

## The vegetation of the Azov-Sivaš National Nature Park. Class *Thero-Salicornietea* (S. PIGNATTI 1953) R. Tx. in R. Tx. et OBERD. 1958

DMYTRO V. DUBYNA<sup>1</sup> & ZDENKA NEUHÄUSLOVÁ<sup>2</sup>

<sup>1</sup>M.G. Kholodny Institute of Botany, Academy of Sciences of Ukraine, Tereščenkivska 2, 01601 Kyiv, Ukraine, e-mail: intereco@post.com.ua

<sup>2</sup>Institute of Botany, Academy of Sciences of the Czech Republic, CZ-252 43 Průhonice, Czech Republic, e-mail: neuhauslova@ibot.cas.cz

---

DUBYNA D. V. & NEUHÄUSLOVÁ Z. (2003): The vegetation of the Azov-Sivaš National Nature Park. Class *Thero-Salicornietea* (S. PIGNATTI 1953) R. Tx. in R. Tx. et OBERD. 1958. – Thaiszia – J. Bot. 13: 1-30. – ISSN 1210-0420.

ABSTRACT: Phytosociological and ecological characteristics of six associations of halophilous vegetation in the Azov-Sivaš National Nature Park and their including into higher syntaxa from the class *Thero-Salicornietea* have been discussed. One new syntaxon, the ass. *Ofaisto monandri-Salicornietum*, has been described in this area. The alliance *Salicornion prostratae* (Soó 1933) GÉHU 1992 is the valid name of this syntaxon.

KEYWORDS: halophilous solonchak vegetation, salinization of soils, syntaxonomy, synecology, *Salicornion prostratae*, *Suaedion salsae*, Azov-Sivaš National Nature Park, Ukraine.

---

### Introduction

For few decades, detailed vegetation research was organized in the Azov-Sivaš National Nature Park in the South Ukraine. In 1990, attention was paid, above all, to the eastern part of this Park – the Birjučij Island Spit. The characteristics of psammophilous and salt-meadows vegetation of this area were given in the foregoing publications (DUBYNA et al. 1994, 1995, DUBYNA & NEUHÄUSLOVÁ 2000a, b).

This paper includes characteristics of the solonchak vegetation of the class *Thero-Salicornietea* in the territory of the whole Azov-Sivaš National Nature

Park. The aim of this study is to characterize the individual communities with regards to the salinization of the soils.

In spite of it that the vegetation of the Azov-Sivaš National Nature Park has been studied by many botanists, detailed studies on halophilous vegetation based on floristic-phytosociological principles have been first published by the authors of this paper.

## Methods

The field studies of the Birjučij Island Spit were performed by the Ukrainian and Czech botanists according to the principles of the BRAUN-BLANQUET approach (BRAUN-BLANQUET 1964), the research in the Sivaš area of the National Park was organized by Ukrainian botanists.

The synthesis and evaluation of the relevés were made by the both authors. Vegetation units distinguished in the Azov-Sivaš Park have been compared with the analogous syntaxa of Ukraine and adjoining areas and with the pan-European surveys of the *Thero-Salicornietalia* communities (GÉHU 2002, GOLUB & SOLOMAKHA 1988, GOLUB & TCHORBADZE 1995, SOLOMAKHA 1996, SOLOMAKHA & ŠELYAG-SOSONKO 1984, SOLOMAKHA et al. 1995, VICHEREK 1973 etc.).

The taxonomic nomenclature follows DOBROČAEVA et al. (1987). The names of syntaxa follow the Code of phytosociological nomenclature (WEBER et al. 2002).

The measurement of the salt content was performed according to the handbook by ARINUŠKINA (1970).

## Basic characteristics of the studied area

The Azov-Sivaš National Nature Park includes the territory of several islets and spits. Besides the Birjučij Island Spit forming the eastern part of the National Park mentioned above, it is formed by the islands Churjuk, Kujuk-Tuk, Martynjačij and Kitaj in the central part of the Sivaš Bay, the Central Sivaš, to the south from the villages Vasilievka, Zaozernoje, Averjanovka and Vesnianska in the western part of the Park. As the physical-geographical characteristics of the Birjučij Island Spit were mentioned in the previous publications, attention will be paid to the Sivaš part of the Park.

The Sivaš Bay is on the border of the Autonome Republic Crimea and the Kherson Region. With the islands it covers an area of ca. 250 000 ha. By a narrow channel, it is linked with the Azov Sea. Its highest depth does not achieve more than 1.0-1.5 m, mostly only 30-40 cm. In the dry period (summer-autumn) its large areas are waterless, covered by salt deposits only and succulent halophyte vegetation. The area of the Churjuk Island with small adjoining islands covers 924 ha, Kujuk-Tuk - 255 ha, Martynjačij - 7 ha and Kitaj - 3 ha. Besides these islands, the Sivaš part of the Park includes 21 200 ha water area (BOLDENKOV 1987).

According to the physical-geographical subdivision, this territory belongs to the North-Sivaš-near Rayon of the Sivaš-Azov Steppe Region (LAŃKO 1967). In the Central Sivaš, psammophilous vegetation, frequent in the eastern part of the Park on the Birjučij Island Spit, is missing, the salt-meadows cover small areas

only and desert-steppe vegetation (according to BILYK et al. 1963) belongs, together with typical solonchak vegetation, to the most frequent types. The last types occur frequently on the Birjučij Island Spit, too.

From the orographical point of view, the islands of the Sivaš part of the Park are quite different. The relief of the Kujuk-Tuk Island is formed by a plateau with two elevations, achieving 10.4 m and 21.9 m. Its northern part is elevated (6 m), the southern part is lower and passes to the solonchak area. The relief of the Churjuk Island is dissected by many bays determining its specific configuration, the relief of the islands Martynjačij and Kitaj is plain with small elevations on the East and 5-6 m high shores. These two islands are colonized by many nesting birds; they are covered by a layer of bird excrements and plant rests. In consequence of it their plant cover is very poor.

The climate is moderately continental, with warm and long summer and relative short winter, in the winter period cyclones prevail, the Azov- and Black Seas contribute to the moderating of summer hot weather, winter frost and the snow-cover do not last long. Mean summer temperature achieves 20-24°C, max. - 35-40°C, mean winter temperature -2 till -3°C (minimum ca. -30 to -32°C). Annual precipitation achieves 300-350 mm, with the minimum in April-July (period of dry winds). In winter, eastern and northeastern winds prevail, evoking the flooding of a large area of depressions.

The soils of the islets Churjuk, Kujuk-Tuk, Martynjačij and Kitaj belong to the group of strongly salinized soils ( $\text{SO}_4^-$ ,  $\text{Cl}^- \geq 2\%$ ) with transition to solonchaks, where salt deposits occur on the soil surface. These soils of the Sivaš Islands correspond to chestnut soils (almost 88% of the whole area), meadow-chestnut soils (8%) and solonchaks (3-4%), developing on loess loams of different salinization degree.

As it was mentioned above, water areas of the Park cover 85 % of its whole area. The water temperature achieves 25-28°C in summer, in winter -1°C on the surface. The water is covered by ice from 1 to 3 months. The maximal depth of the Sivaš in the area of the National Park is not higher than 50-100 cm. The water salinity is high, more than 125-165‰, in summer ca. 260‰, a high content of NaCl,  $\text{MgCl}_2$ ,  $\text{MgSO}_4$ , bromine and iodine compounds is typical.

Recently, individual parts of the Sivaš Bay were separated by artificial dams.

