热带亚热带植物学报 1998, 6(3):187－195
Journal of Tropical and Subtropical Botany

VAGETATION STRUCTURE OF PIRGHAR HILLS, SOUTH WAZIRISTAN, PAKISTAN

Farrukh Hussain Lal Badshah

(Phytoecology Laboratory, Department of Botany, University of Peshawar, Peshawar 25120, Pakistan)

Abstract Phytosociological parameters, soil and temperature conditions, importance values of species, life form, leaf size and grass biomass in vegetation of Pirghar Hills, South Waziristan Agency, Pakistan, were investigated during summer 1995. The air and soil temperatures were higher on south facing slopes which decreased with increase in altitude. The vegetation, life form and leaf size of south and north slopes differed at similar altitudes. Leptophyllous species increased with the rise in altitude. The fresh herbage production was 500 g m^{-2} at 2 000 m on north slope which gradually decreased to 170 g m^{-2} at the hill top. A similar trend was observed for the south slope which had higher productivity than comparable north slope. The original woody species are present on the hills as isolated individuals due to degradation. There is need for restoration of the habitat.

Key words Vegetation structure; Pakistan; Pirghar Hills

中图分类号 Q948.15

1 Introduction

The vegetation of Pakistan varies due to the changes in altitude and climate. Ahmad[1] reported six homogenous plant communities at the foothills of Himalayan range in Gilgit. Hussain & Mustafa[2] reported that the vegetation of Nasirabad Valley, Hunza, was altered due to heavy deforestation and overgrazing. Similarly, deforestation and overgrazing have destroyed the vegetation of Docut and Girbanr hills, District Swat[3－9]. Badshah et al[10] reported the ethnoecology of some plants from Pirghar area.

The Pirghar Hills in South Waziristan Agency lie between latitudes 31°55′ and 32°40′, and longitude 69°15′ to 70°15′ with altitude ranging from 1 800 m to 3 500 m. No exact climatic data is available. However, climatically, the area investigated has a semiarid zone with hot summers and cold snowy winters. The maximum rainfall appears during July－August. Soils are of sandy loam and shallow due to erosion. Usually there is an oak forest in the lower part of the hills, and coniferous forest consisted of *Pinus wallichiana, Abies pindrow, Picea smithiana* in the upper part.

The present study reports the vegetation structure and the potential productivity of

Received 1998－03－18; Accepted 1998－07－27

Pirghar Hills, which might give useful informations for wild life managers, ecologists, taxonomists and others as well.

2 Materiarls and methods

The Pirghar Hills have distinct north and south slopes. Each of these slopes was divided into 4 altitudinal zones, 2 000 m, 2 300 m, 2 600 m and 3 500 m above sea level, and in each of these zones, herbs, shrubs and trees were sampled in 1×1 m, 2×4 m and 2×10 m randomly established quadrats, respectively. The data collected on density, canopy cover and frequency of recorded plants were changed to relative values which were added together to give importance value for each species[11]. The importance values for all tree, shrub and herb species were summed up to get total importance value (TIV). For trees, the circumference at breast height was measured and changed to basal area. The communities were named after 3 species with the hightest importance values. Plants were classified according to leaf size and life form classes[11,12]. The collected plants were dried, preserved and identified with the help of Flora of Pakistan[13, 14] and confirmed in the National Herbarium, NARC, Islamabad.

Fresh weight of herbaceous species at each site was determined from five 0.5×0.5 m quadrats and were separated into grasses and forbs.

Soil samples were collected under each stand at a depth of 15 cm and analyzed for physical and chemical properties following Hussain[11] and Jackson[15]. Soil and air temperatures were measured at each stand with the help of air and soil thermometers. The study was conducted during June－July 1995.

3 Results and discussion

3.1 Habitat feature

The soils were of sandy loam in texture. The nitrogen and $CaCO_3$ contents in soil on south and north slopes at various sites were almost similar (14.00 to 14.5%). The soil on northern slope had generally higher organic matter contents than that on southern slope, a maximum content of which was at the top (5.6%) of the hills. Phosphorus content varied from 10.8 mg kg^{-1} (2 300 m south) to 42.4 mg kg^{-1} (2 600 m south), while potassium content ranged from 100 mg kg^{-1} (2 000 m south) to 455 mg kg^{-1} (2 600 m south). The water holding capacity varied from 12.9% (2 000 m N) to 79.8% (3 500 m). The pH, electrical conductivity and total soluble salts were almost similar among various sites (Table 1).

