Salt meadows of the Birjučij Island Spit, Azov Sea. Classes *Juncetea maritimi* and *Bolboschoenetea maritimi*

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Phytosociological and ecological characteristics of four salt meadow associations from the classes *Juncetea maritimi* and *Bolboschoenetea maritimi* of the Birjučij Island Spit (Azov Sea, Ukraine) are discussed. Two new syntaxa, the *Artemisio santonicae-Juncetum maritimi* and the *Tripolio pannonici-Carice-tum extensae*, have been described from the area, together with two previously described syntaxa, the *Plantaginii salsae-Juncetum maritimi* and *Tripolii vulgaris-Bolboschoenetum maritimi*.

**Key words:** *Juncetea maritimi*, *Bolboschoenetea maritimi*, phytosociology, plant ecology, Ukraine

**Introduction**

The results of phytosociological investigations into wet or waterlogged salt meadows belonging to the classes *Juncetea maritimi* and *Bolboschoenetea maritimi* are summarized in this paper. This vegetation was studied by Ukrainian and Czech geobotanists in 1991 and completed during recent Ukrainian research.

The area analyzed was a narrow spit in the NW part of the Azov Sea (Fig. 1), occasionally isolated from the mainland by high floods (for a description of the general characteristics of this area see DUBYNA et al. 1994). It was the centre of several botanical expeditions and intensive vegetation research in the 1980s and the beginning of the 1990s. The results of these investigations have been gradually published. In the foregoing studies attention was paid to coastal vegetation, sand steppes (DUBYNA et al. 1994, 1995) and salt meadows of the class *Festuco-Puccinellietea* (DUBYNA and NEUHÄUSLOVÁ 2000).

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Fig. 1. Birjučij Island Spit. 1-Transects analyzed (from SW to NE), 2-Dunes, 3-Inlets, 4- Paths

Methods

The investigations were performed on transects running from NW to SE across the Spit. Relevés were analyzed and synthesized according to the principles of the Braun-Blanquet School (Braun-Blanquet 1964).

Taxonomic nomenclature follows Dobročaeva et al. (1987). Names of syntaxa follow the Code of Phytosociological Nomenclature (Barkman et al. 1986). Vegetation units distinguished in this area have been compared with analogous syntaxa from adjoining or other European states (see References).

Location of the relevés

*Artemisio santonicae-Juncetum maritimi* - Birjučij Island Spit, profiles 1, 4–8, 20–30 m from the Utljuk Liman (Tab. 1).

*Plantaginii saldae-Juncetum maritimi* - Birjučij Island Spit, profiles 4–8, 10–20 cm from the Utljuk Liman (Tab. 2).

*Tripolio pannonici-Caricetum extensae* - Birjučij Island Spit, profiles 3–6, depressions of the plains close to the Utljuk Liman (Tab. 3).

*Tripolio vulgaris-Bolboschoenetum maritimi* - Birjučij Island Spit, profiles 1–8, N part of the area near the Utljuk Liman (Tab. 4).
Results

Characteristics of the syntaxonomical units

Class: *Juncetea maritimi* Braun-Blanquet et al. 1952 em. Beefting 1965. South European moist to wet coastal meadows on weakly to moderately salinized soils


Alliance: *Limonio gmelinii-Juncion maritimi* Golub et V. Solomacha ex Dubyna et Neuhäuslová all. nova hoc loco.


Note: Since the alliance mentioned above was based on the invalidly described association *Juncetum maritimi* V. (Solomacha and Šeljag 1984), it was necessary to validate it here.

Association: *Artemisio santonicae-Juncetum maritimi* Šeljag-Sosonko, Neuhäuslová et Dubyna ass. nova hoc loco (Tab. 1, rels. 1–15).

