Salt meadows (*Festuco-Puccinellietea*) of the Biryuchij Island Spit in the Azov Sea, Ukraine

Slané louky třídy *Festuco-Puccinellietea* mořské kosy Ostrov Birjučij v Azovském moři, Ukrajina

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Dedicated to Jiří Vicherek on the occasion of his 70th birthday

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Phytosociological and ecological characteristics of salt meadows (class *Festuco-Puccinellietea*) of the Biryuchij Island Spit (Azov Sea, Ukraine) are given. The following associations have been studied in detail: (1) *Plantagini salsae-Juncetum gerardii*, on temporarily waterlogged solonchak-like soils in narrow depressions with relatively low calcium content. (2) *Scorzonero parviflorae-Taraxacetum bessarabici* influenced by grazing and trampling, in shallow depressions with relatively low salt content. (3) *Artemisio santonicae-Elytrigietum elongatae* in mown sites, covering moderate elevations behind the coastal ridge, with calcium-rich, temporarily drying out soils. (4) *Tripolio vulgaris-Aeluropetum littoralis* occurs on moister soils of lower positions, moderately to highly saline; two subassociations were recorded. (5) *Puccinellietum giganteae* occurs on soils with different degrees of salinization and different texture, with an ecological optimum in temporarily flooded sites of degraded solonchaks. *Plantagini salsae-Juncetum gerardii, Scorzonero parviflorae-Taraxacetum bessarabici, Artemisio santonicae-Elytrigietum elongatae* and *Tripolio vulgaris-Aeluropetum littoralis* are described as new associations in the present paper.

Keywords: Halophytic vegetation, vegetation classification, phytosociology, ecology, economic importance

Introduction

This paper represents the third contribution devoted to the vegetation cover of the Biryuchij Island Spit in the NW part of the Azov Sea (Dubyna et al. 1994, 1995). It summarizes the results of phytosociological and ecological investigations of salt meadows of the class *Festuco-Puccinellietea* obtained by Ukrainian and Czech geobotanists in 1991 and completed by recent Ukrainian studies.

Salt meadows include communities which are inundated for short periods of time by sea water. Flooding is the most important factor differentiating salt meadows from sand-steppe communities of the class *Festucetea vaginatae*, which are not inundated by the sea. From the floristic point of view, salt meadows are characterized by a more or less regular occurrence of species confined to very saline soils.

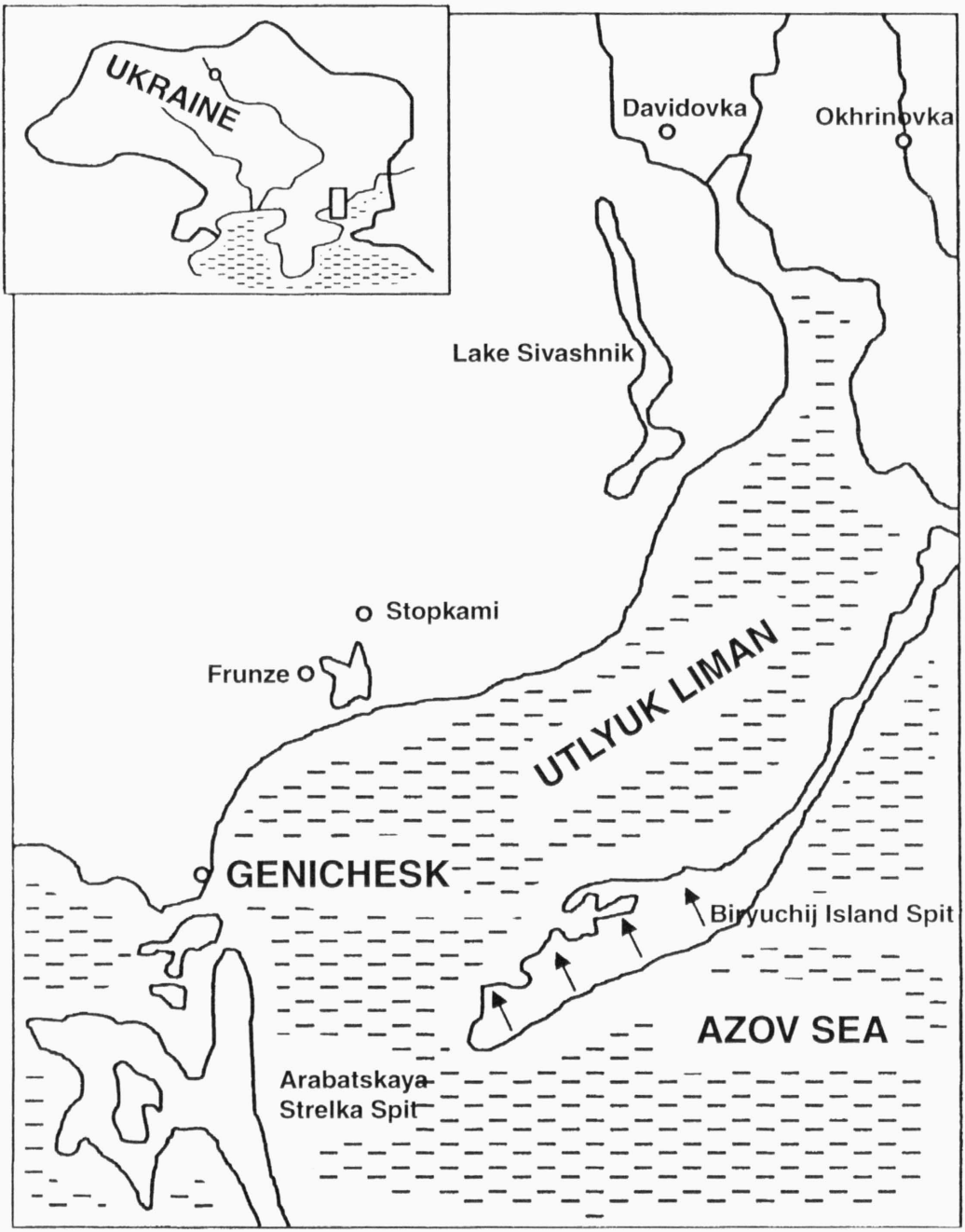

Fig. 1. – Map of the study area. The direction of sampling transects is indicated by arrows. Originally published in Folia Geobotanica & Phytotaxonomica 30: 3, 1995.

Study area

The so called "Biryuchij Island" is a narrow, 40 km long and 3–5 km broad spit in the NW part of the Azov Sea (Fig. 1). It is a peninsula temporarily separated at its lowest NW part from the mainland by high floods. The basic geological bedrock is formed by Upper Pliocene sand-loamy deposits covering Pontic limestones. In the area near Sivash, these Pliocene deposits are covered by loess and loess loams as well as by 25–50 m deep marine and lacustrine loamy, clayey and sand-shelly sediments.

The area belongs to the lowest part of the southern steppe subzone. The altitudes along the Sivash and on the shores of the Azov Sea reaches only 5–10 m. Sandy dunes on the southern shore of the Biryuchij are only 1.5–5 m high; the NW part of the territory washed by the Utlyuk Liman is very flat, divided into many shallow inlets.

The region has continental climate, characterized by the mean annual temperature 9–10 °C, mean June temperature 20–24 °C (maximum 38–40 °C), mean January temperature above –3 °C, occassional very hard frosts (up to –34 °C), snow cover 30–40 days, frostless period 120–200 days. Annual precipitation is rather low (300–350 mm).

Various soil types are present: non-stabilized or stabilized sands with open psammophilous vegetation, primitive sand-shelly chestnut-coloured sand-steppe and salt-meadows soils, chestnut-coloured meadow soils (mostly with *Elytrigia elongata*- or *Cynodon dactylon*-stands), swampy meadow carbonate soils (mainly with *Phragmites australis*- or *Juncus gerardii*-stands), and solonchaks (Dzens-Litovskaya 1951, Vernander et al. 1951).

Methods

The phytosociological relevés were recorded by D. V. Dubyna, partly together with Z. Neuhäuslová, in plots 60–100 m^2 in size, located on transects running in S-N direction (Fig. 1). Braun-Blanquet approach was used to classify the vegetation (Braun-Blanquet 1964). The vegetation units distinguished in the investigated area were compared with analogous vegetation from other parts of the Ukraine, Russia and Romania (Solomakha 1996, Solomakha et al. 1995, Solomeshch et al. 1988, Vicherek 1971, Hanganu et al. 1994).

