Species diversity and productivity of pasture ecosystems of the Ilovlinsky sand massif

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Abstract. The aim of the research was to establish the productivity of pasture ecosystems on the sandy lands of the Don basin. The objects of research are herbaceous plant communities on the sands of the Ilovlinsky massif of the Volgograd region. The analysis of the species diversity of the vegetation cover, its variability in space was carried out by an inventory of 5 test plots measuring 10 x 10 m. Generally accepted methods of statistical analysis, graphical interpretation and scientific generalization were used to process, analyze and present the results. In all the surveyed sites, there is a low proportion of *Fabaceae* family species (0-8 %), a large proportion of the mixed grass group (58-75 %) and the weed species of plants (26-50 %) species. The feed mass consumed on average in the plots is 11-45 g / m^2. A direct relationship was revealed between the influence of the percentage of *Poaceae* and *Cyperaceae (Carex)* species in the phytocenosis on medium-grown sands on the increase in the yield of sandy pastures (g / m^2) in the late autumn period (r = 0.99). The condition of the soil and vegetation cover on forage lands is a consequence of overgrazing.

1 Introduction

The modern development of the livestock industry in arid conditions is in dire need of forage provision through the creation and operation of cultivated pastures and hayfields, since increased degradation of soil and vegetation cover, fluctuations in yield and nutritional value of feed due to unfavorable hydrothermal and edaphic conditions restrain the development of the industry [1-3]. The degree and nature of the influence of each factor affecting the productivity of forage phytocenoses are different, most of them are dynamic [4, 5]. Therefore, it is important to take into account their regime and changes during several plant life cycles [6, 7]. Intensification of feed production is the main direction in solving the problem of feed and includes measures to increase the yield of fodder crops, productivity of hayfields and pastures, reclamation of the feed base [8-10]. Studies of restoration of soil fertility, productivity and ecological stability of pasture ecosystems are relevant, since the problem of creating ecologically sustainable phytocenoses on low-yielding lands in arid climatic conditions remains important [11, 12]. The geobotanical approach contributes to the development of scientific foundations and helps to solve the problems of the organization of rational nature management of landscapes, especially on the sands.

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2 Materials and methods

The purpose of the research is to establish the productivity of pasture ecosystems on the sandy lands of the Don basin. The objects of research are herbaceous plant communities on the sands of the Ilovlinsky massif of the Volgograd region. The plots are located near a rural settlement, where an increased load on pastures was noticed, leading to a decrease in the species diversity of phytocenoses. The method of grazing is free. The pasture has no rest, grazing is carried out unevenly and continuously. Valuable forage species are depleted due to the fact that they do not have time to regrow. The areas remote from the settlement are less strained. The assessment of the degree of overgrowth of the sands was carried out by the projective coating. Open sands were identified with a projective coverage of < 30 %, medium-grown – from 30 % to 50 %, overgrown – with a projective coverage of >50 %. The analysis of the species diversity of vegetation cover, its variability in space was carried out in the first quarter of November by an inventory of 5 test plots measuring 10 x 10 m, which were divided into meter cells (from 1.1 to 10.10). The plots were selected taking into account the microrelief: No. 1 – a pocket at the curtains of tree plantations, No. 2 – a flat plot, No. 3 – at a watering hole (a small lake); No. 4 – the top of a sandy hillock, No. 5 – the windward side of a sandy hillock. At each meter, the following were determined: the average height of the herbage (cm), the projective coverage (%), the mass (and percentage) share of cereal species and various grasses in the total phytomass, the feed mass consumed (g / m^2). The feed mass eaten (the mass of plants excluding dried coarse branches and rotten foliage) was determined by weighing.

Generally accepted methods of statistical analysis, graphical interpretation and scientific generalization were used to process, analyze and present the results. Statistical analysis of the obtained data was performed using the Excel program.

3 Results and discussion

According to the degree of sand overgrowth , monitoring sites were defined as:

No. 1 – open sands (with projective coverage = 24 %);
No. 2 – medium-grown sands (with projective coverage = 37 %);
No. 3 – open sands (with a projective coating = 15 %);
No. 4 – open sands (with a projective coating = 10 %);
No. 5 – open sands (with projective coverage = 21 %).

The forage lands on the top of a sandy hillock (11.3 g / m^2) on site No. 4 differ in the least eaten phytomass. The growth of the shortest individuals is also observed here due to the influence of adverse weather conditions, Figure 1, Table 1.

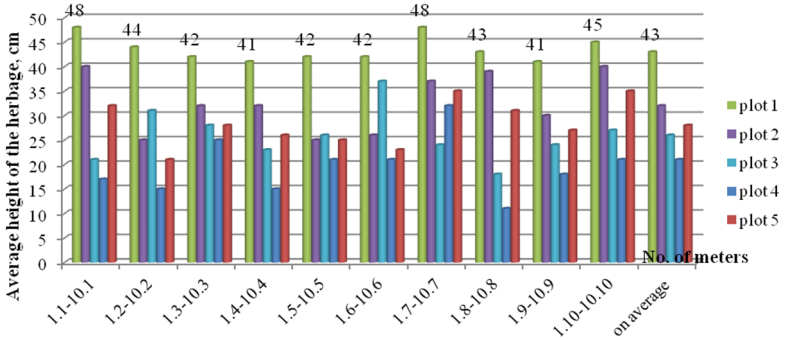

Fig. 1. The average height of plants on meter-high cells of monitoring sites of the Ilovlinsky sand massif.

The share of weed species of plants species in phytocenoses reaches from 1/3 to 1/2, including in the plots: No. 1 – 33 %, No. 2 – 26 %, No. 3 – 43 %, No. 4 – 50 %, No. 5 – 29 %, Table 1.