It appeared that erosion and deforestation had reduced nutrient contents of the soil. Similar results for other mountainous areas had been reported by Shah & Hussain[5] and Hussain et al[3－5]. The water holding capacity at hill top was higher due to the presence of

high organic matter contents.

Table 1 Physico-chemical properties of soil at different sites of Pirghar hills (June 1995)

	Alt. 2 000 m		2 300 m		2 600 m		3 500 m
	N	S	N	S	N	S	Top
Soil Temp. (℃)	23	24	20	22	14	15	9.5
Air Temp. (℃)	26.0	27.8	21.2	23.9	16.7	18.3	10.6
WHC (%)	12.9	14	9.41	9.94	23.1	24.9	79.8
pH	6.7	7.5	7.7	7.5	7.2	7.1	6.9
EC (dS m^{-1})	0.1	0.1	0.10	0.10	0.20	0.35	0.50
TSS (%)	0.032	0.032	0.032	0.032	0.064	0.112	0.160
$CaCO_3$ (%)	14.0	14.5	14.0	14.50	14.5	14.75	14.5
Organic matter (%)	3.51	2.72	2.24	2.58	4.4	2.58	5.6
N (%)	0.175	0.136	0.112	0.129	0.22	0.129	0.28
P (mg kg^{-1})	14.8	11.8	14.0	10.8	14.4	42.4	28.4
K (mg kg^{-1})	136	100	145	173	264	455	255

N=North slopes; S=South slopes; WHC=Water holding capacity; EC=Electrical conductivity; TSS=Total soluble salts

The air and soil temperatures were higher on south slope than those on the north (Table 1). Moreover, the temperature decreased with increasing elevation on both slopes. Shah et al.[7] also observed that south slope of Docut hills were warmer than north. The north slope of Girbanr hills showed lower temperature than the south slope[3]. It is agreed that it is generally warmer on the south slope than on the north, and the temperature decreases with increase in altitude.

3.2 Community structure

A list of plant species with importance values in different communities on Pirghar hills is given (Table 2).

At foothills (2000 m) of south slope there was *Plectranthus−Quercus−Plantago* community, while of north slope, *Pinus−Sophora−Nerium* community (Table 3). Of the 25 species presented on the south slope, 4 were trees, 4 shrubs and 17 herbs, while on north slope, 3 tree, 3 shrub and 15 herbaceous species, thus totaling 21 species in all. The similarity between these two communities was 18.48%. *Quercus baloot, Olea ferruginea, Ailanthus altissima* and *Grewia villosa* were present on south slope, while *Olea ferruginea, Quercus dilatata* and *Pinus wallichiana* occurred on the north slope. The total importance values (TIV) for the shrubs (77.15) and herbs (156.65) on south slope were greater than those on north slope, respectively (Table 3).

Therophytes were dominants on south slope, and thero- hemicryptophytes on norths. Micro- nanophyllous and micro- leptophyllous species dominated the south and the north slope, respectively (Table 4).

Table 2 Importance values of plant species in different communities on Pirghar Hills, South Waziristan, 1995