Nomenclature of higher plants follows Prokudin (1987), partly also Shishkin (1936). Names of syntaxa follow the Code of the Phytosociological Nomenclature (Barkman et al. 1986).

The content of mineral nitrogen in the soil was determined by means of ionoselective electrode, that of carbonates by complexometric titration with fluoreson as an indicator. SO_4 content was determined by gravimetric method, pH according to Kappen (Arinushkina 1970, Gorodnij et al. 1995).

Overview of vegetation units

Class: *Festuco-Puccinellietea* Soó 1968 [natural salt meadows in the steppe and forest-steppe area of SE Europe]
Order: *Scorzonero-Juncetalia gerardii* Vicherek 1973
[natural, obligatory halophytic communities of salt meadows in the Pontic-Pannonian region]
Alliance: *Scorzonero-Juncion gerardii* (Wendelberger 1943) Vicherek 1973
[natural, halophytic communities of salt meadows on clay to loamy, alkaline soils, periodically flooded]
Suballiance: *Scorzonero-Juncenion gerardii* Golub et V. Solomakha 1988
[frequently flooded salt meadows in less continental area of SE Europe]

Association: *Plantagini salsae-Juncetum gerardii* Dubyna et Neuhäuslová 2000
Association: *Scorzonero parviflorae-Taraxacetum bessarabici* Dubyna et Neuhäuslová 2000
Order: *Artemisio santonicae-Limonietalia gmelinii* Golub et V. Solomakha 1988
[briefly flooded communities of salt meadows in river valleys and terraces, on the banks of salt lakes and in the coastal zone of the Black and Azov Seas]
Alliance: *Artemision santonicae* Shelyag-Sosonko et V. Solomakha 1987
[solonetz meadows in the coastal zone of the Ukraine]
Association: *Artemisio santonicae-Elytrigietum elongatae* Dubyna, Neuhäuslová et Shelyag-Sosonko in Dubyna et Neuhäuslová 2000
Alliance: *Salicornio-Puccinellion* Mirkin in Golub et V. Solomakha 1987
Association: *Tripolio vulgaris-Aeluropetum littoralis* Dubyna et Neuhäuslová 2000
Subassociation: *Tripolio vulgaris-Aeluropetum artemisietosum* Dubyna et Neuhäuslová 2000
Subassociation: *Tripolio vulgaris-Aeluropetum suaedetosum prostratae* Dubyna et Neuhäuslová 2000
Alliance: *Puccinellion giganteae* Golub et V. Solomakha in Dubyna et Neuhäuslová 2000[1]
Association: *Puccinellietum giganteae* V. Solomakha et Shelyag-Sosonko in Dubyna et Neuhäuslová 2000

Description of the vegetation

Plantagini salsae-Juncetum gerardii Dubyna et Neuhäuslová ass. nova hoc loco
(Table 1, rel. 1–20)

Nomenclatural type: Table 1, rel. 11 (holotypus). Location: Biryuchij Island Spit, transect no. 6, 15 m from the Utlyuk Liman. Dubyna & Neuhäuslová, September 1991.
Diagnostic species: *Artemisia santonica, Cynanchum acutum, Halimione pedunculata, Juncus gerardii, Plantago salsa, Puccinellia gigantea, Salicornia perennans, Tripolium vulgare.*

Structure and species composition

The near-natural stands of this association are medium-dense to dense, mostly with more than 13 species in a relevé and total species number about 40. Grazing and trampling reduces species richness. Monospecific stands often occur. Apart from the dominant species *Juncus gerardii*, other locally occur as subdominants: *Artemisia santonica, Tripolium vulgare*, rarely also *Atriplex prostrata.*

Habitat

The stands of this association occur only sporadically on moderately humic, temporarily waterlogged, solonchak-like soils in narrow depressions at (5) 15–30 (35) cm a. s. l. In the investigated area, they represent one of the wettest types of salt meadows. The humus horizon is 20–30 cm deep and the soil reaction is alkaline. Loamy-sandy and sandy soils prevail. The salt contents in the groundwater is 30–50 g/l. Both *Juncus gerardii* and *Plantago salsa* are weak competitors preferring sites less frequently occupied by other communities.

Stands dominated by *Juncus gerardii* also grow on non-saline swampy soils with various texture, i. e. shelly-sandy, shelly-loamy-sandy or clay-sandy soils; the latter harbour stands with pronounced presence of *Limonium meyeri, L. caspium* and *Frankenia hirsuta.*

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[1] Association *Puccinellietum giganteae*, representing nomenclatural type of the alliance *Puccinellion giganteae*, has been previously described in a manuscript only. The valid description of the alliance based on this association is thus made in the present paper.

Scorzonero parviflorae-Taraxacetum bessarabici Dubyna et Neuhäuslová ass. nova hoc loco (Table 2, rel. 21–30)

Nomenclatural type: Table 2, rel. 24 (holotypus). Location: Biryuchij Island Spit, transect no. 1, 40 m from the coast of the Utlyuk Liman. Dubyna, September 1991.
Diagnostic species combination: *Artemisia santonica, Halimione pedunculata, Scorzonera parviflora, Taraxacum bessarabicum, Teucrium polium.*

Structure and species composition

The association is represented by two-layered stands dominated by *Taraxacum bessarabicum*. Individual relevés mostly contain 10–20 species, the total number of species in the stands studied was 45. The upper field-layer, 60–80 cm tall and with cover 20–25 %, is formed by grasses (*Elytrigia elongata, E. repens, Calamagrostis epigeios*) and scattered herbs (e. g. *Lepidium latifolium, Artemisia santonica, Chondrilla juncea, Atriplex prostrata, Cichorium intybus*). The lower sub-layer, which determines the physiognomy of this community, does not exceed 30 cm in height. *Taraxacum bessarabicum* forms a marked late-summer aspect. As the stands dominated by this species are intensively grazed by deer and cattle, numerous species of disturbed habitats appear.

Habitat

The stands of this community occur mostly in shallow depressions at 25–40 (50) cm a. s. l. or in non-flooded, permanently moist parts of the plain, less frequently in dune slacks. The alkaline soils (pH 8–10) are sufficiently rich in $CaCO_3$ and $MgCO_3$ and moderately saline. Content of mineral N varies over a wide range, with values between 0.3–0.4% prevailing.

Variability

Three variants can be distinguished in this association: (1) Species-rich stands on drier, weakly saline soils, differentiated by *Elytrigia elongata, Calamagrostis epigeios, Poa angustifolia, P. bulbosa, Achillea euxina, Althaea officinalis* and *Chenopodietea* species. (2) On moister, more saline sites in contact with solonchak vegetation, the most important species are *Salicornia perennans, Suaeda prostrata, Plantago salsa*; *Aeluropus littoralis, Apera maritima* and *Triglochin maritimum* are also frequent. (3) Typical variant without differential species, occupying transitional habitats between the former two types.

Distribution

In the region studied, the stands dominated by *Taraxacum bessarabicum* reach the southern limit of their distribution. They occur frequently in such places which are too saline for sand steppes but insufficiently saline for typical salt vegetation. Eastwards, their distribution is less frequent. The centre of distribution in the Ukraine is in the northern part of the study area where *Taraxacum bessarabicum* grows on salinized terraces of the river Dnepr and its eastern tributaries (Bilyk 1937). There, it is accompanied by other dominant species, such as *Trifolium fragiferum, Potentilla anserina*; the latter is absent from the Biryuchij Island Spit.

