* L.	Fabaceae	Mp	Me	0.2
17.	*Celosia argentea* Var.	Amaranthaceae	Th	N	0.1
18.	*Celtis eriocarpa* Decnee.	Ulmaceae	Mp	Mi	1.3
19.	*Colebrookia oppositifolia* Smith.	Labiateae	Mp	Me	0.8
20.	*Commelina benghalensis* L.	Commelinaceae	Th	Mi	0.9
21.	*Conyza canadensis* L.	Asteraceae	Th	Mi	0.5
22.	*Cynodon dactylon* L.	Poaceae	H	L	3.1
23.	*Cynoglossum lanceolatum* Forssk.	Boraginaceae	H	N	0.4
24.	*Cyperus iria* L.	Cyperaceae	G	L	0.2
25.	*Cyperus rotundus* L.	Cypreaceae	G	L	0.2
26.	*Dalbergia sissoo* Roxb.	Fabaceae	Mp	Mi	0.3
27.	*Dicanthium annulatum* (Forssk). Stapf	Poaceae	H	L	2.5
28.	*Dicliptera roxburgiana* Nees.	Acanthaceae	Th	Mi	1.0
29.	*Dodonaea viscosa* (L) Jacq.	Spindaceae	Np	Mi	0.9
30.	*Eriophorum comosum* (Wallich).	Cyperaceae	G	L	0.2
31.	*Euphorbia indica* Lam.	Euphorbiaceae	Th	N	0.2
32.	*Euphorbia prostrata* Ait.	Euphorbiaceae	H	L	0.3
33.	*Flacourtia indica* (Burm.f) Merriu.	Flacourtiaceae	Mp	Mi	0.8
34.	*Geranium rotundifolium* L.	Geraniaceae	Th	N	0.1
35.	*Grewia villosa* (Willd).	Malvaceae	Mp	Me	2.3
36.	*Heteropogon contortus* L.	Poaceae	H	L	2.2
37.	*Ipomea pestigrides* L.	Convolvulaceae	L	Mi	0.4
38.	*Lantena indica* (Roxb).	Verbenaceae	Np	Mi	0.3
39.	*Lespedeza juncea* (L.f) Pers.	Fabaceae	Th	L	3.3
40.	*Lathyrus odoratus* L.	Fabaceae	L	Mi	2.1
41.	*Mallotus philippensis* (Lamk) Muell.	Euphorbiaceae	Mp	Me	5.2
42.	*Malvastrum coromendelianum* (L.) Garcke	Poaceae	Th	Mi	5.1
43.	*Maytenus royleanus* (Wall. ex Lawson). Cef.	Celastaraceae	Np	N	1.8
44.	*Micromeria biflora* (Ham.) Bth.	Lamiaceae	H	L	1.2
45.	*Morus alba* L.	Moraceae	Mp	Me	0.6
46.	*Olea ferrugenia* Royle	Oleaceae	Mp	N	3.8

Table 1. (Cont'd.)

S. No.	Name of species	Family	Life form	Leaf spectra	IVI %age
47.	*Oxalis corniculata* L.	Oxalidaceae	H	N	2.0
48.	*Parthenium hysterophorus* C.T. Bryson	Asteraceae	Th	N	2.7
49.	*Phylanthus niruri* L.	Euphorbiaceae	Th	L	0.7
50.	*Pinus roxburghii* Sargent.	Pinaceae	Mp	L	9.6
51.	*Plantago lanceolata* L.	Plantaginaceae	H	N	0.1
52.	*Pronus persica* Buch.	Rosaceceae	Mp	N	0.1
53.	*Rhynchosia capitata* (Heyne ex Roth) DC.	Cyperaceae	Ch	Mi	0.3
54.	*Rubus fruticosus* Wall.	Rosaceceae	Np	Mi	1.1
55.	*Sauromatum venosum* (Ait.) Schott	Araceae	G	Mi	0.2
56.	*Setaria palmifolia* (Koen) Stapf	Poaceae	Th	L	0.2
57.	*Sida cordata* (Burm.f.) Borss.	Poaceae	Np	L	3.7
58.	*Sonchus arvensis* L.	Asteraceae	Th	N	0.7
59.	*Stellaria media* (L.) Vill.	Caryophyllaceae	Th	L	1.4
60.	*Taraxacum officinale* Weber	Asteraceae	H	N	1.2
61.	*Themeda anathera* (Ness) Hack.	Poaceae	H	L	14.7
62.	*Tylophora hissuta* Wall.	Ascelepidaceae	L	Me	0.3
63.	*Xanthium stromarium* L.	Asteraceae	Th	Me	0.9
64.	*Vitex trifolia* L.	Verbenaceae	Mp	Me	0.7
65.	*Ziziphus oxiphilla* Miller.	Rhamaceae	Mp	Mi	0.9

