

# Ecological and phytocenotic characteristics of plant communities of *Nitraria schoberi* L. in Dagestan.

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**Abstract.** For the first time, an ecological-phytocenotic classification of communities of *Nitraria schoberi* L., widespread in the territory of the Republic of Dagestan has been developed. 29 geobotanical descriptions were carried out on sample plots (SP) taking into account the floristic composition, as a result of which 7 formations, 14 groups of associations and 27 associations were identified. In the course of research, 179 species of higher vascular plants were identified in communities with the participation of *Nitraria schoberi*. The largest was the Nitrarieta schoberi formation with 7 groups of associations and 14 associations, in which 128 species of vascular plants grow.

## 1 Introduction

Increased unsystematic use of natural resources, disturbance of the condition of pastures and other negative factors contribute to the emergence of many environmental problems, in particular the process of desertification.

In this regard, it became necessary to study communities with the participation of the Red Data Book species *Nitraria schoberi* in Dagestan, one of the few fruits and berry plants capable of growing on salt marshes and well tolerating being covered with sand, which is a natural sand-strengthening agent. Modern studies on the study of communities with the participation of *Nitraria schoberi* are given in works E.V. Mavrodiev et al., I.A. Rukhlenko, E.V. Banaev et al., I.A. Goryaev [1-6].

## 2 Methods

The work used materials and collections of field research carried out in 2015-2018. as part of expeditions. In communities with the participation of *Nitraria schoberi*, test plots of 20 × 20 m were laid. The test plots were tied to a geographic grid using a personal GPS radio navigator. The names of syntaxa are given in accordance with the Code of phytosociological Nomenclature [7].

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Taxonomic affiliation and nomenclature of species are given according to the «Conspectus of the flora of Dagestan» [8], «Conspectus of the flora of the Caucasus» [9], when identifying rare and protected species, «Red Book of the Republic of Dagestan» [10] and «Red Book of the Russian Federation» [11] were used.

### 3 Results

Based on the materials of geobotanical studies processed by the ecological-phytocenotic method of communities with the participation of *Nitraria schoberi* in Dagestan 5 formations, 12 groups of associations and 25 associations were identified:

#### Classification scheme

##### Formation *Nitrarieta schoberi*

###### Group of associations *Artemisieta tschernievianae*

Ass. *Artemisietum tschernievianae nitrariosum schoberae*

###### Group of associations *Botriochleta ischaemae*

Ass. *Cladiumetum martii botriochlosum ischaemae*

Ass. *Nitrarietum schoberae botriochlosum ischaemae*

###### Group of associations *Botriochleta ischaemae-herbosa*

Ass. *Botriochletum ischaemae nitrariosum schoberae*

Ass. *Teucriumietum polium elaeagnoso-nitrariosum schoberae*

Ass. *Rhamnetum pallasii botriochloso-nitrariosum schoberae*

###### Group of associations *Artemisieta Lerchianae*

Ass. *Nitrarieto-artemisetum lerchianosum*

Ass. *Rhamnetum pallasii artemisieto lerchianosum nitrariosum schoberae*

Ass. *Artemisietum lerchianae nitrariosum schoberae – anizanthosum*

###### tectorum

###### Group of associations *Artemisieta Marshallianae*

Ass. *Artemisietum marshallianae*

Ass. *Botriochleto-nitrarieto-artemisetum marshallianae*

Ass. *Nitrarieto-artemisetum marshallianae*

Ass. *Artemisietum marshallianae parietariosum nitrariosum schoberae*

###### Group of associations *Artemisieta santonicae – nitrarieta schoberae*

Ass. *Artemisietum santonicae nitrariosum schoberae*

##### Formation *Artemisieta austriacae*

###### Group of associations *Artemisieta austriacae-fruticosa*

Ass. *Salsoleto-colutieto-artemisetum austriacae*

##### Formation *Artemisieta tauricae*

###### Group of associations *Artemisieta tauricae-fruticosa*

Ass. *Fruticuleta-artemisetum tauricae*

###### Group of associations *Artemisieta tauricae*

Ass. *Tamariceta-artemisetum tauricae carecosum humilis*

Ass. *Tamaricetum laxae artemisiosum tauricae*

Ass. *Calamagrostidetum caucasicae noaeoso- artemisiosum tauricae*

Ass. *Capparicetum herbaceae artemisiosum tauricae*

##### Formation *Artemisieta santonicae*

###### Group of associations *Artemisieta santonicae*

Ass. *Noaeta macronata artemisiosum santonicae*

##### Formation *Tamariceta laxae*

###### Group of associations *Tamariceta laxae*

Ass. *Artemisietum tauricae tamaricosum laxae*

Group of associations *Medicageta minima*

Ass. *Tamaricetum laxae medicagosum minima*

Ass. *Tamaricetum laxae graminoso-medicagosum minima*

### 3.1 Formation *Nitrarieta schoberi*

*Nitraria schoberi* L. - halophytic shrub, xerophyte. The range of the species *Nitraria schoberi* L. is mainly made up of the Caspian and Turan lowlands, where saltpeter is found in large quantities. In the north, its distribution is limited by the line: 56 ° N (Omsk); in the west, it is known in Ergeny, on the territory adjacent to the Caspian Sea. Also, in the west are its severed locations in the eastern Crimea near Sudak, as well as in the Lower Danube lowland. The distribution area of *Nitraria schoberi* (according to literature data) is the Caucasus, Central Asia, Western Siberia, Iran and Western China [12-15]. There is an indication of the growth of *Nitraria schoberi* in the Ploiesti region of Romania in the "Flora of Romania" [16]. Its range covers the entire Ordos, the Alashan Desert, partly the Mongolian Gobi, the foothills and low mountains of the Nan Shan and Altyn Taga, the eastern outskirts of the Tsaidam Basin with the surrounding foothill plains [17, 18]. In the east it reaches the regions of Kashgar and Dzungaria. In the south, the range of *N. schoberi* reaches Afghanistan; so far only one locality is known (Khusan on Gerirud) [19].

The total projective cover in *Nitraria schoberi* in the shrub layer varies from 5 to 50%, and in the herbaceous layer from 10 to 45%.

The species composition of the communities of the *Nitraria schoberi* includes 129 species of higher vascular plants. In communities, species of the genus *Tamarix* often codominated. With saline soils, hyperhalophytes of *Halimione verrucifera* are abundant in them, less often *Halocnemum strobilaceum* and *Nitraria schoberi*.

In cenoses, the main place is occupied by species of the genus *Artemisia* (*A. austriaca*, *A. santonica*, *A. marshalliana*, *A. lercehana*, *A. tschernieviana*, *A. annua*), *Anizantha rubens*, *Poa bulbosa*, and *Botriochloa ischaemum*.

Based on our own descriptions, we carried out an ecological-phytocenotic classification of communities of the *Nitrarieta schoberi* formation, widespread in the Republic of Dagestan. It includes 6 groups of associations and 14 associations.

#### 3.1.1 Group of associations *Artemisieta tschernieviana*

The group of associations *Artemisieta tschernieviana* is rare, on the sandy ridges of the coastal lowland. The projective cover of the shrub layer is about 40%, of the herbaceous layer up to 25%.

*Tamarix laxa* together dominates in the layer of shrubs together with *Nitraria schoberi*. Communities of this group of associations include *Cynanchum acutum*, *Plantago scabra*, *Daucus carota*, *Eryngium campestre*, *Anthemis ruthenica*, *Eremostachys laciniata*, *Syrenia siliculosa*, *Jurinea ciscaucasica*.

#### 3.1.2 Group of associations *Botriochloa ischaemae*

The group of associations *Botriochloa ischaemae* occurs on the rock taluses of Inter Mountain Dagestan. The projective cover of the shrub layer is 10%, herbaceous layer is about 30%.

Along with *Nitraria schoberi*, in the communities of this class of associations, the background species of the shrub layer are *Clematis orientalis*, *Tamarix smyrnensis*, *Paliurus spina-christi*, and *Rosa pimpinellifolia*. The herbaceous layer is dominated by *Cladium martii*, *Artemisia incana*, *A. marshalliana*, *Cynanchum acutum*, *Parietaria*

*judaica*, *Gypsophila capitata*. The constant species for this class of association are *Euphorbia virgata*, *Galium brachyphyllum*, *Solanum dulcamara*, *Satureja subdentata*, *Salvia canescens*.

### 3.1.3 Group of associations *Botriochloeta ischaemae-herbosae*

Communities of the *Botriochloeta ischaemae-herbosae* group of associations are found near saline lakes, hydrogen sulfide springs and depressions in the coastal part of the Primorskaya plain of Dagestan, on salt licks. The projective cover of the shrub layer varies from 25 to 50%, and of the grass layer 20-30%.

In the ravines of a temporary watercourse on the coastal part, the role of the background species, along with *Nitraria schoberi*, is assumed by *Elaeagnus angustifolia*, and at the outcrops of limestone plates, *Rhamnus pallasii*. The main dominants of the herbaceous layer are xero-holophytic perennials *Artemisia santonica*, *A. annua*, *Limonium mejeri*, *Plantago scabra*, *Galium aparine*, *Teucrium polium*, and *Eryngium caucasicum*.