Table 1. – *Plantagini salsae-Juncetum gerardii.*

Relevé no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	C
Area analyzed (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Total cover (%)	100	100	80	100	75	65	60	60	100	85	70	65	85	70	100	85	85	100	95	100	%
Number of species	19	18	17	17	18	18	16	15	17	15	15	15	14	17	14	13	11	13	14	16	
Diagn. Ass.:																					
Juncus gerardii Loisel.	4	4	4	4	3	3	3	4	4	5	4	4	4	3	4	5	4	4	3	4	100
Plantago salsa Pall.	+	+	+	.	+	+	+	+	.	+	+	.	–	+	.	+	.	.	+	r	70
D *Festuco-Puccinellietea* and lower syntaxa:																					
Puccinellia gigantea (Grossh.) Grossh.	.	1	.	1	+	1	+	+	+	2	+	+	+	+	.	+	.	+	.	2	75
Tripolium vulgare Ness	1	+	+	+	2	.	1	+	.	.	.	+	3	3	2	+	.	+	.	1	70
Artemisia santonica L.	.	.	.	3	1	+	+	+	2	1	.	.	+	+	.	+	+	3	1	+	70
Aeluropus littoralis (Gouan) Parl.	+	+	+	.	+	.	.	.	+	.	.	+	.	+	+	.	.	.	1	.	45
Glaux maritima L.	.	.	.	+	+	+	.	.	.	+	+	.	+	+	.	.	.	.	.	1	40
Scorzonera parviflora Jacq.	+	1	+	.	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	+	30
Limonium meyeri (Boiss.) Aell.	.	.	.	.	.	+	.	.	1	.	+	+	.	.	.	.	.	.	1	1	30
Triglochin maritimum L.	1	1	1	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	25
Tripolium pannonicum (Jacq.) Dobrocz.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	15
Apera maritima Klok.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	15
D *Juncetea maritimi:*																					
Juncus maritimus Lam.	.	+	.	.	.	–	.	.	.	+	+	.	.	.	.	.	.	.	.	.	20
D *Bolboschoenetea maritimi* and lower syntaxa:																					
Bolboschoenus maritimus (L.) Palla	.	–	+	.	.	–	+	+	.	.	+	+	.	.	+	.	.	.	.	.	40
Carex extensa Good.	+	.	.	+	+	.	.	.	+	.	.	+	+	+	.	.	.	.	.	.	35
Other species:																					
Halimione pedunculata (L.) Aell.	+	.	+	+	+	–	+	+	+	+	+	+	+	+	.	+	+	+	+	.	85
Salicornia perennans Willd.	+	1	+	+	1	.	+	+	+	.	.	+	+	+	+	.	+	+	+	+	80
Cynanchum acutum L.	+	+	+	+	+	+	+	.	+	+	.	.	.	+	.	+	.	+	+	.	65
Spergularia marina (L.) Griseb.	.	.	.	+	+	.	+	+	+	.	.	+	+	.	+	+	+	1	.	+	60
Lepidium latifolium L.	.	.	.	.	+	+	+	+	.	+	.	.	+	+	+	+	+	+	+	.	60
Agrostis stolonifera L.	+	1	+	.	.	+	+	+	.	+	+	+	.	.	+	+	.	.	.	.	55
Phragmites australis (Cav.) Trin.	+	+	+	+	+	.	.	.	1	.	.	+	+	.	.	.	.	+	.	.	45
Halimione verrucifera (Bieb.) Aell.	+	.	+	+	.	1	.	.	+	.	+	.	.	.	.	.	.	1	+	2	45
Suaeda prostrata Pall.	.	+	.	.	+	2	+	.	+	.	.	+	.	+	+	.	.	.	.	+	45
Atriplex littoralis L.	.	.	.	+	+	–	.	.	.	+	+	.	+	+	.	.	+	+	.	.	45
Lactuca tatarica (L.) C. A. Mey.	+	.	+	+	+	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	35
Elytrigia repens (L.) Nevski	.	+	.	.	.	+	+	+	.	+	1	.	.	.	1	.	.	.	.	.	35
Atriplex prostrata Boucher	.	+	.	.	.	+	+	+	.	+	.	.	.	+	.	.	3	.	.	.	35
Salsola soda L.	+	.	–	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	+	.	25
Taraxacum bessarabicum (Hornem.) Hand.-Mazz.	.	.	.	.	+	+	+	.	.	.	.	.	.	+	.	.	.	.	1	.	25
Althaea officinalis L.	.	.	.	.	.	.	.	.	–	.	+	.	.	.	.	+	.	1	+	.	25
Schoenoplectus lacustris (L.) Palla	.	+	.	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	20
Atriplex tatarica L.	.	.	.	+	.	.	.	.	.	.	.	+	–	.	+	.	.	.	.	.	20
Argusia sibirica (L.) Dandy	.	.	.	.	.	.	.	.	–	.	.	+	.	.	1	.	.	.	.	.	15

Table. 1. – In 1-2 relevés only : *Achillea euxina* Waldst. et Kit. (rel. 1: +, 17: +), *Elytrigia elongata* (Host) Nevski (8 : +, 11: +), *Limonium caspium* (Willd.) Gams (17: +, 20: +), *Odontites salina* (Kotov) Kotov (20: +), *Plantago cornuti* Gouan (1: +, 3: +), *P. maxima* Juss. ex Jacq. (1: + , 2: 1), *P. maritima* L.(20: 1)
Locations of the relevés: NE part of the Biryuchij Island Spit, transects no. 6–8, 10–25 m from the coast of the Utlyuk Liman.

Artemisio santonicae-Elytrigietum elongatae Dubyna, Neuhäuslová et Shelyag-Sosonko ass. nova hoc loco (Table 3, rel. 31–42)

Nomenclatural type: Relevé 41 in Table 3 (holotypus). Location: Biryuchij Island Spit, central part of the transect no. 3, Dubyna & Neuhäuslová, September 1991.
Diagnostic species combination: *Artemisia santonica, Centaurea diffusa, Chondrilla juncea, Crambe pontica, Gypsophila perfoliata, Stipa borysthenica, Elytrigia elongata, Halimione verrucifera, Medicago kotovii*; *Parmelia kamtchadalis, Tortula ruralis.*

Structure and species composition

This association represents a typical example of a salt (steppe) meadow. It forms three-layered, dense stands, whose physiognomy is determined by both name-giving species. The field layer is divided into two sub-layers: the upper one reaches the height of 50–60 cm and is formed mostly by *Elytrigia elongata,* accompanied by *Atriplex prostrata, Cynanchum acutum, Chondrilla juncea, Lepidium latifolium, Medicago kotovii, Melilotus albus* and other species. The lower, less developed sub-layer (height 20–30 cm) is formed by *Halimione verrucifera, Bromus squarrosus* and *Polygonum janatae*. The stands are relatively poor in species (about 10–18 per relevé), total species number was 50. Besides the two name-giving species, only *Cynanchum acutum, Halimione verrucifera* and *Limonium meyeri* occur locally with a higher dominance (up to 10%). *Parmelia kamtchadalis,* together with *Tortula ruralis,* determine the physiognomy of the ground layer (cover 10–20 %). Species of saline soils strongly prevail while the representation of sand steppe species is negligible. The stands are often mown.

Seawards, the association comes into contact with dune stands (as. *Crambo-Leymetum sabulosi* and *Medicago kotovii-Crambe pontica* community) and inland with solonetz vegetation with *Halimione verrucifera, Puccinellia gigantea* and other species.

Habitat

The stands of the *Artemisio-Elytrigietum* colonize moderate elevations behind the coastal ridge, where water stagnates during the spring time, or flat, more elevated sites in various other parts of the island which are flooded for a short time or, occasionally, for a moderately long period. The saline soils are moderately humic, sandy-loamy with an admixture of shell material. The soil reaction is alkaline (pH 8–10), they are rich in $CaCO_3$ and $MgCo_3$, moderately saline (0.1–0.3 % SO_4^{2-}, 0.05–0.1 % Cl^-) to strongly saline (0.5 % SO_4^{2-}, 0.3 % Cl^-). The reserves of mineral N are sufficient (mostly 0.3–0.4 %). The soils can be waterlogged in spring but in late summer or autumn, they dry out temporarily. The stands usually occur 30–50 cm above the sea level but can be also found at 50–120 cm a. s. l. In the area studied, they are typically developed in habitats adjacent to the sea where they cover areas of about 1 ha. Westwards, to the Dnestr, they occur less frequently.