	Alt. 2000 m		2300 m		2600 m		3500 m
	PQP(S)	PSN(N)	PPE(S)	AIQ(N)	PPV(S)	QTP(N)	AEJ
A. Tree layer							
1 *Abies pindrow*	–	–	–	63.74a	11.49	–	–
2 *Ailanthus altissima*	4.87	–	–	–	–	–	–
3 *Grewia villosa*	3.65	–	–	–	–	–	–
4 *Lonicera obovata*	–	–	–	–	–	7.27	–
5 *Olea ferruginea*	12.51	12.71	–	–	–	–	–
6 *Picea smithiana*	–	–	12.27	–	32.05b	–	–
7 *Pinus wallichiana*	–	60.88a	29.23b	19.62	49.99a	19.52c	–
8 *Quercus baloot*	45.16	–	–	–	–	–	–
9 *Q. dilatala*	–	18.26	–	31.36c	–	–	–
10 *Q. incana*	–	–	15.54	–	11.04	–	–
11 *Q. simicarpifolia*	–	–	–	–	–	73.37a	–
B. Shrub layer							
12 *Astragalus grahamians*	–	–	–	–	–	–	57.73a
13 *Capparis spiria*	–	–	8.83	–	–	–	–
14 *Cotoneaster falconeri*	–	–	13.29	–	–	–	–
15 *C. obovata*	–	–	–	–	–	18.71	–
16 *Ephedra cilliata*	–	–	25.53c	–	–	–	–
17 *Hertia intermedia*	–	–	10.49	–	–	–	–
18 *Indigofera heterantha*	–	–	–	–	16.15	–	–
19 *Juniperus communis*	–	–	–	–	–	–	39.26c
20 *Lonicera microphylla*	13.39	–	–	47.13b	–	–	–
21 *Nerium indicum*	–	26.57c	–	–	–	–	–
22 *Plectranthus rugosus*	45.12a	10.32	43.31a	12.85	–	–	–
23 *Rosa webbiana*	8.84	–	–	–	–	17.05	–
24 *Sophora mollis*	9.71	38.88b	–	–	–	–	–
25 *Viburnum cotinifolium*	–	–	–	7.84	31.32c	–	–
26 *V. cylindricum*	–	–	–	–	6.88	–	–
27 *V. mullaha*	–	–	–	–	26.68	11.37	–
C. Herb layer							
28 *Acantholimon leptostachyum*	–	–	–	–	–	–	10.7
29 *Adiantum cappilusveneris*	–	–	–	–	8.92	8.31	–
30 *Allium cosanguineum*	–	–	–	–	–	6.73	11.04
31 *Andrachne cardifolia*	–	4.0	–	–	–	–	–
32 *Androsace rotundifolia*	–	15.01	9.88	13.82	–	–	–
33 *Aquilegia fragrans*	11.21	–	13.02	–	–	–	–
34 *Aster molliusculus*	–	6.76	–	–	–	2.58	–
35 *Astragalus rhizanthus*	–	–	8.15	–	–	–	–
36 *Bergenia himaliaca*	–	–	–	–	6.11	13.7	–
37 *Calendula arvensis*	–	–	–	7.74	–	–	–
38 *Cannabis sativa*	3.59	–	–	–	–	–	–
39 *Carduus edilbegii*	3.59	–	–	–	–	–	–
40 *Chenopodium botrys*	–	8.53	–	–	–	–	–
41 *C. murale*	18.45	–	–	–	–	–	–
42 *C. opulifolium*	–	–	–	–	–	9.16	–

(Continued)

	Alt. 2000 m		2300 m		2600 m		3500 m
	PQP(S)	PSN(N)	PPE(S)	AIQ(N)	PPV(S)	QTP(N)	AEJ
43 *Clematis barbellata*	–	–	6.86	–	–	–	–
44 *Conyza canadensis*	8.57	5.24	–	–	–	–	–
45 *Conringia planisiligua*	–	–	–	7.27	4.86	–	–
46 *Dactyeorhiza hatagirea*	14.11	–	18.15	–	–	–	57.85b
47 *Euphorbia cornigera*	–	–	–	–	–	7.82	–
48 *E. hispida*	–	–	–	9.08	–	–	–
49 *E. thymifolia*	–	6.27	–	–	–	–	–
50 *Fragaria nubicola*	–	6.45	19.93	–	8.92	–	–
51 *Galium boreale*	2.29	–	–	–	–	–	–
52 *Gnaphalium leuteo-album*	–	–	5.54	–	–	–	16.47
53 *G. thomsonii*	–	–	–	–	6.32	10.05	–
54 *Launaea procumbens*	6.57	14.76	–	–	–	–	–
55 *Malva neglecta*	–	16.05	–	–	–	–	–
56 *Medicago polymorpha*	1.39	–	–	–	–	–	–
57 *Phagnalon niveum*	–	6.76	–	–	–	–	–
58 *Phlomis oreophila*	2.54	–	–	4.54	9.4	–	–
59 *Plantago amplixicaulis*	23.11c	–	–	–	–	–	22.1
60 *P. major*	–	9.05	11.95	–	–	–	–
61 *Poa angustifolia*	–	–	–	8.21	–	–	–
62 *Podophyllum emodi*	–	–	–	–	–	–	16.95
63 *Polygonum caespitosum* var. *langistum*	–	–	4.36	9.61	–	–	–
64 *Potentilla doubjouneana*	–	–	–	–	–	9.75	13.59
65 *Rananculus natans*	–	–	–	6.0	7.3	–	–
66 *Saussurea heteromalla*	–	–	–	–	8.92	–	–
67 *Sedum crassipes*	–	–	–	–	6.32	–	15.81
68 *S. roseum*	–	–	–	–	–	–	–
69 *Schveinfurthia papilionacea*	6.63	–	–	–	–	–	–
70 *Salvia moorocoftiana*	–	–	–	–	11.83	–	–
71 *Sorghum nitidum*	–	13.48	7.93	–	–	–	–
72 *Sporobolus arabicus*	–	7.99	10.29	–	–	–	–
73 *Stipa trichoides*	18.6	6.98	5.54	8.61	10.65	–	–
74 *Teucrium stocksianum*	17.01	–	–	18.67	–	–	–
75 *Thymus serphyllum*	9.94	4.0	5.54	6.47	6.26	48.73b	9.79
76 *Torilis leptophylla*	–	–	–	–	11.6	13.05	14.86
77 *Trigonella pubescens*	–	–	–	–	–	9.89	–
78 *Valeriana* sp.	–	–	–	–	–	12.46	–
79 *Verbascum chinese*	–	–	–	17.36	–	–	–
80 *Veronica officinalis*	–	–	8.53	–	6.74	–	–
81 *Wulfenia amharstiana*	10.23	–	40.23	–	–	–	–