**Tab. 1. The Artemisio santonicae-Juncetum maritimi association**

<table>
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<tr>
<th>Relevé Nr.</th>
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D *Juncetea maritimi* and lower syntaxa

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<th>Juncus maritimus Lam.</th>
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<td>+</td>
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<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>40</td>
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<td>2</td>
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<td>2</td>
<td>2</td>
<td>27</td>
</tr>
</tbody>
</table>

D *Festuco-Puccinellietea* and lower syntaxa

| Artemisia santonica L. | + | 1 | + | + | + | 2 | + | + | + | + | + | + | + | 100 |
|------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aegopopus linosius (Gouan) Parl. | 1 | + | + | + | 1 | + | + | + | + | 1 | + | + | + | + | 80 |
| Puccinellia gigantea (Grossh.) Grossh. | 1 | 1 | 1 | + | + | + | + | + | + | + | + | + | + | + | + | 80 |
| Juncus gerardi Lois. | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | 73 |
| Limonium meyeri (Boiss.) O. Kuntze | + | + | + | + | + | + | + | + | + | 1 | + | + | + | + | + | 53 |
| Tripolium vulgare Nees. | 2 | + | + | 2 | + | 1 | + | 2 | + | 2 | + | 2 | + | 2 | + | 53 |
| Triglochin maritimum L. | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | 40 |
| Apera maritima Klokov | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | 40 |
| Taraxacum bessarabicum (Hornem.) Hand.-Mozz. | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | 20 |
| Plantago salsa Pall. | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | 20 |

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One relevé only: Calystegia sepium (L.) R.Br. (rel. 9; +), Lactuca tatarica (L.) C.A.Mey. (15; +).

Nomenclatural type: Tab. 1, rel. 6 (holotypus). Location: Birjučić Island Spit, transect 5, 30 m from the Utljuk Liman. Dubyna, September 1991.

Diagnostic species combination: Juncus maritimus, Aeluropus littoralis, Agrostis maemotica, Artemisia santonica, Atriplex littoralis, Halimione pedunculata, Juncus gerardii, Puccinellia gigantea, Suaeda prostrata.

Structure and floristic composition

This association is represented by dense stands dominated by Juncus maritimus together with a number of species characteristic of salt meadow and solonchak vegetation. Individual relevés contain 10–19 species. The total number of species in the stands analyzed was 32. Some stands are poor in species, a number are almost monospecific.

Habitat, distribution

Stands dominated by Juncus maritimus are quite typical of the investigated area. They are confined to depressions in level plains that are flooded for medium or long periods of time. The salinized soils are shelly-clay. Frequently, these phytocenoses represent ecological relics in areas flooded for a short time. The stands are relatively resistant to mowing, but become degraded under regimes of repeated harvesting. Where this takes place, the regradation of solonchaks and penetration of solonchak elements can be observed.
Economic importance

This association plays an important part in soil-fixing and coastal protection. In its early stage of development, the dominant species serves as wildlife fodder. The dense tussocks of *Juncus maritimus* are relatively impervious to the negative influence of trampling that is so obvious in other salt meadow communities, such as stands dominated by *Puccinellia gigantea* or *Bolboschoenus maritimus*. These dense *Juncus* stands provide habitat and/or shelter of numerous invertebrate colonies, and of small mammals. Drier sites serve as nesting areas for birds.

**Association:** *Plantaginí salsae-Juncetum maritimi* Šeljag-Sosonko et V. Solomacha 1987 (Tab. 2, rel. 16–25)

**Tab. 2.** The *Plantaginí salsae-Juncetum maritimi* association

<table>
<thead>
<tr>
<th>Relevé Nr.</th>
<th>16</th>
<th>17</th>
<th>18</th>
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<td>100</td>
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<td></td>
</tr>
</tbody>
</table>