Key to abbreviation: Mp = Megaphanerophytes, Np = Nanophanerophytes, Th = Therophytes, L = Leptophyll, Me = Mesophyll, G = Geophytes, Ch = Chameophytes, N = Nanophyll, Mi = Microphyll

Themeda-Acacia-Oxalis community was harbored at an altitude of 1090 m from Palahna Hills at 73˚53 5.316 East longitude and 33˚32 9.925 North latitude. This community consisted of 36 species. Dominant species were *Themeda anathera* with an IVI value of 67.1 followed by *Acacia modesta* (37.1) and *Oxalis corniculata* (28.1). The co-dominant species were *Malvastrum coromendelianum*, *Grewia villosa* and *Celtis eriocarpa* whereas *Brachiaria reptans*, *Dicliptera roxburghiana* and *Olea ferruginea* were the associated components. The recorded values of diversity index in the community were 2.47; species richness, 6.17; evenness, 0.33; and maturity index was 20.2%. Results for aggregation showed that 27.7% species were regular, 36.1% were aggregated, and 13.8% were intermediate and 22.2% were unity (Tables 2, 3).

Themeda-Cynodon-Acacia community was present at an elevation of 1100m in Kurti at 73˚53 5.316 East longitude and 33˚32 9.925 North latitude. Community comprised of 15 species. Dominant species were *Themeda anathera* with an IVI value of 43.2 followed by *Cynodon dactylon* (36.1) and *Acacia modest* (34.56). The co-dominant species were *Malvastrum coromendelianum*, *Olea ferruginea* and *Parthenium* whereas *Dicanthium annulatum* and *Maytenus royleanus* were the associated components. The recorded values of diversity index in the community was 2.16; species richness, .2.32; evenness, 0.58; and maturity index was 45%. Results for aggregation showed that 26.6% species were regular, 40% were aggregated, and 33.3% were intermediate (Tables 2, 3).

Pinus-Themeda-Mallotus community was located in Barali hills at a height of 1150m at 73˚53 5.316 East longitude and 33˚32 9.925 North latitude. The community was composed of 19 species. Dominant species were *Pinus roxburghii* with an IVI value of 62.7 followed by *Themeda anathera* (48.5) and *Mallotus philippensis* (41.1). The co-dominant species were *Sida cordata, Malvastrum coromendelianum* and *Cynodon dactylon* whereas *Taraxacum, Stellaria* and *Lespedeza* were the associated components. The recorded values of diversity index in the community was 2.45; species richness, 3.16; evenness, 0.61; and maturity index was 27.1%. Results for aggregation showed that 21% species were regular, 52.6% were aggregated, and 15.7% were intermediate and 10.5% unity (Tables 2, 3).

Pinus-Themeda community was recorded at an altitude of 1250m from Pagwar Morah at 73˚53 5.316 East longitude and 33˚32 9.925 North latitude. The community composed of 19 species. Dominant species were *Pinus roxburghii*, with an IVI value of 51.3 followed by *Themeda anathera,* (26.86). The co-dominant species were *Carissa opaca* and *Rubus fruticosus* whereas 15 species were recorded as rare. The recorded values of diversity index in the community were 2.22; species richness, 2.88; evenness, 0.48; and maturity index was 40.2%. Results for aggregation showed that 26.3% species were regular, 68.4% were aggregated and 5.26% were intermediate.

Table 2. Phytosociological characteristics of recorded plant communities.

S. No.	Community	Height (m)	Diversity	Species richness	Equitability	Maturity index
1.	P-T-M	850	2.51	4.84	0.44	16.42
2.	T-O-A	975	2.56	4.72	0.44	25
3.	T-A-O	1090	2.74	6.17	0.33	20.27
4.	T-C-A	1100	2.16	2.32	0.58	46
5.	P-T-M	1150	2.45	3.16	0.61	27.10
6.	P-T	1250	2.22	2.88	0.48	40

Key to abbreviation: P-T-M = *Pinus-Themeda-Mallotus*, T-O-A = *Themeda-Olea-Adiantum*, T-A-O = *Themeda-Acacia-Oxalis*, T-C-A = *Themeda-Cynodon-Acacia*, P-T-M = *Pinus-Themeda-Mallotus* P-T = *Pinus-Themeda*

Table 3. Degree of aggregation of different plant communities.

