Article

Impact of varying disturbances on the structure and composition of grassland vegetation in Anantnag, Kashmir Himalayas

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Abstract
Grasslands known for their aesthetic, biological and cultural values are being subjected to varied disturbances like grazing, moving, trampling etc. Owing to overgrazing, degradation of pastures has achieved critical dimensions all across the globe. Jammu and Kashmir with significant population of Gujjar and Bakerwal communities is facing more intense problem of grazing and consequently grasslands have degraded. In fact during the present study mild grazing was found to promote growth of more species in grasslands as against heavy grazing which decreases species number. However total protection from grazers also leads to decrease in species number in grasslands.

Keywords disturbances; composition; grassland; vegetation; Kashmir Himalaya; Anantnag.

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1 Introduction

Himalayan region, which has undergone a series of changes in its geomorphology, climate and biota since its origin, is well known for its diverse landscapes and aesthetic, cultural, biological and hydrological values. These changes coupled with more recent human activities have given rise to present day vegetation (Mani, 1974; Singh and Singh, 1988). Of these, the natural and semi natural grasslands are of particular interest due to their relatively recent origin, dynamics and close co-evolution with grazing ungulates (Rawat, 1998).

In fact local inhabitants of Himalayan belt either resort to agriculture or livestock rearing owing to limited choice of occupation due to the geographical features of Himalayas and vagaries of climate experienced by the area. So grazing on grassland ecosystems is almost a common feature. But grazing in India has always been a serious problem because of its being disproportionate to the area and biomass available for grazing. Heavy and uncontrolled grazing and grass trampling by humans and their livestock has adversely affected the regeneration and carrying capacity of grasslands.

The problem of grazing and degradation of pastures is more critical and intense in Jammu and Kashmir due to the lifestyle of its rural people especially Gujjar and Bakerwal communities who manage herds of cattle.

Both the communities being migratory have placed extra ordinary pressure on the part of the grasslands of the state and consequently the pastures and forest areas have deteriorated to critical levels. As a matter of fact, overgrazing has resulted in a decrease in plant diversity and vegetation cover (Dar and Koul, 1985). Besides edible species of grasses and legumes have vanished and most of the pastures are predominantly covered with noxious weeds like Stipa, Sambucus, Aconites, Adonis, Sibbaldia etc (Dar, 1984; Misri, 1988). Anthamus, a non palatable herb is also spreading far and wide in the grasslands of the state at an alarming rate.

Besides grazing, other pressures like tourism and defense have affected the grasslands of Kashmir in particular by camping, treading, littering non biodegradable wastes etc. So the concerned matter has been a subject of interest for many researchers in India like Raina (1960), Kaul and Sarin (1971), Ahuja (1977), Misra (1983), Dar and Kaul (1985), Chauhan and Singh (1990), Katoch et al. (1991), Uniyal et al. (1994), Goyal and Sinha (1996) and Rawat (1998). But the grasslands in Kashmir have not been attended on a large scale although a little has been done by some researchers, such as Kaul and Zutshi (1966), Kaul and Sarin (1976), Gupta (1979), Gupta and Kachroo (1979), Koul and Kachroo (1980), Singh and Kachroo (1983a, b), Dar and Kaul (1985), Bhat and Kaul (1989), Shah (1992) and Ram and Singh (1994).

Although pastures/grasslands in India in general and J&K in particular have depleted due to continued misuse, indiscriminate cutting and grazing, overstocking, noxious and obnoxious weed proliferation, premature grazing, trampling, selective feeding, bad distribution of cattle, shifting cultivation, lack of grazing policy, etc. yet only a few accounts (Dar and Kaul, 1985; Agarwal and Tiwari, 1988; Misri, 1988; Mukherjee et al., 1990; Rajvanshi and Srivastava, 1990; Misra, 1995) from J&K are available on the effects of various disturbances on grassland vegetation. Owing to paucity of information on the said theme, present investigation was carried out to ascertain the structure & composition of grassland vegetation and the effects of varying disturbances on them.

2 Materials and Methods

For assessing the effect of grazing, 12 study sites were selected of which sites 1-4 were totally fenced, sites 5-8 were subjected to controlled grazing by selected number of cattle and sites 9-12 were subjected to intensive grazing by large number of cattle.

To monitor the effect of trampling, 4 study sites (13-16) were selected from the Govt. Degree College Women Anantnag, of which sites 13-14 were not subjected to trampling or any other disturbance and sites 15-16 were subjected to trampling by electric lawn movers although trampling was controlled and done after 20 days.

To study the effect of moving, four study sites (17-20) in protected grassland with pedestrian paths through them were selected. The vegetation along the pedestrian paths was compared with the rest of the grassland with almost no or occasional human moving.