Table 2. – *Scorzonero parviflorae-Taraxacetum bessarabici.*

Relevé no.	21	22	23	24	25	26	27	28	29	30	C
Area analyzed (m^2)	100	100	100	100	100	100	100	100	100	100	
Total cover (%)	60	55	45	40	40	55	45	50	40	40	%
Number of species	20	20	16	14	14	19	15	13	10	10	
D Ass.:											
Taraxacum bessarabicum (Hornem.) Hand.-Mazz.	3	3	3	3	3	3	4	3	3	3	100
Scorzonera parviflora Jacq.	+	+	+	+	+	.	.	.	.	.	50
D *Festuco-Puccinellietea* and lower syntaxa:											
Artemisia santonica L.	1	1	1	1	1	+	+	+	1	1	100
Elytrigia elongata (Host) Nevski	2	1	1	1	1	.	.	.	.	.	50
Tripolium vulgare Ness	+	.	.	+	.	.	.	.	.	.	20
Triglochin maritimum L.	.	.	.	.	.	+	+	+	.	+	40
Aeluropus littoralis (Gouan) Parl.	.	.	.	.	.	+	+	+	.	.	20
Plantago salsa Pall.	.	.	.	.	.	+	+	.	.	.	20
Apera maritima Klok.	.	.	.	.	.	.	+	+	.	.	20
D Var.:											
Calamagrostis epigeios (L.) Roth	+	1	1	+	.	.	.	.	.	.	40
Achillea euxina Klokov	+	+	+	+	.	.	.	.	.	.	40
Althaea officinalis L.	+	+	+	.	+	.	.	.	.	.	40
Poa angustifolia L.	+	+	+	.	.	.	.	.	.	.	30
Poa bulbosa L.	+	+	.	.	.	.	.	.	.	.	20
Suaeda prostrata Pall.	.	.	.	.	.	1	+	+	.	.	30
Salicornia perennans Willd.	.	.	.	.	.	+	+	+	.	.	30
D *Juncetea maritimi*:											
Juncus maritimus Lam.	.	.	+	.	+	.	.	.	.	.	20
D *Chenopodietea* and lower syntaxa:											
Senecio vernalis Waldst. et Kit.	+	+	+	+	.	.	+	+	.	.	60
Bromus squarrosus L.	+	+	.	+	.	.	.	+	.	.	40
Sisymbrium altissimum L.	.	+	.	r	.	.	.	.	.	.	20
Other species:											
Teucrium polium L.	2	1	1	1	.	1	1	.	.	1	70
Halimione pedunculata (L.) Aell.	+	+	+	.	+	+	1	1	.	.	70
Buglossoides arvensis (L.) Johnst.	+	+	.	.	r	+	.	+	.	.	50
Elytrigia repens (L.) Nevski	1	+	+	1	+	.	.	.	.	.	50
Atriplex littoralis L.	.	+	.	.	.	1	+	.	1	1	50
Spergularia marina (L.) Griseb.	.	.	.	.	.	+	+	+	+	+	50
Crepis ramosissima D'Urv.	+	.	.	+	.	+	.	+	.	.	40
Lepidium latifolium L.	.	.	+	.	.	+	.	.	+	+	40
Atriplex prostrata Boucher	.	.	.	.	+	+	.	.	+	+	40
Atriplex tatarica L.	.	.	.	.	+	+	.	.	+	+	40
Cichorium intybus L.	.	.	.	.	+	+	.	.	+	+	40
Odontites salina (Kotov) Kotov	1	+	+	.	.	.	.	.	.	.	30
Chondrilla juncea L.	+	+	.	.	.	.	.	.	.	.	20
Lycopus europaeus L.	+	.	.	+	.	.	.	.	.	.	20
Linum austriacum L.	+	.	.	.	.	.	+	.	.	.	20
Cardaria draba L.	.	.	.	.	+	.	.	.	+	.	20
Marrubium peregrinum L.	.	.	.	.	.	+	+	.	.	.	20
Lepidium ruderale L.	.	.	.	.	.	+	.	.	+	.	20

In one relevé only: *Achillea submillefolium* Klok. et Krytzka (25: +), *Lotus corniculatus* L. (23: r), *Plantago maxima* Juss. et Jacq. (22: r)

Locations of the relevés: W and NW part of the Biryuchij Island Spit, transect no. 1, less frequently transects no. 5 and 6, 20–50 m from the Utlyuk Liman.

Table 3. – *Artemisio santonicae-Elytrigietum elongatae.*

Relevé no.	31	32	33	34	35	36	37	38	39	40	41	42	C
Area analyzed (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	
Total cover (%)	100	75	90	80	85	75	90	80	85	95	95	70	%
Number of species	16	18	15	14	13	12	12	11	10	18	17	12	
Field layer													
D Ass.:													
Elytrigia elongata (Host) Beauv.	5	4	4	4	4	4	4	4	4	3	3	3	100
Halimione verrucifera (Bieb.) Aell.	1	1	2	1	1	1	.	1	1	1	1	1	92
Medicago kotovii Wissjul.	.	.	+	+	+	+	.	.	+	1	1	1	67
Centaurea diffusa Lam.	.	.	+	+	+	+	.	.	.	+	.	+	50
Crambe pontica Stev. ex Rupr.	.	.	.	+	.	.	.	r	.	+	+	.	33
Gypsophila perfoliata L.	.	+	.	.	.	.	r	1	.	.	.	.	25
D *Festuco-Puccinellietea* and lower syntaxa:													
Artemisia santonica L.	2	2	2	2	2	2	2	1	2	2	2	2	100
Limonium meyeri (Boiss.) O. Kuntze	1	1	.	.	.	.	1	2	.	+	+	.	50
Puccinellia gigantea (Grossh.) Grossh.	r	+	.	.	.	.	.	.	.	1	.	r	33
Plantago salsa Pall.	.	1	.	.	.	.	2	.	.	+	+	.	33
D *Honckenyo-Elymetea* and lower syntaxa:													
Cynanchum acutum L.	.	2	+	.	.	1	+	2	.	.	1	1	58
Asparagus levinae Klok.	.	.	r	.	r	.	.	.	.	.	.	.	17
D *Juncetea maritimae*:													
Juncus maritimus Lam.	.	.	.	.	.	.	.	.	.	1	+	.	17
D *Chenopodietea* and lower syntaxa:													
Bromus squarrosus L.	2	+	.	.	.	.	+	1	.	.	.	.	33
Cynodon dactylon (L.) Pers.	+	r	.	.	.	.	.	1	.	.	.	.	25
Bromus japonicus Thunb.	.	.	+	.	.	.	.	.	.	+	+	.	25
D *Festucetea vaginatae* and lower syntaxa:													
Chondrilla juncea L.	.	.	.	r	r	r	.	.	+	.	.	.	33
Stipa borysthenica Klok. ex Prokud.	r	.	.	+	.	r	.	.	.	.	.	.	25
Other species:													
Atriplex prostrata Boucher	+	+	.	.	.	+	.	r	.	1	+	+	58
Melilotus albus Medik.	.	+	r	r	r	r	+	.	.	+	.	.	58
Polygonum janatae Klok.	.	.	+	+	+	.	.	.	+	.	+	.	42
Lepidium latifolium L.	.	+	.	.	.	.	+	.	.	+	+	.	33
Agropyron pectinatum (Bieb.) Beauv.	.	.	+	+	.	.	.	.	+	.	.	.	25
Plantago lanceolata L.	.	.	+	+	.	.	.	.	+	.	.	.	25
Suaeda prostrata Pall.	.	.	.	.	.	.	.	.	.	+	1	+	25
Crepis ramosissima D'Urv.	.	+	.	.	.	.	+	.	.	.	.	.	17
Elytrigia repens (L.) Nevski	.	.	+	.	+	.	.	.	.	.	.	.	17
Odontites salina (Kotov) Kotov	.	.	.	.	.	.	.	.	.	.	+	+	17
Ground layer:													
Tortula ruralis (Hedw.) Gaertn. et al.	.	1	1	1	1	1	.	.	1	1	1	1	75
Parmelia kamtchadalis (Mont.) Mont.	.	.	1	1	1	1	.	.	1	2	2	1	67

In one relevé only: *Aeluropus littoralis* (Gouan) Parl. (rel. 37: 1), *Artemisia taurica* Willd. (31: 1), *Carduus uncinatus* Bieb. (38: r), *Cerastium syvaschicum* Kleop. (31: +), *Consolida regalis* S. F. Gray (31: r), *Dianthus pseudoarmeria* Bieb. (31: +), *Echinops sphaerocephalus* L. (35: +), *Galium humifusum* Bieb. (37: +), *Linaria genistifolia* (L.) Will. (32: +), *Polygonum pulchellum* Loisel. (31: r), *Salicornia perennans* Willd. (40: +), *Senecio vernalis* Waldst. et Kit. (31: r), *Seseli tortuosum* L. (32 : +), *Sisymbrium altissimum* L. (31: +), *Tamarix ramosissima* Ledeb. (31: 2), *Teucrium polium* L. (32: 1).
Location of the relevés: Central and W part of the Biryuchij Island Spit, central part of the transects no. 1–5.

