Vegetation succession in two meadow steppes under influence of grazing in forest-steppe zone of Mongolia

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Abstract.

In 1986-1991, we conducted a vegetation survey in two meadow natural grasslands which distributed in different ecological conditions in forest steppe zone of Mongolia. These meadow grasslands have been had a different livestock grazing intensity as light, moderate and heavy grazing and were located within the 3.0 km range from the sum - settlement. The main characteristics of vegetation such as species composition, cover, relative value of ecological groups, soil moisture and productivity were surveyed comparatively in relation to different levels of grazing pressure in these meadow vegetations.

The vegetation soil moisture in surface layer 0-20 cm is low, because meadow wet soil and its surface layer under permanent trampling of livestock have been hard (Grasslands…, 2000), impermeable, and able to retain little water in one hand, in other hand, with permanent trampling have not plant litter layer at ground and vegetation have been very short and sparce, therefore water transpiration of surface soil is more than light grazing. This indicated that the heavy grazing in meadow vegetation led to the xerophytisation its plant habitat and vegetation was steppizate, namely is transformed to the steppe and to new plant habitat began invade the xerophyte steppe short grass and forbs species, it is related with increase in the species number and productivity in flood flat meadow.

Key words: meadow, forest steppe, soil moisture, trampling, grazing, xerophytisation;

Introduction

Mongolia occupies an ecological transition zone in Central Asia where the Siberian taiga forest, Central Asian steppe, the Altai mountains and the Gobi desert meet. These different ecosystems provide habitat for a variety of plant species.

Therefore Mongolia has been divided into six broad vegetation zones: alpine; taiga; forest steppe; steppe; desert steppe and desert. Our study objectives are the *grass-forb* and *Agrostis Trinii* meadow communities widely distributed in the forest steppe zone of Mongolia especially in east Khentee mountain region.

The forest-steppe zone lies between the steppe and taiga, in the Khangai, and Altai mountain chains, including parts of the Orkhon and Selenge river basins and Khyangan mountains of eastern Mongolia. Therefore, vegetation is a combination of Siberian taiga and Mongolian steppe flora.

Human land use is one of the main causes of ecological change world-wide. Heavy grazing has in many places, particularly in forest-steppe regions in Mongolia and led to changes in soil and vegetation.

Since 1933 in Mongolia began to study the meadow vegetation. First, russian scholars Pavlov (1925), Jebrac (1933) were studied the vegetation types and productivity of meadow vegetation in Khangai mountain region of Mongolia and after, the study of meadow productivity in relation with its improving in north Khangai mountain region have been done by Desyatcin (1936) and Bolodin (1938, 1939).

Further Unatov (1946, 1950, 1954) was studied the the vegetation cover of Mongolia and was reported about distribution, biology-ecological characteristics of more than 500 fodder plant species of Mongolia and it's productivity and palatability by livestock.

The book on "The vegetation and forage resource of western Khentee" have been written by Ochir (1966), which in reported natural phenomen in season and annual dynamics of productivity in different meadow vegetations (alpine meadow, meadow steppe and mountain meadow) distributed in west Khentee region.

Since 1970 within the Mongolian-Russian Joint Biological Complex Expedition in Mongolia carried out extensive field investigation on regional vegetation, which laid the foundation for sequent grassland research and were reported the distribution, productivity and it's seasonal dynamics, structure, plant growth season in meadow vegetation of Mongolia.

The biological and ecological features of meadow hay-pasture types has been defined by Dugermaa (1986) and he reported that after fertilization in meadow vegetation with good water supply productivity was increased.

Systematic study in the Khentee mountain region have been done by our scientists, researchers Jamsran, Ulziikhutag, .Sanchir (1972), Ulziikhutag (1985, 1989) and Darima (1990). Thus, the meadow vegetation was studied is careful, but the study of succession process of meadow vegetation in relation with anthropogenic factors such as grazing intensity was studied not enough. In order to prevent turther degradation of meadow vegetation and restore degraded areas, it is necessary to study impact of grazing in this vegetation.

Degradation and recovery may be preceived as changes in species or ecological group composition, in total above-ground biomass, or in quantity and quality of forage produced

The present work was done on the territory of Mungunmorit sum in Central aimag. Mongolia in 1986-1991 and a comparison was made of the phytocenological characteristics (productivity, species composition and cover) and relative value of plant ecological group in vegetation with different levels of grazing pressure. Introduction of heavy grazing often initiates a regressive succession, including a decrease in biomass and structural complexity. Therefore, our hypotheses were that:

- Productivity of vegetation with heavy grazing would decrease and deteriorate due to decrease biomass of palatable species.

- Due to overgrazing the species richness and diversity would reduce.

- The plant habitat in flood meadow vegetation under heavy grazing intensity have been xerophytisated and transformed into steppe vegetation.

- The mountain meadow vegetation under influence of grazing have been deteriorated more than another.

- Under influence of permanent trampling by livestock the soil moisture in meadow vegetation have been reduced.

Our objectives of the current work are to a) investigate the main characteristics of vegetation such as species composition, cover and productivity in vegetations with different levels of grazing pressure.

b). investigate the relative value of plant ecological group in these vegetations. c). investigate the variation in soil moisture in relation with grazing intensity. d). Based on above mentioned investigations to reveal the succession of meadow vegetations which are distributed in two different ecological conditions: mountain meadow (dry condition) and flood meadow (very wet condition)..

