Pak. J. Bot., 21(1): 107–117, 1989.

TEMPORAL CHANGES IN VEGETATION OF MIRANJANI TOP GALIS, HAZARA, NWFP, PAKISTAN

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Abstract

The vegetation of Miranjani top has considerably changed in twelve years (1974-86). More changes have occurred in the vegetation on east-, west- and south-facing aspects; whereas least change was noticed on north-facing slopes. The vegetation was dominated by *Koeleria gracilis, Sibbaldia cuneata, Potentilla gerardiana, Nepeta erecta* and *Duchesnea indica*. Despite the changes in herbaceous and shrubby vegetation, no tree species was noticed advancing up the top. Grazing, avalanches and fast-bowling winds appear not to allow conifers and other broad-leaved species to get established there.

Introduction

The Miranjani top (alt. 2980 m) lies approximately at Lat. 34°N Long. 37° 30' east near Nathiagali, District Abbottabad, Hazara Division. The peak is located in a massive mountainous tract, 65 km long and 16 km broad, the Murree-Hazara Hills, popularly known as Galis. The tract comprises a range of mountains running north-south with steep lateral spurs. The elevations vary from 1829 to 2980 m; the main ridge runs at an average height of 2438 m and includes two highest peaks, Miranjani (alt. 2980 m) and Mukshpuri (alt. 2821 m). The slopes are generally steep with inclination usually easing at lower limits and sharpening near the top. The forests in the area generally lie above 1829 m on either side of the ridge and on its lateral spurs. The climate is moist temperate with more than 1270 mm of mean annual precipitation (Dichter & Popkin, 1967) and no place in the area receives less than 1010 mm. Most of the rain comes during the monsoon season, also showers during March and April. Dry spell generally prevails from May to middle of July and September to November. The area also receives moderate to heavy snowfall in winter from December till the end of February. The sheltered aspects of the higher slopes continue to have snow cover till the end of April. The driest and the warmest month is June when temperatures may rise upto above 31°C.

The present study describes the changes which occurred in the vegetation of Miranjani top over a time span of 12 years. First sampling was done in July, 1974 and the second in July, 1986.

Materials and Methods

The vegetation was sampled in 0.5 x 0.5m quadrats laid systematically. Daubenmire's technique was used for the estimation of canopy-coverage (Daubenmire, 1959). The number of plants in each quadrat, density, canopy-coverage, frequency and their relative values and the importance value of the species were calculated according to Cox (1967). Maturity index of the vegetation was determined by Pichi-Sermolli's method (1948). Coefficient of community was calculated according to Motyka *et. al.*, (1950) and Culberson (1955). Soil texture was determined by the method ASTM (Anon., 1964) and $CaCO_3$, organic matter, pH and total dissolved solids (T.D.S.) of the soil were determined according to Jackson (1962). Nomenclature followed for the plants is that of Stewart (1972).

Results and Discussion

On cooler and moist north- and west-facing slopes from 2133 m and on south- and east-facing slopes from 2286 m upwards, the forest comprises a varying mixture of *Picea smithiana, Abies pindrow, Pinus wallichiana* and *Cedrus deodara* with a varying inter-mixture of broad-leaved woody species. The tree canopy is frequently broken by a large number of open grassy meadows mostly due to the slow but cumulative effect of the use of these open spots as grazing grounds; the meadows usually carry scattered deciduous trees and the last surviving *A. pindrow. P. wallichiana,* of seral status, occurs in more or less pure patches marking the sites of old landslips or other clearings and regenerates more freely on any blank site. The herbaceous cover largely consists of the members of the families Ranunculaceae and Compositae (Sheikh & Hafeez, 1977). The shrubs are of palaearctic genera.

The top 100-150 m of Miranjani peak are devoid of any arboreal vegetation and constitute a treeless pasture, lying above the mixed conifer zone. Conifers are eliminated largely because of avalanches which sweep down the depressions most winters, but *Betula utilis* hangs on singly or in thin groups to the edges of the strips thus cut through the forests on slopes constituting the tree limit (Champion *et. al.*, 1965; Stewart, 1972; Sheikh & Hafeez 1977). The base of Miranjani top is marked by *A. pindrow* and *P. wallichiana* which are of moderate height and branchy nearly to the ground. *B. utilis* was crooked and branchy and formed an understorey of relatively high conifers. The conifers seemed unable to withstand the harsh climate but *B. utilis* appeared coping with the situation most effectively but was destroyed by overgrazing and confined to steep, rocky and inaccessible slopes (Stewart, 1972). The strong cold and often dry winds appear to be the most important controlling factor in addition to intense solar radiation, short growing season, snow and grazing.