## Vegetation

In the Birjučij Island Spit, solonetz- and solonchak vegetation cover an area of ca. 400 ha, on the Churjuk and Kujuk-Tuk Islands 50 ha. In the Azov part of the Park this vegetation is concentrated in the central and estuary-near areas of the Birjučij Island Spit, in the maritime part its occurrence is markedly rare. It is mostly linked with depressions lying near the permanent or seasonal water areas, and with estuary-near shores. The distribution of these communities is determined by the relief and influence of high or flood tide. In the areas, where from historical purposes these phenomena do not play important role, half-shrub solonchak vegetation (*Eusalsa fruticosa* according to BILYK 1963) dominated by *Halocnemum strobilaceum*, *Limonium caspium*, *Halimione verrucifera* and

*Frankenia hispida* prevails. On the contrary, places with a very marked tide are, characterized by a succulent-grass solonchak vegetation (*Eusalsa crasso-herbosa* sensu BILYK 1963) dominated by *Salicornia prostrata*, *Suaeda prostrata*, *S. confusa*, *Bassia sedoides*, *B. hirsuta*, *Salsola soda* etc. The habitats of the Sivaš part of the Park represent the ecological optimum for the solonchak vegetation, characterized by many obligate halophytes, missing in other parts of the Ukraine. The Sivaš localities of *Limonium suffruticosum* and *Ofaiston monandrum* are the westernmost in Europe. Here, many endemic halophytes occur (e.g. *Puccinellia fominii*, *P. syvaschica* etc.).

On the Kujuk-Tuk Island, the solonchak vegetation is concentrated mostly in its southern and eastern part (near the Solenoe Lake), rarely in the north-east part. It covers an area of 1-2 ha only. On the Churjuk Island it occupies the levels along its periphery with exception of elevated, 3-5 m high parts. It represents the main and the only vegetation type on many small islets and in depressions, periodically covered by water.

From the floristic and phytosociological point of view, the solonchak vegetation of the Sivaš area differs markedly by its high diversity. On the contrary, in the Birjučij Island Spit, salt meadows and psammophilous vegetation are typical.

In the area of the Azov-Sivaš National Nature Park the following syntaxa of the class *Thero-Salicornietea* have been distinguished:

*Thero-Salicornietea* (S. PIGNATTI 1953) R. TÜXEN in R. TÜXEN et OBERDORFER 1958

*Thero-Salicornietalia* (S. PIGNATTI 1953) R. TÜXEN in R. TÜXEN et OBERDORFER 1958

*Salicornion prostratae* (SOÓ 1933) GÉHU 1992

*Salicornietum prostratae* (SOÓ 1927) 1964 ex VICHEREK 1973

*Limonio caspici-Salicornietum* KORŽENĚVSKIJ et KLJUKIN 1991

*Petrosimonia oppositifoliae-Salicornietum* KORŽENĚVSKIJ et KLJUKIN 1991

*Ofaisto monandri-Salicornietum* DUBYNA et NEUHÄUSLOVÁ **ass. nova**

*Suaedo maritimae-Salicornietum prostratae* V. SOLOMAKHA et ŠELYAG-SOSONKO 1984

*Suaedetum salsae* GOLUB et TCHORBADZE 1995

***Thero-Salicornietea* (S. PIGNATTI 1953) R. TÜXEN in R. TÜXEN et OBERDORFER 1958**

### **Structure and species composition**

Solonchak vegetation of the Azov-Sivaš National Nature Park belongs mostly to this class. It represents typical pioneer vegetation of annual succulent-herb halophytes (*Eusalsa crasso-herbosa* BILYK 1963), characteristic for initial phases of vegetation development of solonchaks denuded after a tide. The most species are succulents (*Salicornia prostrata*, *Suaeda salsa*, *S. prostrata*, *Bassia hirsuta*,

*Salsola soda*, *S. laricina*, *Petrosimonia oppositifolia*, *Ofaiston monandrum* etc.), accumulating salt in leaves and stalks. Besides them, many other ecological groups of species, mainly on the Birjučij Island Spit, can be found in these stands as result of gradual degradation and artificial regradation of solonchaks.

The field layer is mostly formed by two sub-layers: upper 30-50 cm high sub-layer, and lower, 5-15 cm high sub-layer. The projective cover markedly oscillates, depending on ecology of a given place. With regards to floods, the floristic composition is poorer (cf. LEVINA 1929, LEVINA & ŠALYT 1927).

### **Ecology**

For communities of the class *Thero-Salicornietea* in the Azov-Sivaš National Nature Park their seasonal development is typical. Their maximal development goes back to the 2<sup>nd</sup> half of summer, to the period of retreat of floods. Their habitats (sometimes depressions, but more frequently, belts of different width) are periodically flooded (cf. RODWELL et al. 2002). During the high tide they are covered by 5-10 (15) cm water.

### **Use and importance of vegetation**

These communities have a phytomeliorative importance - they contribute to melioration of solonchaks. These stands are habitat for many species of animals, above all birds and insects. At higher elevations some birds built their nests (e.g. many protected species of the Red Data Book of Ukraine (1994) - *Charadrius alexandrianis* L., *Himantopus himantopus* L., *Glareola praticola* L. etc.).

### **Distribution**

These communities are typical on the Islands Birjučij and Churjuk, where they cover large areas. On the Kujuk-Tuk Island, where salinized areas are rare, they are less frequent. On the Birjučij Island Spit they occur in contact area with the Utljuk Liman, and cover large areas in deep depressions of the central part of the island. They occur relatively rarely in deep depressions of the eastern part. On the Churjuk Island they occur on its whole periphery with exception of its elevated parts on the west. They are typical mainly for dissoluted remnants of smaller former islets and areas between them. As mentioned above, the Sivaš Bay developed by breaking of a part of dry land, joining the Crimean peninsula with the mainland of the Ukraine. Thus, many small islands developed. They were gradually dissolved and only small elevations remember their past existence.

On the Kujuk-Tuk Island, this vegetation occurs in its southwestern, southeastern and northern parts.

In the area investigated, the class is represented by the only order - *Thero-Salicornietalia* and one alliance - *Salicornion prostratae*.

## **Salicornion prostratae (Soó 1933) GÉHU 1992**

This alliance comprises usually pioneer communities of short-lived succulents (annual *Salicornia* and *Suaeda* species) occurring in salt pans of the Caspian-Pannonian area. The communities of this alliance represented by four associations in the area of the Park occur at the lowest levels, on wet solonchaks with a marked content of salts in soil ( $\text{SO}_4^{2-}$  and  $\text{Cl}^-$  content  $\leq 2\%$ ). Scarcity of nitrogen compounds is typical (0.2-0.3%).

### **1. Ass. *Salicornietum prostratae* (Soó 1927) 1964 ex VICHEREK 1973 (Tab. 1, rel. 1-14)**

Diagnostic species combination: Diff. ass.: *Salicornia prostrata*. Species with higher constancy: Besides *Salicornia prostrata* also *Limonium caspium*, *Suaeda salsa*.

#### **Structure and species composition**

Open stands dominated by *Salicornia prostrata*, sometimes with higher cover of *Suaeda salsa* and *Salsola soda*. The total cover of the stands varies between 20-80%, number of species in the individual relevés (area 100 m<sup>2</sup>) achieves mostly 4-9, rarely > 10. The total species composition is very poor (in 14 relevés 23 species only). Only seven species occur with the constancy  $\geq 50\%$ . Many species of these stands belong to different phytosociological classes (see. Tab. 1). It can be explained by the habitat especiality of this association as well as by its large ecological range.

In the stands from the Birjučij Island Spit, many species of salt meadows occur (*Cynanchum acutum*, *Odontites salina*, *Phragmites australis*, see Tab. 1, rel. 1-6). The same species have been found in corresponding stands of this syntaxon in estuaries of the Danube (POPESCU et al. 1980) and Volga river (ŠELJAG-SOSONKO et al. 1989). Also *Halimione pedunculata* and *Tripolium vulgare* occur more frequently in the Birjučij. The endemic species *Puccinellia sivaschica* and *Artemisia taurica* are characteristic for the Sivaš area (Tab. 1, rel. 7-14).

#### **Ecology and distribution**

The stands of this association, which is the most frequent unit of this class in the Azov-Sivaš Park, are characterized by large ecological range. They initiate the succession at the lowest levels. However, they occur on more elevated places, too, above all on sites of dissolved islets, where the stands of other associations occur only very rarely. They cover large estuary-near areas and depressions (e.g. Birjučij Island Spit), mostly on solonchaks of the seaside belt of the Black and Azov Seas with sulphate-chloride salinization or in depressions of small salinized river terraces in the steppe zone. The salt content achieves 1.5-2.0%. These stands occur also on places of lagoon-bottom chloride-sulphate salinization (Kujuk-Tuk and Churjuk Islands). They are fully developed

in the second half of the summer period only. During the succession, this association is replaced by the *Limonio caspici-Salicornietum*.

