Vegetation Studies of Girbanr Hills, District Swat, Pakistan

Hussain, Farrukh, Mohammad Ilyas and Bong-Seop Kil*

Phytoecology Lab., Department of Botany, University of Peshawar, Pakistan

*Department of Biology Education, Wonkwang University, Republic of Korea**

Girbanr Hills의 식생

Hussain, Farrukh · Mohammad Ilyas · 길봉섭*

Pakistan Peshawar대학교 식물학과 · 원광대학교 생물교육과*

ABSTRACT

Five non-stratified plant communities, *Dichanthium-Artemisia-Themeda, Dichanthium-Plectranthes -Themeda, Plectranthes-Carex-Myrsine, Heteropogon- Dichanthium-Dodonaea* and *Artemisia-Cynodon-Berberis* were recognized in Girbanr hills, District Swat, during autumn, 1992.

The indices of similarity showed that the communities were dissimilar. The percentage of leptophyllous and nanophyllous, therophytic and nanophanerophytic species were higher than other groups. These indicate dry and disturbed conditions. Due to autumn season most of the species were entering in dormant stage. There was no tree layer on southern slopes while northern slopes had a poor layer of *Pinus roxburghii.*

Deforestation, uprooting, terrace cultivation and overgrazing followed by erosion are the main ecological problems. The presence of isolated trees of *Pinus roxburghii* and stunted *Olea ferruginea* indicate that the original vegetation might have been of chirpine or *Olea-Pinus* type. The area having resource potential can be changed into a forest or rangeland by proper protection and management. Suggestions in favour of improvement are given.

Key words: Biological spectrum, Community structure, Indices of similarity, Leaf spectra, Phenological classification, Vegetation studies

INTRODUCTION

Girbanr hills are situated in the northwest of Saidu Sharif at a distance of 11km from Mingora. The average elevation of the area varies from 1,025~1,630m from mean sea level. It lies between latitude 34°50′ to 34°53′N and longitude 72°16′ to 72°20′E in Swat District. The hills run east-westwardly and is distinguished into distinct north and south facing slopes.

Sub-tropical vegetation in Pakistan and adjoining parts is under tremendous biotic-pressure including deforestation and overgrazing. This has caused the change in the original vegetational composition and at present these forests are in the form of degraded scrub or grassland, which are dominated by non-palatable and less-preferred species. Some studies in the sub-tropical zone of Pakistan have been carried out. Beg and Khan (1984) reported the present situtation of the leftover vegetation in dry oak forest zone of Swat. Malik and Hussain (1987) analyzed the vegetation around Muzaffarabad. Phytosociological studies of Badana and Palalan hills near Kotli were reported by Malik and Hussain (1988). Malik *et al.* (1990) reported the vegetation studies of Sund Galli near Muzaffarabad. Malik and Hussain (1990) presented phytosociology of some parts of Kotli hills. Hussain and Shah (1989) and Hussain *et al.* (1992) analyzed the leftover vegetation of sub-tropical forests in Docut hills Swat, and Hussain and Ilahi (1991) gave an account of the sub-tropical forests of Lesser Himalayas. However, no such reference exists on the vegetation of Girbanr hills.

The present endeavors were, therefore, carried out to determine the present status of the leftover vegetation and to suggest measures for the improvement of the area and afforestation. The findings will be of interest to ecologists, foresters, range and natural resource managers and taxanomists.

