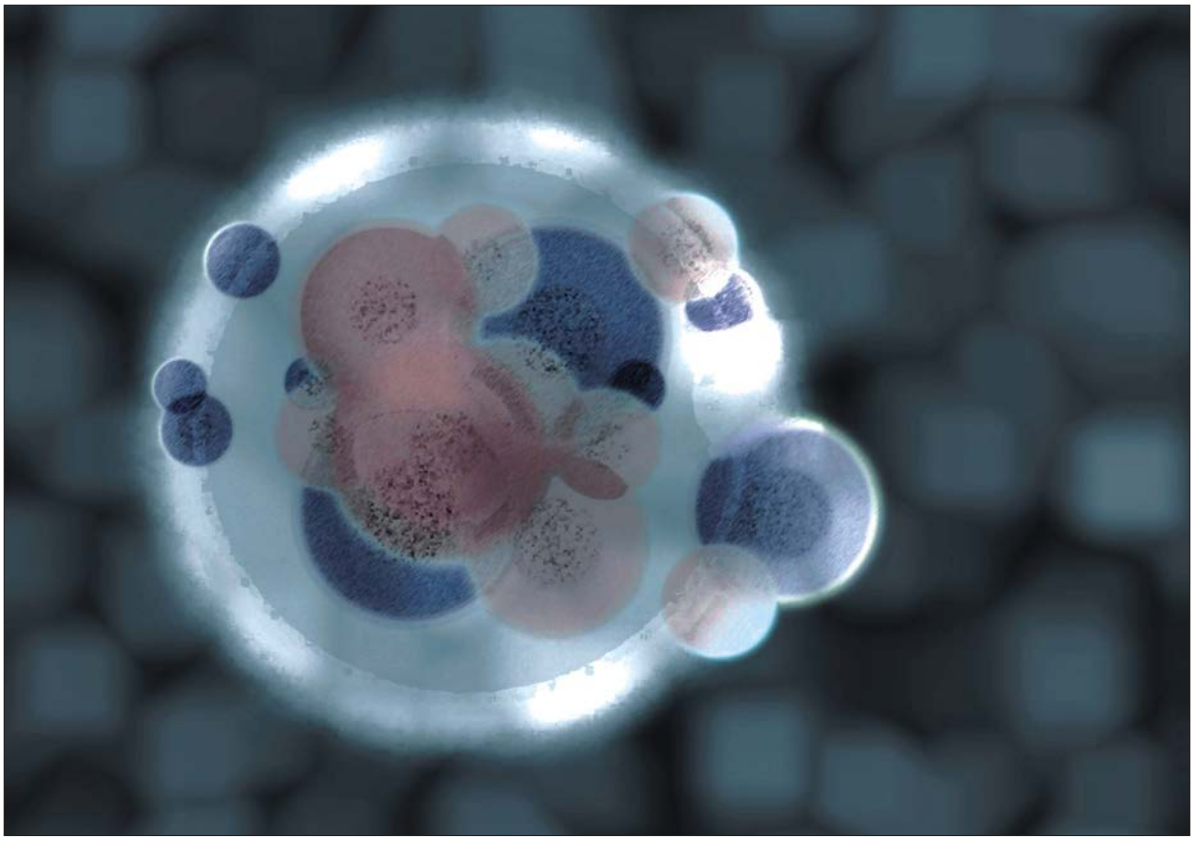

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Effect of Road Construction on Phytogeography of Herbaceous Flora in Areas Adjacent to Balakot-shogran Road, Mansehra District, N.W.F.P, Pakistan

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Abstract: The distribution and abundance of major plant taxa along Balakot to Shogran road was examined. The sampling was carried out at places where rocky slopes were exposed due to road expansion and adjacent undisturbed plots. Frequency of most of the herbaceous species was lower in disturbed sites although the differences were not significant. Total plant cover however, was significantly lower in all sites disturbed due to road construction. The microtopography of rock substrate revealed a significant impact on amount of vegetation present and type of rock plus time of revegetation after being disturbed. Crustose lichens were particularly sensitive and their distribution was restricted to sites that were least altered or otherwise representing the early stages of succession. We found disturbance regime a major factor that decreased vegetation frequency and cover along road sites but a careful assessment of the geological and environmental factors must also be considered on vegetation dynamics.