2. Materials and methods.

2.1. Study area

2.1.1 Location.

According to the physic-geographical subdivision (Tsegmed, 1969) the study area have been belonged to the Khentee subregion of the Khangai and Khentee mountains great region and to the botanical geographical division it is belonged to the Khentee mountain taiga district in Trans-Baical mountain taiga province of the Eurasian coniferous forest division (Unatov, 1950) and here dominated by meadow swampy frozen soil.

Climate is a distinctly continental characteristic, temperatue is a highly variable in annual and for night. Mean annual temperature is a -1.9^0- -3.8^0 C. Coldest mean temperature in January reachs -27.8^0, warmest mean temperature in July is 17.6^0 , absolutly high is a 33.2^0 (The larch forest of East Khentee, 1988). Most variable in air temperature months are march (55.8^0 C), octomber (52.4^0C) and november (57.8^0C). Mean air moisture is a 63-64 %, in winter is a70-75% and in summer is a 53-72%. In spring air moisture is very low (45-47%). Annual mean soil temperature variables between the -2.0^0 - $+1.0^0$ C and soil absolutely low temperature in winter is a -50^0 C, than absolutely high temperature in summer is a$+65^0$C.

Annual precipitation in Eastern Khentee variables in 240-320 mm, of these 293 mm or 70-80% fall in plant growth season.

2.1.2 Site description.

Grass-forb meadow community situated in south at 3 km from Mungunmorit sum, on the flat between the middle mountains, where altitude is 1600 m a.s.l. Mungunmorit sum has a small territory for a grassland, because around are high mountains. There dominated by tall grew forb species: *Sanguisorba officinalis, Potentilla tanacetifolia, Scabiosa Fischerii, Galium verum, Chryzanthemum Zawadskii, Carex pediformis* and codominated grass species: *Elymus chinensis, Stipa baicalensis, Koeleria macrantha, Agropyron cristatum.* Vegetation cover is 42.1%, the species diversity is high. In order to study succession process in relation with grazing in meadow vegetation we chose the study site near the *cow milk farm* which distributed on this territory. By distance from farm meadow vegetation was low alternated. According to the changes in vegetation we distinguished three levels of grazing pressure: *light grazing; moderate grazing; and heavy grazing.*

Meadow vegetation on heavy grazing is located in the 600m range from farm and here dominated Artemisia mongolica, A. commutata, A. laciniata and codominated other steady to grazing forb species. In compare with other sites here quality and productivity were deteroriated due to invade the unpalatable, field weed species as Artemisia and annual and biennial species.

Meadow vegetation on moderate grazing is located within the 400 m of heavy grazing site. By vegetation conditions the dominant grade of the invaders and increasers equilibrates with the decreasers.

Meadow vegetation on light grazing, it is a grass-forb community. Soil is a meadow clay chestnut. It is distributed in a distance on 1.5 km from farm. Here vegetation has a high cover and species diversity.

Agrostis Trinii meadow community situated in the west at 2.5 km from Mungunmorit sum where altitude is a1600 m a.s.l. in the Baruun-Burh river valley. It is a flood meadow vegetation. Here have been distinguished also three levels of grazing intensity. Soil is a hard clay meadow frozen chestnut and dominated by Agrostis Trinii, codominated by Carex pediformis, Sanguisorba officinalis, Galium verum and ets with high cover and productivity.

2.2. Methods.

We used the line transect method. From the cow millk's farm to remote direction randomly was taken 1.5 km's line transect. According to the methodology by Larin (1952) in relation with changes of general characteristics in vegetations, along the transect we distinguished three levels of grazing intensity: light grazing; moderate grazing and heavy grazing. Main criterions by which distingiushed the vegetation into levels are: cover of dominated species in vegetation, mean plant height, productivity and quality (ratio between the biomasses of palatable and unpalatable species).

Species composition and vegetation cover was documented in randomly placed quadrats of $1m^2$, 10 in each plots.

All species classified on ecological group of water requirement. Because, for study the succession process in meadow vegetation in relation with anthropogenic factors very important to investigate ecological group spectra, namely relative value of ecological group in species. The simplest form ecological group spectrum are a ratio sum the number of species by ecological group classes to total number species in all ecological group classes and the results were expressed in percent.

Sampling of above ground biomass was carried out trom 1 m^2 in 10 times during the growing season. All species were cut at ground level and also was taken the litter -biomass. Samples were dried at 80^0C to content weight (24 h) and weighted to the nearest 0.001g. Canopy cover was recorded in percent for all species and measured their hights.

Sampling of soil moisture was taken from every soil depth: 0-10; 10-20; 20-30; 30-40 and 40-50 cm and were dried at 105^0C to content weight (24 h) and weighted to the nearest 0.001g. It expressed in per cent.

2.2.1. Data analysis.

Biomass data were anylized for important species separately. The biomass components were sorted as groups of species: shrubs; grasses; legumes; sedges; warmwoods(Artemisia), forbs and litter. Above all the except litter sorted as palatable and unpalatable groups.

Statistical methods.