## **2. Ass. *Limonio caspici-Salicornietum* KORŽENĚVSKIJ et KLJUKIN 1991 (Tab. 2, rel. 15–26)**

Diagnostic species combination: Diagn. ass.: *Salicornia prostrata*, *Limonium caspium*. Species with higher constancy: *Aeluropus littoralis*, *Halimione verrucifera*, *Limonium caspium*, *L. meyeri*.

### **Structure and species composition**

In comparison with the foregoing association, the species composition is richer in this syntaxon (37 species found on 100 m<sup>2</sup>), from them only 12 species with the constancy  $\geq 50\%$ . Species of other classes of halophilous vegetation, above all those of salt meadows, are typical. Also species of maritime psammophilous vegetation occur here, mainly *Apera maritima*, *Agropyron lavrenkoanum* and *Bassia sedoides*. On the Kujuk-Tuk- and Churjuk Islands, endemic species are typical achieving there the westernmost limit of their distribution (*Artemisia taurica*, *Lepidium syvaschicum*, *Limonium suffruticosum*, *Limonium czurjukiense*).

### **Ecology and distribution**

This association, characteristic for salinized areas, is relatively frequent in the Azov-Sivaš Park. It colonizes wet solonchaks of the sulphate-chloride salinization in the coastal belt (KORŽENĚVSKIJ & KLJUKIN 1991). The salt content achieves 2.0%. The association colonizes also solonchaks of lagoon-bottom chloride-sulphate salinization. In comparison with other parts of the Park, it occurs more frequently on shelly-sandy soils of the Birjučij Island Spit, less frequently on the Churjuk, and very rarely and fragmentarily on the Kujuk-Tuk. It is frequent on loamy or clayey soils of depressions, too. The groundwater level is 5-15 cm deep. Similarly as the foregoing association, it is temporarily covered by 3-5 cm flood. During these floods, the 3-5 cm high microelevations from dispersal sediments (area mostly 1 m<sup>2</sup>) develop. The soils of these microelevations include lower salt content. Here, typical salt-meadows species occur. Frequently, these microelevations joint together. The newly developed structures remember the configuration of flooded areas. In the further succession this unit is replaced by the *Petrosimonia oppositifoliae-Salicornietum*.

## **3. Ass. *Petrosimonia oppositifoliae-Salicornietum* KORŽENĚVSKIJ et KLJUKIN 1991 (Tab. 3, rel. 27–35)**

Diagnostic species combination: Diff. ass.: *Petrosimonia oppositifolia*. Species with higher constancy: *Halimione pedunculata*, *H. verrucifera*, *Limonium meyeri*, *Petrosimonia oppositifolia*, *Puccinellia syvaschica*, *Salicornia prostrata*, *Suaeda salsa*.

## Structure and species composition

The floristic composition of this syntaxon is poorer than that of the foregoing association. Only 25 species have been found here, from them only 10 with the constancy  $\geq 50\%$ . Species of salt meadows and those of psammophilous seaside vegetation are frequent. The stands are rich in endemic species, achieving here the westernmost limit of distribution.

## Ecology and distribution

Relatively frequent unit in the Azov-Sivaš National Nature Park. Also for this association the large ecological amplitude is typical. It covers solonchaks of seaside area with loamy and clayey soils, on contact with the foregoing association. It colonizes moderately higher levels of dissolved solonchaks (Churjuk Island) or less salinized habitats (Birjučij Island Spit), however, it can not grow on sites with long-lasting floods. The groundwater level in strongly regraded solonchaks achieves 5-7 cm (here, succulent halophytes prevail), on places with initial stages of solonchak regradation the groundwater is 12-20 cm deep (here, salt-meadows species play an important role). On regraded solonchaks, salt layer covers the soil surface.

This association is indicator of solonchak regradation. It is typical in the Sivaš part of the Park, on places where the Sivaš Park contacts with flooded arable lands. There, the secondary salinization of solonchak vegetation from salinized groundwater under the arable lands contributes to the development of this association. The habitat conditions are not quite suitable for *Petrosimonia oppositifolia* as it is to be seen from its relatively low cover (maximum 15–20%).

## 4. Ass. *Ofaisto monandri-Salicornietum prostratae* ass. nova hoc loco (Tab. 4, rel. 36–49)

Nomenclatural type: Table 4, rel. 42 (holotypus).

Location: Azov-Sivaš National Nature Park, Churjuk Island, northern part, northern orientation.

Diagnostic species combination: Diff. ass.: *Salicornia prostrata*, *Ofaiston monandrum*. Species with higher constancy: besides the above mentioned diff. species *Suaeda salsa*, *Puccinellia fominii*, *Pholiurus pannonicus*, *Limonium caspium*.

## Structure and species composition

Stands dominated by *Salicornia prostrata* and/or *Ofaiston monandrum* are relatively rich in species (31 in total). However, many species achieve a very low cover only. The number of species with  $\geq 50\%$  constancy is very low (only 8). Besides the name-giving dominant species, *Aeluropus littoralis* occurs as subdominant in some stands, and, some stands are dominated by *Puccinellia fominii*, sometimes, with subdominants *Halimione verrucifera* and/or *Halocnemum strobilaceum*. Halophilous species of different classes (see Tab. 4) participate on the floristic composition of this unit. The total cover does not



exceed 45%. The species of salt meadows (classes *Asteretea tripolium*, *Bolboschoenetea maritimi*) are very rare, they occur on more elevated places. Typical is the occurrence of endemics achieving here the western limit of distribution (e.g. *Limonium czurjukiense*, *Puccinellia syvaschica*, *Tetradiclis tenella*).

### Ecology and distribution

This unit occupies strongly regraded loose solonchaks, as well as newly forming, less salinized parts of the Churjuk Island, rarely Kujuk-Tuk, too. In the ecological-phytocoenotic series it forms the link between the communities dominated by *Halocnemum strobilaceum* and those with prevailing *Salicornia prostrata*. In the Ukraine, it occurs on solonchaks of the Central Sivaš only, in areas of lagoon-bottom chloride-sulphate salinization. The content of salts on the soil surface is high, the salts form there a snow-white cover. These levels are frequently covered by a layer of sediments accumulated during the floods or disintegration of abrasion material. Just such habitats are typical for this association. Besides it, this unit occurs also on strongly regraded, mostly loamy solonchaks with upper loose horizon. The content of salts in water solution achieves up to 3.0-3.5%, in that of deposits only 1.5-2.0%. The groundwater level is 7-20 cm deep. During the further succession, the stands of this association are replaced by the *Suaedo maritimae-Salicornietum prostratae*.

In the area investigated, the *Ofaisto monandri-Salicornietum* achieves the westernmost border of its area. According to BILYK (1963), this vegetation was more frequent in the Ukraine. With diminishing water area it was restricted to the Sivaš area only and more eastern localities behind the Ukrainian boundary.

### 5. Ass. *Suaedo maritimae-Salicornietum prostratae* V. SOLOMAKHA & ŠELJAG-SOSONKO 1984 (Tab. 5, rel. 50–65) (Syn.: *Suaeda salsae-Salicornietum prostratae* GOLUB & TCHORBADZE 1995)

Diagnostic species combination: Diagn. ass.: *Salicornia prostrata*, *Suaeda salsa*. Species with higher constancy: *Aeluropus littoralis*, *Salicornia prostrata*, *Suaeda salsa*.

### Structure and species composition

This association belongs to the species-richest units of the class *Thero-Salicornietea* in the investigated area. Here, 42 species have been found, from those only 10 with the constancy  $\geq 50\%$ . In typical stands, *Salicornia prostrata*, ca. 10-20 cm high, and/or *Suaeda salsa* are dominant, sometimes *Artemisia taurica*, *Halimione verrucifera*, *Limonium caspium* or *Puccinellia syvaschica* occur with high dominance, too. The salt-meadow species with some psammophytic elements (*Apera maritima*, *Agropyron lavrenkoanum*, *Salsola laricina*, *S. soda* etc.) are frequent. During the vegetation period, the aspect of the stands varies from green in summer to red in autumn. Endemic halophytic species are typical here, above all *Puccinellia syvaschica* and *Artemisia taurica*.