S. No.	Name of community	Height (m)	Total sp.	Rare		Aggregated		Intermediate		Unity	
				%	No	%	No	%	No	%	No
1.	P-T-M	850	28	10.7	3	39	11	25	7	25	7
2.	T-O-A	975	29	27.5	8	37.9	11	13.7	4	20.6	6
3.	T-A-O	1090	36	27.7	10	36.1	13	13.8	5	22.2	8
4.	T-C-A	1100	15	26.6	4	40	6	33.3	5	0	0
5.	P-T-M	1150	19	21.0	4	52.6	10	15.7	3	10.5	2
6.	P-T	1250	19	26.3	5	68.4	13	5.26	1	0	0

Plant use data showed that 37% plants had medicinal values followed by 31% having fodder values where as 12% plants were used as Fuel. Rest of the plants had miscellaneous utilizations. About 35 plants were reported having ethnobotanical utilizations. Leaves (31%) were the main plant parts used in herbal recipes followed by whole plant (17%), stem (15%), seeds (13%), fruit (10%), roots (8%) and flower (6%). (Table 4). The recorded herbs were used for the treatment of different ailments including stomach problems, kidneys and liver disorders, Ulcers, Diabetes, respiratory diseases, Dysentery, constipation, fever, skin diseases, cough and digestive problems. Ordination techniques are used to understand the relationship of vegetation and key environmental factors governing its distribution (Ter Braak & Smilauer, 1998). PCA biplot diagram explained the association of dominant species with specific sites due to prevailing environmental conditions (Hill & Gauch, 1980). The common species shared by all sites were overlapped in the center forming a clump (Fig. 2). The distribution of species in DCA scatter plot indicated a continuous change in species composition in the studied sites along the altitudinal gradient (Fig. 3). Detrending and rescaling was done by using recommended default values, whereas the rare species were down weighted. Cluster analyses was performed based on Euclidean distance and similarity measures for segregating plant species at certain similarity levels which reflects their abundance in different communities (Fig. 4).

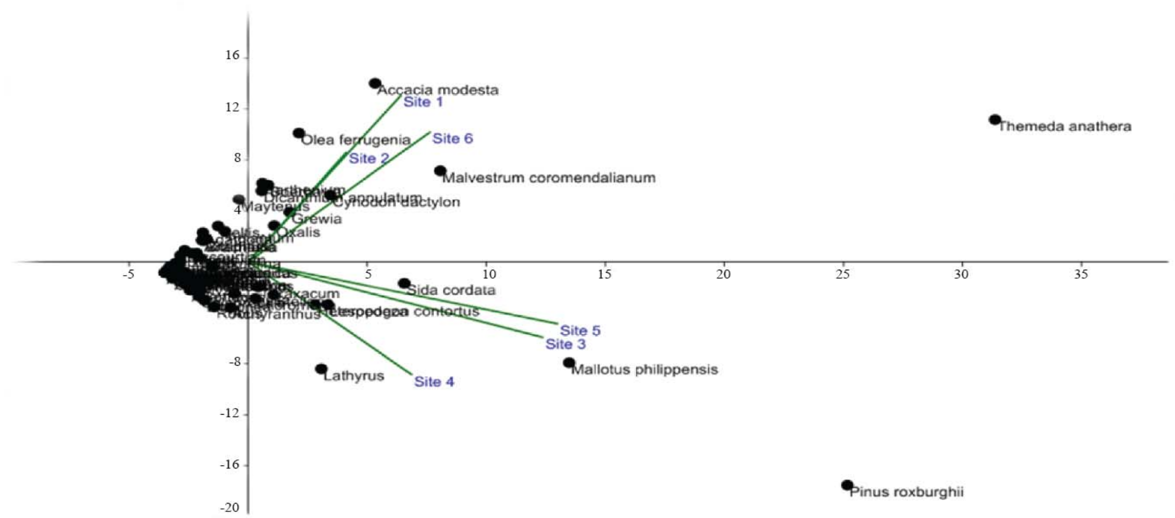

Fig. 2. Principal Component Analyses Biplot of species and sites data.

