

# Rare Communities of the Desert Steppes of the Russian Caspian Sea Region and Their Preservation

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**Abstract** – The phytocenotic diversity of the desert steppes is preserved due to the presence of the Bogdinsko-Baskunchaksky Nature Reserve and Elton Natural Park in the southern steppe subzone of the Russian Caspian Sea region. Steppes in the Trans-Volga region are more diverse than those in the Sarpinskaya lowland. *Agropyron desertorum* + *Artemisia taurica* petrophytic steppes do not stretch as far as the west of the Volga. Petrophytic series of communities on the slopes of Bolshoye Bogdo Mountain and halophytic complexes along the shores of Lake Elton include rare communities of species found on western and eastern distribution limits. These include communities of *Artemisia semiarida*, since Bolshoye Bogdo Mountain is the farthest western habitat of this wormwood, far from the main range of the species. The spectrum of communities of dwarf semishrub perennial saltworts (*Anabasis salsa*, *Atriplex cana*, *Camphorosma monspeliaca*) and wormwoods (*Artemisia lerchiana*, *A. taurica*, *A. semiarida*) features the specificity of the desert steppes of the Russian Caspian Sea region.

**Keywords** – steppes; petrophytic; halophytic; communities of *Agropyron desertorum*; *Artemisia taurica*; *Artemisia semiarida*; *Anabasis salsa*.

## I. INTRODUCTION

Protected areas play a big role in conservation of steppe vegetation biodiversity. More than 20 years ago (in 1997), the Bogdinsko-Baskunchaksky Nature Reserve, and, a little later in 2001, Elton Natural Park were created in the Russian Caspian Sea region. They are located in the southern subzone of the steppe zone, where desert steppes (dwarf semishrub-bunch grasses) are formed.

The Trans-Volga region, the southern subzone includes the area between 49°40' N in the north and 48° N in the south, and to the west of the Volga River, there is the largest area of the Sarpinskaya lowland (Karte der natürlichen Vegetation Europas..., 2000 a, b). The relief of the Sarpinskaya lowland is leveled and features various forms of meso- and microrelief. The Trans-Volga region is characterized by salt-dome structures, the largest of which are paragenetic conjugations of Bolshoye Bogdo Mountain (150.4 m above sea level) and Lake Baskunchak, Ulagan Mountain (69 m above sea level) and Lake Elton located within the southern steppe subzone.

The desert steppes of the Russian Caspian Sea region are not numerous in species composition and not diverse in ecological variats (Safronova, Stepanova, 2018). The zonal

type is represented by the *Stipa sareptana* + *Artemisia lerchiana* steppes. They are formed on soils of different mechanical composition (loamy, loam sandy) and slightly saline. Loam sandy soils are commonly represented by *Stipa lessingiana* + *Artemisia lerchiana* steppes (hemipsammophytic variant). *Stipa capillata* + *Artemisia lerchiana* steppes are less common. Sandy soils are covered by plant communities of two feather grass species – *Stipa capillata* and *S. pennata*, with two wormwood species – *Artemisia lerchiana* and *A. marschalliana* – as codominates (psammophytic variant). Along with feather grass steppes, *Festuca valesiaca* and *Agropyron desertorum* halophyte steppes on saline variation of light chestnut soils are common.

Wormwood-grass steppes on light chestnut soils form complexes with dwarf semishrub communities (*Artemisia lerchiana*, *A. pauciflora*, *Camphorosma monspeliaca*, etc.) on solonetz.

The vegetation cover of the southern subzone as well as the entire steppe zone is greatly changed by plowing, pastures, haying, fires, and phytomeliorative works. Large areas are occupied by anthropogenic communities of wormwoods (*Artemisia austriaca*, *A. lerchiana*, and *A. taurica*) arising during overgrazing and on deposits –.

Due to the presence of the Bogdinsko-Baskunchaksky Nature Reserve and Elton Natural Park in the southern steppe subzone of the Russian Caspian Sea region, the phytocenotic diversity of the desert steppes is preserved.

In the Trans-Volga region, the steppes are more diverse than those in the Sarpinskaya lowland. In addition to the plains with homogeneous and complex cover, in the protected areas there are hills (Bolshoye Bogdo Mountain, 150.4 m above sea level, and Ulagan Mountain, 69 m above sea level) composed of various rocks (limestone, sandstone, saline clay). Their slopes are covered by petrophytic communities. On the shores of salty Baskunchak and Elton lakes hyperhalophytic complexes are formed. Petrophytic communities and halophytic complexes include rare communities of species found on the western and eastern distribution limits.