**D ass.**

*Juncus maritimus* Lam. 4 4 4 4 4 4 4 4 3 3 100

*Plantago salsae* Pall. 2 1 2 3 2 2 2 2 3 3 100

*Suaza prostrata* Pall. + 1 1 2 + + + + 1 + 100

*Carex extenso* Good. + + + + 2 2 + 2 1 70

*Agrastis maenotica* Klokov 2 + + + + + + + 30

**D Festuco-Puccinellietea and lower syntaxa**

*Puccinellia gigantea* (Grossh.) Grossh. 1 + 2 + + + + + + + 70

*Tripolium volgare* Nees 1 + + + + + + + 60

*Limonium mayeri* (Boiss.) Kuntze + + + + + 1 + 40

*Aeluropus littoralis* (Gouan) Parl. + + + + + + + 40

*Glaux marítima* L. + + + + + + + 30

**D Bolboschoenetea maritimi and lower syntaxa**

*Bolboschoenus maritimus* (L.) Polio + 1 1 1 + + + 40

**Other accompanying species**

*Salicornia perennans* Willd. + + + + + + + + + 60

*Phragmites australis* (Cav.) Trin. et Steudel + 1 + + 1 + + + + + + + + + 60

*Limonium caspium* (Willd.) Gams 2 + + + + + + + 40

*Aegrotis stolonifera* L. + + + + + + + 30

*Atropila prostrata* Bouchier + + + + + + + 30

*Spergularia marina* (L.) Griseb. + + + + + + + 20

*Halimione verrucosa* (Bieb.) Aelli 1 + + + + 1 + 20

*Halimione pedunculata* (L.) Aelli + + + + + + 20


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Diagnostic species combination: Juncus maritimus, Agrostis maetica, Carex extensa, Plantago salsa, Puccinellia gigantea, Suaeda prostrata

Structure and species composition

Well-developed stands of this association are dominated by dense tussocks of Juncus maritimus. Stands are poor in species (8–15 species in the individual relevés). The total number of species in ten stands was 27. In comparison with the foregoing association, the species Plantago salsa, Carex extensa and Phragmites australis are frequent here, while Aeluropus littoralis, Artemisia santonica, Juncus gerardi, Triglochin maritimum and Halimione pedunculata are missing or relatively rare.

Habitat, distribution

Although the ecology of these stands is rather similar to that of the foregoing unit, the stands are frequently flooded for long periods. Such stands are relatively frequent in the area investigated.

Association: Tripolio pannonici-Caricetum extensae ass. nova hoc loco (Tab. 3, rels. 26–35)


Diagnostic species combination: Carex extensa, Atriplex littoralis, Bolboschoenus maritimus, Limonium meyeri, Tripolium pannonicum.

Structure and species composition

This association is dominated by Carex extensa, which forms dense populations of up to 1m in diameter. In these stands, species of wet salt meadows and those of other moist or wet sites, such as Agrostis stolonifera, Atriplex littoralis, Bolboschoenus maritimus, Tripolium pannonicum and Juncus maritimus, occur in abundance. The total number of species recorded in these stands was 26. Species numbers in individual stands varied from 9 to 14. In some places the stands are monospecific and formed solely by Carex extensa. Phytocoenoses occuring in depressions among dunes represent the ecological limits of this unit, and differ from typical stands in having denser cover and richness in species of typical and salt meadows.

Habitat, distribution

While the stands of this association are relatively common on the Spit, they are confined to relatively restricted areas (depressions in the plains) in the environs of Liman, where prolonged flooding is a feature. Less frequently, they occur in depressions between the dunes. They are confined to shelly-sandy soils with clay layers. The groundwater level fluctuates between 20 and 50 cm. The species Carex extensa is a good indicator of brackish water.
### Tab. 3. The Tripolion pannonici-Caricetum extensae association

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<tr>
<th>Relevé Nr.</th>
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</tbody>
</table>

**D Juncetea maritimi and lower syntaxa**

*Carex extensa* Good.

Triplontium pannonicum (Jacek.) Dobrocz. 3 3 3 3 3 3 3 2 2 100 60 30

*Juncus maritimus* L.

**D Bulboschoenetae maritimi**

*Bulboschoenus maritimus* (L.) Pol.