MATERIALS AND METHODS

Girbanr hills have distinct north and south facing slopes each of which were divided into three altitudinal zones. Thus two sites each on north and south facing slopes and one site on top of the hill were established. The vegetation was analyzed using 10×14m, 10×14m and 1×1m quadrat, respectively for trees, shrubs and herbs. Twenty quadrats were laid randomly for trees, herbs and shrubs in nested manner (Hussain 1989). The herbage cover was determined by Daubenmire's cover scale (Daubenmire 1959) and basal area coverage/basal area recorded in each quadrat were converted to relative scales (Hussain 1989) and added together to get importance values (Hussain 1989). The communities were named after the three leading dominants (Hussain 1989). Indices of similarity and dissimilarity were calculated by Sorenson's index (Sorenson 1948) and matrix of the number of common species was calculated after Hussain and Tajul-Malook (1984). Leaf spectra was determined after Raunkiaer (1934), while biological spectrum was calculated after Raunkiaer (1934) and Hussain (1983). The study was conducted during October-November, 1992. Soil samples were collected from each stand upto a depth of 15cm and were analyzed in soil testing laboratory of Agriculture Research Institute, Tarnab, Peshawar, Pakistan, using methods described by Hussain (1989). Nomenclature followed here is that of Stewart (1972).

Table 1. Chemical analysis of soil of different sides in Girbanr hills

Site	pH	Electrical Conductivity EC×10^3	$CaCO_3$ (%)	Organic matter (%0	N(%)	T.S.S. (%)	P (ppm)	K (ppm)
Southern slopes (1,025~1,225m)	7.6	0.23	8.25	3.17	0.159	0.073	1.91	238
Southern slopes (1,225~1,425m)	7.8	0.24	7.25	2.97	0.148	0.077	10.95	161
Top hills (1,425~1,630m)	7.5	0.20	0.75	3.00	0.150	0.064	2.36	119
Northern slopes (1,225~1,425m)	7.5	0.09	0.75	2.28	0.114	0.029	4.28	170
Northern slopes (1,100~1,225m)	7.4	0.12	2.25	2.97	0.148	0.038	1.74	85
Springside at northern slopes (1,025~1,100m)	7.4	0.27	9.25	1.38	0.069	0.086	1.91	153

RESULTS

Soil analysis

The soils of Girbanr hills in general were sandy loam except the spring sides where it was silt loam. The sand fraction varied from 36.8~70.8%. Silt varied from 10~48%, while clay varied from 13.2~19.2%.

The soils in general were slightly basic in nature with pH ranging from 7.4~7.8. The electrical conductivity varied from 0.09~0.27 EC×10^3. The percentage of organic matter was generally high varing from 1.38~3.17%. Amount of $CaCO_3$ varied from 0.75~9.25%. Total soluble salts varied from 0.029~0.086%. The percentage of nitrogen in these soils was low, varing 0.069~0.15%. Potassium ranged from 85~228ppm, while phosphorus contents varied from 1.74~10.95ppm (Table 1).

Community structure

1) ***Dichanthium-Artemisia-Themeda*** Community (DAT)

This community consisting of 32 species was present on the foot hills of southern slopes at an elevation of 1,025m. The dominant members were *Dichanthium annulatum* (IV=53.33), *Artemisia scoparia* (IV=31.34) and *Themeda anathera* (IV=29.05). *Heteropogon contortus* and *Aristida* sp. were the co-dominants. Ten species were common and seventeen species had low importance values in this community (Table 2). Sandy loam soil had pH 7.6, $CaCO_3$ 8.25%, K 238ppm, organic matter 3.17%, total soluble salts 0.073%, N 0.159% and P 1.91ppm. Electrical conductivity was 0.23 EC×10^3 (Table 2). This community is

Table 2. Importance value of main species in different plant communities of Girbanr hills, District Swat investigated during Autumn, 1992

