Conference Paper

The Desert Steppes of Eastern Europe: Common Regularities and Specific Features

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Abstract

Desert steppes are formed within the southern subzone of the steppe zone. Some researchers categorize this subzone not as a part of the steppe zone, but as a separate semi-desert zone. The aim of our research is to identify features of the structure of desert steppes and to understand the zonal status of the territory occupied by them. In Eastern Europe, desert steppes are common in the Ergeni Hills and the Caspian Lowland. Research was carried out by the route method. We made about 600 relevés 10 x 10 m^2 in size. Plant communities of desert steppes consist of both firm-bunch grasses and dwarf semishrubs. *Stipeta sareptanae* is a zonal type with light chestnut soils. Communities of dwarf semishrubs (halophytic variations of steppes) grow on saline soils and occupy quite large areas. A substantial part of the southern subzone of the steppe zone in Eastern Europe is used as pasture and hayfield: this is why modern desert steppes have been considerably modified, and dynamically unstable communities are often dominant.

Keywords: desert steppes, zonal type, ecological variants, peculiarities, Ergeni Hills, Caspian Lowland

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1. Introduction

The steppe type of vegetation includes communities of xerophilous frost-resistant, for the most part, herbaceous plants. They dominate the Eurasian steppe zone, which stretches from the Lower Danube (27° E) to the Altai Mountains (85° E). Steppe vegetation includes communities of different biomorphs. Communities of feather-grasses (*Stipa* spp.) grow on plakor and represent the zonal type in the steppe zone. There are hemipsammophytic, psammophytic, halophytic and petrophytic ecological variants of zonal type on sandy loam, sandy, saline and skeleton soils, respectively. They are formed not only by firm-bunch or loose-bunch grasses (*Agropyron, Festuca, Helictotrichon, Poa*, *Cleistogenes,* etc.), but also by perennial herbs (*Allium, Galatella*, etc.), dwarf

semishrubs (*Artemisia* subgenus *Seriphidium, Camphorosma, Kochia, Thymus*, etc.) and shrubs (*Amygdalus, Caragana, Spiraea*, etc.). Subzonal differences are quite clearly in communities on plakor. Ecological variants also indicate zonal features.

The steppe zone is divided into 3 latitudinal subzones based on changes in the structure of steppe communities from north to south with the increase in the degree of aridity: northern with herb-firm-bunch grass steppes ('arid steppe'), -middle with firm-bunch grass steppes ('dry steppe') and southern with dwarf semishrub-firm-bunch grass steppes ('desert steppe') [1]. Within each subzone, the variety of plant communities and the number of their ecological variations depends on a diversity of environmental factors.

2. Methods

For over 20 years, we have been studying the vegetation cover of the steppe and desert zones in the southeast of Eastern Europe. General regularities, spatial structure and composition have been investigated. This article focuses on the desert steppes, the most xerophytic type of steppes. They are formed within the southern subzone of the steppe zone, where there is 250–300 mm of rainfall, the average temperature of January is –10 to –11°C, the average temperature of July is +24 to +25°C and the sum of average daily temperatures above 10°C is 3000–3400°C [2, 3]. The soil is light chestnut and meadow-light chestnut on negative land forms. Solonetz and solonchak formations are typical. Plant communities of desert steppes consist of both firm-bunch grasses and dwarf semishrubs. In Eastern Europe, the southern subzone extends over the Ergeni Hills and the Caspian Lowland. Its western boundary is 43°30′ E, northern – about 50° N, southern – 44° N in the Ergeni Hills, but in the Caspian Lowland it is approximately 47°–48° N.

The Ergeni Hills stretch 350 km from the Volga River near Volgograd in the north to the Kumo–Manych depression in the south. Their width is 20–50 km and their height is 160–220 m. above sea level. They are composed of tertiary clays, limestones and sandstones. The eastern macro-slope of the Ergeni Hills is steep and dissected by a dense network of beams. The western macro-slope is gentle. The watershed is a plateau-like.

The Caspian Lowland is a young territory composed of marine sediments of the quaternary transgressions of the Caspian Sea. Most of the lowland lies below world ocean level. The absolute elevation gradually decreases from 15–20 m in the north to minus 27 m on the coast of the Caspian Sea. It is flat, but there are various forms of

meso- and micro-relief. In Zavolzhye, the monotony of the plain is broken by salt dome structures, the largest of which are the parageneticconjugations of Bolshoe Bogdo (150 m above sea level) and Lake Baskunchak (–21 m below sea level) and Ulagan (69 m above sea level) and Lake Elton (–17 m below sea level). There are shallow salt lakes.

