Pak. J. Bot., 42(5): 3091-3102, 2010.

COMMUNITY DESCRIPTION OF DEODAR FORESTS FROM HIMALAYAN RANGE OF PAKISTAN

MOINUDDIN AHMED, KANWAL NAZIM, MUHAMMAD FAHEEM SIDDIQUI*, MUHAMMAD WAHAB, NASRULLAH KHAN, MUHAMMAD UZAIR KHAN AND SYED SADARUDDIN HUSSAIN

Laboratory of Dendrochronology and Plant Ecology, Department of Botany, Federal Urdu University of Arts, Science and Technology, Gulshan-e-Iqbal, Karachi, Pakistan
**Department of Botany, Govt. Degree Science/Commerce College, Landhi/Korangi, Karachi, Pakistan*

Abstract

Floristic composition and communities of 47 stands of deodar (*Cedrus deodara* Roxb. ex Lamb. G. Don.) forests covering its natural limits in Pakistan are presented. On the basis of phytosociological analysis, floristic composition of tree species and importance value index, following deodar communities and a pure forest type are recognized and described quantitatively.

Deodar – *Juglans* community,
Deodar – *Quercus* community,
Deodar – *Taxus* community,
Deodar – *Picea* community,
Deodar – *Abies* community,
Deodar – *Pinus gerardiana* community,
Deodar – *Pinus wallichiana* community and monospecific Deodar forests

It is anticipated that poor floristic similarities on forest ground, between these communities, within the community and in pure stands are related to difference in climatic zones**,** microclimatic conditions and degree of disturbance. Can deodar compete with its associated species? Due to highly disturbed nature of these stands, no conclusion could be made.

Introduction

After observational vegetation survey of Champion *et al* (1965), Rafi (1965), and Beg (1975), a lot of quantitative Phytosociological investigations have been carried out by various workers in different part of the country. Ahmed (1976, 1986, 1988) and Ahmed & Qadir (1976) conducted extensive quantitative sampling in northern areas of Pakistan during a scientific expedition in 1973. Amin & Ashfaque (1982), Beg & Khan (1984) and Qadri (1986) presented Phytosociological work from Ayub National Park, dry oak forest zone in Swat and Kotli Hills of Azad Kashmir respectively. Phytosociology of the vanishing subtropical vegetation of Swat with special reference to Docut Hills. I: was investigated by Hussain & Shah (1989) and Durrani & Hussain (2005). Hussain & Illahi (1991) also presented an extensive work on ecology and vegetation types for lesser Himalayan of Pakistan.

An extensive Phytosociological work of various Himalayan forests from various climatic zones was presented by Ahmed *et al*., (2006). Recently Wahab *et al*., (2008)**,** described phytosociology and dynamics of some pine forests of Afghanistan**,** close to the Pakistani border while Siddiqui *et al*., (2009), and Ahmed *et al*., (2010) conducted the same type of investigations in *Pinus roxburghii* and *Olea ferruginea* forests respectively.

Beside these studies no comprehensive quantitative investigations were carried out, describing communities of various forests even for deodar which is the most valuable timber tree and have been considered the national tree of Pakistan. Present studies were therefore conducted to describe Phytosociology of one of the most important tree species, throughout its natural limits in Pakistan.

Material and Methods

Samplings were carried out in deodar forests, throughout its natural limit in Pakistan**.** Though all forests are disturbed**,** mature and least disturbed stands were selected for quantitative sampling. The criteria of vegetation sampling was that

i. It should contain deodar trees at least 60cm dbh.
ii. There should be no recent sign of disturbance and
iii. Stand should cover at least two ha in area.

Point Centered Quarter Method of Cottam & Curtis (1956) was applied for quantitative sampling. At each stands 25 points were taken at every 20 meter intervals**.** GPS was used to record elevation, position of stands**,** and aspect while degree of slope was recorded from slope meter.

Phytosociological attributes (relative frequency, density and basal area)**,** and absolute values (stand density ha^{-1} and basal area m^2ha^{-1})**,** were calculated according to the method described by Mueller-Dombois & Ellenberg (1974). Importance value index (Brown & Curtis**,** 1952) was used to rank each species and the plant species with the highest importance value in the stand was considered the dominant species. The plant community of a particular area was named on the basis of first two dominant species. A species list (<10cm dbh) of trees**,** shrubs**,** herbs and grasses were obtained using circular plots (2 meter diameter) at each sampling points which will be reported latter.

Results and Discussion

In Pakistan deodar stands are distributed in various locations of Murree, Hazara**,** Abbotabad**,** Swat**,** Azad Kashmir, Kaghan valley**,** Kohistan Chillas**,** Dir and Chitral. Basically it is a dry temperate species**,** however isolated stand of this species also occur in moist temperate (Champion *et al*.**,** 1965) and sub alpine areas (Ahmed *et al* 2006)**.** According to Hussain & Illahi (1991), most of these forests fall between dry and moist temperate zones and no sharp distinction could be made.