Species	Communities				
	DAT	DPT	PCM	HDD	ACB
Aristida adscensianis	3.42	6.64	–	4.14	12.68
Aristida sp.	22.50	3.93	8.03	3.46	4.05
Artemisia scoparia	31.34[2]	9.49	8.03	8.87	31.68[1]
Berberis lycium	–	–	12.66	11.54	13.36[3]
Calotropis procera	6.68	18.61	–	–	–
Carex longipes	–	–	21.28[2]	–	–
Cynodon dactylon	6.83	–	–	–	16.37[2]
Dichanthium annulatum	53.33[1]	41.66[1]	5.65	21.44[2]	9.12
Dodonaea viscosa	3.18	7.00	4.97	18.05[3]	–
Heteropogon contortus	26.25	15.36	5.98	61.51[1]	6.89
Indigofera heterantha var. *heterantha*	8.85	16.64	2.83	2.71	–
Myrsine africana	–	–	14.60[3]	–	–
Nerium odorum	–	–	–	–	12.96
Otostegia limbata	4.50	11.97	4.09	3.21	–
Periploca aphylla	5.52	17.28	9.29	–	–
Plectranthes coetsa	6.78	23.98[2]	45.23[1]	16.81	12.65
Rumex hastatus	–	13.53	14.02	8.54	13.34
Themeda anathera	29.05[3]	20.21[3]	4.97	7.62	5.68

Keys for communities : DAT, *Dichanthium-Artemisia-Themeda* community; DPT, *Dichanthium-Plectranthes-Themeda* community; PCM, *Plectranthes-Carex-Myrsine* community; HDD, *Heteropogon-Dichanthium-Dodonaea* community; ACB, *Artemisia- Cynodon-Berberis* community.

Note : 1, 2, 3 indicate 1st, 2nd and 3rd dominant species in each community.

under great biotic pressure in the form of overgrazing and uprooting of shruby species.

2) *Dichanthium-Plectranthes-Themeda* Community (DPT)

This community harboured middle southern slopes (Alt. 1,225~1,425m). *D. annulatum* (IV=41.66), *Plectranthes coetsa* (IV=23.98) and *T. anathera* (IV-20.21) were the dominants. *Indigofera heterantha* var. *heterantha*, *Calotropis procera* and *Periploca aphylla* were the associated species with importance value of up to 18 (Table 2). Fifteen species were common in their occurrence while six species registered low status in the community. There were 26 species in the area. Sandy loam soil had a pH 7.8, $CaCO_3$ 7.25%, organic matter 2.97%, total soluable salts 0.077%, N 0.148%, P 10.95ppm, K 161ppm and electrical conductivity 0.24 $EC \times 10^3$. This community receives more solar radiation. The slopes are steep and mostly bare. There is no tree species in this community. The community represents a xerophytic condition.

3) *Plectranthes-Carex-Myrsine* Community (PCM)

This community was recongnized at the top of the hill (Alt.=1,424~1,630m). *P. coetsa*

(IV=45.23), *Carex longipes* (IV=21.28), and *Myrsine africana* (IV=14.60) were the dominants. *Rumex hastatus* and *Berberis lycium* with importance value of 14.02 and 12.66 were the co-dominant species (Table 2). Seventeen species were common and 20 species had importance values less than 5. There were 42 species. Soil is characterized by sandy loam texture, pH 7.5, $CaCO_3$ 0.75%, organic matter 3% and N 0.15%, total soluble salts 0.064%, P and K, 2.36 and 119ppm, respectively, and EC 0.2 $EC \times 10^3$ (Table 2). The community is less accessible to grazing animals, therefore species diversity and coverage was high.

4) *Heteropogon-Dichanthium-Dodonaea* Community (HDD)

This community was present on the northern slopes (Alt.=1,225~1,425m), and was dominated by *H. contortus, D. annulatum* and *Dodonaea viscosa* having importance values of 61.51, 21.44 and 18.05, respectively (Table 1). *P. coetsa* (IV=16.81), *B. lycium* (IV=1,154) were co-dominant species (Table 2). Ten species were common and 26 species had low importance values in this community. In all there was 43 species.

Soil sandy loam had a pH 7.5, $CaCO_3$ 0.75%, organic matter 2.28%, N 0.114%, total soluble salts 0.029%, P 4.38ppm, K 170ppm and EC was 0.09 $EC \times 10^3$. The species number was higher than all other communities as 43 species including 9 grasses were recorded in this community. Deforestation appears to be a major problem. *Pinus roxburghii* is intensely removed, therefore, it has an importance value 3.42 as a shrub and 7.9 as tree layer, in the leftover vegetation.