**D Festuco-Puccinellietea and lower syntaxa**

*Limonium meyeri* (Boiss.) O. Kuntze + 1 + 2 2 + + 70

*Puccinella gigantea* (Grassh.) Grossh. + + + + + + 60

*Tripolium vulgare* Nees. + + + 1 1 2 2 50

*Artemisia santonica* L. + + + 1 1 + + 50

*Glaux maritima* L. + + + + . . 40

*Elýtrigia elongata* (Host) Nevers + + + + + + 40

*Apera roritima* Klokov + + + + + + 30

*Aeluropus littoralis* (Gonan) Port + + + + + + 30

*Plantago salsa* Poll. + + + 2 2 20

Other accompanying species

*Artplex littoralis* L. + + + + + + + 70

*Agratis stolonifera* L. . + 3 + + 3 + 60

*Salicornia perennis* Willd. + + + + + + 60

*Lectucata tatarica* (L.) C.A.Mey. + + + + + + 30

*Althaea officinalis* L. + + + + + + 30

*Leptium lanfolium* L. . + + + 2 . 30

*Poa angustifolia* L. . + + + + + + 30

*Suaeda prostrata* Poll. 1 + + + + + + 20

*Spergularia marina* (L.) Grieseb. + + + + + + 20

*Althaea officinalis* L. + + + + + + 20

*Cynanchum acutum* L. . + + + + + + 20

*Limonium caspium* (Willd.) Gams . + + + + + + 20

In one relevé only: *Juncus gerardii* Loisel. (rel.33: +), *Phragmites australis* (Cav.) Trin. ex Steud. (32: 1).

**Economic importance**

The stands of *Carex extensa* play an important part in the economy of the Spit. In addition to their shore- and soil-protecting functions they are of great importance in providing wildlife fodder. In the early stage of development, *Carex extensa* serves as food for domestic animals (BILYK 1963). Under intensive graz-
ing this species disappears. The stands of Carex extensa harbour many small invertebrates, birds and mammals.


Order: Bolboschoenetalia maritimi Hejny in Holub et al. 1967. Reed communities of brackish and alkaline waters

Alliance: Scirpion maritimi Dahl et Hadač 1941. Reed communities of brackish and alkaline waters with fluctuating water level

Association: Tripolio vulgaris-Bolboschoenetum maritimi Šeljag-Sosonko et V. Solomacha 1987

Original diagnosis: Šeljag-Sosonko and V. Solomacha (1987: 16)


Structure and species composition

The stands of this association are formed by a well-developed herb layer differentiated in three sub-layers. The upper sub-layer determining the physiognomy of the stands is dominated by Bolboschoenus maritimus, which grows to heights ranging from 100 cm to 120 cm. Cover of B. maritimus is usually moderately dense. Stands are relatively poor in species (9 to 15 species per relevé). Species of the family Cyperaceae, the grasses Elytrigia elongata, E. repens, Phragmites australis and Puccinellia gigantea, together with Juncus maritimus are frequent in this sub-layer. In the middle sub-layer (c. 40 cm to 60 [70] cm high) species of the Chenopodiaceae (Atriplex littoralis, Suaeda prostrata, Salicornia perennans, Salsola soda) together with Tripolium vulgare, which is occasionally sub-dominant, the grasses Agrostis stolonifera, Aeluropus littoralis, and Lepidium latifolium determine the physiognomy. The lowermost sub-layer, which does not exceed 30 cm, is only weakly developed and formed mainly by Spergularia marina or Ambrosia artemisifolia. Since Bolboschoenus maritimus is regularly grazed by deer or horned cattle, phytocoenoses of this association are often markedly disturbed and frequently represented by species-poor stands where the dominant B. maritimus is associated with sporadic occurrences of Calamagrostis epigeios, Aeluropus littoralis, Agrostis stolonifera, Elytrigia repens and Phragmites australis. Some stands are formed only by the dominant species.

Habitat, distribution

This association belongs to the rare syntaxa on the Spit. It is mainly found on clay-sandy sediments in the coastal zone that is permanently flooded by 30 cm to 40 cm of water. It occurs more frequently on plains that are flooded for prolonged periods and sporadically on sites that are flooded for short periods.
Tab. 4. The Tripolio vulgaris-Bolboschoenetum maritimi association

<table>
<thead>
<tr>
<th>Relevé Nr.</th>
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<th>37</th>
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D ass.

Bolboschoenus maritimus (L.) Palis
Tripodiun vulgaris Nees

D Festuco-Puccinellietea and lower syntaxa

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</table>

D Juncetae maritimti

Juncus maritimus Lam

Other accompanying species

Suaeda prostrata Pall.
Salicornia perennis Wild.
Spergularia marina (L.) Griseb.
Halimium pedunculatum (L.) Aell.
Lepidium anfractum L.
Agrostis stomionefia L.
Elytrigia repens (L.) Neve.
Calaragrostis argypheus (L.) Roth
Anagallis litoralis L.
Phragmites australis (Common) Trin.
Carex australis (Carex) Bohn.
Cynodon ciliarum L.
Ambrosia artimisiifolia L.