Forty seven different mature deodar forests were sampled. Phytosociological attributes and absolute values were obtained as described earlier. Deodar grows in moist temperate, dry temperate and near the timber line regions in northern areas of Pakistan from 1650m (Kaghan) to 2927m elevation (Chitral) on ridge tops and moderate (17^o) to steep (50^o) slopes. Locations of main sampling area are shown in Fig. 1. Ecological characteristics of each sampling sites, its map locations and absolute values are presented in Table 1. No significant relations were obtained between elevation/slope and stand density, stand basal area, deodar density and deodar basal area.

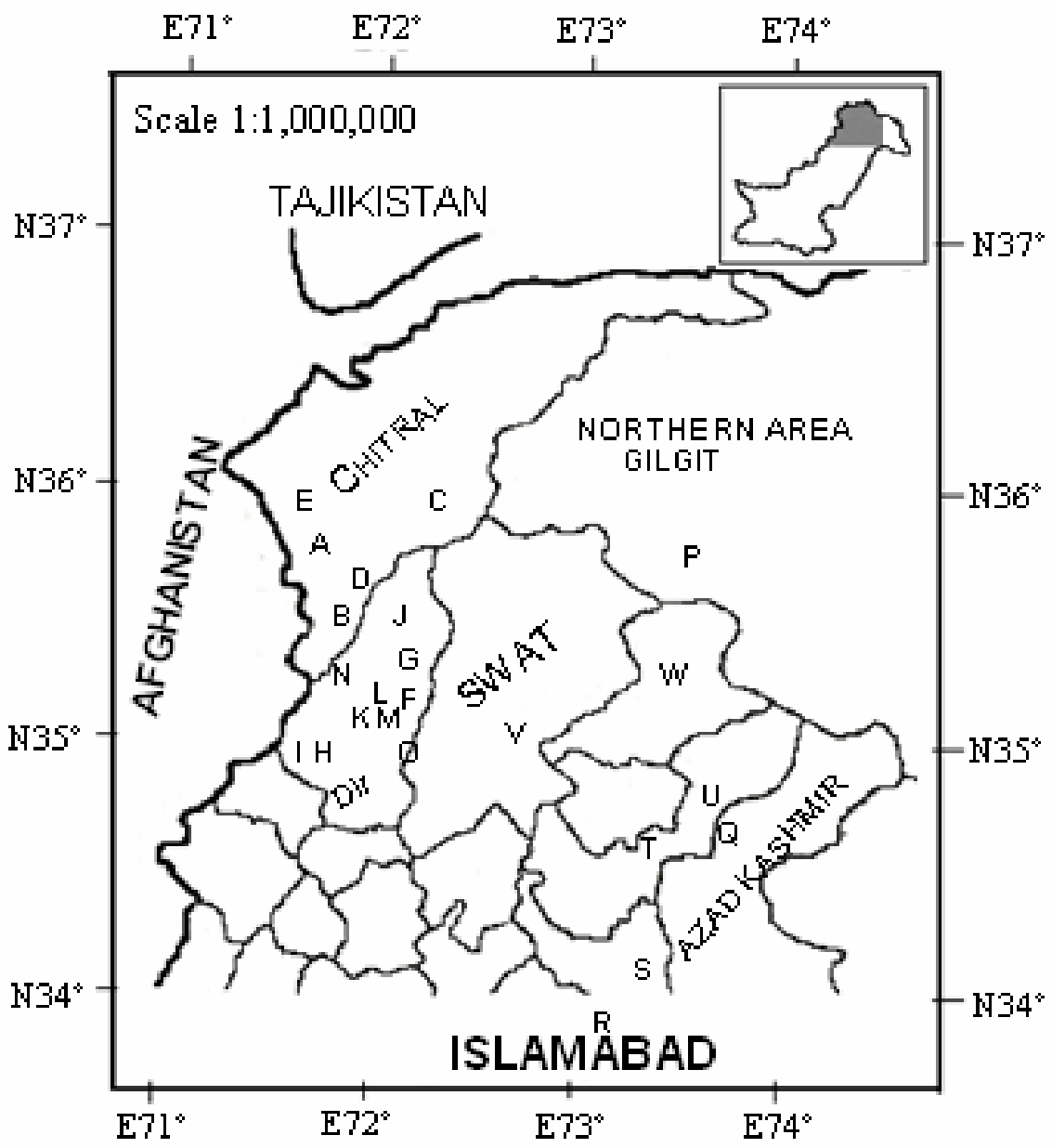

Fig. 1. Map of study areas. A .B .C …., are the main locations. Sampling sites are located around these main locations, for name of sampling sites refer to Table.1.

