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Effect of Grazing Pressure on the Structure of Rangeland Plant Community in Mongolia

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Abstract: The main cause of land degradation is overgrazing in Mongolia. The carrying capacity of rangeland is decreasing. Under heavy grazing, remarkable changes in plant functional type was detected from the perennial and palatable plants (*Stipa krylovii, Agropyron cristatum, Allium Mongolicum*) to the annual and unpalatable plants (*Chenopodium acuminathum, Peganum nigelastrum*).

Key Words: Grazing intensity, Land degradation, Mongolia, Plant palatability

1. Introduction

Animal husbandry is the oldest important traditional production in Mongolia. Currently, about 40% of herders are living by the nomadic and traditional way of life. Mongolian rangeland sustains a livestock activity that is the subsistence farming, and the productivity of rangeland is a key factor for the life and culture of Mongolia. Since the change of Mongolian economic structure from the socialistic control to the capital marketing in 1990, livestock numbers started to increase and became more than 45.3 million heads in 2009 (Jigjidsuren and Johnson, 2003). More than 80% of Mongolian territory is used for pasture. Under the new introduced economical system, herders show a tendency to aggregate around big cities, such as Ulaanbaatar, and/or main routes which make them easy to sell and transport livestock and by-products and to access social services. High grazing pressure in these areas seriously disturbs rangeland ecosystem and causes significant changes in vegetation structure. Over exploitation of above and belowground biomass by heavy grazing for long period induces indispensable degradation of rangeland ecosystem and also decreases in carrying capacity in central area of Mongolia. Changes in community structure by grazing are strongly depending on plant life-form and its palatability (Marcelo *et al*., 2000). Palatability of grassland plants by livestock is the most important factor to evaluate productivity and sustainability of rangeland. However the palatability of each species is not so clear and is limited, not only for introduced but also native species because of the complication of foraging activity.

Besides, a genotypic difference within and between plant species was noted related to the response of plants to salt stress (Saudi *et al*., 2003).

2. Materials and Methods

During winter season, all livestock are kept at night in a pen and every morning start from a camp to all direction opening in front of the camp to feed on dried grass and leaves around the camp. It is necessary to move for long distance from the camp to get enough amounts of dried fodder as the settlement period progress in winter (**Fig. 1**).

The distance from winter camp can be considered as an indicator for grazing pressure on the vegetation, namely grazing intensity decreases as the distance from the camp increases. Research area is the central of Mongolia from the north Darkhan city, N 49 24.853; E 105 58.757) to the south (Mandalgobi, N 45 47.319; E 106 10.192). It ordered from north to south with numbers from 1 to 21 included abandoned a winter camp.

Twenty one winter camps were selected as shown in **Table 1**. Most of all camps were located on flat or gentle south-east facing slope of small mountains or hills.

Vegetation coverage, species composition and height of each species of rangeland around winter camp were recorded. The field survey was carried out growing season, July-Autumn, 2009. Three parallel lines were set from the center of the winter camp and seven experimental plots were established along each line at 25, 50, 100, 200, 400, 800 and 1600 m from the origin. Total number of plots was 441. Four subplots (1 × 1 m) were put within each plot, resulting totally 1764 subplots.

Seasonal changes in species composition and its availability makes the palatability to the relative values, such as palatable in winter (January-March), spring (April-June), summer (July-September), and autumn (October-December). In this study, palatability of each species was classified into 5 classes follows by Damiran (2005).

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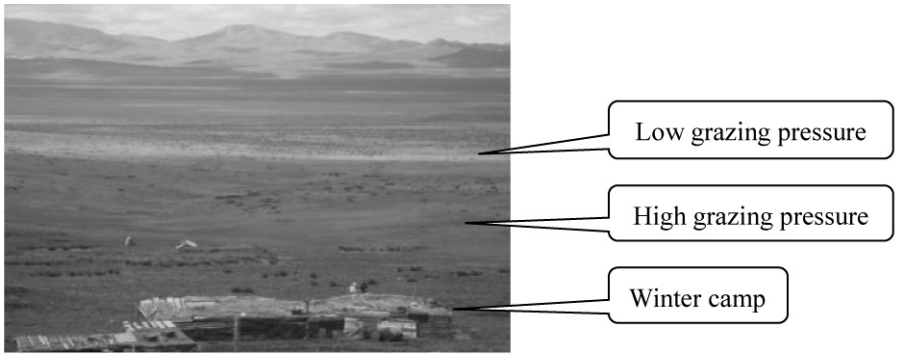

Fig. 1. A winter camp in the rangeland of Mongolia.