Desert steppes on the plains of Bogdino-Baskunchak reserve are characterized by the same properties as in European Russia as a whole. The relief of the plains is flat with depressions, sometimes cut by ravines, or complicated by many sinkholes with caves. Light chestnut soils are of different

mechanical composition (loamy, loam sandy and sandy) and different degrees of salinity. The shore of Lake Baskunchak is steep with numerous ravines. Zonal *Stipa sareptana* steppes in the southern subzone of the steppe zone are found and preserved throughout the reserve. Communities of *Stipa sareptana*, and *Stipa sareptana* + *Artemisia lerchiana*, and *Stipa sareptana* + *Anabasis aphylla* occupy very large areas along flat slopes of hills and in the plains between sinkholes and on the sides of the sinkholes. *Stipa lessingiana* and *Stipa capillata* steppes are rare. The communities of more than 30 formations play a significant role in the vegetation cover.

The greatest diversity of formations is represented on the Bolshoye Bogdo Mountain, which is a salt dome covered by Permian and Triassic, and Quaternary deposits. Bolshoye Bogdo Mountain has a heterogeneous lithological composition (limestone, red saline clay, sandstone), various types of relief and a different degree of development of the soil profile. The conditions on its slopes are favorable for formation of rare communities of species located in the South of European Russia on eastern (*Artemisia taurica*) and western (*Artemisia semiarida*, *Anabasis salsa*, *Suaeda physophora*) borders of ranges. The communities with *Artemisia taurica* and halophytes (*Anabasis salsa*, *Suaeda physophora*) form peculiar complexes along the shores of Lake Elton.

## II. RARE COMMUNITIES IN THE BOGDINO-BASKUNCHAK NATURE RESERVE

### A. *Agropyron desertorum* + *Artemisia taurica* and *Artemisia taurica* + *Agropyron desertorum* steppes

*Agropyron desertorum* (Fisch. Ex Link.) Schult. is firm-bunch grass that plays an important role in the vegetation cover of the southern steppe subzone, Mongolian-Kazakh species extending far to the west in the Black Sea region (Lavrenko, 1980).

In the Sarpinskaya lowland, the subshrub and desert wheat grass steppes of *Agropyron desertorum* with dwarf semishrubs occupy rather large areas in the plains with light chestnut saline soils and sometimes carbonate soils. Complexes with communities of dwarf semishrubs on solonchaks are typically. Such steppes are a halophytic ecological variant.

The codominating dwarf semishrubs include *Artemisia lerchiana*, *A. pauciflora*, *A. taurica* (rarely) and sometimes *Kochia prostrata*. *Tanacetum achilleifolium* is often codominant as well. It occupies an intermediate position between dwarf semishrubs and herbs, and it is referred sometimes to dwarf semishrubs and sometimes to herbs (Lavrenko, 1980). In conditions of increased salinity, *Agropyron desertorum* + *Artemisia lerchiana* communities are replaced by *Agropyron desertorum* + *Kochia prostrata* and then by *Agropyron desertorum* + *Artemisia pauciflora* communities.

During restoration of feather grass steppes on deposits, one of the stages is the *Agropyron desertorum* steppe. The anthropogenic communities are formed: *Agropyron desertorum* + *Tanacetum achilleifolium*, *Agropyron desertorum* + *Stipa sareptana* + *Artemisia lerchiana*, sometimes *Agropyron desertorum* + *Stipa sareptana* + *Artemisia taurica*.

In the Trans-Volga region, in the Bogdinsko-Baskunchaksky Nature Reserve, on slopes of Bolshoye Bogdo Mountain of Triassic limestones with gravelly loamy carbonate light chestnut soils, peculiar petrophytic steppes of *Agropyron desertorum* are formed. *Artemisia taurica*, which has an eastern distribution limit in the Trans-Volga region, is codominant in these steppes. This type of plant communities is absent within the southern steppe subzone to the west of the Volga River.