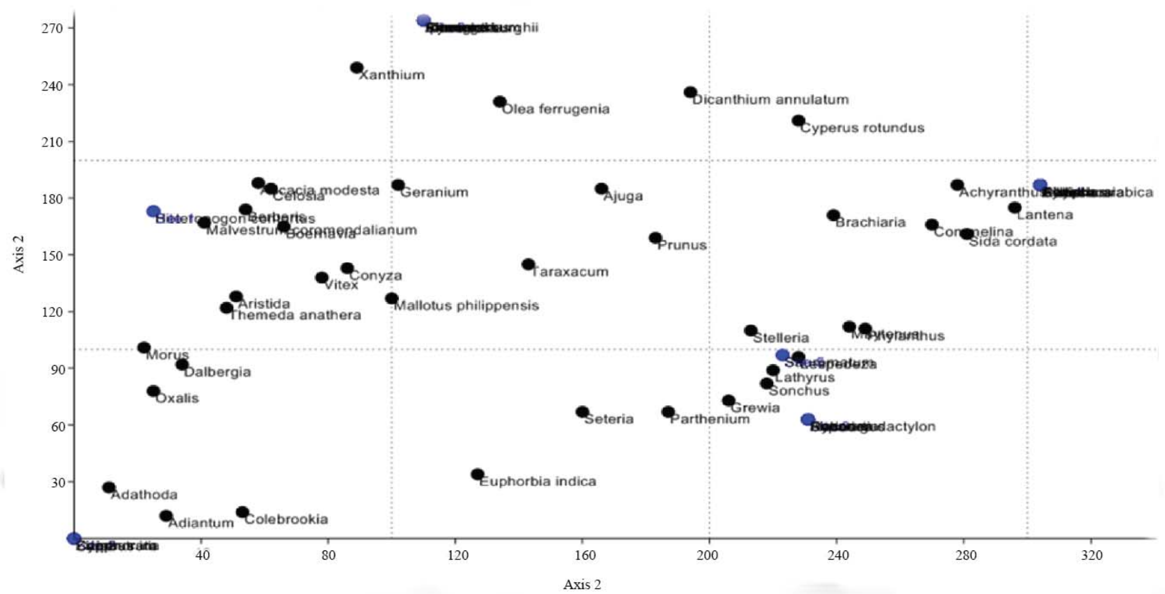

Fig. 3. Detrended Correspondence Analyses diagram showing sites and species distribution.

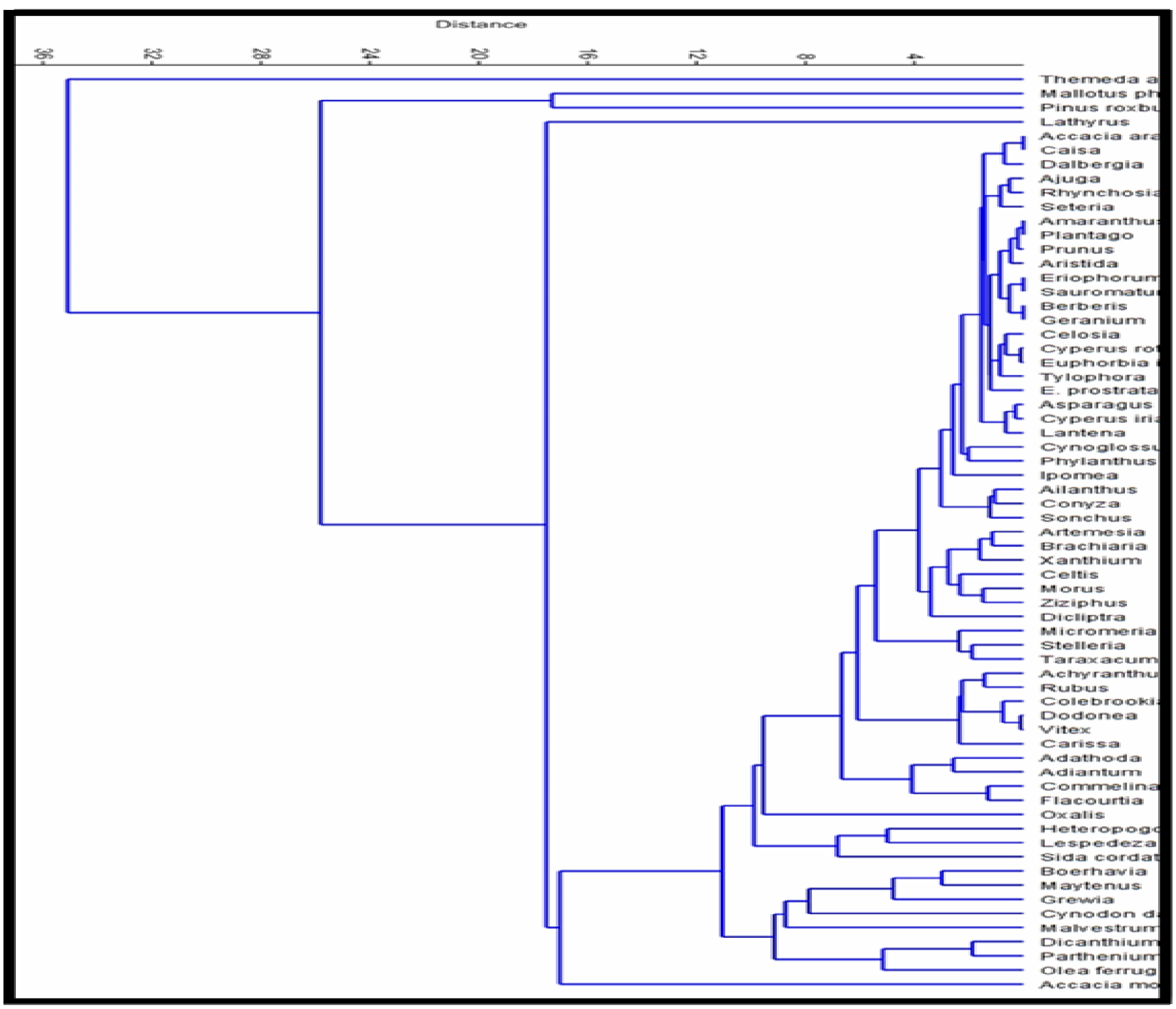

Fig. 4. Cluster Analyses Dendrogram of species dataset based on Euclidean distance.