### 3.1.4 Group of associations *Artemisieta lerchianae*

The group of associations *Artemisieta lerchianae* are found near salt lakes, in depressions of the Caspian lowland with a high groundwater table, on sands. The projective cover of the shrub layer is from 10 to 40%, and of the herbaceous layer 15-45%.

In the group of associations *Artemisieta lerchianae*, the background species of the shrub layer is *Nitraria schoberi* in rare cases, *Rhamnus pallasii* can be a together dominants. In the grass layer, the role of dominants in the communities located near salt lakes is assumed not only by *Artemisia lercheana*, but also by *Plantago lanceolata*, *Galium aparine*, *Artemisia austriaca*, *Botriochloa ischaemum*, and in the depressions of the Caspian lowland *Anizantha rubens* and *Poa bulbosa*. The constant species of this class of associations are *Artemisia lercheana*, *Agropyron pectinatum*, *Medicago caerulea*, *Asparagus officinalis*.

### 3.1.5 Group of associations *Artemisieta marshallianae*

Communities of the group of associations *Artemisieta marshallianae* are more often found on dry slopes with outcrops of salts, in ravines with a temporary watercourse. The projective cover of the shrub layer is from 5 to 12%, and of the herbaceous layer is 10-25%.

In the shrub layer of this of associations, the main dominant is *Nitraria schoberi*, in rare cases, *Clematis orientalis*. The main feature of the herbaceous layer is the occurrence of tap-root perennial plants *Convolvulus arvensis*, *Artemisia marshalliana*, *Parietaria judaica*, *Gypsophila capitata*, *Erysimum meyerianum*, *Euphorbia virgata*. Among cereals, *Botriochloa ischaemum* is a codominant.

### 3.1.6 Group of associations *Artemisieta santonicae - nitrarieta schoberae*

Communities of the group of associations *Artemisieta santonicae - nitrarieta* are rare, near saline lakes and depressions on salt licks. The projective cover of the shrub layer is up to 35%, and that of the herbaceous layer is up to 20%.

The background species of the shrub layer is *Nitraria schoberi*, and *Teucrium chamaedrys*, *Eryngium caucasicum*, and *Centaurea squarrosa* dominate in the herbaceous layer along with *Artemisia santonica*. Among cereals *Botriochloa ischaemum* and *Bromus briziformis* are together dominants.

### 3.2 Formation *Artemisieta austriacae*

*Artemisia austriaca* Jacq. - halophyte, with a creeping adventitious root system. The range of the species stretches from the territory of the Caucasus, Central Asia, Iran, Ukraine, Moldova, Crimea, Belarus to Northwest China. For the growth of *Artemisia austriaca* prefers old fallow lands, forest-steppe and steppe zones, alkaline meadows, pastures, steppe and steppe slopes.

The total projective cover in the communities of the *Artemisia austriaca* and in the shrub and grass layers reaches 40%.

The species composition of the *Artemisia austriaca* communities is very poor and includes up to 10 species of higher vascular plants. This is due to the fact that the soil is subject to water and wind erosion, so ephemeroïds and annuals do not take root.

In these communities, the main place is occupied by the species *Artemisia austriaca* and *Carex humilis*, and among the shrubs *Nitraria schoberi*, *Colutea orientalis*, and *Salsola daghestanica*.

Based on our descriptions, an ecological-phytocenotical classification of communities of the Artemisietae austriacae formation, widespread in the Republic of Dagestan, was carried out. It includes 1 group of associations and 1 association.

#### 3.2.1 Group of associations *Artemisieta austriacae-fruticosa*

Communities of the *Artemiseta austriacae-fruticosa* group of associations occur on dry slopes with loose shale, subject to constant water and wind erosion. The projective cover both in the shrub and grass layers reaches 40%. *Colutea orientalis* and *Salsola daghestanica* are the background species of the shrub layer, together with *Nitraria schoberi*; in the herbaceous layer *Carex humilis* codominates with *Artemisia austriaca*.

### 3.3 Formation *Artemisieta tauricae*

*Artemisia taurica* Willd. - a perennial plant with a rod thick, upright, woody root system. Occurs from Crimea in the west to the Bogdinsko-Baskunchaksky nature reserve in the Astrakhan region in the east. On the territory of the range, *Artemisia taurica* is distributed intermittently, and it is classified as a rare plant. However, at present, this *Artemisia taurica* is expanding its range, actively spreading over fallows in the south of the steppe zone and in the desert zone [20].