Frequent are also species of newly forming habitats (*Salsola soda*, *S. laricina*, *Lepidium pumilum*, *Melilotus albus*, *Suaeda confusa* etc.).

### Ecology and distribution

Stands of this association, characteristic for the Birjučij Island Spit and the Churjuk Island, are frequent, but cover relatively small area in the Park. Rarely, they occur on the Kujuk-Tuk Island, too. They grow on loamy solonchaks of the seaside belt, in depressions of small river terraces in the steppe zone (SOLOMAKHA & ŠELYAG-SOSONKO 1984). They are in contact with the foregoing association, and at higher levels with relatively lower soil moisture, they are replaced by the *Suaedetum salsae*. They indicate habitats with weakly compact loamy solonchak soils, on places where not only salinization, but also weak desalinization can be observed. They are typical for solonchaks of sulphate-chloride coastal salinization. The salt content achieves 2.5-3%. Frequently, they occur in areas with weak floods and with the groundwater level  $\geq 25-30$  cm deep. On the soil surface a white salt layer can be seen. By higher floods the stands degrade, however, the regradation of solonchaks restricts their expansion.

### 6. Ass. *Suaedetum salsae* GOLUB & TCHORBADZE 1995 (Tab. 6, rel. 66–78) (Syn.: *Suaedetum maritimae* auct. ucrain.)

Diagnostic species combination: Diff. ass.: *Suaeda salsa*. Species with higher constancy: *Halimione pedunculata*, *Limonium meyeri*, *Puccinellia syvaschica*, *Suaeda salsa*.

### Structure and species composition

Also this unit is characterized by the high number of species (29), among them only 6 with the constancy  $\geq 50\%$ . *Suaeda salsa* is the only dominant species. The total cover of the field layer is lower here, it achieves mostly 50-60%, only very rarely 100%. The cover of *Salicornia prostrata* is very low, in many stands this species was quite missing. Also the proportion of salt-meadows species is low. Other accompanying species occur only on the periphery of this association and frequently, they are not recorded by many authors.

The stands of this association form a link between the *Suaedetum pannonicae* (SOÓ 1927) WENDELBERGER 1943 and the *Suaedetum salsae* from the Volga delta (GOLUB & TCHORBADZE 1995).

### Ecology and distribution

This association represents the final link in the phytocoenotic-ecological series of the *Thero-Salicornietea* communities of the Azov-Sivaš National Nature Park. In the Ukraine it occurs more frequently on loamy solonchaks of the seaside area (SOLOMAKHA & ŠELYAG-SOSONKO 1984). In comparison with the foregoing associations, these stands cover the highest and less compact levels in the investigated area. They occur frequently, but cover small area only. They

are typical for disturbed places. The groundwater level achieves 30-50 cm, the salt content in water solution  $\leq 2.0-2.5\%$ . For this association, places with changing salinization and desalinization are typical, the desalinization weakly prevails. These stands with a high phytomass production contribute to the desalinization of lands and increasing of chlorides in salt complex. In the further succession they are replaced by salt-meadows communities, mainly those of the class *Asteretea tripolium*.

## Discussion

Since the third decade of the 20<sup>th</sup> century attention was paid to the intensive studies on halophilous vegetation based on floristic-phytosociological characteristics (cf. e.g. SOÓ 1927, BRAUN-BLANQUET 1933). Later on, vegetation research on halophilous communities was linked mostly with the names of BEEFTINK (1966, 1978), GÉHU (1976, 1984, 1987, 1992), GÉHU & GÉHU-FRANCK (1979, 1982 etc.), PIGNATTI (1953) and RIVAS-MARTÍNEZ (1990). Frequent scientific colloquies organized mainly by J.-M. GÉHU contributed to the preparation of many volumes of the vegetation series Colloques Phytosociologiques and Documents Phytosociologiques, where the halophilous vegetation was frequently analyzed in detail. R. TÜXEN (1971-1973) in the series Bibliographia Phytosociologica Syntaxonomica devoted seven volumes to the salt vegetation, later on, MUCINA (1997) characterized ten classes of this vegetation. Large attention has been paid to the communities of the class *Thero-Salicornietea* (cf. TÜXEN & GÉHU-FRANCK 1972, GÉHU 1994), including vegetation units dominated by annual *Salicornia* species (GÉHU 1992, GÉHU & GÉHU-FRANCK 1992, LAHONDÈRE et al. 1992 etc.).

Communities of halophilous vegetation represent specific phytocoenotic-ecological units. The typical halophilous vegetation is relatively species-poor formed by taxa able to grow on strongly salinized soils. The strongly specialized halophilous vegetation is mostly formed by several species only. Thus, e.g. VICHEREK (1973) found in the ass. *Salicornietum prostratae* 2 species only in the individual relevés. GOLUB & TCHORBADZE (1995) recorded 1-3 species in relevés of the *Suaedo salsae-Salicornietum prostratae* from the area of 25 m<sup>2</sup>, and 2-4 taxa in relevés of the *Suaedetum salsae* from the areas of 35-100 m<sup>2</sup>. They proposed to distinguish the new alliance *Suaedion salsae* characterized by the non-nitrophilous *Suaeda*-species (*S. salsa*, *S. confusa*, *S. prostrata*) and annual *Salicornia prostrata*. According to them "the communities of this alliance are vicarious in relation to the West-European *Thero-Salicornion* BRAUN-BLANQUET 1933 em. TÜXEN 1950".

VICHEREK (1973) takes *Salicornia prostrata* for diagnostic species of the class *Thero-Salicornietea* and its lower syntaxa. The ass. *Salicornietum prostratae* belongs, according to him, to this class (order *Thero-Salicornietalia*, alliance *Thero-Salicornion*). On the basis of phytosociological syntheses of a large amount of relevés GÉHU (1992) divided the last-mentioned very large alliance *Thero-Salicornion* into four alliances: *Salicornion dolichostachyo-fragilis* GÉHU et GÉHU-FRANCK (1982) 1984 and *Salicornion europaeo-ramosissimae* GÉHU et

GÉHU-FRANCK 1984 in Atlantic area of Europe, *Salicornion patulae* including Mediterranean glaswort communities of lagoons and *Salicornion prostratae* (syn.: *Salicornion herbaceae* Soó 1933 p. max. p., *Salicornion*-Gruppe WENDELBERGER 1943 p.p.) with the nomenclatural type *Salicornietum prostratae* Soó (1927) 1964 ex VICHEREK 1973 comprizing SE-European vegetation of salt pans dominated by short-lived succulents, with diagnostic species *Salicornia prostrata*, *Suaeda maritima* ssp. *pannonica* and *Puccinellia distans* ssp. *limosa*. He described this alliance as follows: "Il s'agit de végétations thérophytiques crassulantes pionnières des sols salés des bassins salifères continentaux du Sud-Est européen". RODWELL et al. (2002) used the similar syntaxonomical classification of the *Thero-Salicornietea* communities. However, they use the *Thero-Salicornion* for all pioneer glaswort communities of tidal-mud flats on Atlantic shores and for Pannonian-Caspian vegetation of salt pans - *Salicornion herbaceae* (Soó 1933). However, the name *Salicornia herbacea* (= *Salicornia europaea* s. s. according to TUTIN et al. 1990) seems to be confusing: in contrast with *Salicornia prostrata* (typical species of the Pannonian-Caspian area of Europe), *Salicornia herbacea* does not characterize well the specificity of the SE-European area.

The SE-European communities dominated by *Salicornia*- or *Suaeda*-species are usually included into the alliances *Salicornion herbaceae* (Soó 1964), *Salicornion prostratae* (GÉHU 1992) or *Suaedion salsae* (GOLUB & TCHORBADZE 1995). The alliance *Salicornion prostratae* (Soó 1933) GÉHU 1992 is the first validly published name for this syntaxon. GOLUB & TCHORBADZE (1995) comprise in the *Suaedion salsae* phytocoenoses, which consist of annual species of the genus *Salicornia* and non-nitrophilous taxa of the genus *Suaeda*, being "vicarious in relation to the West-European *Thero-Salicornion* BR.-BL. 1933 em. R. Tx. 1950". If we accept the all *Salicornion prostratae* GÉHU 1992 for SE-European *Salsola*- and *Suaeda*-dominated communities, then the all. *Suaedion salsae* GOLUB & TCHORBADZE 1995 based on the diagnostic species *Salicornia prostrata*, *Suaeda salsa*, *S. prostrata*, *S. confusa* must be taken for synonym of the alliance *Salicornion prostratae*.