1. Communities and floristic composition: Summary of phytosociological analysis, species mean absolute values with their dominant positions are given in Table 2. Out of 47 stands 12 stands are monospecific stands of deodar, while at 22 locations *Pinus wallichiana* was associated as a leading or co-dominant species**.** Due to the large number of monospecific stands and a few associated tree species**,** DECORANA and TWINSPAN analysis were not performed. During the circular plot study, overall 200 angiospermic non tree species were recorded. Grasses and lower plants were ignored in most cases**.** A complete list of ground flora is available from the main author. In many deodar containing stands**,** ground flora showed poor floristic composition**,** may be due to difference in climatic area**,** microclimatic condition or degree of disturbance**.** On the basis of important value index and the floristic composition of stands following 7 deodar communities and a monospecific forest were recognized.

Table. 1. Location, ecological characteristics, density $^{ha-1}$ and basal area m^2ha^{-1} of sampling sites.

Main location	Stn	Lat (N)	Long (E)	Ele (m)	Asp	Slp (°)	Std	Sba	Cnp
A- Kalash Valley	1	35 ° 41	71 ° 41	2073	SW	24	126	28.66	Opn
	2	35 ° 41	71 ° 41	2273	N	34	288	55.19	Opn
	3	35 ° 40	71 ° 45	2125	W	27	149	50.07	Mdr
B- Ziarat	4	35 ° 21	71 ° 41	2544	W	34	89	44.87	Opn
	5	35 ° 21	71 ° 46	2544	E	34	206	48.25	Opn
C- Goline Gol	6	35 ° 54	72 ° 05	2584	N	17	100	7.84	Opn
D- Shashe Kuh	7	35 ° 45	72 ° 05	2160	N	31	631	104.80	Cls
	8	35 ° 45	72 ° 40	2344	S	29	403	128.05	Mdr
E- Chitral G.N.P	9	35 ° 53	71 ° 41	2774	E	26	322	76.45	Mdr
	10	35 ° 53	71 ° 46	2331	N	20	287	36.19	Opn
	11	35 ° 52	71 ° 46	2217	NE	38	303	36.44	Opn
	12	35 ° 49	71 ° 43	2927	S	32	260	50.97	Opn
F-Barkand Dara	13	35 ° 21	72 ° 08	2130	E	42	62	8.95	Opn
G-Usheri Dara	14	35 ° 13	72 ° 13	2310	S	33	94	18.35	Opn
H-Barawal	15	35 ° 11	71 ° 73	1920	W	34	99	6.35	Opn
	16	35 ° 13	71 ° 69	1800	E	38	129	8.02	Mdr
	17	35 ° 07	71 ° 69	1950	E	40	103	10.32	Opn
I-Shahi	18	35 ° 09	71 ° 32	2080	N	35	116	8.37	Opn
	19	35 ° 03	71 ° 37	2150	W	40	130	15.09	Opn
J-Kohistan	20	35 ° 54	72 ° 21	2400	N	15	400	65.00	Cls
K-Dir Khas	21	35 ° 16	71 ° 50	1991	W	27	368	49.43	Mdr
L-Janas Banda	22	35 ° 37	72 ° 14	2120	S	30	178	39.65	Opn
M-Sheringal	23	35 ° 28	72 ° 02	2150	N	48	394	65.80	Mdr
	24	35 ° 28	72 ° 07	2340	N	50	457	68.00	Mdr
	25	35 ° 28	72 ° 07	2200	NW	30	195	24.16	Mdr
N-Dok Dara	26	35 ° 20	71 ° 55	2534	W	41	75	95.82	Mdr
	27	35 ° 20	71 ° 55	2672	S	40	104	115.17	Mdr

Table 1. (Cont'd.).

Main location	Stn	Lat (N)	Long (E)	Ele (m)	Asp	Slp (°)	Std	Sba	Cnp
O-Tormang Dara	28	34 ° 51	72 ° 03	2033	N	28	277	47.00	Mdr
P-Diamer	29	35 ° 25	74 ° 06	2370	W	35	85	57.48	Cls
	30	35 ° 18	74 ° 04	2600	W	40	89	5.90	Sct
Q- Azad Kashmir	31	34 ° 15	73 ° 40	1960	NE	30	87	41.00	Opn
R- Murree	32	34 ° 54	73 ° 24	2300	SE	40	435	83.00	Cls
S- Abbottabad	33	34 ° 49	73 ° 24	2730	SE	42	249	59.00	Cls
	34	34 ° 49	73 ° 24	2600	SE	37	178	28.00	Cls
	35	34 ° 02	73 ° 24	2560	plain	--	333	175.00	Mdr
	36	34 ° 02	73 ° 24	2560	SE	28	333	84.00	Cls
	37	34 ° 02	73 ° 22	2320	S	31	179	41.00	Mdr
	38	34 ° 14	73 ° 22	2300	S	38	172	20.00	Mdr
T- Kaghan Valley	39	34 ° 54	73 ° 28	2400	S	23	320	66.00	Cls
	40	34 ° 54	73 ° 28	2500	S	33	412	60.00	Cls
	41	34 ° 54	73 ° 52	1600	NE	20	222	56.28	Cls
	42	34 ° 47	73 ° 32	2000	E	35	338	47.00	Cls
	43	34 ° 38	73 ° 24	1900	NW	39	287	96.00	Mdr
	44	34 ° 38	73 ° 32	1650	W	43	410	36.00	Cls
U- Naran	45	34 ° 47	73 ° 33	2500	NW	12	284	50.00	Mdr
V- Alpuri swat	46	34 ° 54	73 ° 23	2350	W	45	325	43.00	Mdr
W- Dassu	47	34 ° 45	73 ° 33	2650	S	40	221	26.00	Mdr