5) *Artemisia-Cynodon-Berberis* Community (ACB)

The community was estabilshed on the northern slopes (Alt. 1,025~1,225m). *A. scoparia* (IV=31.68), *Cynodon dactylon* (IV=16.37) and *B. lycium* (IV=13.36) were the dominants (Table 1). *R. hastatus* (IV=13.34), *Nerium odorum* (IV=12.29), *Aristida adscensionis* (IV=12.68) and *P. coetsa* (IV=12.65) were other important species (Table 2). The remaining 32 species had low importance in the community. The soil was sandy loam with pH 7.4, $CaCO_3$, organic matter and N were 2.25, 2.97 and 0.148%, respectively. Total soluble salts were 0.038% while P and K were 1.74 and 85ppm, respectively. EC was 0.12 $EC \times 10^3$.

Due to the presence of some perennial springs in the site the community shows a mesic conditions. Some water loving plants like *Imperata cylendrica, Saccharum spontaneum, N. odorum, Ficus foveolata, C. dactylon* and *Platanus orientalis* were also present.

Indices of similarity

The highest similarity was observed between PCM and HDD communities (54.32%), and between DAT and DPT communities (53.75%). Similarity values between 44.47% to 46.2% were recorded for HDD and ACB communities, DPT and HDD communities, DPT and PCM communities. Least similarity of 27.92% was achieved for DAT and PCM communities. On the whole these communities differed from each other by at least 46.25% to

Table 3. Matrices of indices of dissimilarity (ID) and similarity (IS) in percentage for the 5 autumn plant communities of Girbanr hills

Communities		ID				
		DAT	DPT	PCM	HDD	ACB
	DAT	×	46.25	72.08	60.97	68.81
	DPT	53.75	×	55.53	54.73	65.51
IS	PCM	27.92	44.47	×	45.68	64.53
	HDD	39.03	45.27	54.32	×	53.80
	ACB	31.19	34.49	35.47	46.20	×

Key for communities is given in Table 2.

Table 4. Matrices of number of common species and their percentage (within parenthesis) between the plant communities of Girbanr hills during autumn 1992

Communities	Communities				
	DAT	DPT	PCM	HDD	ACB
DAT					
DPT	18(45)				
PCM	18(32.14)	20(41.66)			
HDD	18(31.58)	19(38)	32(60.38)		
ACB	13(22.41)	14(27.45)	16(26.62)	25(43.86)	

Key for communities is given in Table 2.

a maximum of 72.08% (Table 3).

The matrix of number of common species and their percentages

The highest number of common species (60.38%) were shared between PCM and HDD communities. DAT and DPT communities, HDD and ACB communities, DPT and PCM communities, shared moderate number of species. They shared 18, 25 and 20 species representing 45%, 43.86% and 41.66%, respectively (Table 4).

The lowest number of species (22 to 27%) were shared between DPT and ACB communities, PCM and ACB communities, DAT and ACB communities. There is close agreement between the values for similarity indices (Table 4) and matrices of common species between the communities.

Leaf spectra

Leaf spectra based on leaf size classes of Girbanr hills during Autumn (Oct.-Nov.) 1992 is shown in Table 5.