Table 4. Species utilized in ethnobotanical practices by the local population.

S. No.	Botanical name	Families	Local names	Parts used	uses
1.	*Achyranthus aspera*	Amaranthaceae	Puthkanda	Whole plant	Me
2.	*Carissca opaca*	Apocynaceae	Granda	L,R,Fr	Me
3.	*Artemisia scoparia*	Asteraceae	Chahoo	L,F	Me, Fo
4.	*Taraxacum officinale*	Asteraceae	Hand	L	Me
5.	*Xanthium stromarium*	Asteraceae	Unknown	Whole plant	Me, Fo
6.	*Cynoglossum lanceolatum*	Boraginaceae	Lunduri	L,R	Me, Fo
7.	*Casia fistula*	Fabaceae	Amaltas	L, S,Sd	Me, Fu, M
8.	*Maytenus royleanus*	Celastaraceae	Patakhi	Whole plant	Me
9.	*Ipomea pestigrides*	Convolvulaceae	Aair	Sd	Fo, O
10.	*Euphorbia indica*	Euphorbiaceae	Doodal	Whole plant	Me, Fo
11.	*Pinus roxburghii*	Pinaceae	Cheer	S,Sd	Fu,O,M
12.	*Cynodon dactylon*	Poaceae	Khabal	L	Me, Fo
13.	*Heteropogon contortus*	Poaceae	Suriyala	L,S	Me, Fo
14.	*Ziziphus oxiphilla*	Rhamaceae	Bairi	Whole plant	Me
15.	*Pronus persica*	Rosaceceae	Rawara	Whole plant	Fu
16.	*Dodonaea viscosa*	Spindaceae	Snatha	L,S	Me
17.	*Grewia villosa*	Malvaceae	Taman	L,S	Me, Fo
18.	*Rubus fruticosus*	Rosaceceae	Akhra	L,S,Fr	Me
19.	*Mallotus philippensis*	Euphorbiaceae	Kamila	R,Fr	Me,Fo,Fu
20.	*Phylanthus niruri*	Euphorbiaceae	Amla	Whole plant	Fu
21.	*Ajuga bracteosa*	Lamiaceae	Kori booti	Whole plant	Me,Fo
22.	*Micromeria biflora*	Lamiaceae	Baboori	Whole plant	Me,Fo
23.	*M. coromendilianum*	Malvaceae	Gogi booti	L	Fo
24.	*Acacia modesta*	Leguminoceae	Pulai	L,S	Me,Fu,O
25.	*Olea ferrugenia*	Oleaceae	Kahoo	L,S,Sd	Me,Fo,Fu
26.	*Oxalis corniculata*	Oxalidaceae	Jandoro	Whole plant	Me
27.	*Adiantum incisum*	Pteridaceae	Bojni	L,R	Me
28.	*Themeda anathera*	Poaceae	Ghaa	L	Fo
29.	*Flacourtia indica*	Flacourtiaceae	Rattun	L	Fo,Fu,Me
30.	*Amaranthus viridus*	Amaranthaceae	Gunhar	L, S	Me, Fo
31.	*Geranium rotundifolium*	Geraniaceae	Ratan joge	F, L	Me,Fo
32.	*Plantago lanceolata*	Plantaginaceae	Chmchipatr	L	Me,Fo
33.	*Celtis eriocarpa*	Ulmaceae	Khirk	Bark	M
34.	*Lathyrus odoratus*	Papilionaceae	Phul matar	F,Sd	Fo
35.	*Dalbergia sissoo*	Fabaceae	Tahli	F,Sd	Fo

Key to the abbreviations: L = leaves, S = stem, R = Root, F = Flower, Fr = Fruit, Sd = Seed, M= medicinal, Fo = Fodder, Fu = Fuel, O = Ornamental

Discussion

The species presence data indicated random distribution of species except for few dominant species including *Themeda anathera, Pius roxburghii, Olea ferrugenia, Acacia modesta and Oxalis corniculata*. Study area represented average diversity index values of 2.4. Diversity showed a hump shaped pattern with altitude having lower values at the lower and higher altitudes; whereas maximum values were recorded for the communities at moderate elevations (Siddiqui *et al*., 2010). This pattern is well reported in Himalayan foothills showing higher diversities with increase in humidity and altitude (Kessler, 2000; Ahmed *et al*., 2006; Kunwar & Sharma, 2004). The diversity values are considerably low due to increased concentration of dominance. This fact is also responsible for the low stability of the communities reflected by very low maturity index values (Criddle *et al*., 2003). The low maturity index of plant communities shows unbalance and heterogeneous nature of local flora having lesser adaptations to the microclimate of the sites. This effect is also enhanced by anthropogenic disturbances which inhibit the establishment of vegetation to reach the climax stage (Shaheen *et al*., 2011).