The all data were calculated by following formula:

1. $\boldsymbol{X} = \sum_{(c)} / n;$ were n- number of replication; X- mathematical mean; c – 1.2.3…

2. $\mu(variance) = \sum (c-x)^2 / n-1;$

3. $m = \mu/n$; were m-standard error oif means. The standard error of the difference is used to access the difference between the means by the T and F tests.

4. $t_{1.2} = (X_1-X_2) / (m_1^2+m_2^2);$ were (X_1-X_2)- difference between the means

$(m_1^2+m_2^2)$-standard error of the difference.

5. $F_{1.2} = \mu_1/\mu_{2;}$

The level of significance is readily obtained from a table of T and F (Fisher and Yates, 1957).

The significance of our study is a P=0.05 or 95%.

Results.

Overveiw of two meadow communities in different ecological conditions.

Table 1 shows general characteristics of the two meadow grasslands surveyed in 1986-1991. The meadow vegetations most distant from cow farm or Baruun burh river experienced moderate and light levels of grazing, whereas the grassland closest to them experienced the overgrazing. Plants under light grazing conditions grew taller than those overgrazing and hevy grazing conditions (plant height is a simple indicator of grazing intensity). The occurrence of Agtostis Trinii is a characteristic grass preferred by animals in this area, decreased with increasing grazing intensity.

Species composition.

In the grass-forb mountain meadow the total number of species on light and moderate grazing is the same, not differences, but with heavy grazing intensity it was decreased in 1.2 times.

In contrast in *Agrostis Trinii* flood meadow vegetation the total number of species with intensive grazing was increased in 1.5 times or on 17 species.

In relation to great variation in number of species, the phytocenological role (cover and biomass) of dominated species was changed variously (Table 2). For example, The phytocenological role of main species, dominated in light grazing with good palatable and high forage quality as *Stipa baicalensis, Agrostis Trinii, Carex pediformis, Galium verum* and ets with increasing grazing intensity was decreased, whereas have a good vegetative reproduction and unpalatable or steady to grazing species as *Leymus chinensis, Koeleria macrantha, Carex duriuscula, Thermopsis dahurica, Stellera chamaejasme* and ets. was increased and these species began dominated in heavy grazed meadow vegetation.

Vegetation cover

With increasing grazing intensity vegetation cover was decreased in the two meadow communities the same, especially, (figure 3)compare with light grazing, in the heavy grazing of grass-forb mountain meadow it decreased on 24.1% than flood meadow vegetation. Synusia structures in the communities include four kinds: bunch - grass; rhizome – grass; Sedge, Artemisia and forb;

Productivity.

The total productivity and quality in two meadow vegetation varied in relation with increasing species number. In grass-forb mountain meadow community the productivity is decreased whereas in Agrostis Trinii flood meadow community it is increased (Table 3; fig.4).

Total green biomass in vegetation was sorted on economic groups (Table 1; fig.5) and variation of the ratio between the biomass in economic groups of these communities is variously. (Figure 5).

Thus, from figure 5 we can seen that the biomass of woody, unpalatable species (*Artemisia*) was increased with heavy grazing in two meadow vegetation the same, and biomass of grasses increased in the *Agrostis trinii* meadow community, decreased in the *grass-forb* community. And sedge biomass decreased in *Agrostis* meadow, increased in grass-forb meadow community.

Also all the species were classified on ecological group classes of water requirement and their biomass calculated separately.

Soil moisture.

In the table 4 shown that the soil moisture in meadow vegetations was reduce with increasing grazing intensity. For example, in heavy grazing of *grass-forb* meadow soil moisture on soil surface layer 0-10 cm was reduce on 1.9%, in *Agrostis* meadow on 4.6% compare with light grazing; on 10-20 cm soil depth on 1.2% and 3.6% accordingly. Thus, the soil moisture at surface layers on 10-20 cm depth was decreased. But in the below layers of 40 cm depth, soil moisture began increase. It related with that meadow soil has a frozen at below layers of 40 cm depth .

Plant ecological group.

Grass-forb meadow community. Compare with light grazing, in the vegetation on *moderate* and *heavy* grazing the number of xerophyte and galophyte species were not varied, but their biomass increased a little, then the number of mesophyte and cryophyte species were decreased in 1.5 times, and accordingly their biomass in 4.9-5.2 times too.

In the *Agrostis Trinii* flood meadow vegetation with increasing grazing (in heavy grazing) the number and biomass of mesophyte species were decreased and cryophyte species denuded of vegetation. Then number and biomass of xerophyte and galophyte species were increased in 4.0 times (Figure 6).

Discussion

While Mongolian's animal population is increasing, the productivity of its grassland is decreasing in resent years. This imbalance has caused degradation: the reduction of biomass, decline of preferred species and damage of vegetation soil.

An increase in xerophtyte and a decrease in mesophyte species in relation with xerophytisation of meadow vegetation and plant habitat under increasing influense of grazing were reported by Kudelin (1951)., Gertsig (1955) and Kasach(1969)

Also by Coupland (1958) was reported about a decrease in soil moisture, hence a root biomass in relation with increasing grazing.