In one releve only: Halimione veruchicora (Blieb.) Aell. (40; +), Halocnemum strobilei (Pall.) Bieb. (39; +), Plantago cornutu Gouan (40; +), P. sejusa Pall. (43; +), Salsola soda L. (40; +).

Economic importance

Phytocoenoses of this association play an important role on the Spit: Bolboschoenus maritimus contributes to shore and soil protection, colonizing newly forming sites in the shallow waters of the coastal zone. In addition to this protecting function, stands of Bolboschoenus maritimus are of considerable importance as a fodder source for deer and cattle and as a refuge for many small animals (rodents, birds and invertebrates). In sites that are sheltered from strong winds these stands provide nesting sites for some water birds.
Discussion

Although communities of the Juncetea maritimi and Bolboschoenetea maritimi have been relatively frequently studied both in the (sub)Atlantic area of Europe (cf. Tüxen 1971, 1973, Schaminée et al. 1998) and in (sub)continental SE Europe (cf. Bilyk 1937, 1963, Golub et Solomacha 1988, Soloměšč et al. 1988, Solomacha et al. 1995, Solomacha 1996, Soô 1968, Vícherek 1971), there are still many places where new syntaxa of these classes can be found, for example on geographically isolated islands and spits.

Some eponymous species forming wet or waterlogged salt meadows in the Birjučij Island Spit, also occur frequently in vegetation units of W Central, W and SW Europe, for example Bolboschoenus maritimus, Carex extensa and Juncus maritimus. However, the total floristic composition of these mostly (sub)Atlantic communities is markedly different. So for example, Carex extensa is a diagnostic species of the Junco-Caricetum extensae Braun-Blanquet et De Leeuw 1936 or the Juncus maritimus-Carex extensa community Bolos et al. 1970 (cf. Tüxen 1973). The Pontic-Pannonian species typical of the Ukrainian Tripolio pannonici-Caricetum extensae are missing there. On the contrary, many elements of W European communities do not occur in the Ukrainian stands (e.g. Carex punctata, Parapholis strigosa, Armeria maritima, Blysmus rufus, etc.).

Soô (1957), in his survey of Pannonian vegetation, described the Bolboschoenetum maritimi continentale (invalid name!) from SE Europe as a unit analogous to W European communities dominated by Bolboschoenus maritimus. Vícherek (1973) has analyzed the differences from analogous W European stands: occurrence of species of Irano-Turanian salt steppes and semi-deserts, such as Halimione verrucifera and Limonium caspium, and the presence of many, mostly E Mediterranean halophytes, such as Aeluropus littoralis, Salicornia perennans and Suaeda prostrata typifying the SE European stands. In the area investigated, these species occur in salt communities of several classes, for example the Bolboschoeneteta, Junceta maritimi, Festuco-Puccinellietea and Salicornietea fruticosae. The floristic and ecological differences between the Ukrainian and W European Bolboschoenus communities show, that the inclusion of all these communities in the single alliance Scirpion maritimi Dahl et Hadač 1941 is very problematic. However, the classification of higher syntaxa should await a large pan-European synthesis.

Summary

Salt meadows from the classes Juncetea maritimi and Bolboschoenetea maritimi have been described from the Birjučij Island Spit, South Ukraine. Four associations have been distinguished:

1. Artemisio santonicae-Juncetum maritimi Šejlag-Sosonko, Neuhauslová et Dubyna in Dubyna et Neuhauslová, covering plain depressions near the Utljuk Liman, which are flooded for medium to long periods.
2. *Plantaginì salsae-Juncetum maritimi* V. Solomacha in Šeljag-Sosonko et V. Solomacha 1987 on relatively similar habitats, which are flooded for long periods.

3. *Tripolio pannonici-Caricetum extensae* Dubyna et Neuhauslová, dominated by *Carex extensa*, with a frequent occurrence of *Tripolium pannonicum* on shelly-sandy soils with prolonged floods.

4. *Tripolio vulgaris-Bolboschoenetum maritimi* Šeljag-Sosonko et V. Solomacha 1987, dominated by *Bolboschoenus maritimus*, on clay-sandy sediments in the coastal zone that are permanently flooded.

The classification of higher syntaxa (alliances to classes) needs revision on the basis of a pan-European synthesis.

**References**