Note: Stn = Stand No, Lat (N) = North latitude, Long (E) = East longitude, Ele (m) = Elevation in meter, Asp = Aspect, Slp (°) = Slope degree, Std = Stand density, Sba = Stand basal area, Cnp = canopy, Opn = Open, Mdr = Moderate, Cls = closed, sct = scattered,

Sampling sites

1 = Dyimeli Kalash, 2 = Gambag Kalash, 3 = Barir Kalash1, 4 = Ziarat mata Khure, 5 = Ziarat, 6 = Goline Gol-1, 7=Madaglask Shesheko, 8 = Shaheed Bala , 9 = Gohkshal Chitral-2, 10 = Ispidiar GNPC, 11 = Bronshal GNPC, 12 = Gol.National.Park Rest House, 13 = Souray Bailo, 14 = Sore Kamar, 15 = Shahikot, 16 = Baraul Banda, 17 = Shalthalo Bala, 18 = Shahi Khwar, 19 = Shahi Awar, 20 = Kumrat, 21= Penhakot, 22 = Janis Kandao, 23 = Shahoor, 24 = Shahoor-1, 25 = Shahoor 2, 26 = Salam Baiky Sar, 27 = Salam Baiky Ghar, 28 = Manji Baba, 29 = Chillas, 30 = Babusar Thak Village, 31 = Kearn Neelam valley-1, 32 = Patriata top-1, 33 = Ayubia Khera Gali, 34 = Ayubia-5, 35 = Kuzah Gali-1, 36 = Kuzah Gali-2, 37 = Thandyani-1, 38 = Thandyani-2, 39 = Shogran-1, 40 = Shogran-3, 41 = Paras Malakundi, 42 = Khanian, 43 = Shinu near Jurait farm-1, 44 = Shinu near Jurait farm-2, 45 = River belt-2, 46 = Shangla pass, 47 = Kohistan.

Table 2. Summary of Phytosociological sampling of 47 stands. Mean importance value index, absolute density ha^{-1}, basal area m^2ha^{-1} and dominant position of deodar and associated tree species are presented. Species are ranked on the basis of importance value index.

S. No.	Name of species	Pst	Importance value index	Density ha^{-1}	Basal area m^2ha^{-1}	Rank		
						1st	2nd	3rd
1.	*Cedrus deodara* (Roxb. Ex Lamb.) G. Don	47	70.45 ± 4.82	184 ± 23	41±6.43	36	8	3
2.	*Pinus wallichiana* A.B.Jackson	25	37.96 ± 5.16	92 ± 21	19.27 ± 4.42	9	15	1
3.	*Abies pindrow* Royle	13	20.26 ± 5.21	54 ± 16	12.41 ± 3.15	2	4	5
4.	*Pinus gerardiana* Wall. ex Lamb.	4	17.97 ± 4.01	46 ± 14	4.31 ± 1.97	-	4	-
5.	*Picea smithiana* (Wall.) Boiss.	4	14.74 ± 5.34	21 ± 12	6.55 ± 2.2	-	3	1
6.	*Juniperus excelsa* M.B.	3	10.50 ± 4.19	24 ± 14	3.37 ± 1.6	-	-	3
7.	*Taxus wallichiana* Zucc.	1	16.52	26	5.37	-	1	-
8.	*Quercus baloot* Griffith	4	9.64 ± 4.1	17 ± 7	0.93 ± 0.23	-	-	1
9.	*Quercus incana* Roxb	4	10.11 ± 4.98	17 ± 8	0.96 ± 0.38	-	1	-
10.	*Juglans regia* L.	2	11.00	16	1.35	-	1	-
11.	*Populus caspica* Bornm	1	11.00	9	0.97	-	-	1
12.	*Aesculus indica* (Wall.ex Camb.) Hk f.	1	4.00	2	1.0	-	-	-
13.	*Acer villosum* Wall.	1	5.00	3	0.60	-	-	1

Note: Pst Number of stands in which a species is present. 1st = Number of stands in first dominant, 2nd = Number of stands on the basis of importance value. Standard deviation not calculated if a species occur in less than four stands.

a. Deodar-*Juglans regia* community: This community was located on lowest elevation (1600m) on North East facing gentle slope of Malakandi (stand 41). Co-dominant angiospermic tree species occupied only 9% of the total importance value with 19 trees ha^{-1}**.** *Cedrus deodara* (30%) attained 96% of the basal area forming closed canopy. *Pinus wallichiana, Quercus baloot* and *Quercus incana* were the associates of this community.