Key words: Plant rehabilitation, human disturbance, rock, lichen, vegetation dynamics

Introduction

The idea of climate being the indicator of vegetation or vice versa is agreeable in all terms yet type of vegetation prevailing on a certain area governed by specific conditions including climate seems to be more relevant than emphasizing climate alone. The inherent ability of plant species to colonize after disturbance or under stressed conditions is well documented (De Villiers *et al*., 1999). Succession on a bare rock (xerosere) is the most obvious manifestation of such faunal behaviour. Studies related to these factors lead to diverse functional components that are significantly or decisively reigning the phytosociology. Nevertheless, we tried to focus our study on those factors that have played a key role in modifying the vegetation cover. This work is aimed to visualize the effect of human intervention in terms of building roads in an area where natural vegetation was present without any apparent environmental threat.

The present work was conducted along Balakot to Shogran road. The area of Balakot represents a dry temperate region while Shogran a much higher (from sea level) picnic resort is typically also a temperate region but more humid. In winter, from Kewai to Shogran road cannot be used due to heavy snowfall. The flora of this particular region in general comprises of perennials yet burgeoning of several seasonal plants can be witnessed in spring season. In general temperate forests are present intermingled with diverse herbaceous flora (Stewart, 1982).

Materials and Methods

The road patch along Balakot to Shogran constituting 32 km was divided into different sites based on accessibility and disturbance (blasting, cutting etc). Up to "Kewai" about 16 sites were selected where construction work was on its peak. From Kewai to Shogran (8 km), the expansion of road was not in progress yet 4 sites were demarcated here. The disturbed and undisturbed slopes were clearly visible which were analyzed by strip method for vegetation cover. The physical structure of the exposed rock surfaces was determined by collecting small fragments, which were brought to lab, and studied in order to find out the type of parent material. Certain areas of the precipice face were actually large blocks detached from the main bedrock, forming cave-like grottos that have quite different environments than most of the exposed rocks. These were particularly observed in terms of colonization of lichens and mosses. Other environmental factors like shade of tall trees and accumulation of soil were taken into consideration to define habitat composition.

The data was collected by sampling each site with the help of a transect (3 cm wide and 10 m long). The study was conducted in June 2000. The number of plant species intersected by transect at each site was recorded for cover estimation and frequency (Bonham, 1989). The microtopography for each site was noted as being crack, ledge (slope $<10^\circ$ from horizontal), or face with a slope between 10 and 110° (Farris, 1998).

STATISTICA for windows 5.0 was used for all statistical analyses (StatSoft, 1995). To determine whether different taxa were found in the same proportions in disturbed and undisturbed sites, a contingency raw table was used. Differences in the mean mountain height from road to disturbed and undisturbed transects were examined using t-test.

Results and Discussion

Our results have shown that factors like disturbance and microtopography exert significant and independent control over vegetation cover and species composition. The comparison of dicots and monocots revealed that among disturbed ones, the site-9 is the only site where the dicot cover has exceeded from 2% while in rest of all sites, the cover remained less than 1% (Table 1). Monocots were slightly better and retain an edge over dicots by showing more than 1% cover in three sites. It seems that the soil amount, no matter whether it constitutes certain depth or not, needed for seed germination, is supporting the plant life. In particular the grasses (monocots) whose seeds are largely depending on wind for dispersal are able to grow on these sites. Their colonization over dicots seems preferred due to their root system. It can be explained on the fact that grass species so far observed were of shallow root system compared to the woody herbaceous dicots that

Table 1: Cover of the taxa in different sites

Location	Taxon (total vegetation cover in %age)				
	Lichens	Mosses	Ferns	Monocots	Dicots
Balakot–Kewai					
Site 1*	13	1.5	0.1	1.7	0.4
Site 2	12	0.7	2.2	3.4	12.2
Site 3*	15	1.4	0.1	1.3	0.6
Site 4	09	1.1	1.1	5.2	11.0
Site 5*	11	0.7	0	0.9	0.9
Site 6	13	1.6	1.2	4.7	7.2
Site 7*	16	0.9	0	1.2	0.7
Site 8	12	1.9	2.6	11.6	17.2
Site 9*	09	1.7	0.2	0.5	2.1
Site 10	16	2.1	1.3	9.3	13.9
Site 11*	02	0.5	0	0.1	0.9
Site 12	14	2.1	1.1	4.8	12.8
Site 13*	23	1.2	0	0	0
Site 14	07	2.7	0	6.6	0
Site 15*	01	0.4	0	0.1	0
Site 16	12	2.6	2.3	4.9	11.6
Kewai–Shogran					
Site 1	18	2.1	3.2	7.8	13.3
Site 2	07	2.5	0	5.2	9.2
Site 3	13	1.7	4.1	12.6	16.4
Site 4	05	3.2	2.3	11.3	13.9

*Disturbed sites

Table 2: The characteristics regarding microtophography and transect height for study sites