Table. 1. Features of the ecosystem of plant communities in the late autumn period.

Location	Number of plant species per 100 m^2, pcs.	Floral groups (pcs / %)			Biological groups (pcs / %)			Weed species of plants (%)	Feed mass consumed on average, g / m^2
		Poaceae, Cyperaceae (Carex)	*Fabaceae*	motley grass	annuals	biennial plants	perennial plants		
1	27	10/37	0/0	17/63	5/19	2/7	20/74	33	44.8
2	19	7/37	1/5	11/58	3/16	2/10	14/74	26	26.2
3	21	5/24	1/5	15/71	3/14	4/19	14/67	43	17.5
4	12	3/25	1/8	8/67	2/17	2/17	8/66	50	11.3
5	24	6/25	0/0	18/75	3/13	1/4	20/83	29	22.4

There is a decrease in the degree of development of individuals in plots No. 3, No. 4 and No. 5 compared with plots No. 1 and No. 2, which indicates a deterioration in the state of the soil and vegetation cover at the watering hole, on the top of the sandy hillock and on the windward side of the top of the sandy hillock compared with the plots at the curtains of tree plantations and on a flat area.

On site No. 1, where a kind of pocket is formed, protected from the wind on both sides (with one top of the hillock, and on the other – a curtain), under favorable temperature conditions and sufficient soil moisture, the presence of the largest feed mass eaten (44.8 g / m^2) was noted. In the total phytomass of the herbage here, cereals (*Poaceae*) and sedges (*Carex*) account for 37 %, and motley grass – 63 %.

A large proportion of *Poaceae* is also observed in plot No. 2 (37 %). However, the phytomass eaten here averages 26.2 g / m^2 due to the fact that the height of the herbs found on this site is slightly lower than on site No. 1.

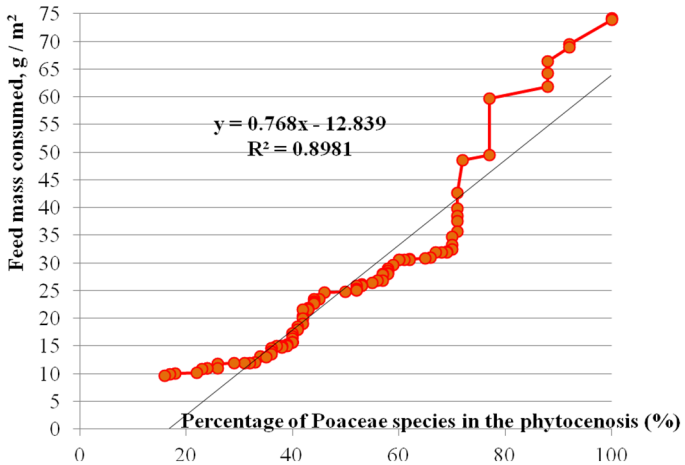

Fig. 2. The influence of the mass fraction of *Poaceae* and *Cyperaceae (Carex)* species in the community (site No. 2, medium-grown sands) on the growth of the forage phytomass of sandy pastures (g / m^2) in the late autumn period.

On medium-grown sands (site No. 2), the feed mass of pastures eaten in the late autumn period increases with the growth of phytomass of *Poaceae* and *Cyperaceae (Carex)* species in the community, Figure 2, Table 2. This is due to their massive autumn regrowth and less

load on the pasture due to the fact that in the autumn bad weather the animals had nowhere to hide, they did not stay in one place for a long time and thereby gave the plants the opportunity to actively grow and develop.

In all areas of open sands (No. 1, No. 3, No. 4, No. 5), which were formed due to a more intense load of animals, no such dependence was revealed.

Table. 2. Correlation and regression analysis in a small sample (for x and y).

Correlation coefficient	Coefficient of determination	Correlation coefficient error	The number of degrees of freedom for r	Reliability of r
0.998	0.995	0.007	98	146.6594792

The analysis of the features of the pasture ecosystem shows that in all the surveyed areas there is a low proportion of *Fabaceae* family species (0-8 %), which are the main source of protein, a large proportion of the group of mixed grasses (58-75 %) and ruderal (26-50 %) species. The state of the soil and vegetation cover of the forage lands of all test sites is a consequence of direct anthropogenic impact from overgrazing. The dominant pasture ecosystems are species of the *Poaceae* family and sedges (*Carex*).

4 Conclusion

The species composition of phytocenoses and the productivity of pastures on sandy massifs were estimated by the late autumn vegetation period, when it becomes obvious how the land was exploited during the year. It has been established that the species diversity is influenced by factors such as the structure of the microrelief, soil moisture, the presence of wind shadow near the curtains of tree plantations, as well as the load of animals. The best microclimatic conditions in the lowlands and near the pine curtain, as well as areas with increased moisture (near water bodies) create favorable conditions for the development of herbaceous species, increase the productivity of pastures. Excessive load on forage lands reduces this positive effect, and does not give the strayed species time and opportunity to recover. This factor reduces the projective coverage and productivity of pastures, is the cause of disruption of the natural functioning and structure of phytocenoses. Under increased load, sandy massifs turn into downed territories littered with ruderal species, with a small proportion of valuable forage grasses in communities. At the same time, the share of *Poaceae* and *Cyperaceae* (*Carex*) in the total phytomass decreases. A direct relationship was revealed between the influence of the proportion of *Poaceae* and *Cyperaceae (Carex)* species on medium-grown sands on the growth of the forage phytomass of sandy pastures (g / m^2) in the late autumn period (r = 0.99).

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