

The Dynamic Structure of Plant Communities in Dry Steppes Central Mongolia

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Abstract: The dynamics of any given plant community are closely related to the population ecology of the principal plant species, but these had hardly been studied in Central Asian plants. The outcomes of long-term studies in the dry steppes of Central Mongolia have shown that the simplification of steppe communities has taken place over recent decades. Annually since 1976, the detailed research of pascual ecosystems in the main natural zones Mongolia are carried out here within the framework of Russian-Mongolian Biological Expedition's program. Changes of dominant and co-dominant species of pasture plant communities occur corresponding to a dried steppe type. The estimation of present state of natural grasslands was given. The area of different degree of anthropogenic disturbance was discovered. Steppes and dry steppes of Mongolia are characterized by highly dynamic and extreme natural conditions. The results of our survey has showed degradation of vegetable communities for 35-40 years' period in connection with overgrazing and strengthening of climate aridity in the last decades. The succession of pastoral ecosystems leads to replacement of ecological niches of fodder grasses with uneatable and poisonous species. It results in unsuitability of such pastures for grazing.

Keywords: Central Mongolia; dry steppe; the dynamic structure; plant community; desertification

1. Introduction

Mongolia's steppe ecosystems, used mainly as natural pastures, cover an area of 6,722,912 km², or almost 55% of the country's territory. In recent decades, the increased grazing pressure on ecosystems has changed the natural balance due to the increased vulnerability of semi-arid and arid ecosystems, which contributes to their degradation and desertification [1-5]. In this regard, the phytocenotic study of the composition of species and biomorphs, vertical and horizontal structures, as well as the nature and characteristics of the production process of plant communities of dry steppes in Central Mongolia is of particular relevance.

In this regard, the phytocenotic study of the composition of species and biomorphs, vertical and horizontal structures, as well as the nature and characteristics of the production process of plant communities of dry steppes in Central Mongolia is of particular relevance. The purpose of the research is identify the long-term dynamics of the main phytocenotic indicators (species and biomorphological composition, number of individuals, projective cover and aboveground phytomass) of the dry steppe communities of the Central Mongolian dry steppes and establish the impact of climatic conditions and pasture loads on their livelihoods.

2. Experiments

The dynamics of the main phytocenotic indicators of communities of dry steppes for a 40-year period of research (1972-2011) in the territory of the Bayan-Undzhul somon was analyzed according to the literature and our own data. The characteristic features of fluctuations in the structure of dry steppe communities under conditions of drought and pasture load, which are manifested in a different quality change in the species composition, as well as in a decrease in the number of individuals and phytomass of dominant species, have been established. In the search for factors that determine the long-term dynamics of primary biological production, a close positive dependence of the annual increase in the phytomass of communities with the amount of precipitation for March-July of the current year and for August-October of the previous year was established.

The main research was carried out on the territory of the Bayan-Undzhul somon, which is located 150 km from the capital of Mongolia. From 1972 to 1976 and 1984 the staff of the Joint Russian-Mongolian Complex Biological Expedition carried out a stationary study of the vegetation of dry steppes here [1, 4, 5]. In 2007-2011. We continued our observations in the reference communities of dry steppes (key sites I, II, III) and in communities.

3. Results

The dry steppes of Mongolia are in a zone of insufficient moisture. According to the Bayan-Undzhul weather station, the average annual precipitation from 1975 to 1999 was 192 mm, of which about 70% fell on the summer season (June-August). For the period from 2000 to 2013, there was a decrease in the average annual amount by 26 mm, i.e. a negative trend is evident in the dynamics of precipitation (Figure 1.).

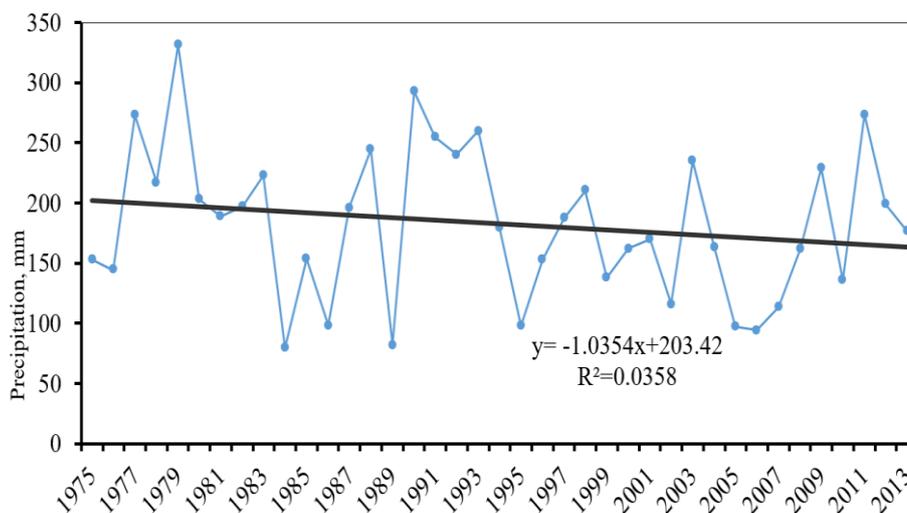


Figure 1. Dynamics of the annual precipitation according to the data of the Bayan-Undzhul somon meteorological station (1975-2013). The dotted line indicates the trend line.

In the long-term dynamics in the community, after a series of dry years in 2007, shrubs and shrubs almost completely disappear. The phytomass of cereals and the annual increase in the phytomass of the community decrease by more than an order of magnitude in comparison with the maximum in the 70s. The main reason for this situation is the natural factor, winter grazing of domestic animals exacerbates the impact of drought (Table 1.).