Location	Height from sea (m)	Distance	Disturbed	Undisturbed
			Microtopography	
Balakot-Kewai Road	1140-1860	24 km	Site 1. Crack	Site 2. Ledge
			Site 3. Crack	Site 4. Ledge
			Site 5. Face	Site 6. Ledge, crack
			Site 7. Face	Site 8. Crack
			Site 9. Crack	Site 10. Ledge
			Site 11. Face	Site 12. Ledge, crack
			Site 13. Face	Site 14. Face
			Site 15. Ledge	Site 16. Ledge
Transect Height (m)			$14.2^{a} \pm 3.1$ (n = 8)	$16.5^{a} \pm 2.3$ (n = 8)
Kewai-shogran	1860-2430	8 km		Site 1. Ledge
				Site 2. Face
				Site 3. Ledge
				Site 4. Ledge
Transect Height (m)				$6.2^{b} \pm 0.6$ (n = 4)

Mean ± standard deviation for transect height from road in disturbed and undisturbed sites
Values sharing different letters are significantly different ($p < 0.01$)

Table 3: Comparison of distrubed and undisturbed sites

	Total plant cover**	Dominant rock substrate	Frequency of herbaceous flora*
Disturbed sites	$22.57^{a} \pm 11.2$ (n = 8)	Sand stone, shale, gravel, detached rock conglomerate	75a%
Undisturbed sites	$52.37^{b} \pm 9.8$ (n = 12)	Shale, sedimentary type, sand stone	91b%

Mean ± Standard error. Values in a column with different letters are significantly different ($p < 0.01$)
**Cover estimation also included aerial plant projections that were not considered in preparing contingency table, which was based only on intersected plant part with strip
*Frequency of herbaceous flora comprising of monocots, ferns and dicots

are comparatively deep rooted and requires considerable soil layer for anchor and support. Inadequate supply of the medium (soil) for physical support has led to the invasion of monocotyledonous species (grasses) to establish a pioneer community (Dunnett *et al*., 1998).

Ferns on the other hand were less frequent on disturbed sites as compared to undisturbed ones yet their presence along lichens gives an indication that soil gathering around lichens as well as in cracks contains spores. This feature of disturbed sites particularly where slope in not steep and cracks are presents suggests that in future rehabilitation of plant cover will progress. Moreover, sites like 5, 7 and 11 are so severely disturbed that plant cover might not be able to restore to its original condition. Especially in site-13 where only few mosses and crustose lichens could survive. Microtopography of these four sites (Face) reveals that here disturbance factor is maximum (Table 2). That is why overall vegetation cover in these four sites was lowest (Table 1). Species richness seems to have a definite correlation with microtopography. In our study, the proportion of three microtopography classes differed between disturbed and undisturbed sites. Face and crack being dominant at disturbed sites with poor species while ledges supported the species richness. Similar results were reported by Ursic *et al*. (1997) that presence of ledges significantly increases the species richness and frequency.

The difference of the overall plant cover was significantly lower in disturbed sites as compared to undisturbed. But in the case the frequency of the herbaceous flora the difference was not significant (Table 3). This indicates two important aspects. One that either the impact of disturbance was not enough to eradicate all the species from the area (Kuss, 1986) or plant species might have survive the change due to their adaptive capability. Secondly, the adjacent undisturbed areas with abundant diversity have played a major role in species invasion towards disturbed sites for prompt establishment. It shows vacillating sensitivity of plant species to disturbance hence distribution of various growth forms depends on disturbance impact and microtopography (Larson, 1980; Kuss *et al*., 1986).

Plants and their environment can provide a better understanding of ecological consequences of disturbances (Medail *et al*., 1998). We observed a devastating picture of the use of heavy machinery and its impact on roadside along Balakot to Kewai. The vegetated slopes were vulnerable to erosion. Those sites were considered disturbed where recent intervention has removed the plant cover. At such spots, lichens were able to establish a colony. They were more frequently observed on disturbed sites. Not only this but they comprises the most dominant part of the floral diversity encountered in this study. No matter what topographic conditions are or the extent to which site has been disturbed, they somehow mange to invade the area and establish their colony. Nuzzo (1996) has also found the greater values for lichens in undisturbed areas. The occurrence of monocots beside lichens in disturbed sites indicate the disturbance-facilitated invasion of species, a trend noticed by Aplet *et al*. (1998). In conclusion it seems appropriate to foresee the role of early colonizers (lichens) to provide suitable conditions for invading herbaceous vegetation. More the lichens increase their area of occupation, it is more likely that lost plant cover is restored to it primeval state. At present however, the topographic elements are less favourable for ferns and dicots to maintain their community yet with the accumulation of soil particles in small crevices and around lichens, the usual pattern of succession could be initiated.

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