Thus, our study results indicated that with increasing grazing the vegetation soil moisture in soil surface layer 0-20 cm is low. It is also reported by Zhang, (1989, 1990)., because under permanent trampling by livestock the wet meadow soil and its surface layer have been hard, impermeable, and able to retain little water, in one hand, in other hand, the vegetation have been very short and sparce and here have no plant litter layer at ground, therefore water transpiration of surface soil is more than light grazing. This indicated that the heavy grazing in meadow vegetation led to the xerophytisation its plant habitat (table 4). Hence, an appearance of new plant habitat under influence of grazing conducted to change in relative value of plant ecological groups (figure 6) in vegetation. Thus, Figure 6 indicated that in the *grass-forb* meadow community with increasing grazing intensity the number of mesophyte and cryophyte (cool likes species) species and its productivity were decreased, it is also reported by O.Chognii (1988), but the number of xerophyte and galophyte species were not changed, whereas in the *Agrostis Trinii* flood meadow community the number of xerophyte and galophyte species and its productivity were increased in 4.0 times, that meadow vegetation have been salinized under influence of heavy grazing and cryophyte species denuded of vegetation. It is a confirmation that plant habitat in meadow vegetation under unfluence of grazing was xerophytisated.

In relation with xerophytisation of plant habitat in *Agrostis Trinii* flood meadow vegetation the species number and vegetation productivity were increased. It is related with invade steppe short grass and another xerophyte , which likes a degradation, species to the xerophytisated new habitat. In contrast, the mountain *grass-forb* meadow vegetation located comparatively in the dry condition than another, therefore the increasing grazing intensity influenced on it strong negatively –reduction of biomass, productivity and decline of preferred and mesophyte species. Becides, the phytocenological role (cover and biomass) of dominated species was changed variously (Table 2). For example, The phytocenological role of main species, dominated in light grazing with good palatable and high forage quality as *Stipa baicalensis, Agrostis Trinii, Carex*

pediformis, Galium verum and ets with increasing grazing intensity was decreased whereas have a good vegetative reproduction-rhizome species and unpalatable or steady to grazing species as *Leymus chinensis, Koeleria macrantha, Carex duriuscula, Thermopsis dahurica, Stellera chamaejasme* and ets. was increased and these species began dominated in heavy grazed meadow vegetation. If in the light grazing have been dominated tall grew grass, forb species, than in heavy grazing have dominated short grew rhizome and rosette plant species.

According to the change in phytocenological role of dominated species, we can distinguish three category of species: a). some species decrease as grazing pressure increase, e.g., *Stipa baicalensis, Agrostis Trinii, Galium verum, Scabiosa Fischerii, Carex pediformis, Sanguisorba officinalis* and ets b). while the other species gradually increase, e.g., *Artemisia laciniata, A. mongolica, Carex duriuscula, Plantago depressa, Thermopsis dahurica and Leymus chinensis*, and c). category of species has no obvious increase or decrease, grew good only under moderate grazing pressure such as *Koeleria macrantha, Halenia corniculata, Leontopodium ochroleucum* and ets.

With increasing grazing intensity in *grass-forb* meadow vegetation on heavy grazing the total productivity (Table 3; fig.4) was decreased due to decrease in litter and forb biomass, whereas in the *Agrostis Ttrinii* flood meadow vegetation it is increased due to increase the biomass of xerophyte grass and forb species in 1.2 times and Artemisia species in 2.4 times. It is also related with increasing species number in this community. Therefore compare the succession in relation with grazing intensity on two different meadow vegetation distinguished by environmental condition we made conclusion that under heavy grazing the meadow vegetation was xerophytisated and steppizated due to decrease in soil moisture of surface layer and increase steppe especially rhizome short grasses and xerophyte forb species.

Conclusion

- An increasing grazing intensity or the permanent trampling by livestock in meadow vegetation led to the decrease soil moisture in it's surface layer and it have been hard, impermeable, and able to retain little water, hence plant habitat in vegetation was xerophytiseted.

- Xerophytiseted plant new habitat in meadow vegetation conducted an increase in xerophyte and galophyte species and decrease in mesophyte and cryophyte species and the meadow has been salinized.

- In relation to appearance the steppe xerophyte short grass and forb species in the flood meadow vegetation the total productivity and total species number were increased.

- Under influence of heavy grazing the meadow vegetation was steppizated (have been formed to the steppe).

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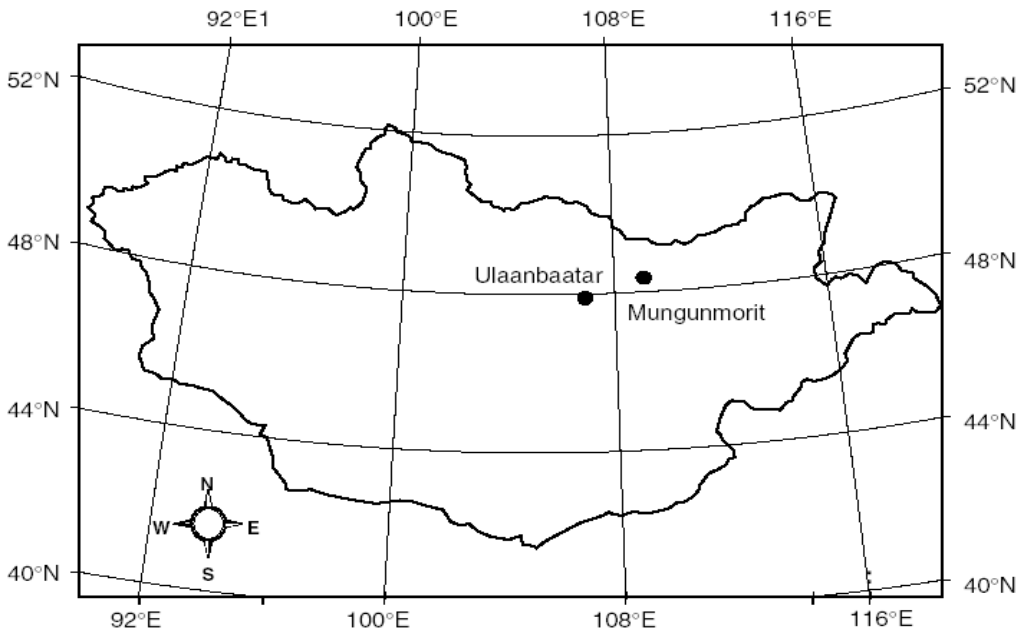