Variability

Within this association, two sub-units can be distinguished: (1) species-rich stands with a pronounced dominance of *Elytrigia elongata* and with the presence of *Festucetea vaginatae* species on drier sites at relatively higher levels above the sea, and (2) more halophilous vegetation with *Suaeda prostrata, Salicornia perennans*, or *Juncus maritimus* at lower positions, more frequently inundated by sea water (Table 3, rel. 40–42). However, it is not possible to distinguish both units syntaxonomically on the basis of a limited number of relevés.

Economic importance

Artemisia santonica is suppressed by regular mowing which leads to the development of monospecific stands of *Elytrigia elongata*, a species of a high nutritive value. These stands represent a basic source of winter fodder for deer (about 200–500 tons of hay are harvested annually in the whole region). With the cessation of mowing, the stands of *Artemisio santonicae-Elytrigietum elongatae* become sparse and species typical of solonetz vegetation expand. The stands are favoured by deer, especially during the spring, when they provide a valuable source of fodder.

Besides the production of hay, these stands also contribute to the consolidation of soils and provide a biotope for rodents and a number of protected animal species.

Tripolio vulgaris-Aeluropetum littoralis Dubyna et Neuhäuslová ass. nova hoc loco (Table 4, rel. 45–64)

Nomenclatural type: Table 4, rel. 47 (holotypus). Location: Biryuchij Island Spit, transect no. 6, 20 m from the Utlyuk Liman. Dubyna, September 1991.
Diagnostic species: *Aeluropus littoralis, Agrostis stolonifera, Artemisia santonica, Bolboschoenus maritimus, Juncus gerardii, Spergularia marina, Tripolium vulgare.*

Structure and species composition

The association is represented by stands with dense to moderately dense cover and the average height of 50–60 cm. They are mostly dominated by *Tripolium vulgare* or *Aeluropus littoralis* which, together with other grasses and species of *Chenopodiaceae, Cyperaceae* and *Juncaceae*, determine their physiognomy. The average species number in a relevé was 13 and the total species number in the analyzed stands was 40. The differentiation of the field layer into sub-layers is less marked than in the preceding association. The upper sub-layer (about 1 m tall) is only weakly developed while the lower sub-layer has usually moderate cover. Of the species indicating solonchak soils *Salicornia perennans, Suaeda prostrata* are frequent; *Limonium caspium* and *Petrosimonia oppositifolia* occur here, too. In contrast to the *Artemisio-Elytrigietum elongatae*, the *Tripolio-Aeluropetum* is differentiated by the absence or very weak occurrence of species of drier sand steppes and by a regular or frequent occurrence of *Aeluropus littoralis, Tripolium vulgare, Agrostis stolonifera, Triglochin maritimum, Bolboschoenus maritimus, Phragmites australis* and other species of wet sites (Table 6).

Habitat and distribution

The stands of this association occur on clay-sandy and sandy-shelly soils on flat sites (5–30 cm a. s. l.). The soils are mostly flooded for only short periods. Mineral nitrogen content is sufficient, pH-values are high in *Tripolio-Aeluropetum suaedetosum prostratae.*

Table 4. – *Tripolio vulgaris-Aeluropetum littoralis.*

Subassociation	*artemisietosum*											*suaedetosum prostratae*											
Relevé no.	45	46	47	48	49	50	51	52	53	54	C	55	56	57	58	59	60	61	62	63	64	C	C Ass.
Area analyzed (m^2)	100	100	100	100	100	100	100	100	100	100		100	100	100	100	100	100	100	100	100	100		
Total cover (%)	80	75	75	90	45	80	90	95	60	65	%	75	70	75	90	90	85	90	90	90	75	%	%
Number of species	17	14	13	13	12	11	11	10	11	11		17	16	17	13	12	14	9	11	8	15		
D Ass.:																							
Aeluropus littoralis L.	2	1	1	+	2	3	1	3	1	1	100	4	3	4	5	5	4	4	4	4	4	100	100
Tripolium vulgare Ness	3	3	3	4	3	3	4	4	3	4	100	+	+	+	2	+	+	+	+	+	1	100	100
D Subass.:																							
Artemisia santonica L.	+	+	+	+	+	r	+	r	r	+	100	.	+	+	.	.	.	.	.	.	.	20	55
Suaeda prostrata Pall.	.	.	.	.	+	+	.	+	.	.	30	+	+	+	+	+	+	3	3	3	+	100	65
Salsola soda L.	.	.	.	.	.	.	.	.	.	+	10	+	+	+	+	2	.	+	+	+	.	80	45
Salicornia perennans Willd.	.	.	+	.	.	1	.	.	.	.	20	2	r	2	+	+	+	.	.	.	.	60	40
Schoenoplectus lacustris (L.) Palla	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	+	.	+	50	30
Limonium caspium (Willd.) Gams	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	40	20
D *Festuco-Puccinellietea* and lower syntaxa:																							
Puccinellia gigantea (Jacq.) Parl.	+	+	2	.	.	.	1	.	.	2	50	1	+	+	+	2	2	+	+	+	+	100	75
Juncus gerardii Loisel.	.	+	r	2	+	1	+	+	1	+	90	+	+	+	+	.	.	.	+	.	+	60	75
Triglochin maritimum L.	.	2	+	.	.	.	+	.	.	2	40	+	+	+	+	+	+	.	.	.	+	70	55
Limonium meyeri (Boiss.) O. Kuntze	+	+	2	+	.	.	2	.	.	.	50	+	+	+	.	.	2	.	.	.	+	50	50
Scorzonera parviflora Jacq.	+	+	r	+	.	.	.	.	+	+	60	+	.	.	1	1	+	.	.	.	.	40	50
Apera maritima Klok.	+	.	.	.	+	+	.	+	+	.	50	.	.	+	.	.	.	+	+	.	+	40	45
Elytrigia elongata (Host) Nevski	+	1	.	.	.	.	1	.	.	.	30	.	+	.	.	.	.	+	+	.	.	30	30
Plantago salsa Pall.	.	.	.	.	.	.	.	r	.	.	10	+	+	2	.	.	r	.	.	.	.	40	25
D *Bolboschoenetea maritimi*:																							
Bolboschoenus maritimus (L.) Palla	.	.	+	+	+	+	.	+	1	+	70	+	+	.	.	.	1	.	+	+	.	50	60
D *Juncetea maritimi*:																							
Juncus maritimus Lam.	.	.	.	.	+	.	+	.	+	.	30	.	.	+	.	.	.	.	.	.	.	10	20
Other species:																							
Agrostis stolonifera L.	+	r	.	+	+	+	2	+	+	.	80	.	.	+	+	+	+	.	.	.	r	50	65
Spergularia marina (L.) Griseb.	+	r	.	+	+	+	.	+	+	.	70	+	+	+	.	.	+	.	.	+	+	60	65
Phragmites australis (Cav.) Trin.	.	.	1	.	+	1	+	+	.	.	50	.	.	.	+	+	+	+	+	+	+	70	60
Lepidium ruderale L.	+	+	+	+	.	.	+	.	.	.	50	.	.	.	.	.	.	.	.	.	r	10	30
Halimione pedunculata (L.) Aell.	.	.	1	.	+	.	.	+	.	.	30	2	3	.	.	.	.	+	.	.	.	30	30
Lepidium latifolium L.	+	+	.	+	.	.	.	.	.	+	40	+	.	.	.	.	.	.	.	.	.	10	25
Atriplex littoralis L.	.	.	.	.	.	.	.	.	.	.	.	+	+	+		.	.	.	.	.	+	40	20
Plantago cornuti Gouan	+	+	.	.	.	+	.	.	.	.	30	.	.	.	.	.	.	.	.	.	.	.	15
Achillea euxina Klok.	+	.	.	+	.	.	.	.	r	.	30	.	.	.	.	.	.	.	.	.	.	.	15
Taraxacum bessarabicum (Hornem.) Hand.- Mazz.	.	.	.	.	+	.	.	.	.	.	10	+	+	.	.	.	.	.	.	.	.	20	15
Petrosimonia oppositifolia (Pall.) Litv.	.	.	.	.	.	.	.	.	+	.	10	.	.	.	+	+	.	.	.	.	.	20	15

In 1–2 relevés only: *Althaea officinalis* L. (48: +, 64: +), *Atriplex prostrata* Boucher (46: +), *Cirsium arvense* (L.) Scop. (45: +), *Cynanchum acutum* L. (55: +, 57: +), *Elytrigia repens* (L.) Nevski (45: +, 47: +), *Glaux maritima* L. (54: +), *Gypsophila perfoliata* L. (64: r), *Halimione verrucifera* (Bieb.) Aell. (59: 2), *Lactuca tatarica* (L.) C. A. Meyer (50: +), *Tripolium pannonicum* (Jacq.) Dobrocz. (55: +)
Location of the relevés: Central and W part of the Biryuchij Island Spit, transects no. 3–8, 10–30 m from the Utlyuk Liman (subass. *artemisietosum*); transects no. 3–8, on banks of flooded depressions (subass. *suaedetosum prostratae*)

This association occurs relatively frequently in the study area. It belongs to pioneer communities of newly developing habitats where they grow together with vegetation typical of solonchak soils. They usually form mosaic-like stands covering 0.2–0.3 ha. Other habitats in which they also occur are on lower coastal ridges and at lower elevations in the vicinity of limans, in dune slacks, local depressions in the plain or at the bottom of episodically flooded areas.