Themeda anathera, an unpalatable species and indicator of overgrazing was recorded as dominant species in most of the communities. It is reported to have allelopathic affect suppressing the growth of other herbs (Pinheiro & Monteiro, 2006). The dominance of *Cynodon dactylon*, drought tolerant specie, is well reported in warm subtropical landscape (Joshi *et al*., 2001). *Boerhavia* is also among the persistent species due to procumbent branching which save it from prevailing biotic disturbances helping in its establishment (Cronin & Pandya, 2009).The introduction of nonnative fast growing species like *Cannabis sativa*, can pose a challenge for the endemic flora due to their ability to consume the limited resources. *Pinus roxburghii* has also replaced *Quercus leucotrichophora*, originally dominant specie of lesser Himalayan forest (Kharakwal, 2009; Siddiqui *et al.,* 2009). This phenomenon can lead to the long term changes in floristic composition and ecosystem functioning.

Life form classes are indicators of micro as well as macro habitat of species (Guo *et al*., 2009). Therophytes were the dominant species in the investigated area which are the indicator of subtropical zone and disquieted vegetation. Therophytes are experts of occupying vacant niches as a result of disturbances like deforestation and overgrazing (Pysek *et al*., 2005). Leaf size classes showed that vegetation of the investigated area was dominated by Leptophylls and Microphylls indicating the impact of xeric conditions, decreasing the leaf size (Kar *et al*., 2010).

Polythetic clustering analysis based on Euclidean distance was performed which separated the species at certain cut levels on the basis of their weight age in community data set (Malik & Hussian, 2006). In the investigated area aggregated species were dominant followed by regular species. *Themeda anathera, Cynodon dactylon* and *Heteropogon contortus* were the dominant grasses showing aggregation due to perennial rhizomatous habitat and enormous seed output (Sahu *et al*., 2008). The aggregation of plants occur in response to daily and seasonal weather changes and as a result of reproductive processes (Gairola *et al*., 2008). Highest similarity (66.29%) was recorded between *Pinus-Themeda-Mallotus* (650m) and *Pinus-Themeda-Mallotus* (750m) community (Table 5). This can be attributed to similar altitude and similarity in nutrients and habitat (Nazir & Malik, 2006). The lowest index of similarity (8.96%) was recorded between *Themeda-Olea-Adiantum* (675m) and *Pinus-Themeda* (850m) community harbored at two different altitudinal limits having prominent climatic and edaphic differences (Bocuk *et al*., 2009). Fifty nine percent plants, mainly herbs, recorded from the study sites had medicinal importance. Common plant parts used to make the herbal preparation were leaf, root, whole plant, seed, fruit, flower and tuber.

Local forests are facing deteriorating changes in their structure and composition due to anthropogenic disturbances including extensive fodder and fire wood extraction, overgrazing, trampling, road construction (Mishra *et al*., 2003). Key stone tree species including *Pinus roxburghii, Acacia modesta* and *Olea ferruginea* were under pressure in the study area (Abbas *et al*., 2009). Visual indicators like browsed vegetation, trampling, droppings and hoof marks indicated that palatable shrubs were subjected to over grazing at all the studied sites. Local forest stands demand immediate attention of policy makers as well as forest management so that local diversity and floristic richness could be conserved and rehabilitated.

Table 5. Index of similarity and dissimilarity (Pichi-Sermolli Method).

Altitude (m)	Community	650m	675m	690m	700m	750m	850m
		P-T-M	T-O-A	T-A-O	T-C-A	P-T-M	P-T
850	P-T-M		74.07	73.24	80.26	33.71	70.66
975	T-O-A	25.93		65.42	52.08	73.98	91.04
1090	T-A-O	26.76	34.58		57.18	73.81	89.06
1100	T-C-A	19.74	47.92	42.82		73.69	91.04
1150	P-T-M	66.29	26.02	26.19	26.13		71.59
1250	P-T	29.34	8.96	10.94	8.96	28.41	

References

Abbas, F., T. Akhtar and A. Mian. 2009. Phytosociological analysis within the range of Grey Gorial in Pakistan and Azad Kashmir. *Pak. J. Bot.,* 41(2): 667-682.

Ahmed, M., N. Khan, M. Wahab, S. Hamza, M.F. Siddiqui, K. Nazir and M.U. Khan. 2009. Vegetation structure of *Olea ferruginea* Royle Forests of Lower Dir District of Pakistan. *Pak. J. Bot*., 41(6): 2683-2695.