N=North slope; S=South slope; PQP=*Plectranthus–Quercus–Plantago* community; PSN=*Pinus–Sophora–Nerium* community; PPE=*Plectranthus–Pinus–Ephedra* community; ALQ=*Abies–Lonicera–Quercus* community; PPV=*Pinus–Picea–Viburnum* community; QTP=*Quercus–Thymus–Pinus* community; AJE=*Astragalus–Euphorbia–Juniperus* community.

The letters a, b and c after figures in the table represent the 1st, 2nd and 3rd dominant species, respectively, in each stand/community.

Table 3 The numbers of tree, shrub and herbaceous species and their total importance values (TIV) in communities at different altitudes and slope aspects

	Alt. 2 000 m		Alt. 2 300 m		Alt. 2 600 m		Alt. 3 500 m
	PSN(N)	PQP(S)	ALQ(N)	PPE(S)	QTP(N)	PPV(S)	AEJ
Tree num.	3	4	3	3	3	4	–
TIV	19.65	66.19	114.72	57.04	100.16	104.57	–
Shrub num.	3	4	3	5	3	4	2
TIV	75.77	77.15	67.85	101.54	47.13	81.03	96.99
Herb num.	15	17	12	16	12	14	11
TIV	131.53	156.65	117.35	141.36	152.63	113.97	202.9
Total species	21	25	18	24	18	22	13

For abbreviations see Table 2.

Table 4 Life form and leaf size spectra of plant communities at different sites of Pirghar Hills, South Waziristan (June–July, 1995)

	Alt. 2 000 m		2 300 m		2 600 m		3 500 m
	S	N	S	N	S	N	Top
a. Life form spectrum							
Therophytes (%)	36.0	28.7	25.10	16.6	13.6	22.2	23.03
Geophytes (%)	8.0	9.5	12.5	16.6	13.6	11.1	38.4
Hemicryptophytes (%)	4.9	19.1	29.1	27.7	31.8	27.7	23.3
Chamaephytes (%)	4.0	–	4.1	5.5	4.5	5.5	–
Nanophanerophytes (%)	12.0	14.2	16.6	16.6	18.8	16.6	15.3
Megaphanerophytes (%)	12.0	14.2	12.5	16.6	18.8	16.6	–
Microphanerophytes (%)	4.0	–	–	–	–	–	–
Community type	T	TH	TH	H	HN	HT	GT
b. Leaf size spectrum							
Leptophylls (%)	16.0	28.5	29.16	16.6	18.1	11.1	53.8
Nanophylls (%)	32.0	20.88	44.4	45.4	33.3	33.3	15.3
Microphylls (%)	40.0	41.6	33.3	27.2	50.0	50.0	23.1
Mesophylls (%)	8.0	8.3	5.5	9.1	5.5	5.5	7.6
Megaphylls (%)	4.0	–	–	–	–	–	–
Community type	MN	ML	ML	NM	NM	MN	LM

N=North slope; S=South slope; T=Therophytic; TH=Thero- hemicryptophytic; H=Hemicryptophytic; HT=Hemicrypto- therophytic; HN=Hemicrypto- nanophanerophytic; GT=Geo- therophytic; MN=Micro- nanophyllous; ML=Micro- leptophyllous; NM=Nano- microphyllous; LM=Lepto- microphyllous

At 2 300 m on south slope existed *Plectranthus–Pinus–Ephedra* community with 24 species, while on north slope *Abies–Lonicera–Quercus* community with 18 species (Table 3). The similarity between them was 20.35%. *Quercus incana, Pinus wallichiana* and *Pinus smithiana* were observed on south slope, and *Q. dilatata, Abies pindrow* and *Pinus wallichiana* on north slope (Table 2). There were 5 shrub and 16 herb species on south, and 3 shrub and 12 herb species on north slope. The TIV for trees, shrubs and

herbs on south slope were 57.04, 101.54 and 141.36, and the corresponding values on north slope were 114.72, 67.85 and 117.35, respectively (Table 3).