Besides the phytocoenoses dominated by *Tripolium vulgare*, stands dominated by the Black-Sea endemic species *Tripolium pannonicum* can be also found in this region. From an ecological point of view, these stands differ from the *Tripolio-Aeluropetum* principally in the flooding regime. They are confined to sites flooded for long periods with a thick clay layer and a large amount of detritus. They occur very frequently in typical reed swamp sites with abundant *Phragmites australis* or in sites of *Plantagini salsae-Juncetum gerardii*. The associated soils are markedly less saline in comparison with stands dominated by *Tripolium vulgare*. *Tripolium pannonicum* communities also occur frequently on soils in river deltas where the water regime of the river prevents permanent salinization.

Variability

Two sub-units, i. e. *Tripolio-Aeluropetum artemisietosum santonicae* and *Tripolio-Aeluropetum suaedetosum prostratae* can be clearly distinguished (Table 4). The former subassociation grows on less alkaline and less saline soils than the latter.

(a) ***Tripolio vulgaris-Aeluropetum littoralis artemisietosum* Dubyna et Neuhäuslová subass. nova hoc loco** (Table 4, rel. 45–54)

Nomenclatural type: Relevé 47 in Table 4 (holotypus). Location: Biryuchij Island Spit, transect no. 6, 20 m from the Utlyuk Liman. Dubyna, September 1991.
Diff.: *Artemisia santonica*.
Diagnostic species: *Aeluropus littoralis, Artemisia santonica, Agrostis stolonifera, Bolboschoenus maritimus, Juncus gerardii, Spergularia marina, Tripolium vulgare*.

Structure and species composition

The stands of this subassociation have mostly dense to moderately dense cover, and are dominated by *Tripolium vulgare*; this species forms a striking aspect in the late summer and autumn. *Aeluropus littoralis* occurs regularly, sometimes as subdominant. *Juncus gerardii, Triglochin maritimum* or *Limonium meyeri* are occassionally abundant, while species of the following subassociation are missing or occur only rarely.

(b) ***Tripolio vulgaris-Aeluropetum littoralis suaedetosum prostratae*** **Dubyna et Neuhäuslová subass. nova hoc loco** (Table 4, rel. 55–64)

Nomenclatural type: Relevé 58 in Table 4 (holotypus). Location: Biryuchij Island Spit, transect no. 6, banks of flooded depression near the Utlyuk Liman. Dubyna, September 1991.
Diagnostic species: *Aeluropus littoralis, Limonium caspium, Phragmites australis, Puccinellia gigantea, Salicornia perennans, Salsola soda, Schoenoplectus lacustris, Suaeda prostrata, Triglochin maritimum, Tripolium vulgare.*

Structure and species composition

Salt meadows markedly dominated by *Aeluropus littoralis,* with a higher proportion of species of saline soils. *Suaeda prostrata*, sometimes *Salicornia perennans*, less frequently *Salsola soda* or *Tripolium vulgare* are subdominants.

Puccinellietum giganteae **V. Solomakha et Shelyag-Sosonko ass. nova hoc loco** (Table 5, rel. 65–74)

Nomenclatural type: Table 5, rel. 69 (holotypus). Location: Biryuchij Island Spit, transect no. 5, 15 m from the Utlyuk Liman. Dubyna, September 1991.
Diagnostic species: *Aeluropus littoralis, Artemisia santonica, Halimione pedunculata, Juncus maritimus, Limonium meyeri, Phragmites australis, Puccinellia gigantea, Salicornia perennans, Spergularia marina.*

Structure and species composition

Stands dominated by *Puccinellia gigantea* are rather poor in species (35 in total). Several strictly halophilous species occur frequently, although mostly with a very low cover (*Salicornia perennans, Suaeda prostrata, Salsola soda, Crypsis aculeata, Frankenia hispida, Petrosimonia oppositifolia*). Besides the dominant *Puccinellia gigantea*, *Aeluropus littoralis* occurs as subdominant in some stands. Species of the class *Festuco-Puccinellietea* and of its lower syntaxa are frequently represented.

This association shows close relations to *Tripolio-Aeluropetum*. However, floristic differences between both units can be seen: (1) High representation of *Juncus gerardii, Tripolium vulgare, Agrostis stolonifera,* and *Scorzonera parviflora* is typical of Tripolio-Aeluropetum. In this association, *Puccinellia gigantea* occurs relatively frequently, but with a markedly lower dominance. (2) In the *Puccinellietum giganteae*, *Puccinellia gigantea* absolutely dominates, and a high representation of *Juncus maritimus*, *Halimione pedunculata*, *H. verrucifera* and *Carex extensa* is typical.

The subassociation *Tripolio-Aeluropetum suaedetosum* forms a transition between both associations.

Habitat

Stands of this association occupy sites inundated for short to moderately long periods. In the study area, they are confined to 3–5 (7) cm high elevations of the Biryuchij Island Spit. Such habitats form the beginning of the ecological series from flooded to non-flooded flat sites, where *Puccinellia gigantea* occurs without having any special ecological importance. High ecological plasticity of this species enables it to spread into many different sites of the area investigated with the exception of dunes and water bodies. Its more or less closed stands grow on soils of different degrees of salinity and different texture (coastal sandy elevations to heavy, loamy soils). However, temporarily flooded sites of degraded

solonchak soils represent ecological optimum of these stands. Under extreme conditions, this unit forms almost monospecific communities covering areas of about 0.5–1 ha.

Compared to *Tripolio-Aeluropetum*, a higher salinity is typical of this association.

Distribution

This association belongs to the most widely distributed types of salt meadows in the area. It occurs namely in the northwestern part of the Biryuchij Island Spit, facing the liman.

Table 5. – *Puccinellietum giganteae*.

Relevé no.	65	66	67	68	69	70	71	72	73	74	C
Area analyzed (m^2)	60	60	60	60	60	60	60	60	60	60	
Total cover (%)	100	85	80	100	75	85	100	85	100	100	%
Number of species	13	17	16	15	14	16	17	12	14	14	
D Ass.:											
Puccinellia gigantea (Grossh.) Grossh.	5	5	5	5	5	4	4	4	4	4	100
D *Asteretea tripolium* and lower syntaxa:											
Aeluropus littoralis (Gouan) Parl.	.	+	1	1	1	2	3	2	1	+	90
Artemisia santonica L.	.	+	+	1	+	+	+	+	+	+	90
Limonium meyeri (Boiss.) O. Kuntze	.	+	+	2	+	1	1	.	2	1	80
Triglochin maritimum L.	+	.	+	.	.	+	+	1	.	.	50
Apera maritima Klok.	.	+	+	+	.	.	.	.	+	.	40
Tripolium vulgare Nees	1	.	1	.	.	.	.	.	2	.	30
Scorzonera parviflora Jacq.	.	+	.	.	+	.	.	.	.	.	20
Juncus gerardii Loisel.	.	.	1	.	.	.	.	.	.	+	20
D *Bolboschoenetea maritimi* and lower syntaxa:											
Bolboschoenus maritimus (L). Palla	.	.	.	+	+	+	1	.	.	r	50
Carex extensa Good.	+	+	+	.	.	.	.	.	.	.	30
Schoenoplectus lacustris (L.) Palla	.	.	.	.	+	+	+	.	.	.	30
D *Juncetea maritimi*:											
Juncus maritimus Lam.	+	1–2	+	+	.	+	.	+	+	+	80
Other species:											
Phragmites australis (Cav.) Trin. ex Steud.	+	+	+	.	+	+	1	+	+	1	90
Spergularia marina (L.) Griseb.	.	+	+	.	+	+	+	+	1	+	80
Halimione pedunculata (L.) Aell.	.	+	.	+	+	+	+	+	2	2	80
Salicornia perennans Willd.	+	+	.	.	.	1	+	+	+	2	70
Salsola soda L.	+	+	+	+	.	.	+	.	.	.	50
Elytrigia repens (L.) Nevski	+	+	+	.	+	+	.	.	.	.	50
Suaeda prostrata Pall.	.	.	.	.	+	+	+	.	1	1	50
Lactuca tatarica (L.) C. A. Mey.	+	.	.	.	.	+	+	+	.	.	40
Halimione verrucifera (Bieb.) Aell.	.	+	+	+	.	.	.	.	1	.	40
Cynanchum acutum L.	.	.	.	+	+	+	1	.	.	.	40
Althaea officinalis L.	+	+	+	.	.	.	.	.	.	.	30
Lepidium ruderale L.	.	.	.	.	+	.	+	+	.	.	30
Limonium caspium (Willd.) Gams	.	+	.	+	.	.	.	.	.	.	20
Lepidium latifolium L.	.	.	.	.	.	.	+	+	.	.	20