Ahmed, M., T. Hussain, A. H. Sheikh, S. S. Hussain and M. F. Siddiqui. 2006. Phytosociology and structure of Himalayan forests from different climatic zones of Pakistan. *Pak. J. Bot.*, 38(2): 361-383.

Akhani, H. 2007. Diversity, biogeography and photosynthetic pathways of *Argusia* and *Heliotropium* in south-west Asia with an Analysis of phytogeographical units. *Bot. J. Linn*. *Soc*., 155: 401-425.

Bibi, S., S.Z. Husain and R.N. Malik. 2008. Pollen analysis and heavy metals detection in honey samples from seven selected countries. *Pak. J. Bot.,* 40(2): 507-516.

Bocuk, H., C. Ture and O. Ketenoglu. 2009. Plant diversity and conservation of the Northeast Phrygia region under the impact of land degradation and desertification (Central Anatolia, Turkey). *Pak. J. Bot.,* 41(5): 2305-2321.

Chandra, J., V.S. Rawat, Y.S. Rawat and J. Ram. 2010. Vegetational Diversity along altitudinal range in Garhwal Himalaya. *Int. J. Bio. Conser*., 2(1): 014-018.

Chawla, A., S. Rajkumar, K.N. Singh, B. Lal and R.D. Singh. 2008. Plant species diversity along an altitudinal Gradiant of Bhabha Valley in Western Himalaya. *J. Mt. Sci*., 5: 157-177.

Cox, G.W. 1967. Laboratory Manual of General Ecology. WMC Brown Co. Dubuque, IA.

Criddle, R.S., J.N. Church, B.N. Smith and L.D. Hansen. 2003. Fundamental causes of the global patterns of species range and richness. *Russ. J. Plant Physiol*., 50: 192-199.

Cronin, R. and A. Pandya. 2009. Eds, Exploiting natural resources, growth, instability, and conflict in the Middle East and Asia. The Henry L. Stimson Center, ISBN: 978-0-9821935.

Durrani, M.J., F. Hussain and S.U. Rehman. 2005. Ecological characteristics of plants of Harboi rangeland, Kalat, Pakistan. *J. Trop. & Sub Trop. Bot.,* 13(2): 130-138.

Gairola, S., R.S. Rawal and N.P. Todaria. 2008. Forest vegetation patterns along an altitudinal gradient in sub-alpine zone of west Himalaya, India. *African J. Plant Sci*., 2(6): 042-048.

Greig-Smith, P. 2010. Quantitative Plant Ecology, 3rd ed. Blackwell Scientific, Oxford.

Guo, Q.S., X.F. Wang, G. Bar, Y. Kang, M. Hong, S.X. Pei and F.J. Zhang. 2009. Life form spectra, leaf character, and hierarchical-synusia structure of vascular plants in Thuja sutchuehensis community. *Pub Med*., 20(9): 2057-2062.

Hill, M.O. and H.G. Gauch. 1980. Detrended correspondence analysis, an improved ordination technique. *Vegetation*, 42: 47-58.

Joshi, P.K., S. Singh, S. Agarwal and P.S. Roy. 2001. Forest cover assessment in western Himalayas, Himachal Pradesh using IRS 1C/1D WiFS data. *Curr. Sci*., 80: 941-947.

Kar, P.K., A.K. Biswal and K.L. Barik. 2010. Floristic composition and biological spectrum of a grassland community of Rangamatia in the district of Mayurbhanj, Odisha. *Curr. Sci*., 15(2): 465-469.

Kessler, M. 2000. Elevational gradients in species richness and endemism of selected plant groups in the central Bolivian Andes. *Plant Ecology*, 149: 181-193.

Khan N., M. Ahmed, M. Wahab, K. Nazim and M. Ajaib. 2010. Phytosociology, structure and physiochemical analysis of soil in Quercus Baloot Griff, Forests District Chitral, Pakistan. *Pak. J. Bot*., 42(4): 2429-2441.

Kharkwal, G. 2009. Qualitative analysis of tree species in evergreen forests of Kumaun Himalaya, Uttarakhand, India. *Afr. J. Plant Sci.,* 3(3): 049-052.

Kharkwal, G. and Y.S. Rawat.2010. Structure and composition of vegetation in subtropical forest of Kumaun Himalaya. *Afr. J. Pl Sci.,* 4(4): 116-121.

Kunwar, R.M. and S.P. Sharma. 2004. Quantitative analysis of tree species in two community forests of Dolpa district, mid-west Nepal. *Him. J. Sci*., 2(3): 23-28.

Malik, R.N. and S.Z. Husain. 2006. Classification and ordination of vegetation communities of the Lohibehr reserve forest and its surrounding areas, Rawalpindi, Pakistan. *Pak. J. Bot*., 38: 543-558.

Mishra, C., H.T. Prins and Van Wieren. 2003. Diversity, Risk Mediation, and Change in a Trans-Himalayan Agropastoral System, *Human Eco*., 31(4): 595-609.