Figure 1. Location of study area. Mungunmorit sum of Central Mongolia

Table 1.

The features of the two meadow communities on the different levels of grazing intensity.

The attributes of the community.	*Grass-forb meadow*			*Agtostis Trinii meadow*		
	Light grazing	Moderate grazing	Heavy grazing	Light grazing	Moderate grazing	Heavy grazing
Average number in 10 quadrats of $1m^2$	62 ± 3.58	61 ± 3.49	50 ± 2.79	33 ± 1.98	51 ± 2.83	50 ± 2.98
Vegetation cover (%) average of 10 quadrats.	90	82.5	65.9	85.6	74.9	73.8
Mean height of plants (cm)	32	17	12	37	21	15
Total productivity: (c/ha)	17.2	18.0	16.0	21.3	24.4	24.9

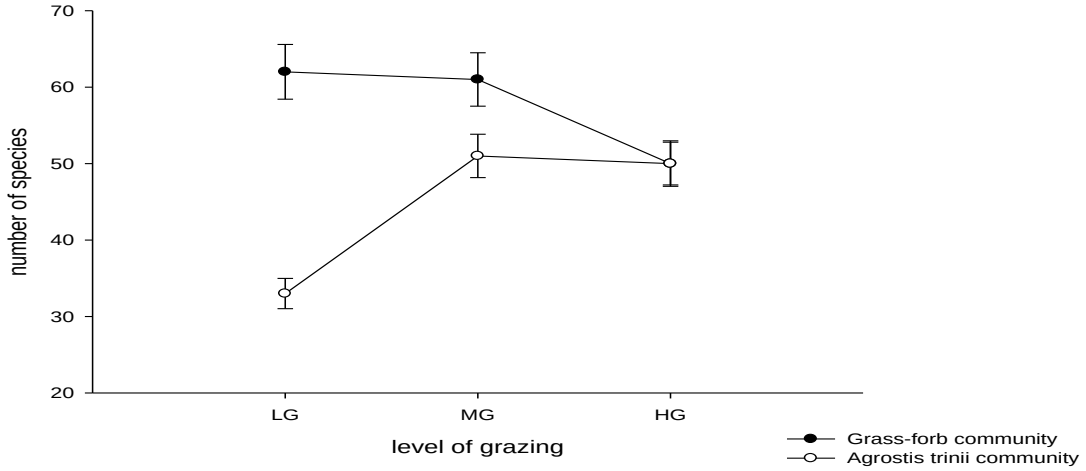


Figure 2. The number of species in two meadow communities. were, LG- light grazing; MG- moderate grazing; HG- heavy grazing; 1-grass-forb mountain meadow; 2- Agrostis Trinii flood meadow.

Table 2.

The change in phytocenological role of dominated species in the two meadow vegetations.

a. ***grass-forb meadow community***.

Plant names.	The levels of grazing pressure					
	Light grazing		Moderate grazing		Heavy grazing	
	Cover %	Biomass g/m^2	Cover %	Biomass g/m^2	Cover %	Biomass g/m^2
Leymus chinensis (Trin)Tzvel	4.9	3.7	4.5	10.1	12.1	14.3
Stipa baicalensis Roshev.	8.6	6.2	2.0	2.5	0.3	1.8
Festuca lenensis Drob.	1.3	4.1	2.1	11.9	1.8	3.2
Agrostis Trinii Turcz.	4.0	18.5	2.0	4.1	1.0	4.4
Koeleria macrantha (L).Pers	1.7	2.5	6.2	24.7	6.1	5.7
Carex duriuscula C.A. Mey	2.0	3.2	3.5	9.2	6.4	11.0
Carex pediformis C. A. Mey	9.4	7.5	4.7	13.7	1.4	0.6
Sanguisorba officinalis L.	4.7	7.6	4.9	15.3	1.0	2.5
Potentilla tanacetifolia Willd.ex.Schjent	7.0	31.9	5.8	10.2	4.0	2.0