The research has been carried out by the route method. Over 20,000 kilometers were covered. We made about 600 releves 10 x 10 m^2 in size, including coordinates, habitat characteristics, full species composition of the community, the common projective cover and projective cover of each species, the phenology, the average height, species abundance and the relationship of communities with soils of different mechanical composition. The spatial distribution of the communities was analyzed through profiles and transects. To process the results, we used the program Excel. Small-scale mapping of the territory was performed. About 1,000 sheets were taken from the herbarium.

3. Results

As a result of the research, the main regularities and specific features of the desert wormwood-feather-grass steppes of Eastern Europe are revealed. The plant communities of *Stipa sareptana* dominate both Eastern Europe and the whole southern subzone. The peculiarities of the desert steppes of Eastern Europe are the codominance of dwarf semishrub wormwood such as *Artemisia lerchiana* and *A. taurica*. In the Ergeni Hills, both species are abundant; in the Caspian Lowland, *A. lerchiana* dominates [5, 6].

The common projective cover in communities is 50–60%, the projective cover of graminoids is 30–35%, the projective cover of dwarf semishrubs is 20% and the projective cover of perennial forbs is 5–7%. The species composition is poor (10–15 species). Perennial forbs are more numerous and abundant (20–25 species) only on sandy or stony and gravelly soils. The Eastern European desert steppes are represented by a small number of ecological variants. Hemipsammophytic and halophytic variants dominate. Pelitophytic variants are less common. *Stipeta sareptanae* is a zonal type in the region of investigation: communities of *Stipeta lessingianae* and *Stipeta capillatae* are formed on sandy loam soils, while *Festuceta valesiacae* and *Agropyreta desertori* communities are usual in saline soils. *Festuca valesiaca* and *Stipa capillata* steppes are often also indicators of disturbed habitats. The ephemeroid (perennial) grass *Poa bulbosa* is nearly always present in the communities. Other ephemeroids (*Tulipa gesneriana, T. biebersteiniana, T. biflora*) are often abundant, as are ephemers (annuals); xerophytic perennial herbs are rare.

Vegetation in the Caspian region is highly heterogeneous due to the wide distribution of saline soils. Steppes halophytic complexes occupy large areas. Very often, grass communities of *Stipa sareptana, Festuca valesiaca* or *Agropyrum desertorum* create complexes with communities of dwarf semishrub on solonetz, which are represented by species of *Artemisia* from the subgenus *Seriphidium* (*Artemisia lerchiana, A. pauciflora, A. santonica*) and species of *Chenopodiaceae* (*Kochia prostrata, Camphorosma monspeliaca*, etc.). The ratio between grass communities and dwarf semishrub communities depends on the area occupied by saline soils. There are three groups of complexes: (1) with the dominance of grass communities, (2) with the dominance of dwarf semishrub communities, and (3) including only dwarf semishrub communities. The communities of hyperhalophytes (*Halocnemum strobilaceum, Atriplex cana, Anabasis salsa, Suaeda physophora*, *Limonium suffruticosum*) form original complexes and combinations on solonchak within the steppe zone.

The vegetation of Bolshoye Bogdo is more diverse than the vegetation on the plains. Bolshoye Bogdo has varied lithological composition, relief and soil profiles. In this regard, its vegetation is represented by a large number of plant communities, which may be combined into various petrophytic series – limestone, tertiary clay and sandstone. *Agropyreta desertori* and *Artemisieta tauricae* communities are widespread on limestone. On tertiary clay, the communities of dwarf semishrubs are very varied: *Artemisieta lerchianae, Artemisieta pauciflorae, Atripliceta canae, Anabasieta canae* and *Kochieta prostratae*. Communities of *Agropyreta fragili* and *Artemisieta marschallianae* are associated with sandstone.

A comparison between the desert steppes of Eastern Europe and similar types of eastern regions brings out their specific features. One such feature is the prominent role of *Festuceta valesiacae* and *Agropyreta desertori* halophytic steppes in the vegetative cover. Another feature is the dominance of dwarf semishrub communities, which grow on solonetz and salted soils. One more specific feature of the desert steppes of Eastern Europe is *Artemisia taurica*. The eastern border of its distribution is Bolshoe Bogdo and the shores of Lake Baskunchak and Lake Elton. Desert steppes are intensively used as pastures and hayfields, so modern vegetation has been significantly changed. Dynamically unstable communities are often dominant.