Table 1 Location of research sites.

No.	E	N	Altitude (m)	Prefecture	County
1	105^{0}58.757'	49^{0}24.853'	786	Darkhan Uul	Darkhan
2	105^{0}55.258'	49^{0}21.042'	785	Darkhan Uul	Khongor
3	105^{0}28.429'	47^{0}46.423'	1152	Tov	Lun
4	105^{0}28.425'	47^{0}46.413'	1150	Tov	Argalant
5	106^{0}49.905'	47^{0}33.610'	1435	Tov	Sergelen
6	106^{0}45.679'	47^{0}31.954'	1463	Tov	Sergelen
7	106^{0}43.607'	47^{0}28.988'	1509	Tov	Sergelen
8	106^{0}44.500'	47^{0}27.264'	1583	Tov	Sergelen
9	106^{0}31.958'	47^{0}06.452'	1508	Tov	Bayantsagaan
10	105^{0}58.753'	47^{0}03.002'	1283	Tov	Bayan-O'njuul
11	106^{0}23.647'	46^{0}46.347'	1419	Tov	Bayantsagaan
12	106^{0}27.768'	46^{0}41.596'	1388	Tov	Delgertsogt
13	106^{0}24.894'	46^{0}37.106'	1332	Tov	Bayantsagaan
14	106^{0}26.284'	46^{0}33.322'	1372	Dundgobi	Delgertsogt
15	106^{0}23.858'	46^{0}31.196'	1336	Dundgobi	Delgertsogt
16	105^{0}39.915'	46^{0}29.122'	1486	Dundgobi	Adaatsag
17	106^{0}05.684'	46^{0}14.220'	1504	Dundgobi	Adaatsag
18	106^{0}11.166'	46^{0}10.228'	1508	Dundgobi	Sain tsagaan
19	106^{0}13.058'	46^{0}09.673'	1458	Dundgobi	Sain tsagaan
20	106^{0}06.630'	45^{0}49.954'	1500	Dundgobi	Sain tsagaan
21	106^{0}10.192'	45^{0}47.319'	1470	Dundgobi	Sain tsagaan

Each winter camp, number of livestock, composition of them and duration of rangeland utilization were recorded by interview to the owner and neighbor. The soil type in Mongolian rangeland steppe is the mostly typical Kastanozems (Haase, 1983).

The meteorological data was provided from Mongolian Institute of Meteorology and Hydrology, Ministry of Nature and Environment, in 2009. The climate condition of study sites was shown in **Table 2**.

These 4 meteorological stations data can show the condition of climate in our sites. The precipitation is decrease and air temperature increase from north to south.

3. Results and Discussion

Eighty two species of 53 genus and 24 families were recorded throughout the study sites. According to these species composition sites are characterized by typical steppe and dry steppe vegetation, which dominated by the feather grass (*Stipa* spp*)* genus, shrubs (*Caragana* spp) and wormwood (*Artemisia* spp) species on the chestnut soils. In addition, *Achnatherum splendens, Chenopodium acuminatum, Cleistogenes squarrosa, Artemisia adamsii, A.frigida, Carex duriusculla* and *Leymus chinensis* are common in these areas. Plant palatability should be taken into account in order to estimate correctly or monitor precisely the foraging resources of the Mongolian rangeland.

3.1. The changes of vegetation by grazing intensity with grazing gradient

According to the result all species with north and south areas were classified by 4 relationship types with grazing distance from the winter camps such as negative, positive, independent and temporal (**Fig. 2**).

Table 2. Climate information of nearby meteorological stations from research sites.

Location	Air temperature (^{0}C)			Wind velocity (m/s)		Relative humidity (%)			Precipitation (mm)
	ave.	min.	max.	ave.	max.	ave.	min.	max.	
49^{0}28.148'N 105^{0}57.464'E	36.2	-33.9	16.2	1.9	8.8	60.7	44.4	81.6	338.9
47^{0}38.855'N 105^{0}34.820'E	31	-29.8	12.3	2.5	7.2	54.7	38.6	71.8	332.4
47^{0}42.428'N 106^{0}56.970'E	30.5	-27.9	13.4	3.1	10.3	55.1	39	74.8	261
45^{0}45.942'N 106^{0}16.500'E	34.2	-24.3	19.7	5.3	12.2	44	27.5	66	86.4

Table 3. Representative species of relation groups.