The preliminary phyto-sociological analysis of the study sites was accomplished by using quadrants. The size and number of quadrants needed for each site was determined separately using the species area curve method (Misra, 1968). Subsequently vegetation of the sites was quantitatively analyzed for frequency, density and dominance following Curtis and McIntosh (1950). Relative frequency, density and dominance were computed with the help of the formulae (Phillips, 1959):

$$\text{Relative Frequency} = \frac{\text{No. of occurrence of a species}}{\text{No. of occurrence of all the species}} \times 100$$

$$\text{Relative Density} = \frac{\text{No. of individuals of a species}}{\text{No. of individuals of all the species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{No. of occurrence of a species}}{\text{No. of occurrence of all the species}} \times 100$$

Diversity was measured using the heterogeneity index developed by Shannon and Weaver (1949)

$$H = -\Sigma\, [ni/N \ln (ni/N)]$$

where H= general diversity, ni = stem count per species/site, N = total stem count per site.

General diversity is affected by both the number of species present and evenness with which they are distributed (Potter and Kesselle, 1980). To separate these effects, Margalef's (1957) species richness index and Shannon and Weaver's (1949) index of evenness was measured

Richness: $r = (S-1)/\ln N$

Evenness: $e = H/\ln S$

where S is the total number of species present at a site and all other notations being the same as above.

Coefficient of similarity between the physiognomically similar sites but subjected to varying disturbances were computed by Wolda's (1981) formula:

Coefficient of Similarity: $S = 2C/A+B$

where A and B are the total species recorded at each of the given pairs of the sites and 'C' is the total number of the species recorded at both sites.

This index however does not reflect the actual situation as the density of species is not taken into consideration. To compare sites on the basis of density, Index of Similarity developed by Thibodeau and Nickerson (1985) was adopted.

Above ground biomass was determined by clipping the above ground living matter of all the species from specific quadrants of 1m × 1m size. The living mater was separated species wise and dried in oven at 70-75^{0}C for 24 hours to determine the species wise biomass.

Soil temperature was measured with the help of soil thermometer. Moisture content and other physico-chemical parameters of soil were estimated while following Wilde et al (1978).

3 Results

Following quadrant method, a total of 16 species (Table 1) were recorded at protected sites (1-4). *Bothriochloa pertusa* L. dominated the grassland community at these sites which recorded sustained active association with *Plantigo lanceolata* L. But at sites 5-8, 22 species (Table 2) were recorded of which *Cynodon dactylon* L. dominated the vegetation community that recorded close association with *Medicago lupilina*. In fact, study sites 9-12 recorded sustained interactive association of *Cynodon dactylon* L. and *Bothriochloa pertusa* L. with 6 other species observed to constitute the grassland community at these sites (Table 3). While trampling free sites (13-14) had 12 species (Table 4) with dominant *Bothriochloa pertusa* L. and *Medicago lupilina* L. association, regularly trampled sites (15-16) had 7 species (Table 5) with dominant *Cynodon dactylon* L. and *Bothriochloa pertusa* L. association. But vegetation composition at sites 17-20 recorded 4 species (Table 6) with dominant *Cynodon dactylon* L. and *Bothriochloa pertusa* L. association like regularly trampled sites. Similar association of *Cynodon dactylon* and *Bothriochloa pertusa* has also been observed by Dar (1984) and Bhat and Koul (1989). In fact the observations recorded during the present study reveal that while mild grazing promotes growth of more species in grasslands as against heavy grazing which decreases species number. However total protection from grazers also leads to decrease in species number in grasslands. Likewise trampling and moving eliminate most of the species from grasslands and permit growth of selected species with reduced stems, underground stems, runners or suckers. The species with upright stems and growth buds high above the ground are eliminated by disturbances. The present observations are in complete conformity with the findings of Dyksterhuis and Schmutz (1947), Branson and Weaver (1953), Ash and Mclvor (1998), Collins and Glenn (1988), Fensham et al. (1999), Bullock et al. (2001) and Hayes and Holl (2003). Decreased canopy height and damage to higher statured species are likely driving factors in this shift (Hayes and Holl, 2003).

Table 1 species composition at protected (fenced) sites 1-4.

S. No.	**Species**	**IVI**
1.	*Bothriochloa pertusa* L.	76.80
2.	*Plantago lanceolata* L.	66.60
3.	*Trifolium dubium*	44.10
4.	*Poa annua* L.	29.10
5.	*Plantago major*	19.30
6.	*Crepis* sp.	15.40
7.	*Ranunculus sp.*	9.70
8.	*Lathyrus* sp.	9.00
9.	*Cynodon dactylon* L.	8.80
10.	*Euphorbia* sp.	6.96
11.	*Anthamus cotla*	6.79
12.	*Medicago lupilina*	2.96
13.	*Carex* sp.	1.92
14.	*Stellaria media*	1.35
15.	*Polygonum* sp.	0.98
16.	*Sessembrium* sp.	0.28

Table 2 Species composition at sites 5-8 subjected to controlled grazing.