Muller-Dombois, D. and N. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. John Wiley & Sons, NY.

Nazir, A. and Z.H. Malik. 2006. Life form and index of similarity of plant communities recorded at Sarsawa Hills, District Kotli. *J. Res. Sci*., 17(1): 27-33.

Nazir, A., R. Naseem and M. Ajaib. 2012. Phytosociological Studies of the Vegetation of Sarsawa Hills District Kotli, Azad Jammu and Kashmir. *Bio. Pak.,* 58(1, 2): 123-133.

Oswalt, S.N., T.J. Brandeis and B.P. Dimick. 2006. Phytosociology of Vascular Plants on an International Biosphere: Virgin Islands National Park. *Caribbean J. Sci.,* 1: 53-66.

Pak-Met. 2012. The Normals of climatic data of Azad Jammu & Kashmir. Islamabad, Pakistan: Pakistan Meteorological Department.

Pichi-Sermolli RE.1948. An index for establishing the degree of maturity in plant communities. *J. Ecol.,* 36(1): 85-90.

Pinheiro, M.H.O. and R. Monteiro. 2006. Contribution of forest species to the floristic composition of a forested savanna in southeastern Brazil. *Brazilian Arch. Biol. Tech*., 49(5): 763-774.

Pysek, P., V. Jarosik, Z. Kropac, M. Chytry, J. Wild and L. Tichy. 2005. Effects of Abiotic Factors on Species Richness and Cover in Central European Weed Communities. *Agri. Eco. Env*. 109: 1-8.

Rehman, E.U. 2007. An overview Of Forests Habitats Situation Village Barali Kass, Kotli Azad Kashmir Pakistan. *Ethnobotanical Leaflets*, 11: 266-279.

Roy, P.T. and M.D. Behera. 2005. Assessment of biological richness in different altitudinal zones in the eastern Himalayas, Arunachal Pradesh, India. *Curr. Sci.*, 88:2.

Ruschel, A.R., R.O. Nodari and B.M. Moerschbacher. 2007. Woody plant Species Richness in Turvo State Park, a Large Remnant of Deciduous Atlantic Forest, Brazil. *Biodiv. Cons*., 16: 1699-1714.

Sahu, P.K., R. Sagar and J.S. Singh. 2008. Tropical forest structure and diversity relation to altitude and disturbance in biosphere reserve in central India. *App. Veg. Sci.,* 11: 461-470.

Shaheen, H., R.A. Qureshi, Z. Ullah and T. Ahmad. 2011. Anthropogenic pressure on the western Himalayan moist temperate forests of Bagh, Azad Jammu & Kashmir. *Pak. J. Bot.,* 43(1): 695-703.

Shannon, C.E. and W. Wiener. 1949. The Mathematical Theory of Communication. Urbana, IL: University of Illinois Press.

Shinwari, Z.K. 2010. Medicinal Plants Research in Pakistan. *J. Med. Pl. Res.,* 4(3): 161-176.

Siddiqui, M.F., M. Ahmed, M. Wahab, N. Khan, M.U. Khan, K. Nazim and S.S. Hussain. 2009. Phytosociology of *Pinus roxburghii*, Sargent (Chir Pine) in lesser Himalayan and Hindu Kush range of Pakistan. *Pak. J. Bot.*, 41 (5): 2357-2369.

Siddiqui, M.F., M. Ahmed, S.S. Shaukat and N. Khan. 2010. Advanced multivariate techniques to investigate vegetation-environmental complex of pine forests of moist temperate areas of Pakistan. *Pak. J. Bot.*, 42(S I): 267-293.

Singh H., M. Kumar and M.A. Sheikh. 2009. Distribution pattern of oak and pine along Altitudinal Gradients in Garhwal Himalaya. *Nat. Sci.*, 7(11): 81-85.

Sorensen, T.A.1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish commons. Kongelige Danske Videnskabernes Selskabs Biologiske Skrifter, 5(4): 1-34.

Ter Braak, C.J.F. and P. Smilauer. 1998. CANOCO Reference Manual and User's Guide to CANOCO for Windows: Software for Canonical Community Ordination (version 4). Microcomputer Power, Ithaca, New York, USA.

Timilsina, N., M. S. Ross and J.T. Heinen. 2007. A community analysis of Sal (*Shorea robusta*) forests in the western Terai of Nepal. *For. Ecol. Manage*, 241: 223-234.

Todaria, N.P., P. Pokhriyal, P. Uniyal and D.S. Chauhan. 2010. Regeneration status of tree species in forest of Phakot and Pathri Rao watersheds in Garhwal Himalaya. *Curr. Sci.*, 98(2): 171-175.

Valdiya, K.S. 2002. Emergence and evolution of Himalaya: reconstructing history in the light of recent studies. *Prog Phys Geogr*, 26: 360-399.

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