Plant communities were dominated by *Koeleria gracilis, Scirpus setaceus, Sibbaldia cuneata, Salix denticulata, Plantago himalaica, Artemisia tournefortiana, Lonicera quin-*

Table 1. Soil characteristics of Miranjani tops.

	Top	Stands West-facing	South-facing	North-facing	East-facing
pH	6.3	6.8	6.4	6.3	6.1
$CaCO_3$ (%)	0.25	1.25	0.45	0.25	1.00
Organic Matter (%)	17.3	14.4	15.9	10.8	10.3
T.D.S. (mg/l)	443	636	505	236	229
Sand (%)	6.0	7.6	8.0	6.0	9.6
Silt (%)	50.0	46.0	52.0	40.0	46.0
Clay (%)	44.0	46.4	44.0	54.0	44.4
Soil Type	Silty-clay	Silty-clay	Clay	Clay	Clay

T.D.S. = Total dissolved solids.

quelocularis, Potentilla gerardiana, Nepeta erecta and *Duchesnea indica*. The dominant species of one community, in some cases, was either a codominant or a prominent species in another community. Ahmed (1973, 1986) and Shaukat *et. al.*, (1976) have also come across a similar situation. The overlapping distribution of some associated species in some communities reflected upon the homogenity of the habitat and also, in some cases, the wider ecological amplitude of these species.

Soil of the research area was rich in organic matter, slightly acidic 229-636 mg/l with very low sand fraction (Table 1).

1974's Study

The top was flat and covered an area about twice the size of a tennis court. Soil formed a thin layer except the depressions where it was appreciably deep. The thawing of snow starts here earlier than the north- and west-facing slopes because of direct exposure to sun and the absence of thick vegetation cover which also reduces the temperature effect of radiation. Early thawing makes the growing season stretch a little. The elevation was 2980 m and the outcrops of rocks bearing patches of lichens were scattered all over. The top, as compared to other sites, supported largest number of species mainly because of extended growing season (Table 2). *Koeleria-Plantago* community dominated by *Koeleria gracilis* and *Plantago himalaica* inhabited the site. Plantains are considered the inhabitants of grazed and trampled lands (Sagar & Harper, 1960). The presence of *P. himalaica*, the codominant, hints at the disturbed status of the stand. The flat top seemed to be the resting place of grazing animals. The presence of *Rumex nepalensis*, a species of trampled areas (Beg & Khan, 1984) and *Achillea millefolium*, an unpalatable and poisonous plant which is evaded by cattle (Brotherson *et. al.*, 1980) provided more proof of the extent the vegetation was subjected to grazing. No woody species was noticed here; graz-

ing, trampling, exposure and fast-blowing wind seemed to inhibit the establishment of tree species. The community supported two grasses and a sedge besides some annuals and perennials.

North-facing slopes were very gentle, the soil was relatively deeper and fine and humus more accumulated. *Sibbaldia-Salix* community dominated by *Sibbaldia cuneata* and *Salix denticulata* inhabited the site and supported 30 species (Table 2). Among the arborescent species a few stunted specimens of *Betula utilis*, a prominent tree of higher elevations and depressions (Sheikh & Hafeez, 1977), were found largely confined to a vertical depression on these slopes. West-facing aspect was also gentle but not so as the north-facing was. It was dominated by *Scirpus setaceus*. Besides *B. utilis*, young specimens of some other woody species were noticed on both the sites. Because of being more moist and protected from wind and radiation, these aspects had the potential of supporting the tree species but their accessibility to grazing animals made the establishment of woody species very difficult. The flora, by and large, comprises moisture and shade-loving species; families Compositae and Rosaceae were more prevalent.

South- and east-facing slopes were more exposed, drier and steeper than the north- and west-facing slopes. The soil formed a relatively thin layer and was rich in fine fractions (Table 1). Limestone outcrops were scattered all over the area. These slopes, because of their steepness, were relatively inaccessible to grazing animals. South-facing aspect was inhabited by *Artemisia-Lonicera* community in which *Artemisis tournefortiana* and *Lonicera quinquelocularis* shared the dominance almost equally (Table 2). The presence of many extremely rare and sporadic species suggested that there existed many vacant niches which were not fully occupied and that the chances of invasion by new species were bright.