*Artemisia taurica* Willd. is wormwood from the subgenus *Seriphidium*, a primitive dwarf semishrub, Eastern Black Sea, Pre-Caucasian, Western Caspian, foothills and plain steppe species, halophyte and halopetrophyte, penetrates in the desert zone through disturbed lands. It has a disjunctive area. In the Crimea and in the Prisivashye, *A. taurica* is participated in halophytic steppes of *Agropyron pectiniforme* and grows on deposits. On the slopes of the Yergeni upland and in the Sarpinskaya lowland this wormwood and *A. lerchiana* are codominants of *Stipa sareptana* steppes. In some places, it dominates on deposits. It does not exhibit continuous distribution between the Yergeni upland and the Volga River.

In the Trans-Volga region, only several habitats of *Artemisia taurica* are known. It is indicated by F.Ya. Levina for the left bank of the Volga to the north of Volgograd (Levina, 1963). In addition, as already mentioned above, *A. taurica* is relevant as a codominant and dominant species in the communities of the desert steppes on Triassic limestones of Bolshoye Bogdo Mountain, and less often on the Permian red clay. Communities of *Artemisia taurica* are part of halophytic complexes on solonchak and solonetz soils on the north-eastern and northern shores of Lake Elton.

The slopes of Bolshoye Bogdo Mountain are gravelly, therefore, communities of *Artemisia taurica* are rather sparse. Their total projective cover is 50–65%. The total number of species is 55, and one community includes 26–35 species. The projective cover of *Agropyron desertorum* is 15–30%. Among grasses, *Poa bulbosa*, *Stipa lessingiana* and *Catabrosella humilis* are common in small quantities. The projective cover of *Artemisia taurica* is 15–20%. Among dwarf semishrubs, *Camphorosma monspeliaca* is nearly always found with a projective cover of up to 10%. Perennial forbs are quite numerous. A projective cover of such species as *Tanacetum achilleifolium*, *Galatella tatarica*, *G. villosa* in almost all communities is 10–15%. Permanent but low-abundant species are *Allium inderiense*, *Asparagus inderiensis*, *Allium inderiense*, *Asparagus inderiensis*, *Echinops ruthenicus*, *Gagea bulbifera*, *Nepeta ucrainica*, *Phlomis pungens*, *Rindera tetraspis* *Tragopogon marginifolius*, and *Tulipa biflora*.

Diverse communities growing in this area are dominated by *Agropyron desertorum* + *Galatella villosa* + *Tanacetum achilleifolium* + *Artemisia taurica*, and *Agropyron desertorum* + *Artemisia taurica* + *Galatella villosa*. Typical communities are represented by *Agropyron desertorum* + *Artemisia taurica* + *Camphorosma monspeliaca*; and *Agropyron desertorum* + *Galatella tatarica* + *Rindera tetraspis* + *Tanacetum achilleifolium* + *Artemisia taurica*.

Two abundant wormwood species are quite often encountered in the communities – *Artemisia taurica* and

*A. lerchiana*, and sometimes – *Artemisia taurica* and *A. pauciflora*: *Agropyron desertorum* + *Artemisia lerchiana*, *A. taurica* + *Galatella tatarica*, *G. villosa*, *Tanacetum achilleifolium*), and *Agropyron desertorum* + *Atriplex cana*, *Camphorosma monspeliaca* + *Galatella tatarica*, *Serratula erucifolia*, *Tanacetum achilleifolium* + *Artemisia pauciflora*, *A. taurica*).

The petrophyte communities of *Artemisia taurica* growing on Triassic limestone of the rocky rubble slopes of Bolshoye Bogdo Mountain are as follows: *Artemisia taurica* + *Agropyron desertorum* + *Galatella villosa*, *Erysimum leucanthemum*; and *Artemisia taurica* + *Agropyron desertorum* + *Galatella tatarica*; and *Artemisia taurica* + *Galatella villosa*, *G. tatarica*, *Echinops ruthenicum* + *Agropyron desertorum*; and *Artemisia taurica* + *Agropyron desertorum* + *Alyssum desertorum*, *Eremopyrum orientale*, *Rochelia retorta*, *Lappula spinocarpos*; and *Artemisia taurica* + *Poa bulbosa*; and *Artemisia taurica* + *Poa bulbosa* + *Rochelia retorta*, *Alyssum desertorum*; and *Artemisia taurica* + *Catabrosella humilis*.

The cover in communities is sparse. The total projective cover is 40–60%. The projective cover of dwarf semishrubs is 25–55%, that of grasses is 5–30%, that of herbs is 5–35%, and the projective cover of ephemers is 2–3%.