The total projective cover in communities of *Artemisia taurica* in the shrub layer varies from 8 to 40%, and in the herbaceous layer from 20 to 50%.

The *Artemisia taurica* communities are rich in species composition, including 59 species of higher vascular plants. The background species in the communities of this formation are *Nitraria schoberi*, *Spiraea hypericifolia*, *Colutea orientalis*, *Salsola ericoides*, *Salsola daghestanica*, *Rhamnus pallasii*, *Tamarix ramosissima*. The main dominants of the herbaceous layer are *Artemisia taurica*, *Iris timofejewii*, *Noaea mucronata*, *Halimione verrucifera*, *Carex distans*, *Calamagrostis caucasica*, *Phleum phleoides*, *Capparis herbacea*.

Based on the results of our own descriptions, we carried out an ecological-phytocenotical classification of communities of the Artemisietae tauricae formation widespread in the Republic of Dagestan, which includes 2 groups of associations and 6 associations.

### 3.3.1 Group of associations *Artemisieta tauricae-fruticosa*

Communities of the group of associations *Artemisieta tauricae-fruticosa* occur on dry slopes with loose shale, subject to constant water and wind erosion in the ravines of a temporary watercourse. The projective cover of shrub and grass layers reaches 40%.

In the group of associations *Artemisieta tauricae-fruticosa*, the background species of the shrub layer is *Nitraria schoberi*, *Spiraea hypericifolia*, *Colutea orientalis*, *Salsola ericoides*, *Salsola daghestanica*. *Rhamnus pallasii* and *Cerasus incana* are also found. In the herbaceous layer, *Artemisia taurica* is the main dominant species. *Medicago caerulea*, *Iris timofejewii*, and *Artemisia salsoloides* are often found in such communities.

### 3.3.2 Group of associations *Artemisieta tauricae*

The group of associations *Artemisieta tauricae* is found on heavily eroded shale slopes in the ravines of a temporary watercourse, as well as on salt marshes with a salt crust, on the shores of salt lakes. The projective cover of the shrub layer is from 8 to 20% and of the herbaceous layer is from 20 to 50%.

In the *Artemisieta tauricae* group of associations, the background species of the shrub layer are *Nitraria schoberi* and *Tamarix ramosissima*. *Tamarix laxa*, *Atraphaxis daghestanica* are rare.

In the herbaceous layer, the dominant communities of this class of associations located on the shale slopes in the ravines of the temporary watercourse are played by the species *Medicago caerulea*, *Convolvulus arvensis*, *Capparis herbacea*, and *Artemisia marshalliana*. The communities of the class of associations *Artemisieta tauricae* located along the shores of salt lakes are dominated not only by *Artemisia taurica*, but also by *Noaea mucronata*, *Halimione verrucifera*, *Carex distans*, *Calamagrostis caucasica*, *Phleum phleoides*.

## 3.4 Formation *Artemisieta santonicae*

*Artemisia santonica* L. is a halophytic perennial plant with a rod-and-root system. The range of the species is the Black Sea-Northwest Caspian, it stretches from the Black Sea region (33° E) in the west, to North-Western Kazakhstan (45° E) in the east. The northern border reaches 52° N, the southern one - 44° N. [21]. *Artemisia santonica* is a desert-steppe species [22, 23].

The projective cover of the shrub layer is up to 10%, of the grass layer is 30%.

The species composition community of the *Artemisia santonica* is scanty (10 species of higher vascular plants). The communities are often dominated by shrubs of *Nitraria schoberi* and species of the genus *Tamarix*. In the herbaceous layer, the main role is played by *Artemisia santonica*, *Noaea mucronata*, *Halimione verrucifera*.

Based on the results of our own descriptions, we carried out an ecological-phytocenotical classification of communities of the *Artemisieta santonicae* formation, widespread in the Republic of Dagestan, which includes 1 group of associations and 1 association.

### 3.4.1 Group of associations *Artemisieta santonicae*

Communities of the *Artemisieta santonicae* group of associations are found on salt marshes along the shores of salt lakes of the coastal plain. The projective cover of the shrub layer reaches 10%, of the herbaceous layer 30%.

The background species of the shrub layer is *Nitraria schoberi* and *Tamarix ramosissima*, rarely *Salsola glauka*. The main dominants in the communities of the group of associations *Artemisieta santonicae* are *Artemisia santonica*, *Noaea mucronata*. These communities also contain *Artemisia taurica*, *Alhagi pseudalhagi*, *Gypsophila paniculata*, and one of the hyperhalophytes, *Halimione verrucifera*, is often found.