Ground flora was represented by *Rosa webbiana* and *Rubus brunonii* which was recorded in 22% of the sampling plots. *Rosa webbiana* (50%), *Rubus ulmifolius, Hedera nepalensis*, seedlings/sampling of *Quercus ilex* and C*edrus deodara* (30%) were also recorded during circular plot analysis from forest floor.

b. Deodar-*Quercus ilex* community: Shahoor 2 (stand 25) sampling area lies on North West facing moderate slope on 2200m elevation. *Cedrus deodara* showed 75% importance value with 97 individual ha^{-1} and 29.8 m^2ha^{-1} basal area, while co-dominant broad leaved species was present with 26 individual ha^{-1} with a low value of basal area. Deodar seedlings and other angiospermic plants were not recorded in plot study due to patchy nature of distribution**.**

c. Deodar-*Taxus* community: Janas Banda sampling site (stand 22) was located on South facing moderately steep slope on 2120m elevation. About 17% importance value with 26 stem density ha^{-1} was recorded from a co-dominant species *Taxus wallichiana*. *Cedrus deodara* showed higher (83%) importance value with a density of 152 stem ha^{-1}. *Taxus wallichiana* is one of the most disturbed gymnospermic tree of the northern area**.** People use its branches to decorate welcome gates. Therefore it may be suggested that its low values may be related to the continuous cutting for decoration and fuel purposes.

Twelve species including seedlings of leading dominant species were recorded from forest floor in which *Vicia sativa, Medicago denticulata, Rumex hastatus* and *Cynodon dactylon* were recorded 80 to 55% of the circular plots**.** In this community deodar showed good regeneration appearing in 85% of the sampling plots.

d. Deodar-*Picea* community: This community was recorded from Chitral Ziarat on East facing steep slope on 2544m elevation while at Shogran and Kaghan on South facing steep slope on similar elevation (Stand 5, 26, 40, Table 1). At first location co-dominant species *Picea smithiana* has 30% while in 3rd location it showed only 5% of the total importance value. In this location *Abies pindrow* was also associated with similar quantitative value but lower basal area**.** In this community deodar density ranged from 68 to 392 ha^{-1} with 36.98 to 86.45 m^2ha^{-1} basal area.

Ground flora was composed of 15 species in 1st location while only 6 species including deodar seedling were recorded from 2nd location. In these stands commonly found species were *Rumex dentatus*, *Urtica dioica* and *Geranium rotundifolium*. At Ziarat *Fragaria vesca**,** Viola conescens, Tribulus terrestris* and *Aconitum chasmanthus* were dominant species of ground flora, recorded in 40 to 50% of the plots. Shogran 3 (stand 40) sampling site indicated quite different species composition in which *Acer cesium, Pteris* spp.**,** *Rubus fructicosus* and grasses were abundant (16 to 32% plots) on forest floor.

e. Deodar–*Abies* community: This community was recorded at Ziarat Mata Khure (stand 4), Chillas (stand 29), (west facing steep slope on about 2500m elevation) and Kuza Gali 1 (stand 35) on moderate ridge top and almost same elevation. *Cedrus deodara* importance values ranged from 50 to 76%. High density ($233ha^{-1}$) and highest basal area ($159m^2ha^{-1}$) was recorded from Chilas while lowest (37 ha^{-1}) density and basal area

($31m^2ha^{-1}$) was recorded from Ziarat Mata Khure. Beside first two dominant species, other associated tree species were quite different in each area. At Ziarat *Picea smithiana*, at Chilas, broad leaved species, *Acer villosum*, *Aesculus indica* and *Quercus incana* while at Kuza Gali 1, *Pinus wallichiana* was recorded as other associates.

Ground flora in three locations is also quite different, and 15, 24 and 6 species were recorded respectively. Beside seedling/sampling of first two dominant species and *Barberis lycium* (common in first two locations), no floristic similarity is found on group flora. This may be due to the difference in climatic zones, microclimatic situation and the local factors.

Most abundant species of Ziarat was *Viola canescens* (70% of the circular plots)**.** *Aconitum chasmanthus***,** *Aquilegia nivalis***,** *Aconitum leave***,** *Geranium rotundifolium***,** *Astragalus amherstianus* and *Fragaria vesca* were recorded in 40 to 50% of the circular plots. At Chilas, ground flora was comprised with *Nepeta clarkei***,** *Rosa webbiana***,** *Clematis Montana***,** *Rubus ellipticus* and *Ranunculus muricatus* (50 to 90% plots). Kuza Gali 1 was represented by poor *ground flora* and consisted of *Acer cesium***,** *Pteris cretica* and *Andropogon lancifolius* only. At all three places large number of deodar seedling and sampling were recorded**,** indicating survival potential of this species.

f. Deodar. *Pinus gerardiana* community: Since co-dominant species *Pinus gerardiana* restricted to drier sites of dry temperate area**,** this community was recorded at four locations of Chitral and Dassu (stand No 1-2-12-47, Table 2). It occurred**,** predominantly South facing gentle (24^o) to extreme steep slopes (40^o) on 2073 to 2900m elevation in Kalash Valley**,** Chitral Gol National Park and Kohistan. In these communities *Cedrus deodara* occupied from 43% to 88% importance value**,** while co-dominant species *Pinus gerardiana* showed 9% to 28% importance value**.** At Dyimeli Kalash (stand 1), *Quercus baloot* was associated with 22% of the importance value while there was a slight difference in density ha^{-1} with co-dominant species.