S. No.	**Species**	**IVI**
1.	*Cynodon dactylon* L.	90.40
2.	*Medicago lupilina*	70.00
3.	*Bothriochloa pertusa* L.	40.20
4.	*Trifolium repens*	20.20
5.	*Trifolium dubium*	19.30
6.	*Plantigo lanceolata* L.	10.50
7.	*Taraxicum annum*	8.30
8.	*Poa annua* L.	6.00
9.	*Capsella bursapastoris*	5.30
10.	*Ranunculus sps.*	4.00
11.	*Heteropogon contortus* L.	3.00
12.	*Echinochloa crusgalli* L.	3.00
13.	*Stipa sibirica*	2.90
14.	*Cyperus sps.*	2.60
15.	*Clematis sps.*	2.60
16.	*Lathyrus sps.*	2.50
17.	*Cichorium intigbus* L.	2.50
18.	*Oxalis comiculatus*	2.50
19.	*Melilotus sps.*	2.00
20.	*Fragaria sps.*	2.00
21.	*Geranium sps.*	1.60
22.	*Agropyron sps.*	1.00

Table 3 Species composition at intensively grazed sites 9-12.

S. No.	Species	IVI
1.	*Cynodon dactylon*	132.50
2.	*Bothriochloa pertusa* L.	87.70
3.	*Trifolium repens*	34.80
4.	*Cyperus sps.*	20.80
5.	*Plantigo major* L.	12.80
6.	*Plantigo lanceolata* L.	5.90
7.	*Sonvhus sps.*	2.80
8.	*Polygonum sps.*	2.70

Table 4 Species composition at trampling free sites 13-14.

S. No.	Species	IVI
1.	*Bothriochloa pertusa* L.	140.70
2.	*Medicago lupilina* L.	60.30
3.	*Plantigo lanceolata* L.	40.20
4.	*Taraxicum annum*	12.60
5.	*Hordeum sps.*	12.40
6.	*Poa annua* L.	6.60
7.	*Trifolium repens*	5.20
8.	*Ranunculus sps.*	5.20
9.	*Hypericum perforatum*	2.30
10.	*Stellaria sps.*	1.30
11.	*Capsella bursapastoris*	1.20
12.	*Varonica sps.*	1.20

Table 5 Species composition at regularly trampled sites 15-16.

S. No.	Species	IVI
1.	*Cynodon dactylon* L.	100.40
2.	*Bothriochloa pertusa* L.	80.60
3.	*Trifolium repens*	39.40
4.	*Plantigo lanceolata* L.	20.40
5.	*Plantigo major* L.	20.00
6.	*Medicago lupilina*	20.00
7.	*Poa annua*	18.40

Table 6 Species composition along pedestrain paths in protected grasslands at sites 17-20.

S. No.	Species	IVI
1.	*Cynodon dactylon*	140.00
2.	*Bothriochloa pertusa* L.	138.00
3.	*Plantigo major* L.	12.00
4.	*Trifolium repens* L.	9.60

Table 7 Summary of the species diversity in grassland ecosystem at different sites subjected to varying disturbances.

Study Site	Nature of Disturbance	No. of Plant Species	H	r	e
1	Fenced site	16	1.06	4.73	0.34
2	Fenced site	14	1.02	4.43	0.39
3	Fenced site	18	1.04	4.54	0.31
4	Fenced site	16	1.07	4.82	0.38
5	Controlled grazing	21	2.08	6.44	0.41
6	Controlled grazing	22	2.12	7.28	0.53
7	Controlled grazing	22	2.20	8.42	0.62
8	Controlled grazing	22	2.21	6.45	0.45
9	Intensive grazing	6	0.52	0.62	0.21
10	Intensive grazing	6	0.55	0.84	0.22
11	Intensive grazing	6	0.61	1.00	0.23
12	Intensive grazing	6	0.57	0.94	0.19
13	Occasional moving, no trampling or grazing	12	0.99	4.20	0.43
14	Occasional moving, no trampling or grazing	12	1.02	4.00	0.41
15	Regular but controlled trampling	7	0.64	0.84	0.23
16	Regular but controlled trampling	7	0.57	1.04	0.26
17	Heavy moving	4	0.43	0.54	0.22
18	Heavy moving	4	0.51	0.66	0.26
19	Heavy moving	4	0.60	0.57	0.18
20	Heavy moving	4	0.48	0.48	0.16

Table 8 above ground biomass (gm/m^2) recorded at different sites.

S. No.	Site	Nature of Disturbance	Total Above ground Biomass		
			March	**April**	**May**
1	1	Totally Fenced	120	200	425
2	5	Controlled Grazing	70	165	384
3	10	Heavy Grazing	50	70	80
4	15	Regular Trampling	100	120	120
5	20	Heavy Moving	50	60	60

Table 9 Physico-chemical characteristics of soil at different study sites.