East-facing slopes were dominated singly by *Koeleria gracilis*. The importance value of none of the supporting species came close to that of *K. gracilis* (Table 2). The community had only 6 extremely rare and sporadic species and the number of frequent species was also low. This suggested that most of the vacant niches had already been occupied and the chances of establishment of new species were far remote.

1986's Study

The top was inhabited by *Koeleria-Potentilla* community dominated by *Koeleria gracilis* and *Potentilla gerardiana* (Table 2). Of the 28 species the site supported, no other species seemed to come close to the dominants in density, coverage and distribution. The values of the community attributes of the supporting species were so low that they failed to contribute sufficiently towards the importance value and had thus remained insignificant. Extremely rare species were about 30%. About 39% species reported from

Table 2. Importance values of species in 1974 and 1986 vegetations.

Species	Top		West-facing		East-facing		North-facing		South-facing	
	'74	'86	'74	'86	'74	'86	'74	'86	'74	'86
Abies pindrow			+			+	+	+		
Acer caesium							+			
Achillea millefolium	16	4	11	2	22	11		8	7	9
Androsace rotundifolia								+	17	4
Anemone obtusiloba			+	1						
Angelica glauca		10		2		13				9
Aquilegia fragrans	+				+	+	+	+		
Artemisia tournefortiana	7	+	29	20	24	10			47	21
Astragalus himalayanus	4		3	1	4				7	
Barberis kunawurensis	+								9	11
Bergenia ciliata				1						
Betula utilis							+	+		
Bupleurum candollei					10		19			
B. longicaule var. *hazarica*	7	+	19	3	18	+	21	3	+	9
Calamintha vulgaris	19	+	26	+	16	+	14	+	33	+
Carex nubigena							6			
Cerastium fontanum var. *triviale*	+			4	4				5	
Chenonodium album		+								
Chrysanthemum leucanthemum								+		
Clematis grata							8			
Corydalis diphylla		6				9		8		3
Cotoneaster microphylla	+	+	+						+	+
Diplazium polypodioides							+			
Dryopteris odontoloma							6			
Duchesnea indica	9		29	31	10		27	6	31	50
Erigeron multicaulis		2								
Euphorbia wallichii	+	11	+	2	+	+			25	2
Galium asperifolium							8			2
Gentiana argentea		8		2		6		20		
Geranium wallichianum							6			
Gnaphalium stewartii				7		5				9
Gypsophila cerastioides		2		1		2				4
Heracleum candicans								+		+
Hypericum perforatum						+				+
Impatiens edgeworthii									7	
Iris hookeriana	+	16	16	5		25		2	+	6
Koeleria gracilis	72	56	23	85	75	22	18	59	38	51
Lathyrus emodi	4		9	2		4		1	25	15
Leontopodium leontopodinum	11		19						25	
Lonicera quinqueloeularis									46	14
Malva neglecta	+	+		1						
Minuartia lineata	4	13	9	3		2		2	5	
Nepeta erecta		18	25	10		45	+	1		30

(Table 2. Cont'd)

Species	Top		West-facing		East-facing		North-facing		South-facing	
	'74	'86	'74	'86	'74	'86	'74	'86	'74	'86
Phlomis bracteosa	+			+	10	3		+	8	+
Pinus wallichiana			+			+			+	+
Plantago himalaica	53	25		16	29			14		2
Poa pratensis	26	+		5		1		+	23	+
Podophyllum emodi							+			
Polygonum amplexicaule	28	22	36	14	18	16	14	7	33	24
Potentilla gerardiana	30	46		+	24	38		19	+	
Primula denticulata		2		1		1	16	4		
Ranunculus hirtellus			11	1	4	1	14	7	+	2
Rosa webbiana			33	13		2	26	6		1
Rumex acetosa				6	+	6				6
R. nepalensis	39	14		+	+			3	+	
Salix denticulata	+				+		50	19		
Salvia sp.								+		
Sanicula elata	18		13		20		8		13	
Sarcococca saligna				1						
Sibbaldia cuneata	+	12		37	29	32	62	67		2
Stachys sericea									+	
Taraxacum officinale	7									
Trifolium pratense	23	31		26	31	24	14	42		6
Valeriana jatamansi							14	1		
Verbascum thapsus	7	+		1					3	1
Veronica lasiocarpa					8	+	6	+	8	+
Viburnum foetens	+		+				18	+		
Vicia rigidula				1						1
Viola serpens				1	4	1		1		1

top in 1974 disappeared in 1986, whereas only 32.1% new species appeared there (Table 3); and this reflects upon the extent of stability and maturity of the top vegetation. The two vegetation types shared a maximum of common species i.e. 31.6%. Of all the aspects studied in 1986, the vegetation on top carried highest value of maturity index (Table 4).