Abies pindrow was associated as a third dominant species at Gambag Kalash**,** with 16% importance value and 43 trees ha^{-1}. Its basal area m^2ha^{-1} was higher than co-dominant species. This community has considerable amount of *Pinus wallichiana***,** *Quercus baloot* and *Quercus dilatata* with low basal area m^2ha^{-1}**.** A localized climatic and edaphic situation created in dry temperate area where a moist temperate species *Abies pindrow* and *Pinus wallichiana* can survived and propagate. Similar situation also exist at 2900m elevation on one site of Tukht-e-sulamain Baluchistan**,** where *Pinus gerardiana* was associated with *Pinus wallichiana* and later at higher elevation *Pinus gerardiana* was completely replaced by *Pinus wallichiana*. Around the rest house of Gol National Park on 2927m elevation another dry temperate species *Juniperus excelsa* appeared with 63 density ha^{-1}, and 23 m^2ha^{-1} basal area**,** though it importance value was only 3%.

As far as ground flora is concerned, both valleys of Kalash show floristic similarities**.** However, ground flora do not contain seedlings and samplings of first two dominant species. Both area showed *Impatients brachycentra*, *Delphinium ajacis***,** *Sambucus wightiana***,** *Echinops cornigerus***,** *Fragaria vesca***,** *Pedicularia rotundata*, *Pedicularia chitralensis* and *Consolida ambigua*. Area closed to rest house at Gol National Park**,** is highly disturbed due to anthropogenic disturbance. Besides germinating seedling of *Cedrus deodara* and *Pinus gerardiana***,** *Rosa webbiana*, *Artimesia maritima* and *Impatiens brachycentra* were recorded from ground surface**.** At Kohistan 31 associated species were recorded from forest floor in which *Berberis lyceum, Stachys emodi, Rubus ellipticus, Ranunculus muricatus***,** *Impatiens brachycentra* and *Adiantum venustam* were abundant and found in 40 to 70% of the circular plots.

g. Deodar–*Pinus wallichiana* community: It is the most prominent combination of species and widely distributed community of the study area**.** This community was recorded at 22 different locations from 1950m elevation to 2700m elevation on moderate (23^o) to very steep (45^o) slopes. At many places the canopy was open.

On the basis of importance value, at some locations, this community may be designated as *Pinus wallichiana* – deodar community. Stands No. 7, 13, 14, 17, 20, 21, 37 and 38. In these stands importance values of *Pinus wallichiana* were higher than deodar. Stands in which deodar appeared as a first leading dominant (stands No. 8, 10, 11, 19, 30, 31, 32, 33, 39, 42, 43, 46) its importance values ranged from 60% to 85% while in stands where *Pinus wallichiana* is the leading species I.V of deodar ranged from 19% to 53% with density 15 to 110 ha^{-1}. Importance value ranged from 56 to 81% and 40 to 276 density ha^{-1} of *Pinus wallichiana,* were recorded in those stands where this species appeared as a leading dominant. In these stands a broad leaved species *Populus caspica was* associated as a third dominant and a few trees of *Abies pindrow* were recorded only at Kumrat (stand 20).

Stands dominated by deodar, contained *Juniperus excelsa* (stand No. 10 and 30) as a third dominant species, occupying 19 to 11% importance value and 52 to 9 ha^{-1} density respectively. *Abies pindrow* were the other associates with considerable density and basal area values in stand No. 30. This species (*Abies pindrow*) was also recorded as a third dominant species at Khaira Gali, Shogran and Shangla Pass (stands 33, 39, 46). In two locations (stands 34 and 36), on the basis of highest importance value index, this could be regarded as *Abies – Pinus wallichiana* community.