The communities dominated by *Artemisia taurica* include more than 60 species, and each community consists of 20–30 species. *Agropyron desertorum* and *Poa bulbosa*, and rarely *Catabrosella humilis* are abundant in grasses. Some typical herbs are *Allium inderiense*, *Astragalus physodes*, *Euphorbia undulata*, *Gagea bulbifera*, *Galatella villosa*, *G. tatarica*, *Serratula erucifolia*, *Tanacetum achilleifolium*, *Tragopogon marginifolius*, and *Tulipa biflora*. Some annual plants are often encountered in the communities: *Rochelia retorta*, *Alyssum desertorum*, *Eremopyrum orientale*, *Lappula spinocarpos*, etc.

#### *B. Halopetrophytic and halophytic communities of dwarf semishrubs*

The northern extremity of Bolshoye Bogdo Mountain is the highest and most dissected part of the mountain. The bulk of the outcrops of Permian red clays covered with a thin layer of carbonate gray clay is concentrated in this area. A diverse spectrum of dwarf semishrub communities that include perennial saltworts (*Anabasis salsa*, *Atriplex cana*, *Camphorosma monspeliaca*) and wormwoods (*Artemisia lerchiana*, *A. taurica*, *A. semiarida*) is distributed on these outcrops. In the subzone of desert steppes of the Russian Caspian Sea region, a number of these communities are unique and restricted to this area only. First of all, these are communities of *Artemisia semiarida* or communities that include *A. semiarida*. Bolshoye Bogdo Mountain is westernmost habitat of this wormwood, which is far from the main range of the species.

*Artemisia semiarida* (Krasch. Et Lavr.) Filat. was described by I.M. Krasheninnikov and E.M. Lavrenko in the Flora of Western Siberia (1949) as a subspecies of *A. terrae-albae*. Later, N. S. Filatova (1966) defined this subspecies as species. The species mostly occupies the steppe zone, where *A. semiarida* is confined to saline light chestnut soils, solonetz and

solonchak soils. This wormwood is also characteristic of the desert zone, namely its northern subzone (Filatova, 1984).

On red-clay outcrops of Bolshoye Bogdo Mountain, *A. semiarida* forms communities with perennial saltwort species: *Artemisia semiarida* + *Anabasis salsa*; and *Artemisia semiarida* + *Anabasis salsa* + *Atriplex cana*, *Anabasis salsa* + *Limonium suffruticosum*, *Galatella tatarica*; and *Artemisia semiarida* + *Atriplex cana*. The *Galatella tatarica* halophyte is abundant in almost all communities, the *Poa bulbosa* ephemeroid is often encountered, and the *Catabrosella humilis* ephemeroid is rarely found in the communities. Peculiar communities of two wormwoods include *Artemisia semiarida*, which came from the East, and *A. taurica*, which came from the West: *Artemisia semiarida*, *A. taurica* + *Poa bulbosa*, *Catabrosella humilis* + *Eremopyrum triticeum*, *Rochelia retorta*; and *Artemisia semiarida*, *A. taurica* + *Atriplex cana* + *Eremopyrum orientale*) or *Artemisia lerchiana*, *A. semiarida* + *Ephedra distachya*. Rarely, *Artemisia semiarida* grows on limestone, where it codominates in the steppes of *Agropyron desertorum*.

In the *Artemisia semiarida* communities, the total projective cover varies from 35 to 60%. The projective cover of grasses is 20–40%, and the projective cover of dwarf semishrubs is 20–40%. Each community includes 15–17 species.

In the Caspian lowland, *Anabasis salsa* – a steppe-desert halophilic dwarf semishrub – approaches the western distribution limit. The species range covers the Eastern European–Kazakh–Dzungarian territories extends from the Yergeni Upland (44 °E) to Dzungaria and Western Gobi (92 °E). The northern distribution limit of *Anabasis salsa* is 54 °N, and the southern one is 40 °N (Musaev, 1976, Botanical Geography ..., 2003).

*Anabasis salsa* is one of the common plants of the Turan deserts. It grows on soils of different salinity and mechanical composition (from loam sandy to loamy). The species also occurs on gypsiferous, rubble and takyr soils. In the Eurasian steppe zone, the communities of *Anabasis salsa* in some places play a significant role in the vegetation cover of the southern subzone. They are confined to solonetz, carbonate and residual-carbonate soils, and outcrops of saline rocks.