Study Sites	Nature of Disturbance	Dominant Plant Associations	Color	WHC %	Moisture Content	Soil Temp.	pH	OM
1	Fenced Site	*Bothriochloa pertusa-Plantago lanceolata*	Brown	60.2	16.4	19.0	7.4	12.0
5	Controlled Grazing	*Cynodon dactylon-Medicago lupilina*	Light Brown	58.1	16.0	20.2	7.6	10.9
10	Heavy Grazing	*Cynodon dactylon-Bothriochloa pertusa*	Light Brown	38.3	10.4	26.2	7.8	7.4
15	Controlled Trampling	*Cynodon dactylon-Bothriochloa pertusa*	Light Brown	40.8	12.7	24.2	7.8	7.8
20	Heavy Moving	*Cynodon dactylon-Bothriochloa pertusa*	Light Brown	34.6	10.0	27.0	7.8	6.0

WHC= Water Holding Capacity; **OM=** Organic Matter

Besides the increase in the dominance of *Cynodon dactylon* L. in the disturbed sites is not because of favorable effects of disturbances on it but due to decrease in the dominance of other species and selective grazing that tends to alter the composition of the forest or grassland ecosystem, causing an increase in the population of undesired species, which are not consumed by the animals. In other words *Cynodon dactylon* L. has more resistance to grazing, trampling and moving therefore its IVI is highest at the sites encountering such disturbances. Dominance of *Cynodon dactylon* L. in the grazed and other disturbed sites may also be due to stimulation of basal shoot production and proliferation of its runners. Similar reasons have been placed on record by Trilica and Rittenhouse (1992).

As a matter of fact there are differences among grazing lands in terms of their responses to grazing animals. Plant communities in the lands that have a long history of grazing such as of the Central Great Plains are affected little by livestock grazing (Sims et al., 1978; Milchunas et al., 1998). Since the grasslands under present study that are subjected to grazing and other disturbances sustain *Cynodon dactylon* and *Bothriochloa pertusa* association indicates that the said association is resistant to heavy grazing in the grasslands and pastures of Kashmir and grazing favors its sustenance and stability.

As is evident from the Table 7, disturbances like intensive grazing, trampling and moving reduce the species diversity, richness and evenness. Similar deterioration in the vegetation due to heavy grazing has also been propounded by Looman (1969) and Kumar and Joshi (1972). Controlled grazing however is promoting species diversity, richness and evenness at sites 5-8. This observation is in concordance with the findings of Grubb (1986), Dar and Koul (1987), Dar (1988), McNaughton (1993), Knapp et al. (1999) and Bullock et al. (2001). Total fencing eliminates the anthropogenic disturbances and keeping away the herbivores slightly reduces the number of species, species diversity, species richness and evenness. Maximum number of species was recorded at sites 5-8 subject to controlled sites and sites subject to heavy moving. Reduction in similarity index was recorded with increased disturbances like grazing, trampling and moving because of elimination of less resistant plant species from such sites.

As a matter of fact, highest total above ground biomass/m^2 was recorded for protected sites but heavy disturbances reduce the above ground biomass (gm/m^2) per unit area of grassland (Table 8) where as mild disturbances like controlled grazing do not affect it much. Moreover growth controlling factors like moisture, aeration, temperature etc also affect the biomass production.

Indiscriminate grazing besides other disturbances also leads to the degradation of the soil which loses its porosity and aeration. This in turn results in the seeds not germinating as they do not get sufficient air and water from the soil. Moreover, the hooves of the animals break down the soil aggregates, which give a crumbly structure to the soil. Due to this, the soil loses its ability to absorb sufficient amounts of water. This translates into little percolation of rain water, most of which gets drained away. Since indiscriminate grazing leaves large parts of the bare land, the rainwater that gets drained away tends to erode the soil in its path. Besides texture, the physico-chemical characteristics of the soils collected from differently disturbed grasslands also reveal that soil water holding capacity, moisture content and organic matter decreases with increasing disturbances. Decrease in soil water holding capacity may be attributed to soil compaction and loss of capillary spaces in the soil with increasing disturbances. This observation confirms the findings of earlier studies undertook by Blackburn (1984), Warren et al. (1986), Dar and Koul (1987), Dar (1988) and Heady and Child (1994). The soil compaction by disturbances can decrease plant growth and reduce diversity. Soil temperature and soil pH shares an inverse relationship with organic matter. In fact temperature and pH of the soil shows increasing trend with an increase in disturbances. Sites with more disturbances have low organic matter in their soils and exhibit alkaline pH as against the soils with low or no disturbances which have high percentage of organic matter and low pH. This is in conformity with the earlier studies of Dar and Koul (1987) and Dar (1988).

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