In one relevé only: *Crypsis aculeata* (L.) Ait. (rel. 68: +), *Elytrigia elongata* (Host) Beauv. (73: +), *Frankenia hispida* DC. (65: +), *Glaux maritima* L. (65: +), *Gypsophila perfoliata* L. (68: +), *Petrosimonia oppositifolia* (Pall.) Litv. (74 : r), *Plantago maxima* Juss. ex Jacq. (74: +), *Taraxacum bessarabicum* (68 : +)

Location of the relevés: Central and W part of the Biryuchij Island Spit, transects no. 2–7, on plain, periodically flooded parts 10–30 m from the Utlyuk Liman.

Economic importance

The stands of *Puccinellietum giganteae* play an important part in the economy of the Biryuchij Island Spit. The growing period of *Puccinellia gigantea* begins at a time when other plant species are still dormant. It is very valuable as wildlife fodder, and overgrazing results in the degradation of the stands. These stands are also of great importance for their soil-fixing and desalinization ability. The dense stands of *Puccinellia gigantea* at blossom time form a typical colour aspect. They are very resistant to mowing and in stands mowed once a year, the growth of *Puccinellia gigantea* increases to the detriment of other species sensitive to mowing. These dense stands provide a habitat and/or shelter for numerous birds, small mammals and invertebrates and are frequently visited by deer. The intensive trampling and grazing causes the degradation of the solonchaks and retreat of *Puccinellia* stands. Regulated grazing is necessary for proper conservation of this vegetation.

The association *Puccinellietum giganteae*, representing nomenclatural type of the alliance *Puccinellion giganteae,* has been previously described in a manuscript only. The valid description of the alliance based on this association is thus made here:

***Puccinellion giganteae* Golub et V. Solomakha in Dubyna et Neuhäuslová all. nova hoc loco**

Diagnostic species: *Aeluropus littoralis, Puccinellia gigantea, Artemisia santonica, Limonium meyeri.* Nomenclatural type: *Puccinellietum giganteae* V. Solomakha et Shelyag-Sosonko in Dubyna et Neuhäuslová 2000 (see p. 43)

Discussion

The Ukrainian halophytic vegetation has been studied frequently (e. g. Bilyk 1963, Solomakha & Shelyag-Sosonko 1984, Dubyna et al. 1994, 1995). The book by Bilyk (1963) is a synthetical study describing its development, ecology, use and management, and serves as a basic information on the diversity of Ukrainian halophytic vegetation. Bilyk divided the vegetation into three formation classes, i. e. *Eusalsa* (typical solonchak vegetation), *Salsuginosa* (solonetz vegetation) and *Prata salina* (salt meadows). These are further divided into groups of formations, particular formations and associations (in the sense of East-European phytosociological schools), and completed with short characteristics.

In spite of the fact that the survey of Ukrainian syntaxa has been recently published (Solomakha 1996), the vegetation classification of this large country is associated with certain problems. New syntaxa are gradually being described from various areas, some syntaxa have been described in manuscripts only and sometimes, the vegetation classes proposed for and used in other parts of Europe do not correspond to the (sub)continental Ukrainian conditions.

Salt meadows of the SW-Ukrainian coast including Biryuchij Island Spit (Table 6) are usually included within three classes: *Asteretea tripolium, Bolboschoenetea maritimi* and *Juncetea maritimi.* All these classes include salt meadow communities from climatically, as well as phytogeographically very different parts of Europe – from the cold coasts of the North Sea and Baltic, over mild Atlantic coasts and warm Mediterranean to warm and dry coasts of the Black and Azov Sea in South Ukraine and SE European Russia. Of these three classes, fresh to moist, partly temporarily wet meadows of the *Asteretea tripolium* in

Table 6. – Synoptic table of the salt meadows communities (abbreviated). 1 – *Plantagini salsae-Juncetum gerardii*, 2 – *Scorzonero parviflorae-Taraxacetum bessarabici*, 3 – *Artemisio santonicae-Elytrigietum elongatae*, 4a – *Tripolio vulgaris-Aeluropetum littoralis artemisietosum*, 4b – *Tripolio vulgaris-Aeluropetum littoralis suadetosum*, 5 – *Puccinellietum giganteae*. Species constancies and range of values in Braun-Blanquet scale are shown.