Leontopodium ochroleucum Beauv.	3.0	0.4	4.2	2.6	2.6	1.3
Scabiosa Fischerii	2.7	3.8	2.3	0.8	-	-
Thermopsis dahurica Czefr.	1.4	1.1	2.4	2.8	3.9	4.9
Galium verum L.	2.0	2.9	2.1	4.7	-	0.7
Plantago depressa Willd.	1.1	1.8	2.8	2.3	3.3	9.8
Bupleurum bicaule Helm.	3.4	3.0	4.8	18.0	1.0	4.9
Chrysanthemum Zawadskii Herb	2.2	2.4	1.0	2.1	-	-
Halenia corniculata	4.0	1.5	6.4	6.3	-	-
Heteropappus altaicus (Willd.)Novopokr	1.3	18.5	2.0	6.1	1.6	6.4
Stellera chamaejasme L	2.1	7.5	5.0	16.2	2.6	12.3
Artemisia laciniata Willd.	2.0	4.1	2.7	1.6	4.5	8.5
Artemisia mongolica Sisch.ex.Nakai	-	-	0.7	1.4	5.1	11.2
Artemisia commutate Bess		-	-	-	4.1	6.3
b. Agrostis meadow						
Agrostis Trinii Turcz.	22.5	65.9	9.3	24.6	2.6	7.9
Leymus chinensis (Trin)Tzvel	0.7	1.3	3.2	10.9	7.2	20.9
Koeleria macrantha (L).Pers	0.4	1.0	2.3	1.9	4.0	3.4
Carex duriuscula C.A. Mey	0.6	1.1	3.7	12.7	8.0	10.9
Carex pediformis C. A. Mey	17.2	51.8	8.0	32.4	1.5	0.4
Sanguisorba officinalis L.	11.8	22.1	9.0	12.7	1.0	0.9
Parnasia palustris L.	1.2	1.0	1.0	1.3	-	-
Leontopodium ochroleucum Beauv.	-	-	1.2	1.9	2.6	2.1
Galium verum L.	2.6	2.4	0.9	1.6	-	-
Plantago depressa Willd.	1.0	1.9	3.6	4.9	5.2	11.2
Bupleurum bicaule Helm.	-	-	1.0	2.2	1.3	1.5
Halenia corniculata	5.0	3.2	6.0	9.9	0.5	0.9

Heteropappus altaicus (Willd.)Novopokr	1.2	2.1	1.0	2.1	1.0	2.0
Artemisia laciniata Willd.	3.0	2.3	5.0	9.3	8.0	12.1
Artemisia commutate Bess	0.3	0.9	1.2	1.4	1.6	0.9

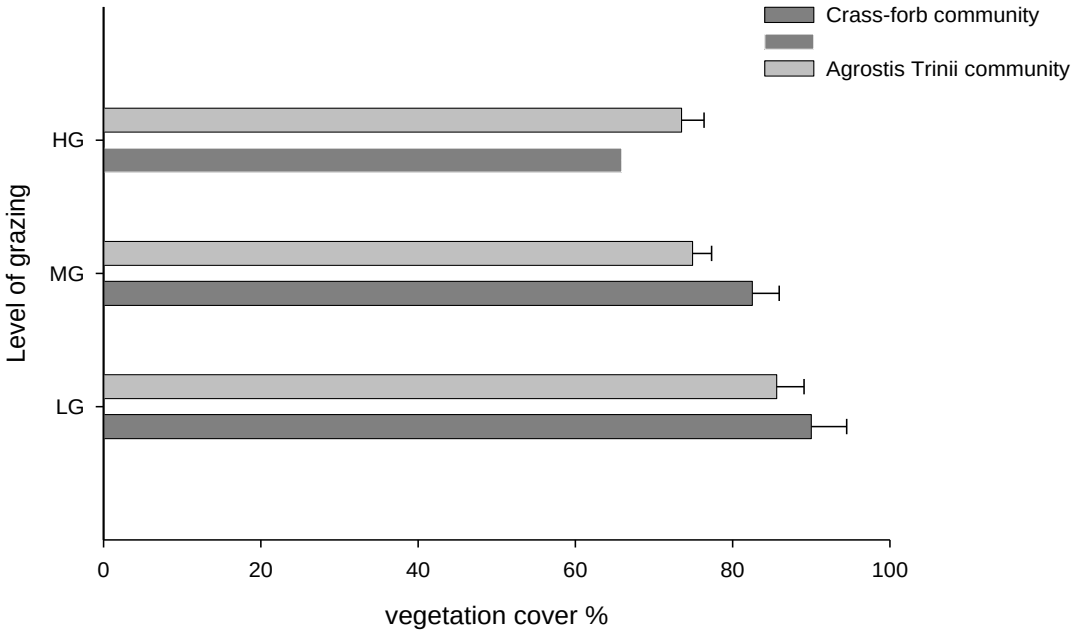


Figure. 3. Vegetation cover on two meadow communities.

LG- light grazing; MG- moderate grazing; HG-heavy grazing;

Table 3.

The variation in productivity on two meadow vegetations.