Some researchers categorize the southern subzone not as a part of the steppe zone, but as a separate semi-desert zone. The term 'semi-desert' was used for the first time by N. A. Dimo and B.A. Keller [7] for the northern part of the Ergeni Hills. They described semi-desert as a combination of 'steppe' (= grasses) communities on light chestnut soils and 'desert' (= dwarf semishrub) ones on saline soils. Thus, the

reason for the appearance of the term 'semi-desert' was the complexity of vegetation and soil cover. It occurs due to the salinization of soils, dry climate, vast evaporation, significant moisture deficit and the redistribution of moisture in the elements of the microrelief. However, complexity '... is not a strictly required genetic characteristic' [8:38] and cannot be attributed to semi-deserts, as it is common for both steppe and desert zones. There are complexes of grass and dwarf semishrub communities even in the forest-steppe zone. The relationship between grass and dwarf semishrub communities depends on the area occupied by strongly saline soils and solonetz. In some places, solonetz predominate over light chestnut soils. As a result, dwarf semishrub communities dominate in the vegetation of the steppe zone, which looks like desert in such cases.

Until the 1960–70s, geobotanists associated dwarf semishrub life forms only with desert. Certainly, dwarf semishrubs dominate in temperate desert zones but they are also typical for the steppe zone. In the steppe zone, they are usually confined to saline and stony-gravelly soils and represent halophytic and petrophytic ecological variants of steppes. Some of the dwarf semishrubs have a range setting in steppe and desert zones – *Artemisia pauciflora, A.lerchiana, Anabasis salsa* and *Nanophyton erinaceum*. Some dwarf semishrubs belong to the steppe zone, only occasionally appearing in the desert – *Artemisia lessingiana, A. nitrosa, A. salsoloides* and *A. taurica*. There are dwarf semishrubs that grow in the desert zone only – *Salsola gemmascens, Artemisia kemrudica* and others.

It should be noted that in the second half of the last century new data on the ecology of grasses appeared, especially after large-scale studies in Kazakhstan and Central Asia. Some species of graminoids (*Stipa sareptana, S. lessingiana, Agropyron fragile* and *Poa bulbosa*) are part of communities on sandy and rocky-gravelly soils in the desert zone, but they have a phytocoenotic optimum in the steppe zone. There are desert grass species that do not grow in the steppe zone.

Since its emergence until present time, the content of the term 'semi-desert' is quite uncertain. Various specialists (geographers, ecologists, soil scientists, zoologists, etc.) understand it differently. Soil scientists of the Moscow school consider light chestnut and brown soils as semi-desert soils [9]. Kazakhstan soil scientists proved that light chestnut soils are steppe soils and brown soils are desert ones [10]. This corresponds to vegetation cover. Firm-bunch grasses do not grow on loamy brown soil.

Each area is characterized by a certain zonal type of vegetation. A. B. Keller [11] suggested identifying the semi-desert type as a constant complex of plant communities. However, most geobotanists [12, 13] agree with V. A. Prozorovsky [14], who argued

that no such type exists. According to G. Walter [15], typical elements of semi-desert do not exist. A semi-desert zone is often defined as a zone characterized by desert steppes. Nevertheless, the term became widely used in the scientific, educational and reference literature.

4. Conclusion

The semi-desert zone was placed between 50 and 48° N based on the complexity of vegetation and soil cover. Many geobotanists were against the identification of semi-desert as a separate zone. However, the term 'semi-desert' is easy to use, so it has survived in the literature for over 100 years. Its emergence is understandable, since in the early twentieth century data on steppe and desert vegetation was scarce. The authors followed existing ideas. Only in the middle of the last century were many biocomplex expeditions were organized. As a result of these studies, some traditional views have changed: for example, on the distribution of dwarf semishrubs and grasses in arid and semi-arid areas. Complexity is not a characteristic only of 'semi-desert', but also of the other subzones of the steppe and desert zones. There are also different understandings of the term. Some Western Europe scientists use the term 'desert' if vegetation is absent [16]. On the other hand, if there is vegetation they consider it 'semi-desert'.

Undoubtedly, the survival of the term 'semi-desert' can be attributed to anthropogenic influence. Irrational nature is one of the reasons for the dominance of dwarf semishrub coenoses in the steppe zone. Certain features of the natural conditions of the southern subzone of the Eastern Europe steppe zone and anthropogenic influence have resulted in an ambiguous understanding of the zonal status of the territory.

Because there is no semi-desert type of vegetation, no semi-desert flora, no semi-desert type of soil (according to Kazakh soil scientists) and no semi-desert type of climate, there is no reason to separate semi-desert zone from other categories. E. M. Lavrenko borrowed the term 'desert steppe' from A. V. Prozorovskiy and included desert steppes in the steppe zone as its southern subzone [17, 18]. We follow this understanding of the zonal status of this area because its watersheds with loamy soils are occupied by *Stipeta sareptanae*. Since the late 1950s, the semi-desert zone has not been indicated on vegetation maps [19, 20]. It is absent on the vegetation map of Europe [21]. In our opinion, the separation of the semi-desert zone is more traditional but does not correspond to the natural potential.

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