The overall vegetation area was dominated by leptophylls. Out of the total 78 species, 35 (44.87%) were leptophylls (Table 5). Nanophylls and microphylls were the second and third dominating groups having a contribution of 25.64% and 21.79%, respectively. Mesophylls had the least contribution of 7.69%, and microphylls and mesophylls were totally absent in the study area. The reduction in size of leaf indicate dry and xeric con-

Table 5. Leaf spectra of the plant communities of Girbanr hills during autumn, 1992

Communities	Total species	Leptophylls No.	%	Nanophylls No.	%	Microphylls No.	%	Mesophylls No.	%	Remarks
DAT	32	17	53.12	9	28.12	3	9.37	3	9.37	LN
DPT	26	12	46.15	10	38.46	2	7.69	2	7.69	LN
PCM	42	19	45.24	14	33.33	8	19.05	1	2.38	LN
HDD	43	21	48.89	11	25.58	8	18.60	3	6.98	LN
ACB	39	19	48.72	9	23.08	8	20.51	3	7.69	LN
As a whole	78	35	44.87	20	25.64	17	21.79	6	7.69	LN

LN = Lepto-nanophyllous community.
Key for communities is given in Table 2

Table 6. Biological spectrum of the plant communities of Girbanr hills established during autumn 1992

Communities	Total species	MP No.	%	NP No.	%	Ch No.	%	H No.	%	L No.	%	Th No.	%	Remarks
DAT	32	–	–	9	28.12	4	12.50	5	15.62	–	–	14	43.75	TN
DPT	26	–	–	8	30.77	6	23.08	6	23.08	–	–	6	23.08	NP
PCM	42	1	2.38	18	42.86	5	11.90	7	16.66	–	–	11	26.19	NT
HDD	43	1	2.33	17	39.53	2	4.65	8	18.60	1	2.33	14	32.56	NT
ACB	39	2	5.13	8	20.51	3	7.69	13	33.33	–	–	13	33.33	TH
As a whole	78	3	3.85	24	30.77	8	10.26	15	19.23	1	1.28	27	34.62	TN

Keys for life form : MP, Macrophanerophyte; NP, Nanophanerophyte; Ch, Chamaephyte; H, Hemicryptophyte; L, Liana; Th, Therophyte. TN = Thero-nanophanerophytic, NP = Nanophanerophytic, NT = Nanophanero-therophytic, TH = Thero-hemicryptophytic.

dition. The climatic condition is sub-tropical dry chirc pine type. All the five communities are classified as lepto-nanophylls type while overall vegetation also belongs to the same category.

Biological spectrum

The biological spectrum based on life forms is presented in Table 6.

Three species (3.85%) were macrophanerophytes, 24 spp. (30.77%) were nanophanerophytes, 8 spp. (10.26%) were chamaephytes, 15 (19.23%) were hemicryptophytes, 27 spp. (34.62%) were therophytes and only 1 spp. (1.28%) was liana (Table 6).

The overall vegetation is of thero-nanophanerophytic type. These four communities slightly differ from each other in their life form structure, all of them having therophytes or nanophanerophytes as first or second dominants. The only exception is that of ACB community where hemicryptophytes also emerged as dominant but having equal value to that of therophytes.

It was assumed that the original vegetation used to be of macrophanerophytic type which changed to therophytic due to intense human influences in the form of logging and

Table 7. Distribution of plants in different phenological stages during autumn, 1992 and summer, 1993

Phenological stage	Season			
	Autumn(Oct~Nov) 1992		Summer(May~Jun) 1993	
	No.	%	No.	%
Veg-1	–	–	4	3.42
Veg-2	4	5.13	36	30.77
Veg-3	34	43.59	4	3.42
Fl-1	1	1.28	11	9.40
Fl-2	4	5.13	16	13.68
Fl-3	10	12.82	20	17.09
Fr-1	2	2.56	8	6.84
Fr-2	9	11.54	9	7.69
Fr-3	14	17.95	9	7.69
TOTAL	78	100	117	100

Key for phenological stages; Veg-1, Seedling stage; Veg-2, Vegetatively mature but yet no floral buds; Veg-3, After completion of life cycle (Dormant); Fl-1, Mostly floral buds with occasional flowers; Fl-2, All flowers blooming; Fl-3, Plant blooming with initiation of occasional fruiting; Fr-1, Some fruits present; Fr-2, Mostly fruiting; Fr-3, Fruits mature and start dispersal.

deforestation of woody species.