Association	1	2	3	4a	4b	5
Field layer						
D Ass.:						
Juncus gerardii Loisel.	100 (3–5)	.	.	90 (r–2)	60 (+)	20 (+–1)
Plantago salsa Pall.	70 (r–1)	20 (+)	33 (+–2)	10 (r)	30 (+–2)	.
Glaux maritima L.	40 (+–1)	.	.	10 (+)	.	10 (+)
Tripolium pannonicum (Jacq.) Dobrocz.	15 (r–+)	.	.	.	10 (+)	9 (+)
Taraxacum bessarabicum (Hornem.) Hand.-Mazz.	25 (+–1)	100 (3–4)	.	10 (+)	20 (+)	10 (+)
Scorzonera parviflora Jacq.	30 (+–2)	50 (+)	.	60 (r–+)	40 (+–1)	20 (+)
Teucrium polium L.	.	70 (+–2)	8 (1)	.	.	.
Senecio vernalis Waldst. et Kit.	.	60 (+)	8 (r)	.	.	.
Bromus squarrosus L.	.	40 (+)	33 (+–2)	.	.	.
Elytrigia elongata (Host) P. Beauv.	10 (+)	50 (1–2)	100 (3–5)	30 (+–1)	30 (+)	10 (+)
Halimione verrucifera (Bieb.) Aell.	45 (+–2)	.	92 (1–2)	.	10 (2)	40 (+–1)
Medicago kotovii Wissjul.	.		67 (+–1)	.	.	.
Chondrilla juncea L.	.	20 (+)	33 (r–+)	.	.	.
Crambe pontica Steven ex Rupr.	.	.	33 (r–+)	.	.	.
Gypsophila perfoliata L.	.	.	25 (r–1)	.	10 (r)	10 (+)
Stipa borysthenica Klokov ex Prokudin	.	.	17 (r–+)	.	.	.
Melilotus albus Medik.	.	.	58 (r–+)	.	.	.
Centaurea diffusa Lam.	.	.	50 (+)	.	.	50 (+)
Cynodon dactylon (L.) Pers.	.	.	25 (r–1)	.	.	.
Tripolium vulgare Nees	70 (+–3)	20 (+)	.	100 (3–4)	100 (+–2)	30 (1–2)
Agrostis stolonifera L.	55 (+–1)	.	.	80 (r–2)	50 (r–1)	.
D *Festuco-Puccinellietea*:						
Artemisia santonica L.	70 (+–3)	100 (+–1)	100 (1–2)	100 (r–+)	20 (+)	90 (+–1)
Limonium meyeri (Boiss.) Kuntze	35 (+–2)	50 (+–2)	50 (+–2)	50 (+–2)	50 (+–2)	80 (+–2)
Aeluropus littoralis (Gouan) Parl.	45 (+–1)	20 (+)	8 (1)	100 (+–3)	100 (3–5)	90 (+–3)
Puccinellia gigantea (Grossh.) Grossh.	75 (+–2)	.	33 (r–1)	50 (+–2)	100 (+–2)	100 (4–5)
Triglochin maritimum L.	25 (+–1)	40 (+)	.	40 (+–2)	70 (+)	50 (+–1)
Apera maritima Klokov	15 (+)	20 (+)	.	50 (+)	40 (+)	40 (+)
D *Bolboschoenetea*:						
Bolboschoenus maritimus (L.) Palla	40 (+)	.	.	70 (+–1)	50 (+–1)	50 (+–1)
Carex extensa Good.	35 (+)	.	.	.	.	30 (+)
D *Juncetea maritimi*:						
Juncus maritimus Lam.	20 (+)	20 (+)	17 (+–1)	30 (+)	10 (+)	80 (+–2)
Other species:						
Limonium caspium (Willd.) Gams	10 (+)	.	.	.	40 (+)	.
Halimione pedunculata (L.) Aell.	85 (+)	70 (+–1)	.	30 (+–1)	30 (+–3)	80 (+–2)
Salicornia perennans Willd.	80 (+–1)	30 (+)	8 (+)	20 (+–1)	60 (r–2)	70 (+–2)
Suaeda prostrata Pall.	45 (+–2)	30 (+–1)	25 (+–1)	30 (+)	100 (+–3)	50 (+–1)
Spergularia marina (L.) Griseb.	60 (+–1)	50 (+)	.	70 (r–+)	60 (+)	80 (+–1)
Salsola soda L.	20 (+–1)	.	.	10 (+)	80 (+–2)	50 (+)
Petrosimonia oppositifolia (Pall.) Litv.	.	.	.	10 (+)	20 (+)	10 (r)
Lepidium latifolium L.	60 (+)	40 (+)	33 (+)	40 (+)	10 (+)	20 (+)
Elytrigia repens (L.) Nevski	35 (+–1)	50 (+–1)	17 (+)	20 (+)	.	50 (+)
Althaea officinalis L.	25 (+)	40 (+)	.	10 (+)	10 (+)	30 (+)
Atriplex prostrata Boucher	35 (+–3)	40 (+)	58 (r–1)	10 (+)	.	.
Cynanchum acutum L.	65 (+)	.	58 (r–2)	.	20 (+)	40 (+–1)
Atriplex littoralis L.	45 (+)	50 (+–1)	.	.	40 (+)	40 (+)
Plantago maxima Juss.ex Jacq.	10 (+)	10 (+)	.	30 (+)	.	10 (+)
Phragmites australis (Cav.) Trin. et Steudel	45 (+–1)	.	.	50 (+–1)	70 (+)	90 (+–1)
Achillea euxina Klokov	20 (+)	40 (+)	.	30 (r–+)	.	.
Schoenoplectus lacustris (L.) Palla	20 (+)	.	.	.	50 (+)	30 (+)
Lactuca tatarica (L.) C. A. Meyer	35 (+)	.	.	10 (+)	.	40 (+)
Lepidium ruderale L.	.	20 (+)	.	50 (+)	10 (r)	.
Atriplex tatarica L.	20 (+)	40 (+)	.	.	.	.

Buglossoides arvensis (L.) Johnst.		50 (r–+)				
Crepis ramosissima D'Urv		40 (+)	17 (+)			
Cichorium intybus L.		40 (+)				
Calamagrostis epigejos (L.) Roth		40 (+)				
Poa angustifolia L.		30 (+–1)				
Polygonum janatae Klok.			42 (+)			
Agropyron pectinatum (Bieb.) Beauv.			25 (+)			
Ground layer						
Tortula ruralis (Hedw.) Gaertn. et al.			75 (1)			
Parmelia kamtschadalis (Mont.) Mont.			67 (1–2)			

particular, show large differences in species composition in the forest-steppe and steppe zone of the Ukraine in comparison with other coastal sites of Europe. Tüxen (in Vicherek 1973) often paid attention to the fact that this heterogeneous and very broadly characterized class needs to be divided into smaller homogeneous units. Vicherek (1973) has included part of the salt-meadow vegetation within the class *Festuco-Puccinellietea* Soó 1968 which has replaced the *Asteretea tripolium* in the (sub-)continental area of SE Europe. Into this class, characterized by *Tripolium pannonicum, Plantago salsa* and *Taraxacum bessarabicum*, he included the order *Scorzonero-Juncetalia gerardii* Vicherek 1973 with the alliance *Scorzonero-Juncion gerardii* (Wendelberger 1943) Vicherek 1973 and the association *Juncus gerardii-Scorzonera parviflora* Wendelberger 1943, a vicariant of the *Plantagini salsae-Juncetum gerardii* from the Biryuchij Island Spit. However, this very suitable solution has not been accepted in a new version of the Ukrainian vegetation survey (Solomakha 1996). There, the class *Festuco-Puccinellietea* is reserved for halophilous steppes of the order *Artemisio-Festucetalia pseudovinae* Soó 1968 on substrates with alternating soil moisture regimes, and the order *Scorzonero-Juncetalia gerardii* Vicherek 1973 has been kept in the class *Asteretea tripolium*. If we respect the well-justified proposal by Vicherek (1973) and place the order *Scorzonero-Juncetalia* back into *Festuco-Puccinellietea*, there is no reason to keep the only floristically similar order *Artemisio santonicae-Limonietalia gmelinii* Golub et V. Solomakha 1988 in the class *Asteretea tripolium*. So, the class *Asteretea tripolium* would be reserved for other parts of Europe outside the steppe and forest-steppe area. The separation of SE European salt meadows can be supported by their floristic composition: the occurrence of many species of Irano-Turanian salt steppes to semideserts (*Halimione verrucifera, Limonium caspium, Odontites salina* etc.), and the presence of many E Mediterranean halophilous species (*Aeluropus littoralis, Plantago cornuti, Cakile euxina, Salicornia perennans, Suaeda prostrata* etc., see Vicherek 1973). Thus, the class *Festuco-Puccinellietea* (syn.: *Puccinellio-Salicornietea* E. Topa 1939 p. p.) includes "natural, halophilous communities of hygrophilous to xerophilous salt meadows in the (sub)continental area of SE Europe" (Vicherek 1973) with the diagnostic species *Tripolium pannonicum, Plantago salsa, Taraxacum bessarabicum.*

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Souhrn

V článku, třetím v řadě zabývajícím se fytocenologií mořské kosy Ostrov Birjučij (Dubyna et al. 1994, 1995) jsou shrnuty výsledky fytocenologického výzkumu slaných luk třídy *Festuco-Puccinellietea*. Fyziognomie slanomilných společenstev je určována zejména dominantními druhy trav (*Elytrigia elongata, Puccinellia gigantea, Calamagrostis epigeios, Aeluropus littoralis*) a ostatních druhů (*Juncus gerardii, Tripolium vulgare, Taraxacum bessarabicum*). V rámci třídy *Festuco-Puccinellietea* jsou v území zastoupena následující společenstva: (1) *Plantagini salsae-Juncetum gerardii* na dočasně zaplavovaných půdách typu solončak v úzkých, vápníkem relativně chudých depresích. (2) *Scorzonero parviflorae-Taraxacetum bessarabici*, společenstvo silně ovlivněné pastvou a sešlapem, v mělkých relativně málo zasolených depresích. (3) *Artemisio santonicae-Elytrigietum elongatae*, asociace kosených stanovišť rostoucí na vápníkem bohatých, dočasně vysychajících půdách. (4) *Tripolio vulgaris-Aeluropetum littoralis*, asociace vyskytující se v zóně 5–30 cm nad mořskou hladinou, s těžištěm výskytu na vlhkých půdách charakteristických střední nebo vysokou koncentrací solí. V oblasti se diferencuje v následující subasociace: *T. v.-A. l. artemisietosum* Dubyna et Neuhäuslová a *T. v.-A. l. suaedetosum prostratae* Dubyna et Neuhäuslová na půdách s vyšším obsahem solí. (5) *Puccinellietum giganteae* roste na půdách s různou salinitou a texturou, přičemž ekologického optima dosahuje na dočasně zaplavovaných stanovištích degradujících solončaků.

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