Negative	Positive	Independent	Temporal
Chenopodium acuminatum	*Stipa Krylovii*	*Artemisia Adamsii*	*Convolvulus Ammanii*
Salsola collina	*Agropyron cristatum*	*Carex pediformis*	*Heteropappus hispidus*
Artemisia scoparia	*Artemisia frigida*	*Kochia prostrata*	*Thermopsis dahurica*
Potentilla bifurca	*Cleistogenes squarrosa*	*Cymbaria dahurica*	*Peganum nigellastrum*

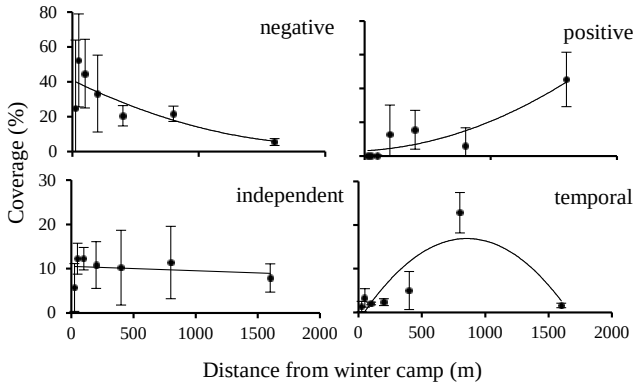

Fig. 2. Relationship types between plant cover and grazing gradient.

The representative species of each relation group were shown in **Table 3**.

We focused on important relationship with positive and negative effects. These species can show any tendency of changes species coverage with grazing distance from the winter camp.

3.2. The relationships of plant palatability and life form

As shown in **Table 4**, plants sought by particular species of animal and made up a major part of the diet or consumed far in excess were classified into preferred (P), plants sought and readily eaten but to a lesser portion than preferred plants were classified into desirable (D), plants eaten but usually made up only a minor part of the diet or consumed in a much smaller proportion than occurred on the rangeland were classified into undesirable (U). Moreover, plants not eaten intentionally, and plants with toxic substances were classified into not consumable (N) and toxic (T) respectively.

Most of annual plants were undesirable or not consumable species. On the other hand, most of grasses such as *Stipa krylovii, Agropyron cristatum* and *Cleistogenes squarrosa* were preferred or desirable species as shown in Table 4.

Table 4. Plant palatability and life form.

Palatability	Life form			
	Annual	Perennial		
		Grass	Herb	Shrub
Preferred	-	4	5	1
Desirable	1	5	8	2
Undesirable	5	-	13	3
Not consumable	5	-	7	2
Toxic	-	-	2	-
No data	-	-	2	1
Unknown	2	2	12	-
Total (82)	13	11	49	9

Table 5. Species relation with grazing distance from winter camp. (P: Palatable species, UP: Unpalatable species).

Relation	Annual		Perennial					
			Grass		Herb		Shrub	
	P	UP	P	UP	P	UP	P	UP
Negative	-	2	1	-	-	1		-
Positive	-	-	6	-	5	6	3	1
Independent	1	7	3	-	20	10		4
Temporal	-	2	2	-	2	4		2
Total (82)	1	11	12	0	27	21	3	7

Comparison between species relation with distance from the winter camp and species life forms classified into groups of palatable (P + D) and unpalatable (U + N + T), most unpalatable species shown the negative relation and palatable species shown the positive relation with grazing distance from the winter camp (**Table 5**).

As shown in Figure 2 and Table 4, most annuals and unpalatable species were with independent relation and grasses and palatable species were with positive relation within the grazing distance from the winter camp. According to the

grazing intensity, the structure of rangeland plant community is becoming from palatable and grass species to unpalatable and annuals species by the grazing intensity.

In our results, that nearby the winter camp are coincided with Zhang *et al*. (2001), who showed that continued heavy grazing changed species composition and decreased species richness of plant community in Inner Mongolia. However in our studied case, seasonal use of winter camp gives plant community a rest time in grown season by release from grazing pressure. It has been suggested that management of grazing intensity among dimensions of time and space have an important role to the sustainability of steppe vegetation resources and livestock industry itself in the Mongolian plateau.

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