(by means of 1986-1991. c/ha)

a. grass-forb meadow

The economic group of species.	The levels of grazing			$F_{1/2}$	$F_{1/3}$
	light	moderate	heavy		
Grass	2.4 ± 0.61	2.7 ± 0.33	2.3 ± 0.44	4.9	9.3
Sedge	1.6 ± 0.52	2.4 ± 0.52	2.4 ± 0.5	10.2	8.3
Warmwood (Artemisia)	1.0 ± 0.31	1.9 ± 0.31	2.9 ± 0.38	6.4	5.9
Forb	3.9 ± 1.17	4.2 ± 1.28	2.6 ± 0.65	4.3	2.9
Green biomass	9.4 ± 2.01	11.3 ± 2.9	10.2 ± 1.97	2.8	8.1
Litter	7.8 ± 1.29	6.7 ± 0.91	6.2 ± 0.49	5.3	2.9
Total	**17.2 ± 3.3**	**18.2±3.9**	**16.6± 2.8**	**6.2**	**9.7**
b. Agtostis meadow					
Grass	4.4 ± 1.21	3.9 ± 1.12	5.3 ± 1.23	4.1	2.9
Sedge	4.4 ± 1.23	3.8 ±1.04	2.8 ± 0.4	8.3	8.1
Warmwood (Artemisia)	2.2 ± 0.2	2.6 ± 0.13	5.2 ± 1.19	6.4	4.5
Forb	2.4 ± 0.34	4.5 ± 1.4	3.0 ± 0.42	5.2	3.1
Green biomass	13.4 ± 3.02	14.8 ± 3.48	16.3 ± 3.29	3.9	2.9
Litter	7.9 ± 0.45	9.6 ± 0.43	8.6 ± 0.09	2.7	2.5
Total	**21.3 ± 5.47**	**24.4 ±3.91**	**24.9 ±4.33**	**8.8**	**9.3**

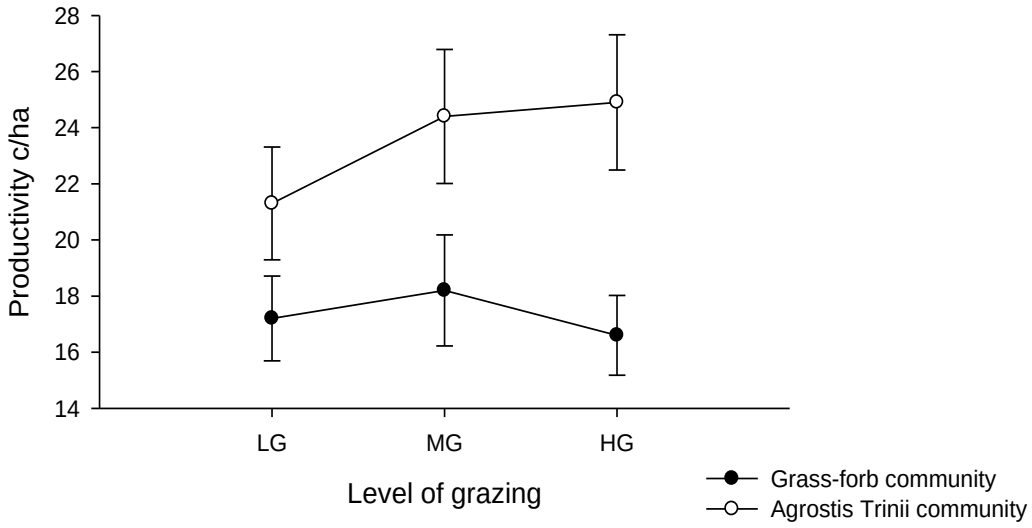


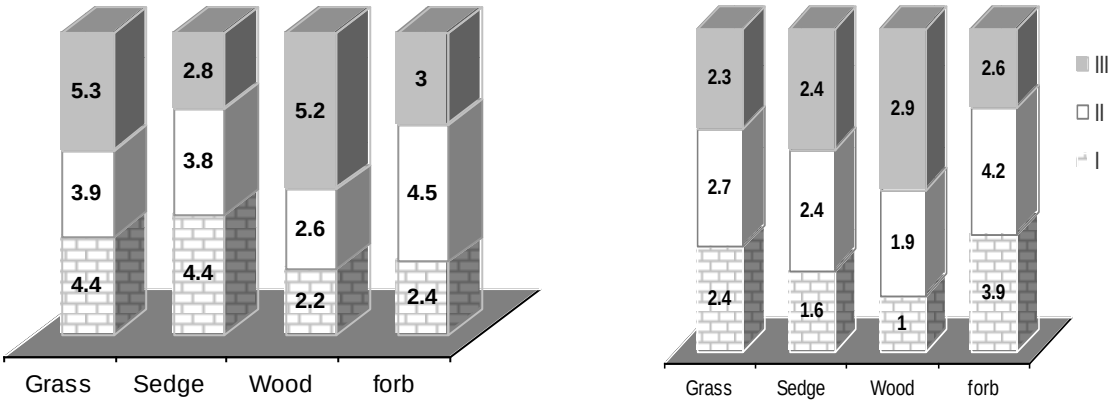
Figure 4. The total productivity in two meadow communities.

were: I-light grazing; II- moderate grazing; III- heavy grazing.

Table 4.

Variation in soil moisture (%) in meadow vegetations.