North- and west-facing aspects were dominated by *Koeleria gracilis* and *Sabbaldia cuneata*; on north-facing slopes *S. cuneata* took the lead, whereas on west-facing exposure, *K. gracilis* became the leading dominant (Table 2). On these aspects, besides the dominants, *Trifolium pratense* was the only species which could attain some prominence. About 32% species on north-facing aspect were extremely rare, whereas there were only 11% rare plants on west-facing slopes suggesting the intensity of competition going on in the latter. The two stands supported highest number of species hinting at the availability of many niches and it also reflected upon their early seral status. From amongst the two

Table 3. Comparative account of species in '74's and '86's vegetations of Miranjani.

Aspect	Total number of species in		% of species of '74's vegetation disappeared in '86's vegetation	% of new species appeared in '86's vegetation	% of common species shared by '74's and '86's vegetations
	'74	'86			
Top	32	28	39.1	32.1	31.6
West-facing	24	36	32.3	55.5	26.6
South-facing	29	36	34.4	47.2	29.2
North-facing	30	36	32.4	45.9	29.8
East-facing	27	33	32.2	45.4	30.0

stands studied in 1974, about 32% species disappeared in 1986, whereas 45.9% new plants appeared on north-facing and 55.5% on west-facing aspects. It showed that despite the similarity in habitat more changes had occurred in west- than north-facing sites.

The cluster of stunted *Betula utilis*, noticed on north-facing aspect 12 years ago, still remained confined to the vertical depression on this aspect and did not show any lateral or vertical advancement. East-facing warm and exposed slopes were inhabited by *Nepeta-Potentilla-Sibbaldia* community dominated by *Nepeta erecta, Potentilla gerardiana* and *Sibbaldia cuneata* (Table 2). The importance values of the three dominants were close to one another and they shared the dominance almost equally. *Koeleria gracilis*, the sole dominant of '74's vegetation, had completely faded away. In comparison with three stands discussed before, this stand supported a relatively greater number of prominent species; very rare species were 24%. On these exposures, 32.2% species of '74's vegetation were eliminated whereas 45.4% new plants carved their way in (Table 3). The level of maturity of the vegetation was low largely because of many insignificant and rare species which failed to contribute sufficiently to the frequency (Table 4).

South-facing slopes supported *Koeleria-Duchesnea* community dominated by *Koeleria gracilis* and *Duchesnea indica* (Table 2). Both the dominants shared the lead equally; besides these, there were three other supporting species viz., *Nepeta erecta, Polygonum amplexicaule* and *Artemisia tournefortiana* which could attain some significance. There were 22.2% extremely rare species. *Lonicera quinquelocularis*, the dominant of '74's vegetation, although managed to remain there but was found completely subdued. About 34% of species of the old vegetation disappeared from this site studied 12 years later; whereas 42.7% new plants invaded the area. The vegetation had tremendously been changed during these years and was still unstable which was clear from its lowest maturity index (Table 4).

Table 4. Maturity index and its components of '86's vegetation of Miranjani.

Stand	Points	Number of species	Maturity Index
Top	495	28	18
West-facing	496	36	14
South-facing	405	36	11
North-facing	445	36	12
East-facing	495	33	15

Coefficient of Community. Among the plant communities constituted in 1974, a maximum coefficient of community was found between *Koeleria-Plantago* and *Koeleria* communities inhabiting top and the east-facing aspect respectively (Table 5). Both these sites were more exposed and had extended growing season because of early thawing of snow and these factors may account for the similarity in vegetation. *Sibbaldia-Salix* and *Artemisis-Lonicera* communities found on north- and south-facing aspectes, respectively, carried a minimum of coefficient of community reflecting upon least resemblance between the two vegetation types primarily because of different environmental conditions prevailing there.