## Summary

In the Azov-Sivaš National Nature Park halophilous vegetation of the alliance *Salicornion prostratae* (Soó 1933) GÉHU 1992 has been studied. In this area, six associations have been distinguished (*Salicornietum prostratae*, *Limonio caspici-Salicornietum*, *Petrosimonia oppositifoliae-Salicornietum*, *Ofaisto monandri-Salicornietum*, *Suaedo maritimae-Salicornietum prostratae* and *Suaedetum salsae*) forming phytosociological-ecological series from the lowest to the highest, relatively rarely flooded levels. Their floristic composition can be seen in tab. 1-6. The *Ofaisto monandri-Salicornietum* has been described as a new syntaxon. All associations are characterized by their diagnostic species combination, structure and species composition, ecology and distribution.

The classification of the vegetation into higher syntaxa has been discussed. The SE-European communities dominated by *Salicornia*- or *Suaeda*-species

were included into the alliance *Salicornion prostratae* (SOÓ 1933) GÉHU 1992. The all. *Suaedion salsae* is taken for its synonym.

## References

- ARINUŠKINA E.V. (1970): Rukovodstvo po chimičeskomy analizu počv. [Guide on chemical analysis of soils]. – Izd. Mosk. Gosud. Univ., Moskva. [252 pp.]
- BEEFTINK W.G. (1966): Vegetation and habitat of the Salt marshes and beach plains in the south-western part of the Netherlands. – *Wentia* 15: 83-108.
- BEEFTINK W.G. (1968): Die Systematik der europäischen Salzpflanzengesellschaften. – In: TÜXEN R., *Pflanzensoziologische Systematik, Internat. Sympos. Stolzenau/Weser 1964*, p. 239-263, Den Haag.
- BEEFTINK W.G. (1978): The coastal salt marshes of Western and Northern Europe: an ecological and phytosociological approach. – In: CHAPMAN (ed.), *Wet coastal ecosystems*, p. 109-155, Amsterdam.
- BILYK G.I. (1940): Ekologični riady galofitnykh fitocenziv prymorskoji smugy URSR. [Ecological series of halophyte coenoses of the seaside belt of the URSR] – *Bot. Ž. AN URSR* 1/3-4: 325–331.
- BILYK G.I. (1941): Solončakovaja roslynnist' prymorskoji smugy URSR. [Solonchak vegetation of the seaside belt of the URSR]. – AN URSR, Kyjiv. [96 pp.]
- BILYK G.I. (1963): Roslynnyst zasolenyh gruntiv Ukrajinu. – AN URSR, Kyjiv. [299 pp.]
- BORHIDI A. (ed.) (1996): Critical revision of the Hungarian plant communities. – Pécs. [138 pp.]
- BRAUN-BLANQUET J. (1933): *Prodrome des groupements végétaux 1. Ammophiletalia et Salicornietalia méditer.* – Montpellier. [23 pp.]
- BRAUN-BLANQUET J. (1964): *Pflanzensoziologie*. 3. ed. – Wien, New York.
- BOLDENKOV V.S. (1987): Azovo-Sivaškoe zapovedno-ochotničje chozajstvo. – In: *Zapovedniki SSSR. Zapovedniki Ukrainy i Moldavii*, p. 177-185, Izd. Mysl', Moskva.
- DUBYNA D.V. (1999): Istorija organizacii i botaničnykh doslidzhen' Azovo-Sivaškogo Nacional'nogo Pryrodnogo Parku. [History of botanical-research organisation in the Azovo-Sivaš National Nature Park]. – *Ukr. Fitocenol. Zbirn., Ser. A*, 1-2: 142-149.
- DUBYNA D.V. & NEUHÁUSLOVÁ Z. (2000a): Salt meadows (*Festuco-Puccinellietea*) of the Birjučij Island Spits in the Azov Sea, Ukraine. – *Preslia* 72: 31-48.
- DUBYNA D.V. & NEUHÁUSLOVÁ Z. (2000b): Salt meadows of the Birjučij Island Spit, Azov Sea. Classes *Juncetea maritimi* and *Bolboschoenetea*. – *Acta Bot. Croat.* 59/1: 167-178.
- DUBYNA D.V., NEUHÁUSLOVÁ Z. & ŠELYAG-SOSONKO Yu.R. (1994): Coastal vegetation of the Birjučij Island Spit in the Azov Sea, Ukraine. – *Preslia* 66: 193-216.
- DUBYNA D.V., NEUHÁUSLOVÁ Z. & ŠELYAG-SOSONKO Yu.R. (1995): Vegetation of the Birjučij Island Spit in the Azov Sea. Sand steppe vegetation. – *Folia Geobot. Phytotax.* 30: 1-31.
- GÉHU J.-M. (1976): Approche phytosociologique synthétique de la végétation des vases salées du littoral atlantique français. – *Coll. Phytosociol.* 4, La végétation des vases salées (Lille 1975), p. 395-462.
- GÉHU J.-M. (1987): Réflexions et observations sur le classement des végétations halophiles européennes. – In: HUISKES, *Vegetation between land and sea*, p. 134-143, Dordrecht.
- GÉHU J.-M. (1992a): Les Salicornées annuelles d' Europe: système taxonomique et essai de clé de détermination. – *Coll. Phytosociol.* 18: 227-241.
- GÉHU J.-M. (1992b): Essai de typologie syntaxonomique des communautés européennes de Salicornes annuelles. – *Coll. Phytosociol.* 18: 243-260.