Soil depth (cm)	*Grass- forb mountain meadow*			*Agrostis flood flat meadow*		
	Light grazing	Moderate grazing	Heavy grazing	Light grazing	Moderate grazing	Heavy grazing
0-10	5.7	4.6	4.2	12.4	10.9	7.8
10-20	6.0	4.9	3.0	10.0	9.7	6.4
20-30	6.0	6.8	5.1	12.8	10.4	8.4
30-40	6.3	7.0	6.9	14.4	16.8	16.3
40-50	9.3	10.9	11.2	16.4	18.9	18.4



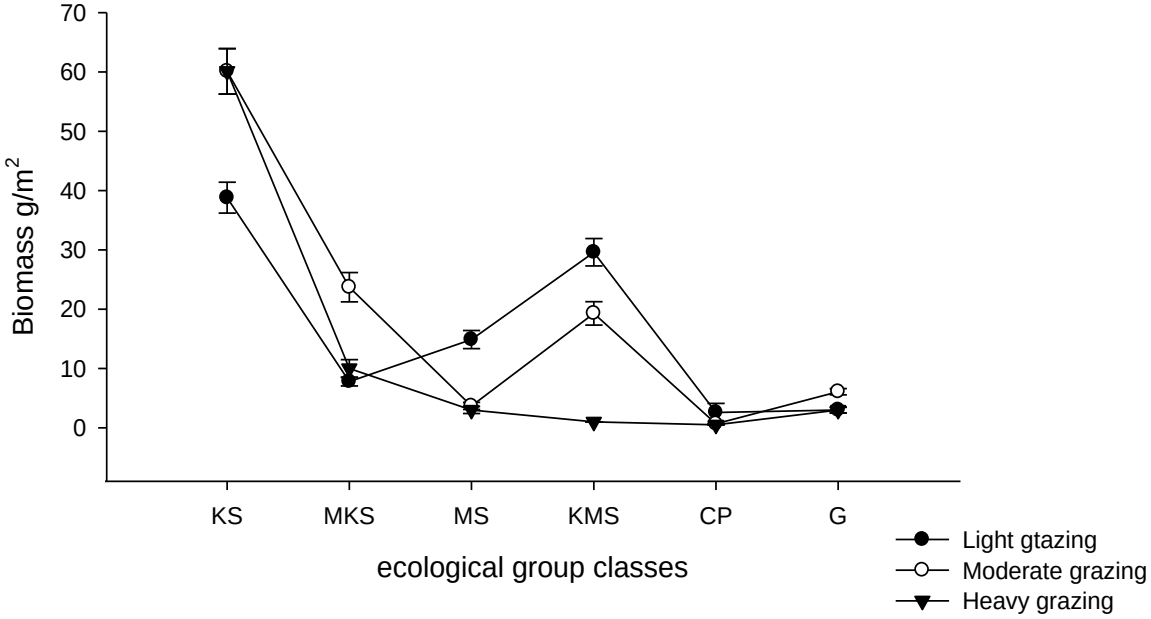
a. *Agrostis meadow community*

b. Grass-forb meadow community

Figure 5. The ratio between the biomass in ecological groups of two communities

were: I-light grazing; II- moderate grazing; III- heavy grazing. Biomass in c /ha**.**

a. Grass-forb mountain meadow



b. Agrostis Trinii flood meadow

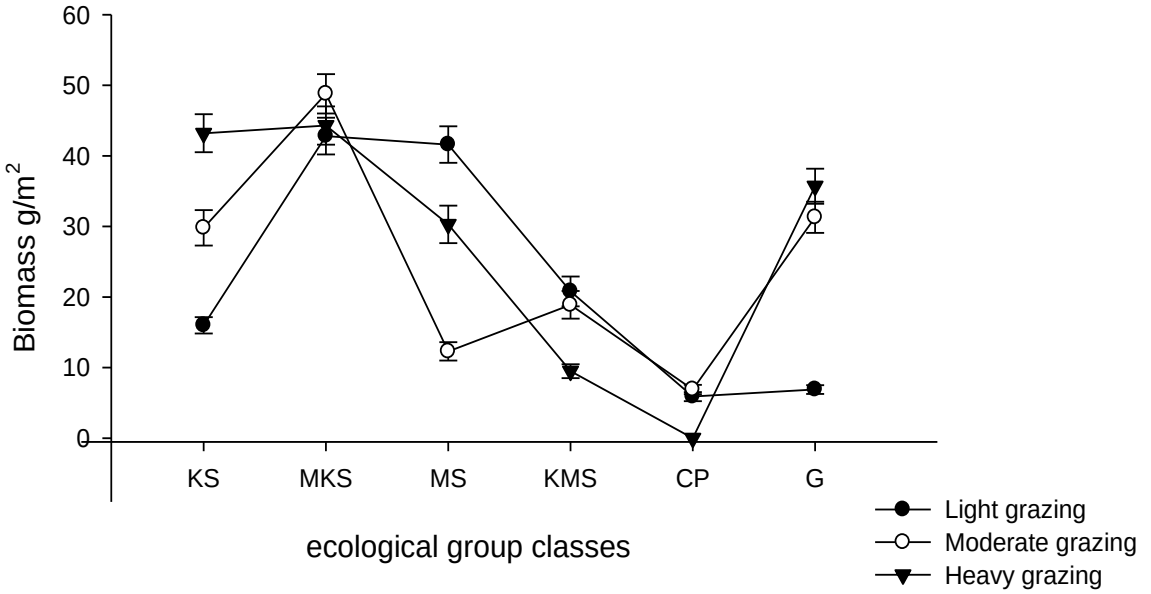


Figure 6. The variation in biomass of plant ecological groups in meadow vegetations.

KS- xerophytes; *MKS*-meso-xerophytes; *MS*- mesophytes; *KMS*- xero-mesophytes; *CP*- cryophytes; *G*- galophytes; *LG*-light grazing; *MG*-moderate grazing; *HG*-heavy grazing;