Like other communities, ground flora of this community also exhibit different floristic composition. Some dominant non tree species were *Acer caesium, Pteris cretica***,** *Rosa webbiana***,** *Podophylum emodi* and *Berberis lycium* etc**.**

h. Monospecific deodar forest: At 12 locations, deodar is recorded as a single dominating species. These sampling stands were located at the elevation of 1650m to 2770m and 12 to 50^o steep slopes. In these monospecific stands deodar density ranged from 99 to $457ha^{-1}$ with 6.35 to 115 m^2ha^{-1} basal area. In these areas, community was not recognized and the stands were named based on the only dominant species. These stands are distributed mainly in dry temperate areas however pure deodar stands were also recorded in moist temperate areas, showing wide ecological amplitude. Ten to 19 non tree species, including seedling of deodar were associated on forest floor, under the pure stands of *Cedrus deodara*, however poor floristic similarities exist among different stands. A complete list of these species is available from the senior author. However, following are the widely spread under storey plants i.e., *Viola canesens* was occupied 30 to 85% of the circular plots at 6 different locations (stand No. 3, 15, 16, 18, 23, 28). *Rumex dentetus* found in 45 to 75% plots in stand No. 15 and 16, while *Vicia sativa* were recorded in stand No. 15, 16, 23 and 28 with 30 to 80% frequency. In stand No. 9, *Rosa webbiana, Ormoeterum tuberosum* and *Ferula assafoetida* were distributed in 7 to 90% of the plots, while in stand No. 27 *Oxalis corniculata, Indigofera heterantha* and *Anagallis arvensis* were recorded in 45 to 55% plots. Stand No. 28 was supporting *Viola conesens, Medicago denticulata* and *Mentha longifolia* (50 to 75% plots) while stand No. 45 had *Vebrascum nerusum* and *Clematis montana* in 40% of the plots. No vegetation was recorded underneath *Cedrus deodara* in stand No. 6, 24 and 44 due to scattered and patchy nature of ground flora.

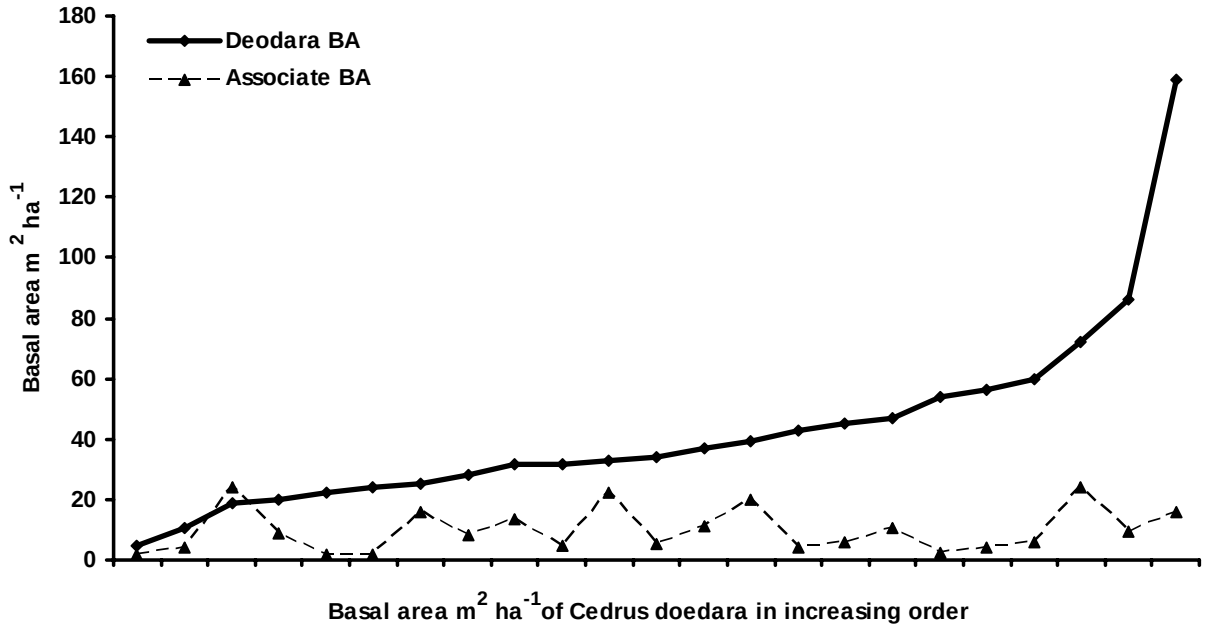

Fig. 2. Basal Area m2 ha-1 of *Cedrus deodara* and associated species of some stands, dominating by deodar.

In the present study above mentioned 8 deodar forest types were recognized however, on the basis of the description given, it is possible to recognize 11 deodar forest types, defined by their co-dominant species. It is recorded that in most cases the co-dominant species of any particular deodar type is also prominent in other deodar type and much overlap in species composition exists. When the floristic composition was the only criterion, the number of types were reduced and Deodar – *Abies* community may be merged into Deodar – *Pinus wallichiana* community. In addition due to cutting, logging and disturbance it was not possible to properly recognize any particular community specially in similar floristic condition (tree species) of the stands.

Does deodar compete with associated species?: The basal area of deodar dominated stands is displayed in Fig. 2, in order of increasing values and compared with the basal area of other associated species. It is evident that, the basal area of deodar is higher than the sum of basal areas of the other members of the community**.** Deodar basal area shows a higher variance than that of associates**.** Similarly**,** the density of deodar was also compared with the density of other associates and similar trends were observed. Lesser basal area and density of deodar in some stands may be due to the cutting of the deodar trees in those stands. Furthermore, no correlation is observed between deodar basal area and that of "the rest"**.** A negative non significant correlation with a wide variance was also observed between deodar and associates density. One explanation of these results is that deodar and its associates are in a sense independent**;** the larger basal area and density does not depress the other members of the community.