Hemicrypto- therophytic species dominated the south slope, while on north slope it was almost mixed in life form except hemicryptophytes which had somewhat greater proportion. Micro- leptophyllous and nano- microphyllous species dominated south and north slope, respectively (Table 4).

At 2 600 m altitude, *Pinus－Picea－Viburnum* community occurred on south slope, and *Quercus－Thymus－Pinus* community on north slope. They shared only 6.27% similarity. *Pinus wallichiana, Picea smithiana, Abies pindrow* and *Quercus incana* were present on south, while *Quercus semicarpifolia* and *Lonicera obovata* on north slope (Table 2).

There were 23 and 21 species on south and north slopes, respectively. The TIV of trees, shrubs and herbs were 104.57, 81.03 and 113.97 on south, and 100.16, 47.13 and 152.63 on north slope, respectively (Table 3).

Hemicryptophytes and hemicrypto- therophytes dominated the south and north slope, respectively. The community consisted of nano- microphyllous species on south slope, and of micro- nanophyllous on north slope (Table 4).

At the peak (3 500 m) a treeless community consisting of *Astragalus－Euphorbia－Juniperus* with 13 species was present. The two shrubs, *Astragalus grahamanus* and *Juniperus communis*, had a TIV of 96.99, while the remaining 11 herbaceous species contributed TIV of 202.9 (Table 3). The dominant life form was geotherophytic, and the dominant leaf spectrum was leptophyllous (Table 4).

Deforestation has altered the original forests. The once dense forest of *Quercus baloot* is now changed by either scatered shrubs or isolated overmatured individuals with thick boles. Its leaves are palatable by goat and sheep while branches and sterms serve as fire-wood. Similarly, conifers are confined to the protected sites. *Olea ferruginea* mixes with *Quercus* to form *Quercus－Olea* forest which is similar to the *Olea* and *Quercus* association found in the lower zone of Swat and to that with Chir pine (*P. roxburghii)* in subtropical zone. Beg & Khan[8,9] described a mixed Oak－blue pine forest at altitudes 1 600－1 900 m, and *Abies pindrow* and *Cedrus deodara* forests in upper part of Bahaderwah hills, India. Conventry[16] reported that *Pinus wallichiana* mixed with *Quercus incana* at 1 600－2 600 m in the lower zone of Punjab Himalayas, while *Abies pindrow* and *Picea smithiana* make forest from altitude 2 600 to 3 800 m. Likewise, Champion et al[17] and Hussain & Ilahi[18] described low temperate forests consisting of *Pinus wallichiana* and *Quercus incana* at altitude 1 600－1 900 m, and *Cedrus deodara, Abies pindrow* and *Pinus wallichiana* between 1 600 and 2 800 m.

Life form and leaf size spectra help in understanding the structure of

vegetation in relation to climate[3,4,7,18]. The overall vegetation of Pirghar hills was dominanted by therophytes and hemicryptophytes which indicate less favorable habitat conditions. Although, the habitat is potentially suitable for phanerophytes, but human influences such as deforestation, overgrazing, have changed it to therophytic type[3,19]. The dominance of micro- nanophyllous species clearly indicates the relatively dry condition in the area.

3.3 Vegetation zonation

The vegetation of the area could be divided into subtropical type consisting of *Quercus baloot* and *Olea ferruginea* on the south slopes at altitude 2 000 m, and low temperate type consisting of *Pinus wallichiana, Quercus incana* and *Picea smithiana* at 2 300 to 2 600 m. Deforestation has reduced the woody species, which causes the appearance of grasslands.

The north slope at foothills (2 000 m) are covered by mixed ecotonal forest of *Pinus wallichiana, Q. dilatata* and *Olea ferruginea*. At altitude 2 300 m, *Olea ferruginea* disappears except other two species which ascend to associate with *Abies pindrow* to form temperate forest, while at 2 600 m, *Quercus semicarpifolia, Pinus wallichiana* and *Lonicera* appear.