Phenological classification

In autumn season most of the species were entering in the dormant stage of their life cycle representing vegetative stage-3(Veg-3). Of the total 78 species 43.59% species were in this stage. The second dominant group of plants had mature fruits and had started dispersal representing Fr-3 stage. They were 17.95%. In Fr-1 and Fr-2 stages there were 2.56% and 11.54% species, respectively. In Fl-1, Fl-2 and Fl-3 stages representing the flowering stages there were 1.28, 5.13 and 12.82% species, respectively. Some 5.13% species were vegetatively mature but had no flowering buds and were placed in Veg-2. No species was recorded in the seedling stage (Veg-1) during this season (Table 7). In this area autumn season starts from October to November. The environmental conditions become unfavourable and the plant start entering in the dormant phase.

DISCUSSION

The climate and vegetation of Girbanr hills as a whole is of subtropical chir pine type (Hussain and Ilahi 1991). However, due to the marked differences in edaphic, physiographic, and local climatic conditions in the different slopes at different elevation, they support various communities (Ahmad 1986).

D. annulatum, A. scoparia, T. anathera, P. coetsa, C. longipes, M. africana, H. contortus, C. dactylon, D. viscosa and *B. lycium* are the dominant plants of the area, appearing as dominants of various categories in different communities. Most of the dominant species are grasses and in all the communities at least one dominant is grass. The dominance of grasses may be due to their allelopathic potential (Rice 1984), high seed output (Burton 1944), patch forming habit (Malik 1986) and openness of the area (Salim and Shahid 1973). *D. annulatum* (Dirvi and Hussain 1979) and *C. dactylon* (Hussain and Khan 1987) have been found strongly allelopathic. Among the other dominant species *Artemisia* is also allelopathic (Hussain and Khanum 1982). It's dominance may also be due to the sandy nature of the site. The dominance of *D. viscosa* may be due to the dryness of the site (Salim and Shahid 1973).

On the basis of leaf size classes the area was dominated by small leaved plants. The reduction in size of leaf indicate dry and xeric condition, and dry sub-tropical climate (Cain and Castro 1959). In xeric habitats xeromorphism, besides other characters, is exhibited by reduction in leaf size (Malik 1986).

Biological spectrum is an important physiognomic attribute which has been widely used in vegetation studies (Qadir and Shetvy 1986). The life form spectra are said to be the indicators of climate, microclimate and mesoclimate (Shimwell 1971). Habitat conditions also are indicated by them (Braun-Blanquet 1932). Biological spectrum also help indicating the biotic interaction (Malik 1986). The overall vegetation of Girbanr hills is dominated by therophytes. The prevalence of therophytes as the dominant reflects that the environmental condition or human influences are probably not very well suited to the phanerophytes especially macrophanerophytes. Desertification reduces the macro-elements and thereby therophytes appear to occupy the vacant niches (Malik 1986). The plant climate is potentially phanerophytic but has been reduced to therophytic by intense biotic exploitation (Rajwar and Gupta 1984).

Another most important ecological problem of Girbanr hills is the overgrazing and browsing of cattles including goats, sheep, cows and donkeys. The vegetation experiences severe biotic stress and strain due to heavy grazing (Hussain 1981). No species can reach its climax stage in the presence of intensive overgrazing (Shah 1993). The overexploited vegetation assumes sparse, patchy and scattered pattern with few unhealthy, stunted and isolated plants providing chance to non-palatable species to spread efficiently. Girbanr hills has a variety of palatable grasses, including *T. anathera, D. annulatum, H. contortus, Aristida* sp. and *Cymbopogon* etc. *D. annulatum* and *T. anathera* has been assumed to have prostrate and patchy habit due to intensive overgrazing. High frequency and low canopy coverage of these grasses is an indicator of overgrazing (Hussain 1981). Stresses such as grazing, browsing and trampling are more important than edaphic factors in determining the community composition and modifies the original vegetation pattern (Karagiannakidou and Kokkini 1988). Soil erosion is a side effect of the ill-managed grazing, which causes the loss of top fertile soil (Hussain 1981). Overgrazing indirectly accelerates soil erosion by reducing plant cover and regeneration (Hussain and Ilahi 1991). Marked differences prevail in the overgrazing and non-grazed areas (Noor 1978).

