Short Reports

PRODUCTIVITY OF THE DRY STEPPES OF TUVA UNDER THE GRAZING PRESSURE

Sambuu A.D.

Tuvinian Institute for the exploration of natural resources SB RAS, Tuvinian state university Republic of Tuva, Kyzyl, e-mail: sambuu@mail.ru

Grassland resources are important on a worldwide basis. Intensified grazing is one of the main causes of ecological change of meadows and steppes. Almost all steppes are grazed and represent different stages of succession. Heavy grazing impact generally initiates a retrogressive succession (degradation) including a decrease in above-ground net primary production and phytomass as well as a change in species composition, especially in dominant structure. Removal of grazing pressure leads to a progressive succession (restoration) with an increase in phytomass and production and replacement of degraded pasture community by the original plant association. Stocking rate is one of the most important factors affected a stage of pasture succession. At the same time stocking rate is a powerful management tool allowing to regulate the amount of herbage available to animals (Gorshkova, 1954; Smith, Rushton, 1994; Wei et al., 1997; Titlyanova et al., 1999).

Study areas and Methods. The study was carried out on grasslands within Tuvinian steppes (on the Ubsunur hollow – 48-51 °N 91-99 °E) of Central Asia. The climate of this area is characterized by a rigorous cold and late spring. The yearly mean temperature is –5 °C (1975–1996). The coldest month is January with a mean temperature of -37^{0}C. July is the warmest month with 17 °C (Nosin, 1963). On the basis of definition of the growing season as the period over which the daily mean temperature remains above +5 °C, Ubsunur hollow has a growing season of 150 days (Experiment Uvsu-Nur, 1995).

Investigated steppes is located on the river terrace, another ones represent submountain steppes. Erzin steppe is linked to alluvial chestnut soil, submountain steppes to loamy sand chestnut soils. Their species composition is dependent on relief, soil and grazing.

The soil at the study sites have developed on chestnut with sand material. The humus profile is 10-20 cm deep and roots grow down to 50 cm.

Four sites were investigated:

1. Overgrazed site (OG), were after many years of very intensive cows and sheepgrazing, the steppe replaced by an anthropogenic open grassland community with different dominating.

2. Moderately grazed site (MG) on chestnut soil. This site was heavily grazed by sheep, cows. Grazing was later gradually reduced and finally stopped in 1996.

3. Lightly grazed during 1 year.

4. Lightly grazed during 4 years.

We were investigated dry steppes with different grazing impact.

Ten 0,25 m^2 sample plots were laid out along a 50 m long transect at moderately grazed site and overgrazed site. 8 sample plots were chosen at random. The above-ground plant material was sorted into green phytomass and total standing dead biomass.

Soil monoliths with a surface area of 10 cm^2 were collected on each sample plot with a special steel cylinder to a depth of 10 cm^2. From each monolith one-fifth was cut off to analyzes the composition of the below-ground plant material. The monoliths were washed and below-ground plant material was collected on a 0,3 mm sieve. The soil samples were analyzed by generally used methods.

Definitions and symbols. The following variables of the plant biomass structure are used (Van der Maarel & Titlyanova 1989). NPP – net primary production; ANP – above-ground net primary production; BNP – below-ground net primary production.

Net primary production, NPP, was calculated as the sum of the above-ground production, ANP, and below-ground production, BNP. ANP and BNP were estimated using balance equations.

For above-ground plant biomass we have:

$$\Delta G_n = G_{n+1} - G_n + \Delta D_n;$$

$$\Delta D_n = D_{n+1} - D_n + \Delta L_n;$$

$$\Delta L_n = L_{n+1} - L_n + \Delta M_n.$$

For below-ground plant biomass we have:

$$\Delta B_n = B_{n+1} - B_n + \Delta V_n;$$

$$\Delta V_n = V_{n+1} - V_n + \Delta W_n,$$

where G_n, D_n, L_n, B_n and V_n are green biomass, standing dead, litter, living below-ground organs, and below-ground dead mass of the sample at occasion *n* respectively, and G_{n+1} etc. are the same variables at sampling occasion *n* + 1; ΔG_n is the green biomass production, ΔD_n the standing dead production, ΔL_n the litter production, ΔM_n, the litter mineralization; ΔB_n, and ΔV_n are the below-ground living and dead mass production respectively, and ΔW_n the below-ground dead mass mineralization, all for the period between sampling occasions n and *n* + 1 (Titlyanova, 1977).

Results. *Plant composition and biomass.* Species richness was the total number of vascular plant species occurring within the four plots per well location. Mean plant cover was calculated for each well location. Spearman rank correlations among mean total biomass, species richness, mean plant cover, soil for each site.

Total aboveground biomass did not differ significantly among the dry steppe communities; however, the relative contribution of individual biomass components was indicative of community differences in species composition. This steppe communities are pure on cover, were composed with the dominant graminoids being *Stipa krylovii, Agropyron cristatum, Cleistogenes squarrosa*. In dry steppe communities, aboveground biomass was composed almost entirely of plant material from the dominant sedge species. The vertical distribution of belowground biomass was distinctive for each community, and significant differences in root, rhizome, and total belowground biomass with depth were observed for both sites

The storage of the soil organic matter have been determined by 3 principal factors: values of vegetable matter, entering to soil, the rate of the mineralization of the vegetable leavings and the mechanical structure of soil. The entrance of the carbon have been conditioned by values the net primary production.

Net primary production was calculated for three years in moderately grazed steppe and for one season in overgrazed and recovering steppes (Table).

Net primary production in steppes, g/m^2 dw. Below-ground production for 0–20 cm soil layer. OG – overgrazed, MG – moderately grazed, LG-1 = lightly grazed for 1 year, LG – 5 = lightly grazed for 5 years

Production	OG	MG			LG-1	LG-4
	1999	1996	1997	1999	1999	1999
Above-ground	70	220	288	80	77	110
Below-ground	630	1930	1425	494	352	2026
Total	700	2150	1713	574	429	2136

The NPP of moderately grazed steppe varies during three years from 574 to 2150 g/m^2 per year in dependent on weather conditions. The growing seasons in 1996 and 1997 were normally warm and dry while summer in 1998 was very hot and dry. The NPP value in 1996 and 1997 was very high (2150–1713 g/m^2) but in 1999 it decreased drastically. In this very dry season production process was not influenced by the grazing regime. Plants in overgrazed, moderately grazed and recovering for one year pastures produced modest quantity of biomass, moreover NPP is highest in overgrazed steppe. By the end of the fourth year of recovery a burst in the development of the community occurred. Shoots, rhizomes and roots of all species represented in the community had increased. An enormous flow of assimilates was going out of the above-ground into the below-ground phytomass. With a rapid root growth there was an increased death of roots and the standing crop of below-ground dead mass was high compared with dead mass of another pastures.

Conclusions

1. Difference between moderately grazed and overgrazed sites may arise mainly from the different factors that originate their xerophytic character: soil and climatic characteristics, respectively. Summers are very cool and the winters are hot and the soil with a low water storage capacity in the central Asia.

2. Moderately grazing of Tuvinian dry steppes is resulted in higher biomass values for the above- and below-ground production for 0–20 cm soil layer, entering of the vegetable leavings to the soil, the storage of the humus, carbon.

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