Most common communities that grow on the eroded slopes of Bolshoye Bogdo Mountain with outcrops of red saline clays include: *Anabasis salsa* + *Atriplex cana*, and *Anabasis salsa* + *Artemisia pauciflora*, and *Anabasis salsa* + *Artemisia semiarida*. The communities are sparse. Their total projective cover is 30–40%. The *Atriplex replicata* shrub, the *Limonium suffruticosum* dwarf semishrub, and various herbs like *Galatella tatarica*, *G. villosa*, *Echinops ritro*, *Serratula cardunculus*, and *Tanacetum achilleifolium* are common.

In the Bogdinsko-Baskunchaksky Nature Reserve, *Anabasis salsa* grow not only on the slopes of Bolshoye Bogdo Mountain, but also in the lake plains. The communities growing in this area are *Anabasis salsa* + *Poa bulbosa* and *Anabasis salsa* + *Lepidium perfoliatum*, *Anisantha tectorum*, *Eremopyrum triticeum*; and *Artemisia lerchiana* + *Anabasis salsa* + *Poa bulbosa*.

### III. RARE COMMUNITIES IN ELTON NATURAL PARK

Despite the fact that the number of rare communities in Elton Natural Park is inferior to the Bogdinsko-Baskunchaksky Nature Reserve, extremely peculiar halophytic communities of *Artemisia taurica*, which include *Anabasis salsa*, *Limonium suffruticosum*, *Suaeda physophora*, and *Atriplex cana*, are found to grow on the shores of Lake Elton. A large portion of their range lies to the east.

These are the communities of *Artemisia taurica* + *Anabasis salsa* + *Poa bulbosa*; and *Artemisia taurica* + *Poa bulbosa* + *Anabasis salsa*, *Suaeda physophora*; and *Artemisia taurica* + *Atriplex cana* + *Poa bulbosa* + *Suaeda physophora*; and *Artemisia taurica* + *Poa bulbosa* + *Kochia prostrata*, *Suaeda physophora*; and *Artemisia taurica* + *Poa bulbosa* + *Suaeda physophora*; and *Artemisia taurica* + *Suaeda physophora* + *Artemisia pauciflora*; and *Artemisia taurica* + *Poa bulbosa* + *Atriplex cana*, *Limonium suffruticosum*.

The complexes of the above listed rare communities are restricted to Elton Nature Park only.

The halophytic communities of *Artemisia taurica* include up to 20 species in total, and each separate community consists of up to 15 species. The total projective cover varies from 60 to 80% and may be even sparser. In the communities are constantly present *Limonium suffruticosum* and *Prangos odontalgica*, and annual plants – *Eremopyrum triticeum*, *E. orientale*, *Bassia sedoides*, etc.

On the shores of Lake Elton communities of *Anabasis salsa* are not numerous – *Anabasis salsa* + *Suaeda physophora* + *Artemisia taurica*, *A. pauciflora*. *Suaeda physophora* takes part in this or that abundance in almost all communities on solonchaks.

### IV. CONCLUSION

The conservation of phytocenotic diversity of the steppe is currently one of the most important problems. Protected areas help solve this problem. The Bogdinsko-Baskunchaksky Nature Reserve and Elton Natural Park contribute to restoration and conservation of the desert steppes. In the Trans-Volga region, steppes are more diverse than those in the Sarpinskaya lowland, which is probably due to difference in natural conditions. There are no petrophytic steppes to the west of the Volga River. The petrophyte regions of Bolshoye Bogdo Mountain are unique. They include rare communities of species found on the western and eastern distribution limits. Rare communities of dwarf semishrub perennial saltworts (*Anabasis salsa*, *Atriplex cana*, *Camphorosma monspeliaca*) and wormwoods (*Artemisia lerchiana*, *A. taurica*, *A. semiarida*) are peculiar to the desert steppe in the Russian Caspian Sea region.

In the reserve, certain plant species are preserved as relics. *Rheum tataricum*, *Megacarpaea megalocarpa*, *Eversmannia subspinoso*, *Glycyrrhiza aspera*, *Astragalus testiculatus*, *Allium inderiense*, *Tragopogon marginifolius*, *Scorzonera tuberosa*, *Taktajianantha pusilla*, and *Artemisia semiarida* occupy western-most areas; other species – *Stipa ucrainica*, *Limonium platyphyllum*, and *Artemisia taurica* – grow to the west (Popov, 2012).

The diversity and uniqueness of the desert steppes in the Russian Caspian Sea region undoubtedly requires careful treatment and conservation.

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