Erosion comes in scene where malpractices such as overgrazing, deforestation or fire and other misuses of the natural vegetation becomes usual. During the degradational process of any climax vegetation to barren land or desertification, erosion probably gives the finishing touch to the picture.

The present study indicated that Girbanr hills had high potentialities for forest, and rangeland. Proper protection, afforestation and management can return the original vegetation. If properly protected, *P. roxburghii, D. viscosa, B. lycium, I. heterantha* var. *heterantha,* and *P. coetsa* would attain the climax status. Plants as well as animals including birds would find the protected habitat suitable for themselves. This will ultimately lead to the increase in productivity both at primary and secondary level (Malik and Hussain 1990). Moreover, these are our bioresources that must survive for us and our future generations. Any effort directed for improving these degraded sites cannot be successful without the cooperation of local inhabitants.

적 요

1992년 Pakistan의 Girbanr hills에서 조사한 비충상 식물군락은 다음과 같다. 즉, *Dichanthium-Artemisia-Themeda, Dichanthium-Plectranthes-Themeda, Plectranthes-Carex-Myrsine, Heteropogon-Dichanthium-Dodonaea, Artemisia-Cynodon-Berberis* 군락이 그것이다. 군락간 유사도지수는 낮고 연면적 25mm^2 이하인 leptophyllous 와 25~225mm^{2}인 nanophyllous식물, 일년생식물과 왜형지상식물의 출현율이 비교적 높았다. 이는 조사지가 건조하고 그곳 식물이 훼손된 상태라는 것을 의미한다. 또 가을철이 되면서 대부분 식물은 휴면기에 들었다. 남사면에는 교목층이 없으나 북사면에는 *Pinus roxburghii*의 빈약한 교목층이 존재한다. 벌채, 뿌리캐기, 계단식 경작, 침식과 가축의 과방목 등은 조사지 식물에게 생태학적으로 큰 문제점이다. *P. roxburghii* 나무가 띠엄띠엄 나있고 왜소한 *Olea ferruginea*가 있는 것을 보면 이곳의 원래 식생은 이들 두가지 식물로 대표된다. 잘 가꾸고 보호한다면 본 연구의 조사지가 나무숲을 이루게되고 동식물 보호지로 조성되어 자원화할 수 있으리라고 생각한다.

LITERATURE CITED

Ahmad, M. 1986. Vegetation of some foothills of Himalayan range in Pakistan. Pak. J. Bot. 18:261-269.

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

Braun-Blanquet, J. 1932. Plant sociology. The study of plant communities. McGraw Hill, N.Y.

Burton, G.W. 1944. Seed production of several southern grasses as influenced by burning and fertilization. Amer. Soc. Agron. J. 36:523-529.

Cain, S.A. and G.M. de Oliveria Castro. 1959. Manual of vegetation analysis. Harper and Brothers, N.Y.

Daubenmire, R.G. 1959. A canopy coverage method of vegetation analysis. North-West.

Sci. 33:43-46.

Dirvi, G.A. and F. Hussain. 1979. Allelopathic effect of *Dichanthium annulatum* (Forssk.) Stapf. on some cultivated plant. Pak. J. Sci. Ind. Res. 22:194-197.

Hussain, F. 1981. Ecological approach towards the development and improvement of forests in Balochistan, Pakistan. Central Asia (Area Study Jour.) 9:1-38.