The plant communities established as a result of sampling in 1986 exhibited relatively higher coefficient of community (Table 5). Maximum similarity was noticed between top and east-facing aspect supporting *Koeleria-Potentilla* and *Nepeta-Potentilla-Sibbaldia* communities respectively for the same reason as discussed earlier. Cool and protected north-facing aspect supporting *Sibbaldia-Koeleria* community showed least rememblance with *Koeleria-Duchesnea* community inhabiting warm and exposed south-facing slopes. In spite of having *Koeleria gracilis* as a common dominant and sharing 30.1% common species, the lowest value of coefficient of community between these two communities seemed to be confusing. The main reason was that most of the common species these communities shared were extremely rare; furthermore, the two habitats certainly differed in microclimate but *K. gracilis*, possessing a wider ecological amplitude, managed to dominate both habitats - one in association with *Sibbaldia cuneata* and the other with *Duchesnea indica.* A relatively low value of similarity coupled with highest number of common species between *Nepeta-Potentilla-Sibbladia* community, inhabiting east-facing aspect, and *Koeleria-Duchesnea* community, occupying south-facing slopes, indicated that the common species these communities shared were extremely sporadic and rare. On the other hand, 1974's *Sibbaldia-Salix* community, dominating south-facing slopes, and 1986's *Koeleria-Sibbaldia* community, inhabiting west-facing aspect, shared lowest number of common species and yet they carried a relatively higher value of coefficient of community suggesting that the common species were more frequent.

A comparison of the plant communities on various aspects, established in 1974 and 1986, showed relatively lower coefficient of community indicating that the vegetation

Table 5. Matrix of values of coefficient of community. Figures in parentheses are percentage values of common species in Miranjani.

	'74 *Koeleria-Plantago* (top)	'74 *Scirpus* (west)	'74 *Koeleria* (east)	'74 *Sibbaldia-Salix* (north)	'74 *Artemisia-Lonicera* (south)	'86 *Koeleria-Potentilla* (top)	'86 *Koeleria-Sibbaldia* (west)	'86 *Nepeta-Potentilla-Sibbaldia* (east)	'86 *Sibbaldia-Koeleria* (north)
1974									
Scirpus	39								
(west)	(32.1)								
Koeleria	61	50							
(east)	(35.5)	(25.4)							
Sibbaldia-Salix	25	34	43						
(north)	(20.9)	(24.0)	(26.3)						
Artemisia-Lonicera	46	39	43	20					
(south)	(36.0)	(32.0)	(28.5)	(13.5)					
1986									
Koeleria-Potentilla	43	22	29	21	18				
(top)	(31.6)	(23.0)	(25.4)	(15.5)	(24.5)				
Koeleria-Sibbaldia	40	31	38	44	33	44			
(west)	(32.3)	(26.6)	(30.1)	(16.6)	(29.2)	(34.3)			
Nepeta-Potentilla-Sibbaldia	31	24	32	20	15	62	48		
(east)	(27.6)	(29.8)	(30.0)	(23.8)	(25.8)	(32.7)	(36.2)		
Sibbaldia-Koeleria	37	18	35	47	14	55	50	50	
(north)	(30.4)	(26.2)	(29.6)	(29.8)	(22.7)	(27.6)	(28.7)	(35.7)	
Koeleria-Duchesnea	28	27	21	22	32	37	56	45	31
(south)	(27.9)	(26.6)	(26.9)	(18.1)	(29.2)	(28.1)	(34.7)	(37.6)	(30.1)

had considerably been changed during a period of twelve years. Top vegetation did not change much in totality although one codominant of 1974's study was replaced by a new one. Top and east-facing vegetation of the two years was quite similar, as manifested by highest values of coefficient of community; whereas little similarity was found between north- and south-facing vegetation of the two calendar years.

The vegetation has sufficiently changed during these twelve years. Of the seven dominants of 1974's vegetation, five were replaced. The leading role of *K. gracilis* seemed to increase significantly and *S. cuneata*, which dominatged only one community in 1974, gained considerable prominence in 1986 and managed to include two more communities. Despite the changes that occurred in the herbaceous and shrubby vegetation of Miranjani top, no arborescent species was noticed advancing up the top. It seems logical to conclude that the top would never be covered by woody plants mainly because of persistent interference. Even if grazing is controlled, avalanches and the fast-blowing winds would make it almost impossible for the conifers and other broad-leaved species to establish and flourish there.

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