- GÉHU J.-M. et al. (1984): Essai synsystématique et synchronologique sur les végétations littorales italiennes dans un but conservatoire. I. Dunes et vases salées. – Docum. Phytosociol. 8 (Ser. n.): 393-474.
- GÉHU J.-M. & GÉHU-FRANCK J. (1984): Schéma synsystématique et synchronologique des végétations phanérogamiques halophiles françaises. – Docum. Phytosociol. 8 (Ser. n.): 51-70.
- GÉHU J.-M. & GÉHU-FRANCK J. (1985): Données synchronologiques sur la végétation littorale européenne. – Vegetatio 59/1-3: 73-83.
- GOLUB V.B. (1995): Halophytic desert and semi-desert plant communities on the territory of the former USSR. – Togliatti. [32 pp.]
- GOLUB V.B. & SOLOMAKHA V.A. (1987): Syntaksonomija klasu *Salicornietea fruticosae* galofitnoji roslynnosti Evropejskoji častyny SRSR. [Syntaxonomy of the halophilous vegetation of the class *Salicornietea fruticosae* of the European part of the USSR]. – Ukrayins'k. Bot. Zhurn. 44/6.
- GOLUB V.B. & SOLOMAKHA V.A. (1988): The higher units of the salt vegetation classification of the European part of the USSR. – Byull. Mosk. Obšč. Isp. Prir., Sect. Biol., 93/6: 80-92.
- GOLUB V.B. & TCHORBADZE N.B. (1989): The communities of the order *Halostachyetalia* Topa 1939 in the area of Western Substeppe Ilmens of the Volga Delta. – Folia Geobot. Phytotax. 24: 111-130.
- GOLUB V.B. & TCHORBADZE N.B. (1995): Vegetation communities of western substeppe ilmens of the Volga delta. – Phytocoenologia 25/4: 449-466.
- KORZENĚVSKIJ V.V. & KLJUKIN A.A. (1991): Vegetation description of mud volcanoes of Cremia. – Feddes Repert. 102/1-2: 137-150.
- KOTOV M.I. & PRJANIŠNIKOV A.V. (1937): Geobotaničnyj narys ostrova Birjučij v Azovs'komu mori. [Geobotanic study of the Birjučij Island Spit in the Azov Sea]. – Zhurn. Inst. Bot. Akad. Nauk USSR 13-14: 297-234.
- LAHONDÈRE CH., BOTINEAU M. & BOUZILLE J.-B. (1992): Les Salicornes annuelles du Centre-Ouest (Vendée, Charente-Maritime): Taxonomie, morphologie, phytosociologie, phytogéographie. – Coll. Phytosociol. (Berlin & Stuttgart) 18: 1-24.
- LANKO A.I. (1967): Privašsko-Azovskaja stepnaja oblast'. – In: Fiziko-geografičeskoe rajonirovanie Ukrainskoj SSR, p. 519-538, ed. Izd. Kiev. Univ., Kiev.
- LEVINA F.Ya. (1929): Materialy do vyvčennia roslynnosti nadsivaš'koji smugy Ukrajinny. [Materials for vegetation study of the Sivaš-near part of the Ukraine]. – In: Material doslidzhen' zemel'meliofondu Melitopol'shyny, Trudy Doslid. Kafedry gruntoznavstva, 2/1: 133-159, Kharkiv.
- LEVINA F.Ya. & ŠALYT M. (1927): Pro roslynnist' ostroviv Churjuk i Churjuk-Tiuba na Sivaši, Melitopol'. Okr. [On vegetation of the isle Churjuk i Churjuk-Tiuba in Syvash, Melitopol region]. – Okhor. Pamjiat. Pryr. Ukr. 1: 167-190, Kharkiv.
- LOSKOT N.P. (1974): Suchasnyj stan flory i roslynnosti o. Churjuka na Syvaši [Contemporary state of flora and vegetation of the isle Churjuk in the Syvash]. – Ukrayins'k. Bot. Zhurn. 30/4: 463-470.
- PIGNATTI S. (1953): Introduzione allo studio fitosociologico della Pianura Veneta orientale. – Arch. Bot. 29: 265-329.
- POPESCU A., SANDA V. & DOLTU M. (1980): Suspectul asociatiilor vegetale de pe nisipurile din Romania. – Stud. și Comun. (Sibiu) 1980: 149-314.
- RIVAS-MARTÍNEZ S. (1990): Sintaxonomia de la clase *Thero-Salicornietea* en Europa occidental. – Ecol. Medit. 16: 359-364.
- RODWELL J.S., SCHAMINÉE J.H.J., MUCINA L., PIGNATTI S., DRING J. & MOSS D. (2002): The Diversity of European Vegetation. An overview of phytosociological alliances and

- their relationships to EUNIS habitats. – Report EC-LNV, Nr. 2002/054, Wageningen. [168 pp.]
- SOLOMAKHA V.A. (1996): Syntaksonomija roslynnosti Ukrainy [Vegetation syntaxonomy of the Ukraine]. – Ukr. Fitocenol. Zbirn. 1996/4: 1-120.
- SOLOMAKHA V.A. & ŠELYAG-SOSONKO Ju.R. (1984): Florističeskaja klassifikacija galofil'noj rastitel'nosti Ukrainy [Floristic classification of halophilous vegetation of Ukraine]. – VINITI (UISTI), Nr. 5965-884. [29 pp.]
- SOLOMAKHA V.A., ŠELYAG-SOSONKO Ju.R., DIDUCH JA.P. et al. (1995): Fitosociologična schema syntaksoniv roslynnosti Ukrainy. [Phytosociological scheme of vegetation syntaxa of Ukraine]. – Inst. Bot. AN Ukrainy, Kyjiv. [52 pp.]
- Soó R. (1927): Geobotanische Monographie von Kolosvár (Klausenburg). – Mitt. Komm. Heimatkd. Wiss. Gr. Stefan Tisza Ges. 4 (1927-28): 1-151.
- Soó R. (1964): A Magyar flóra és vegetáció renszertani-növényföldrajzikézikönyve. 1. – Budapest.
- ŠALYT M.S. (1948): O rastitel'nosti Prisisvašja [On vegetation of Sivash Region]. –Byull. Mosk. Obšč. Isp. Prir., Sect. Biol., 53/6:1-53.
- ŠELYAG-SOSONKO Ju.R., GOLUB V.B. & SOLOMAKHA V.A. (1989): Syntaksonomia klasu *Salicornietea fruticosae* galofitnoji roslynnosti Evropejs'koji častyny SRSR [Syntaxonomy of the class *Salicornietea fruticosae* of halophyte vegetation of European part of the USSR]. – Ukrayins'k. Bot. Zhurn. 46/3: 5-10.
- ŠELYAG-SOSONKO Ju.R. & SOLOMAKHA V.A. (1987): Novi syntaksony galofil'noji roslynnosti Ukrajiny [New syntaxa of halophyte vegetation of the Ukraine]. – Ukrayins'k. Bot. Zhurn. 44/6: 13-17.
- The Red Data Book of Ukraine (Animal kingdom) (1994). – M.P. Bazhan Ukr. Encyclop., Kyiv. [456 pp.]
- TUTIN T.G. et al. (1990): Flora Europaea. Vol. 1. – Cambridge.
- TÜXEN R. & GÉHU-FRANCK J. (1972): *Thero-Salicornietea*. – In: TÜXEN J. (ed.), Bibliographia Phytosociologica Syntaxonomica 10: 1-44, Lehre.
- TÜXEN R. & OBERDORFER E. (1958): Eurosibirische Phanerogamengesellschaften Spaniens. – Veröff. Geobot. Inst. Rübel Zürich 32.
- VICHEREK J. (1971): Grundriss einer Systematik der Strandgesellschaften des Schwarzen Meeres. – Folia Geobot. Phytotax. 6: 127-145.
- VICHEREK J. (1973): Die Pflanzengesellschaften der Halophyten- und Subhalophytenvegetation der Tschechoslowakei. – Vegetace ČSSR, Ser. A, 5: 1-200.
- WEBER H.E., MORAVEC J. & THEURILLAT J.P. (2002): Mezinárodní kód fytocenologické nomenklatury. 3. vydání. – Zprávy. Čes. Bot. Společn. 37, Suppl. 2002/1 et Bull. Slov. Bot. Spoločn. 24/3: 1-80.
- WENDELBERGER G. (1943): Die Salzpflanzengesellschaften des Neusiedler Sees. – Wiener Bot. Z. 92: 124-144.

Received: 15 March 2003

Revised: 10 September 2003

Accepted: 10 September 2003

Tab. 1-6 on the pages 16-30.

Tab. 1. *Salicornietum prostratae*.

Relevé Nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	%
Island (abbreviation)	B	B	B	B	B	B	C	C	C	C	C	K	K	C	
Orientation	W	W	W	W	SW	SW	N	N	N	NE	SW	W	SW	N	
Inclination	1	1	1	1	1	1	<1	<1	<1	<1	<1	1	1	<1	
Area analyzed (m <sup>2</sup> )	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Total cover (%)	20	30	40	50	55	50	45	80	40	25	20	65	60	60	60
Number of species	4	7	9	9	9	9	8	5	8	5	7	12	14	14	17
<b>Diagn. ass. and higher syntaxa</b>															
<i>Salicornia prostrata</i> PALL.	2	3	3	4	4	4	2	4	2	2	2	4	4	2	100
<b>Diagn. Crithmo-Staticetea</b>															
<i>Limonium meyeri</i> (BOISS.) O. KUNTZE	.	+	+	.	1	1	.	.	+	.	.	+	+	+	57
<i>Lactuca tatarica</i> (L.) C. A. MEY.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	21
<b>Diagn. Thero-Suaedetea maritimae</b>															
<i>Suaeda salsa</i> (L.) PALL.	.	1	1	+	+	+	3	2	.	.	.	+	+	+	71
<i>Suaeda prostrata</i> PALL.	+	+	.	.	.	.	1	.	.	.	+	.	.	.	29
<b>Diagn. Asteretea tripolium</b>															
<i>Tripolium vulgare</i> NEES	.	.	+	+	+	+	+	.	.	.	.	.	.	.	36
<b>Diagn. Phragmiti-Magnocaricetea</b>															
<i>Phragmites australis</i> (CAV.) TRIN. ex STEUD.	.	.	.	+	+	+	+	.	.	.	.	.	.	+	29
<b>Diagn. Festuco-Puccinellietea</b>															
<i>Artemisia santonica</i> L.	.	.	.	.	.	+	.	.	.	.	.	1	1	+	29
<b>Other accompanying species</b>															
<i>Cynanchum acutum</i> L.	1	+	+	+	+	+	.	.	.	.	.	.	.	+	50
<i>Halimione pedunculata</i> (L.) AELL.	+	+	+	+	+	+	.	.	.	.	.	.	.	.	1
<i>Odontites salinus</i> (KOTOV) KOTOV	.	.	+	+	+	+	.	.	.	.	.	.	.	+	29