Hussain, F. and H. Khanum. 1982. Phytotoxic potentiality of *Artemisia maritima* L. Pak. J. Bot. 14(Abs.):18-19.

Hussain, F. and S. Tajul-Malook. 1984. Biological spectrum and comparison of coefficient of communities between plant communities harbouring Karamar hills, District Mardan, Pakistan. J. Sci. Tech. 8:53-60.

Hussain, F. and T.W. Khan. 1987. Allelopathic effect of *Cynodon dactylon* (L.) Pers. Pak. J. Weed Sci. Res. 1:8-18.

Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology. N.A.H.E., University Grants Commission, Islamabed.

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

Hussain, F. and I. Ilahi. 1991. Ecology and Vegetation of Lesser Himalayas, Pakistan. Jadoon Printing Press, Peshawar.

Hussain, F., A.R. Saljoqi, A. Shah and I. Ilahi. 1992. Phytosociology of the vanishing sub-tropical vegetation of Swat with special reference to Docut hills. II: Spring Aspect. Sarhad. J. Agic. 8:185-191.

Karagiannakidou, V. and S. Kokkini. 1988. Vegetation and altitudinal zones of Mount Menikion northern Greece. Bot. Helv. 98:149-160.

Malik, Z.H. 1986. Phytosociological study on the vegetation of Kotli, hills, Azad Kashmir. M. Phil. Thesis, Department of Botany, University of Peshawar.

Malik, Z.H. and F. Hussain. 1987. Phytosociological studies on the vegetation of Muzaffarabad hills, Azad Kashmir. *In* I. Ilahi, and F. Hussain. (eds.). Mod. Trends PL. Sci. Res. Pak., pp. 13-17.

Malik, Z.H. and F. Hussain. 1988. Phytosociological studies on the vegetation of Badana and Palalan hills near Kotli, Azad Kashmir. J. Sci. Tech. 12:65-70.

Malik, Z.H. and F. Hussain. 1990. Phytosociology of some parts of Kotli hills, Azad Kashmir. J. Sci. Tech. 14:117-123.

Malik, Z.H., A.A. Awan, G. Murtaza and F. Hussain. 1990. Phytosociology of Sund Galli near Muzaffarabad, Azad Kashmir. J. Sci. Tech. 14:111-116.

Noor, M. 1978. Comparison of grazed and ungrazed vegetation of sub-alpine ecological zone at Sar. Pak. J. For. 28:186-189.

Qadir, S.A. and O.A. Shetvy. 1986. Life form and leaf-size spectra and phytosociology of some Libyan plant communities. Pak. J. Bot. 18:271-286.

Rajwar, G.S. and S.K. Gupta. 1984. Biological spectrum of Garhwal Siwalik. Indian Forester 110:1171-1176.

Raunkiaer, C. 1934. Life forms of plants and statistical plant geography. Clarendon press, Oxford.

Rice, E.L. 1984. Allelopathy. Academic press. N.Y. 500p.

Salim, K.M. and R.G. Shahid. 1973. A note on the winter flora of Cherat hills. Pak. J. Forr. 23:133-148.

Shah, A. 1983. Phytosociological study of Docut hills, District Swat, N.W.F.P., Pakistan. M. Sc. Thesis, Botany Department, University of Peshawar.

Shah, S.H. 1993. Ecological studies on Ambela pass, Buner. Ph.D. Thesis, Botany Department, University of Peshawar.

Shimwell, D.W. 1971. Description and classification of vegetation. Sidgwick and Jackson, London.

Sorenson, T. 1948. A method of estabilshing groups of equal amplitude in plant sociology based on similarity of species content. Det. Kong. Danske. Selsk. Biol. Skr. 5:1-34.

Stewart, R.R. 1972. An annotated catalogue of the vascular plants of West-Pakistan and Kashmir. Fakhri Printing Press, Karachi. 1029p.

(Received 26 January, 1995)