## 3.5 Formation *Tamariceta laxae*

*Tamarix laxa* Willd. - a large, highly branched shrub or in the form of a small tree up to 5 m tall. Grows in the lower reaches of the Volga, Central Asia, Mongolia, Northwest China, Northern Iran, Afghanistan. In Dagestan, it grows on the Terek-Sulak lowland to the lower mountain belt [7]. It is very unpretentious to soil conditions, tolerates salinity well, and is insensitive to drought. It is used in single and group plantings as an ornamental and sand-fixing plant in the south and southeast of the European part of Russia.

The projective cover of the shrub layer varies from 10 to 35%, and of the herbaceous layer from 25 to 55%.

The species composition of the communities of this formation includes 40 species of higher vascular plants. The communities are often dominated by shrubs of *Nitraria schoberi* and species of the genus *Tamarix laxa*. In the herbaceous layer, the main role is played by *Artemisia taurica*, *Medicago caerulea*, *Medicago minima*, *Leymus racemosus*, *Poa bulbosa*, *Hordeum leporinum*, *Silene conica*, *Aira notarisiana*, *Carduus cineris*.

Based on the results of our own descriptions, we carried out an ecological-phytocenotical classification of communities of the *Tamariceta laxae* formation, widespread in the Republic of Dagestan, which includes 2 groups of associations and 3 associations.

### 3.5.1 Group of associations *Tamariceta laxae*

Communities group of associations *Tamariceta laxae* are found on the Terek-Sulak lowland to the lower mountain belt, on sands and salt marshes.

The projective cover of the shrub layer is 35%, of the grass layer 25%. In the group of associations *Tamariceta laxae*, the background species of the shrub layer is *Nitraria schoberi*, *Tamarix laxa*, *Salsola glauka*. *Artemisia taurica*, *Leymus racemosus*, *Medicago caerulea*, *Frankenia hirsuta*, *Phleum phleoides* take on the role of dominants of communities of this class of associations in the herbaceous layer.

### 3.5.2 Group of associations *Medicageta minimae*

The group of associations *Medicageta minimae* is found on the salt marshes of the Terek-Sulak lowland to the lower mountain belt.

The projective cover of the shrub layer ranges from 10 to 20%, and of the herbaceous layer from 50 to 55%. In the communities of this group of associations, the background species of the shrub layer are *Nitraria schoberi* and *Tamarix laxa*. In the herbaceous layer *Medicago minima*, *Medicago caerulea*, *Poa bulbosa*, *Hordeum leporinum*, *Silene conica* play the main role. There are also *Artemisia taurica*, *Anthemis ruthenica*, *Leymus racemosus*, *Bromus commutatus*, *Aira notarisiana*, *Melandrium album*, *Carduus cineris*, *Asparagus officinalis*.

## 4 Discussion

According to the conducted studies using the ecological-phytocenotical method of communities with the participation of *Nitraria schoberi* 5 formations, 12 groups of associations and 25 associations were identified in Dagestan.

The formation of the Nitrarieta schoberi (128 species) is characterized by the greatest floristic diversity. The Artemisieta tauricae (59 species), Tamariceta laxae (40 species) are diverse. The Artemisieta santonicae (11) and Artemisieta austriacae (8) formations are much inferior in species diversity.

No one has studied the communities with the participation of *Nitraria schoberi* on the territory of Dagestan. Work was carried out to study a similar flora using the ecological-phytocenotical method on the territory of Kalmykia [4, 23]. Studies have also been carried out from the standpoint of the ecological-floristic approach to study the communities of steppe vegetation where *Nitraria schoberi* directly grows [24-26]. Based on the results of both their own studies and the results of other authors, it is necessary to carry out a comparative assessment of the species richness of communities with the participation of *Nitraria schoberi*.

## 5 Conclusion

There are many species in need of protection in the populations of *Nitraria schoberi*, which have a high phytosociological value, as they are represented by rare and endemic vegetation types of Dagestan.

For the first time, an ecological-phytocenotic classification of communities with the participation of *Nitraria schoberi* widespread in the Republic of Dagestan has been developed. The current state of these communities with the participation of the Dagestan Red Data Book species *Nitraria schoberi* at the present time remains unsatisfactory. On the basis of the classification, more valuable and rare communities will be recommended, the study and monitoring of which will allow preserving and predicting the further development of areas that are on the verge of extinction and are subject to constant anthropogenic pressure.

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