Relevé Nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	%
Island (abbreviation)	B	B	B	B	B	B	C	C	C	C	C	K	K	C	
Orientation	W	W	W	W	SW	SW	N	N	N	NE	SW	W	SW	N	
Inclination	1	1	1	1	1	1	<1	<1	<1	<1	<1	1	1	<1	
Area analyzed (m <sup>2</sup> )	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Total cover (%)	20	30	40	50	55	50	45	80	40	25	20	65	60	60	60
Number of species	4	7	9	9	9	9	8	5	8	5	7	12	14	17	17
<i>Limonium caspium</i> (WILLD.) GAMS	.	.	.	.	+	+	+	.	+	1	+	+	+	1	64
<i>Puccinellia syvaschica</i> BILYK	.	.	.	.	.	.	+	+	.	+	+	+	+	1	50
<i>Artemisia taurica</i> WILLD.	.	.	.	.	.	.	1	.	+	+	+	.	+	.	36
<i>Petrosimonia oppositifolia</i> (PALL.) LITV.	.	+	1	+	.	.	.	.	.	1	1	.	.	+	43
<i>Salsola soda</i> L.	.	.	.	.	.	.	.	2	3	.	.	+	1	3	36
<i>Juncus gerardii</i> LOISEL.	.	.	+	+	.	.	.	.	.	.	.	+	1	.	29
<i>Lepidium pumilum</i> BOISS. et BALL.	.	.	.	.	.	.	.	+	.	.	.	+	+	+	29
<i>Elytrigia elongata</i> (HOST) NEVSKI	.	.	.	.	.	.	.	.	+	.	.	1	+	+	29
<i>Plantago salsa</i> PALL.	.	.	.	.	.	.	.	.	.	.	+	+	+	1	29
<i>Halimione verrucifera</i> (BIEB.) AELL.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	21

**In one relevé only:** *Aeluropus litoralis* (GOUAN) PARL. (rel. 11.+); *Lepidium syvaschicum* KLEOP. (7.+).

**Explanations:** B - Birjučij Island Spit, C - Chuņuk Island, K - Kujuk-Tuk Island.

Tab. 2. *Limonio caspici-Salicornietum*.

Relevé Nr.	15	16	17	18	19	20	21	22	23	24	25	26	%
Island (abbreviation)	B	C	B	B	B	K	C	B	C	C	C	C	C
Orientation	NW	N	NW	NW	NW	NE	N	NW	N	NE	NE	NE	NE
Inclination	1	<1	1	1	1	<1	<1	1	<1	<1	<1	<1	<1
Area analyzed (m <sup>2</sup> )	100	100	100	100	100	100	100	100	100	100	100	100	100
Total cover (%)	70	60	70	60	60	50	60	70	50	50	55	50	50
Number of species	6	8	13	16	16	15	12	13	19	13	15	24	24
<b>Diagn. ass. and higher syntaxa</b>													
<i>Limonium caspium</i> (WILLD.) GAMS	5	5	5	5	5	3	4	5	2	3	4	2	100
<i>Salicornia prostrata</i> PALL.	3	4	4	5	5	4	4	2	4	3	3	3	100
<b>Diagn. Asteretea tripolium</b>													
<i>Tripolium vulgare</i> NEES	.	.	1	.	.	.	.	.	+	.	+	+	33
<i>Carex extensa</i> GOOD.	.	.	+	+	+	.	.	.	.	.	.	.	25
<b>Diagn. Crithmo-Staticea</b>													
<i>Limonium meyeri</i> (BOISS.) O. KUNTZE	.	.	+	+	+	.	+	2	+	+	+	.	67
<b>Diagn. Festuco-Puccinellietea</b>													
<i>Puccinellia forminii</i> BILYK	+	.	.	.	.	.	+	1	+	.	+	+	50
<b>Diagn. Salicornietea fruticosae</b>													
<i>Halocnemum strobilaceum</i> (PALL.) BIEB.	.	2	.	.	.	.	+	.	1	1	2	1	50
<b>Diagn. Thero-Salicornietea</b>													
<i>Suaeda salsa</i> (L.) PALL.	.	.	.	+	1	.	.	.	+	.	.	+	33
<b>Diagn. Thero-Suaedetea</b>													
<i>Suaeda prostrata</i> PALL.	.	.	.	.	.	.	.	.	1	+	.	+	25

Relevé Nr.	15	16	17	18	19	20	21	22	23	24	25	26	%
Island (abbreviation)	B	C	B	B	B	K	C	B	C	C	C	C	C
Orientation	NW	N	NW	NW	NW	NE	N	NW	N	NE	NE	NE	NE
Inclination	1	<1	1	1	1	<1	<1	1	<1	<1	<1	<1	<1
Area analyzed (m <sup>2</sup> )	100	100	100	100	100	100	100	100	100	100	100	100	100
Total cover (%)	70	60	70	60	60	50	60	70	50	50	55	50	50
Number of species	6	8	13	16	16	15	12	13	19	13	15	24	24
<b>Other accompanying species</b>													
<i>Halimione verrucifera</i> (BIEB.) AELL.	2	+	2	+	+	+	2	2	.	+	1	1	92
<i>Aeluropus litoralis</i> (SOUAN) PARL.	.	.	+	+	+	.	.	+	+	1	2	+	67
<i>Salsola soda</i> L.	.	.	.	.	+	2	.	+	+	+	1	1	58
<i>Artemisia santonica</i> L.	.	.	1	2	1	+	+	.	+	.	.	+	58
<i>Halimione pedunculata</i> (L.) AELL.	.	.	.	2	+	+	.	.	+	+	+	1	58
<i>Artemisia taurica</i> WILLD.	+	+	.	.	.	.	1	.	.	1	+	+	50
<i>Apera maritima</i> KLOK.	+	.	1	1	1	+	.	+	.	.	.	.	50
<i>Lepidium pumilum</i> BOISS. et BALL.	.	2	.	.	.	2	1	.	.	.	1	1	42
<i>Limonium suffruticosum</i> (L.) O. KUNTZE	.	+	.	.	.	.	.	.	1	+	+	1	42
<i>Agropyron lavrenkoanum</i> PROKUD.	.	.	+	+	+	.	+	+	.	.	.	.	42
<i>Plantago salsa</i> PALL.	.	.	.	1	+	+	.	.	+	.	.	+	42
<i>Elytrogia elongata</i> (HOST) NEVSKI	.	.	+	+	2	1	.	.	.	.	.	.	33
<i>Frankenia hispida</i> DC.	.	.	.	+	+	.	.	.	4	.	.	.	33
<i>Lepidium syvaschicum</i> KLEOP.	.	.	.	.	.	+	+	.	.	+	+	.	33
<i>Puccinellia syvaschica</i> BILYK	.	.	.	.	.	+	+	.	.	+	.	+	33
<i>Salsola laricina</i> PALL.	.	.	.	.	.	+	.	3	+	.	.	+	33
<i>Frankenia pulverulenta</i> L.	.	.	.	2	3	.	.	.	.	.	.	+	25

Relevé Nr.	15	16	17	18	19	20	21	22	23	24	25	26	%
Island (abbreviation)	B	C	B	B	B	K	C	B	C	C	C	C	
Orientation	NW	N	NW	NW	NW	NE	N	NW	N	NE	NE	NE	
Inclination	1	<1	1	1	1	<1	<1	1	<1	<1	<1	<1	
Area analyzed (m <sup>2</sup> )	100	100	100	100	100	100	100	100	100	100	100	100	
Total cover (%)	70	60	70	60	60	50	60	70	50	50	55	50	
Number of species	6	8	13	16	16	15	12	13	19	13	15	24	
<i>Petrosimonia oppositifolia</i> (PALL.) LITV.	.	.	.	.	.	.	.	+	1	.	.	1	25
<i>Lepidium latifolium</i> L.	.	.	+	.	.	.	.	.	.	.	.	.	17
<i>Limonium czurjukense</i> (KLOK.) LAVR. et KLOK.	.	.	.	.	.	.	.	.	+	.	.	+	17
<i>Artemisia pontica</i> L.	.	.	.	.	.	.	.	.	.	+	+	.	17

In one relevé only: *Bassia sedoides* (PALL.) ASCHERS. (rel.24:+); *Camphorosma monspeliaca* L. (15:+); *Cynanchum acutum* L. (15:+); *Elytiglia pseudocaeasia* (PACZ.) PROKUD. (20:+); *Juncus gerardii* LOISEL. (17:+); *Juncus maritimus* LAM. (16:+); *Spergularia marina* (L.) GRISEB. (23:+); *Puccinellia distans* (JACO.) PARL. (20:1).