It is interesting to note that *Quercus baloot* occurs at hill foot, while *Quercus dilatata* ascends up to 2 300 m, and *Quercus incana* occurs at 2 300 to 2 600 m on south slope and *Q. semicarpifolia* at 2 600 m on north slope. *Pinus wallichiana* appears at 2 000 m on north slope and ascends up to 2 600 m on both slopes, but their importance values decreased from 60.88 (2 000 m N) to 19.52 (2 600 m N) (Table 2).

3.4 Productivity (Fresh mass)

The total fresh biomass weight of 500 g m^{-2} was harvested at 2 000 m on north slope which gradually decreased to 170 g m^{-2} at the top. A similar decrease was observed for south slope (Table 5). Total biomass was more on the south slope than on the north at all altitudes except 2 000 m.

Table 5 Fresh biomass production (g m^{-2}) at Pirghar hills

	Alt. 2 000 m		Alt. 2 300 m		Alt. 2 600 m		Alt. 3 500 m
	N	S	N	S	N	S	Top
Grasses & grasses like	250	50	150	150	20	25	20
Others (Forbs)	250	300	240	260	210	300	150
Total	500	350	390	410	230	325	170

N=North slopes; S=South slopes

The area is highly degraded due to over-exploitation by local inhabitants. The increase in population demands more space, fodder, fuelwood and timberwood which are essentially produced from these forests. Overgrazing has humpered not only the regeneration of fodder species but also that of medicinal and other species[10]. Most of habitat is bare with open vegetation which is subjected to erosion. There is a need to encourage reforestation with suitable fodder and fuel wood species besides protection and

management of grazing system.

References

1 Ahmed M. Plant communities of foot hills of Himalayan ranges in Pakistan from Gilgit to Passu roadside at 17 locations. Pak J Bot, 1986, 18:261－269

2 Hussain F, Mustafa M. Phytosociological studies on the vegetation of Nasirabad, Hunza Valley, Pakistan. Paper presented at 9th Botanical Conference, Department of Botany, Dhaka, Bangladesh. 1997. (Proceeding in Press)

3 Hussain F, Ilyas M, Kill B. Vegetation studies of Girbanr Hills, Dist. Swat, Pakistan. Korean J Ecol, 1995, 18: 207－218

4 Hussain F, Ilyas M, Takatsuki S. Plant communities of Girbanr Hills, Swat District, Nowshera Pakistan. Ecological Review, 1997, 23:247－260

5 Hussain F, Shah A. Phytosociology of vanishing subtropical vegetation of Swat with special reference to Docut Hills. Winter aspect. Scientific Khyber, 1989, 2:27－36

6 Hussain F, Saljoqi A R, Shah A et al. Phytosociology of the vanishing subtropical vegetation of Swat with special reference to Docut Hills. Ⅱ. Spring aspect. Sarhad J Agric, 1992, 8:185－191

7 Shah A, Avaz S, Hussain F. Similarity indices, biological spectrum and phenology of plant communities of Docut Hills District Swat during winter. J Sci Tech, 1991, 15:15－21

8 Beg A R, Khan M H. The present situation and the future of dry oak forest zone in Swat Valley. Pak J Forest, 1980, 30:109－122

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

10 Badshah L, Hussain F, Mohammad Z. Floristic and ethnoecological studies on some plants of Pirghar Hills, S. Waziristan, Pakistan. Pak J Pl Sci, 1996, 2:167－176

11 Hussain F. Field and lab atory manual of plant ecology. University Grants Commission, Islamabad. 1989

12 Raunkiaer C. Life form of plants and statistical plant. Geography. Clarendon Press, Oxford. 1934

13 Stewart R R. An Ann catalogue to the vascular plants of west Pakistan & Kashmir. Fakhri Printing Press, Karachi 1972

14 Nasir E, Ali S I. Flora of Pakistan, Families 1－190. 1971－1996. Pakistan Agric Res Council, Islamabad

15 Jackson M A. Soil chemical analysis. Constable and Co. London, 1962, 497

16 Coventry B O. Denudation of the Punjab Hills. 1929, Indian Forest Rec. 15 No. 2 (Cited in Ref. No. 17)

17 Champion H G, Seth S K, Khattak G M. Forest types of Pakistan. Pakistan Forest Inst, Peshawar, 1965

18 Hussain F, Ilahi I. Ecology and vegetation of Lesser himalayas. Jodoon Printing Press, Peshawar, 1991

19 Rajwar G S, Gupta K S. Biological spectrum of Garhwal Swalik. Ind Forester, 1984, 110:1171－1176