These results are similar to the forest dominated by Araucaria in New Guinea (Enright, 1982a, b) and *Agathis australis* in New Zealand (Ahmed 1984). Enright (1982b) considers that this may be a unique phenomenon of this species, while Fedorow (1966) concluded that the dominant species of tropical rain forest never suppress other species. Whether or not reduction in competition with associated understory species is a common feature of complex forest as suggested by Fedorow (1966) or rare, (as implied by Enright) cannot be addressed here, however, due to highly disturbed nature of many

deodar forests in Pakistan, further investigation is required before making any conclusion about this phenomenon. Therefore, this phenomenon does draw attention to the need to study the life cycles and dynamics of dominant species to understand their ecological role in the forest.

Acknowledgement

The work was supported by WWF Pakistan, grant no 50040901 and partially from Higher Education Commission grant for foreign professor.

References

Ahmed, M. 1976. Multivariate analysis of the vegetation around Skardu. *Agri. Pak*., 26: 177-187.

Ahmed, M. 1984. *Ecological and dendrochronological studies on Agathis australis Salisb, Kauri*. Ph.D. Thesis. University of Auckland. New Zealand.

Ahmed, M. 1986. Vegetation of some foothills of Himalayan range of Pakistan. *Pak. J. Bot*., 18(2): 261-269.

Ahmed, M. 1988a. Plant communities of some northern temperate forests of Pakistan. *Pak. J. Forest*, 38: 33-40.

Ahmed, M. and S.A. Qadir. 1976. Phytosiological studies along the way of Gilgit to Gopis, Yasin and Shunder. *Pak. J. Forest*, 26: 93-104.

Ahmed, M., T. Hussain, A.H. Sheikh, S.S. Hussain and M.F. Siddiqui. 2006. Phytosociology structure of Himalayan Forest. from different climatic zones of Pakistan. *Pak. J. Bot*., 38(2): 361-382.

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

Amin, A. and R.M. Ashfaque. 1982. Phytosiological studies of Ayub National Park, Rawalpindi. *Pak. J. Forest*, 32: 130-135.

Beg, A.R. 1975. *Wildlife habitats of Pakistan*. Bull, No. 5. Pak. Forst. Inst.

Beg, A.R. and M.H. Khan. 1984. Some more plant communities and the future of dry oak forest zone in Swat valley. *Pak. J. Forest*, 34: 25-35.

Brown, R.J and J.J. Curtis. 1952. The upland conifer-hardwood communities of southern Wisconsin. *Ecol. Monog*., 22: 217-234.

Champion, H., S.K. Seth and G.M. Khatlak. 1965. Forest types of Pakistan. Pak. For. Inst. Peshawar.

Cottam, G and J.T. Curtis. 1956. The use of distance measures in phytosociological sampling. *Ecology*, 37(3): 451-460.

Durrani, M. Jan and F. Hussain. 2005. Ethno ecological profile of plants of Harboi rangeland, Kalat, Pakistan. *Inst. J. Bio. Biotech*., 2(1): 15-22.

Enright, N.J. 1982a. Araucaria forests of New Gunea-monographiae Biologicae, vol. 42: (Ed.): J.L. Gressitt & W. Junk Publishers, The Hague. 381-99.

Enright, N.J. 1982b. Short note – Does *Araucaria hunsteinii* compete with its neighbours? *Australian Journal of Ecology*, 7: 97-99.

Fedorow, A. 1966. The structure of the tropical rainforest and speciation in the humid tropics. *Journal of Ecology*, 54(1): 1-11.

Hussain, F. and A. Shah. 1989. Phytosociology of the vanishing subtropical vegetation of Swat with special reference to Docut Hills. I: Winter Aspect. *Sci. Khyber*, 2: 27-36.

Hussain, F. and I. Illahi. 1991. *Ecology and vegetation of Lesser Himalayan Pakistan*. Bot. Dept. Uni. of Peshawar, pp. 187.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of vegetation Ecology. John Wiley and Sons. Inc., New York. 547 pp.

Qadri, M.Z.H. 1986. *Phytosociological study on the vegetation of Kotli Hills, Azad Kashmir*, M.Phil Thesis. Bot. Dept. Peshawar University, 211 pp.

Rafi, M. 1965. *Vegetation types of Baluchistan Province*. Pak. Govt. Printing Press, Punjab, Lahore, Pakistan.

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

Wahab, M., M. Ahmed and N. Khan. 2008. Phytosociology and dynamics of some pine forests of Afghanistan. *Pak. J. Bot*., 40(3): 1071-1079.

(Received for publication 17 October 2009)