Explanations: B - Birjučij Island Spit, C - Churjuk Island, K - Kujuk-Tuk Island.

**Tab. 3. *Petrosimonia oppositifoliae-Salicornietum*.**

Relevé Nr.	27	28	29	30	31	32	33	34	35	%
Island	B	B	B	B	K	C	C	C	C	
Orientation	W	W	W	W	S	NE	NE	NE	NE	
Inclination	1	1	1	1	<1	<1	<1	<1	<1	
Area analyzed (m <sup>2</sup> )	100	100	100	100	80	100	100	100	100	80
Total cover (%)	80	80	100	100	60	70	80	80	80	60
Number of species	13	13	12	11	8	17	14	14	14	9
<b>Diagn. ass. and higher syntaxa</b>										
<i>Salicornia prostrata</i> PALL.	3	3	4	4	3	1	4	4	3	100
<i>Petrosimonia oppositifolia</i> (PALL.) LITV.	1	2	3	2	1	+	+	+	1	100
<b>Diagn. Crithmo-Staticeae</b>										
<i>Limonium meyeri</i> (Boiss.) O. KUNTZE	+	2	+	+	+	1	1	1	+	100
<b>Diagn. Thero-Suaedetea maritimae</b>										
<i>Suaeda salsa</i> (L.) PALL.	+	+	+	+	.	+	+	+	.	78
<i>Suaeda prostrata</i> PALL.	+	.	.	.	.	1	1	1	+	56
<b>Diagn. Salicornietea fruticosae</b>										
<i>Halocnemum stobilaceum</i> (PALL.) BIEB.	.	.	.	.	.	+	+	+	1	44
<b>Diagn. Festuco-Puccinellietea</b>										
<i>Puccinellia foeniculifolia</i> BILYK	1	.	.	.	+	+	.	.	+	44
<i>Artemisia santonica</i> L.	.	.	.	.	.	.	+	+	.	22
<b>Diagn. Asteretea tripolium</b>										
<i>Tripollum vulgare</i> NEES	.	+	+	+	.	+	.	.	.	44
<b>Diagn. Crypsietea aculeatae</b>										
<i>Spergularia marina</i> (L.) GRISEB.	+	+	.	.	.	.	+	+	.	44

Relevé Nr.	27	28	29	30	31	32	33	34	35	%
Island	B	B	B	B	K	C	C	C	C	
Orientation	W	W	W	W	S	NE	NE	NE	NE	
Inclination	1	1	1	1	<1	<1	<1	<1	<1	
Area analyzed (m <sup>2</sup> )	100	100	100	100	80	100	100	100	100	80
Total cover (%)	80	80	100	100	60	70	80	80	80	60
Number of species	13	13	12	11	8	17	14	14	9	
<b>Other accompanying species</b>										
<i>Halimione pedunculata</i> (L.) AELL.	+	+	+	+	2	+	4	4	2	100
<i>Halimione verticifera</i> (BIEB.) AELL.	+	+	+	1	.	.	1	1	.	67
<i>Puccinellia syvaschica</i> BILYK	+	.	.	.	+	+	1	1	+	67
<i>Limonium caspium</i> (WILLD.) GAMS	.	+	+	+	+	+	.	.	.	56
<i>Salsola laricina</i> PALL.	.	+	+	+	.	.	+	+	.	56
<i>Melilotus albus</i> MEDIK.	2	+	+	.	.	+	.	.	.	44
<i>Apera maritima</i> KLOK.	2	+	.	.	.	3	.	.	.	33
<i>Gypsophila perfoliata</i> L.	.	+	2	+	.	.	.	.	.	33
<i>Cynanchum acutum</i> L.	.	.	+	+	.	1	.	.	.	33
<i>Atriplex littoralis</i> L.	+	.	.	.	.	+	.	.	.	22
<i>Lepidium pumilum</i> BOISS. et BALL.	.	.	.	.	+	.	.	.	+	22
<i>Lepidium syvaschicum</i> KLEOP.	.	.	.	.	.	.	+	+	.	22
<i>Suaeda baccifera</i> PALL.	.	.	.	.	.	.	+	+	.	22

In one relevé only: *Aeluropus littoralis* (GOUAN) PARL. (rel.32:1); *Atriplex tatarica* L. (32:1).

Explanations: B - Birjučij Island Spit, C - Churjuk Island, K - Kujuk-Tuk Island.

Tab. 4. *Ofaisto monandri-Salicornietum*.

Relevé Nr.	36	37	38	39	40	41	42	43	44	45	46	47	48	49	%
Island	C	C	C	C	C	C	C	C	C	C	C	C	C	K	C
Orientation	N	NE	E	E	N	N	N	NE	N	N	N	N	N	N	E
Inclination	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Area analyzed (m <sup>2</sup> )	40	50	60	50	50	60	40	30	30	40	50	50	50	40	40
Total cover (%)	40	40	45	40	30	30	30	30	40	30	25	25	30	25	25
Number of species	16	9	9	7	12	10	7	6	6	6	16	16	18	15	15
<b>Diagn. ass. and higher syntaxa</b>															
<i>Salicornia prostrata</i> PALL.	3	3	3	3	2	2	2	1	2	2	1	1	1	1	100
<i>Ofaiston monandrum</i> (PALL.) MOQ.	1	1	1	1	1	1	3	3	3	3	2	2	1	1	100
<b>Diagn. Thero-Suaedetea maritimae</b>															
<i>Suaeda salsa</i> (L.) PALL.	1	.	.	.	1	1	+	.	+	+	+	+	+	+	71
<i>Suaeda prostrata</i> PALL.	.	.	.	.	.	.	.	+	.	.	+	1	+	+	36
<b>Diagn. Crithmo-Staticetea</b>															
<i>Limonium meyeri</i> (BOISS.) O. KUNTZE	+	+	1	1	.	.	.	.	.	.	+	+	+	+	57
<b>Diagn. Salicornietea fruticosae</b>															
<i>Halobnemum strobilaceum</i> (PALL.) BIEB.	.	2	1	1	.	.	1	.	.	1	.	.	.	2	43
<b>Other accompanying species</b>															
<i>Puccinellia fominii</i> BILYK	1	1	2	.	1	1	.	.	2	.	2	1	2	2	71
<i>Pholurus pannonicus</i> (HOST) TRIN.	.	.	.	.	1	1	+	+	+	+	+	+	+	+	71
<i>Limonium caspium</i> (WILLD.) GAMS	1	+	+	+	.	+	.	.	.	.	+	+	+	+	64
<i>Frankenia hispida</i> DC.	.	1	.	.	.	+	.	+	.	.	+	1	+	1	57
<i>Artemisia santonica</i> L.	+	.	+	.	.	.	.	.	.	.	+	1	+	+	43
<i>Halimione verrucifera</i> (BIEB.) AELL.	.	1	.	.	.	.	+	.	.	+	2	.	1	2	43
<i>Salsola larcina</i> PALL.	.	.	.	.	1	.	.	.	.	.	1	1	1	+	36