Table 1. Annual growth of dry land phytomass of plants of the main life forms on key site I in 1972-1976, 1984, 2007 and 2011.

Life forms	1972	1973	1974	1975	1976	1984	2007	2011
Amount of precipitation, mm	~200	~200	~200	152	140	93	113	273
Shrubs	128 24	113 14	62 6	69 9	63 6	112 19	4 5	17 9
Primitive shrubs	137 26	106 14	290 26	147 20	243 23	19 3	1 1	- -
Perennial herbs:								
- <i>Stipa, Agropyron</i>	243 45	484 62	627 57	488 65	673 62	356 62	57 71	101 52
- <i>Carex</i>	6 1	12 2	27 2	8 1	13 1	2 -	2 2	10 5
- Onion	5 1	17 2	26 2	5 1	20 2	5 1	5 7	20 10
- Herbs	15 3	28 4	34 3	27 4	53 5	44 8	3 4	19 10
one and biennial herbs	1 -	17 2	42 4	2 -	15 1	38 7	8 10	27 14
Total	535 100	777 100	1108 100	746 100	1080 100	576 100	80 100	194 100

Note that for two key sites there are data on plant phytomass for 8 years of observation. The annual growth rate varied in these years from 80 to 1108 kg / ha in plot I and from 240 to 2450 kg / ha in plot III. For the arid ecosystems of Mongolia, it is known that these fluctuations are associated with soil moisture, which in an automorphic regime depends not only on the amount of atmospheric precipitation, but on the time of precipitation.

In the search for the closest relationship between the annual increase in phytomass and precipitation for both sites, a close positive dependence of this indicator on the amount of precipitation for March-July of the current and for August-October of the previous year was obtained.

The reliability of the equations was checked in section III by the amount of precipitation for spring 2011 and autumn 2010, which is 220 mm. The value of the annual growth of phytomass calculated from it is about 2.5 t / ha, that is, as in 1973. Therefore, in the range from 50-80 to 220 mm of the optimal amount of precipitation for plant growth, the regression equation can be used to calculate the yield without labor-intensive measurements in the field (Figure 2).

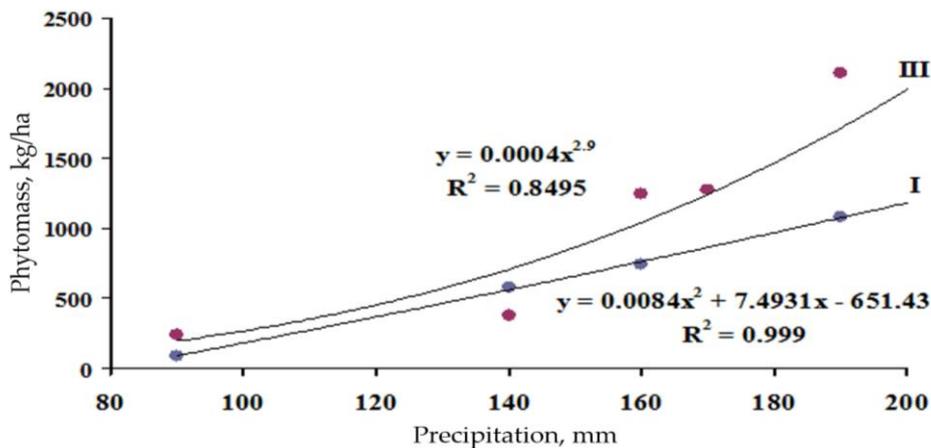


Figure 2. Relationship between the aboveground phytomass of dry steppe communities and the amount of precipitation for March-July of the current year and for August-October of the previous year. II, III - key areas..

4. Discussion

Droughts and overgrazing in the dry steppe over the past two decades have led to severe degradation of pastures. A prerequisite for the restoration of vegetation on forage lands is the use of traditional methods of grazing for domestic animals. The most highly productive communities with *Caragana microphylla* develop in habitats along the path of windsand flows, which contribute to the accumulation of fine earth and sand under the crowns of bushes during their formation. In the lowland dry steppe communities, the caragana is small-leaved, like a tap-root and short-root shrub, unstable to overgrazing. The primitive subshrub *Artemisia frigida*, characteristic of dry steppes, is an indicator of moisture conditions and pasture load. In dry years, wormwood is cold, like a small-rooted species, does not vegetate. Under conditions of optimal moisture with a low and medium degree of grazing, the share of wormwood in communities is more or less the same, and with grazing failure (for example, on cattle passes), it becomes the only dominant.

5. Conclusions

As a result of periodic monitoring for 45 years (since 1972), the dynamics of phytocenotic indicators and the vital state of plant communities of the dry steppes of the Middle Khalkha in modes of climate fluctuations and increased pasture load have been studied.

The values of phytomass, as an integral parameter of the vital state of communities, differ greatly in wet and dry years, which is determined not only by the amount, but also by the time of precipitation in the summer season. Rains at the beginning of the growing season promote the germination of youngsters. With a massive renewal, they often hinder the development of turf grasses.

Stipa krylovii, *S. grandis*, *Leymus chinensis*, *Allium bidentatum*, *A. polyrrhizum* are characterized by relatively resistance to arid conditions and strong grazing. In drought, they are able to transfer in a dormant state. Drought-resistant friable bunch grains *Agropyron cristatum*. *Cleistogenes squarrosa* cannot withstand pasture overload.

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Conflicts of Interest: The author declared and reported no potential conflict of interest.

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