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Coastal vegetation of the 'Birjučij Island' Spit in the Azov Sea, Ukraine

Pobřežní vegetace mořské kosy ‚Ostrov Birjučij' v Azovském moři, Ukrajina

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K e y w o r d s : White dunes, seashore vegetation, phytosociology, ecology, 'Birjučij Island' Spit, Ukraine

Phytosociological and ecological conditions of white-dunes and seashore vegetation of the 'Birjučij Island' Spit (Azov Sea, Ukraine) are discussed. Among the syntaxa of the classes *Cakiletea maritimae*, *Honckenyo-Elymetea* and *Agropyretea pungentis*, the following units were described: two new associations (*Cakilo euxinae-Euphorbietum peplidis* with two new subassociations, and *Cynancho acuti-Lepidietum latifolii*), three new subassociations of the *Elymo-Astrodaucetum littoralis* and the ass. *Tournefortietum sibiricae* and *Salsola soda-Leymus sabulosus* comm.

Introduction

This is the second paper that contributes to the knowledge of vegetation conditions of the 'Birjučij Island' Spit in the NW of the Azov Sea. It contains the results of phytosociological and ecological studies on initial nitrophilous stages occurring in inundated parts of seashores (class *Cakiletea maritimae* R. Tüxen et Preising 1950 in R. Tüxen 1950), nitrophilous ruderal coastal dune vegetation (class *Agropyretea pungentis* Géhu J.-M. et Géhu J. 1969) and coastal (white) dunes (class *Honckenyo-Elymetea* R. Tüxen 1966). The results were obtained by Ukrainian and Czech geobotanists in 1991. In addition, results are given of recent studies performed by Ukrainian specialists.

The territory under investigation represents a narrow spit in the NW part of the Azov Sea, at its lowest part temporarily separated from the mainland by high floods. Since general characteristics of the 'Birjučij Island' Spit were published in a paper on the vegetation of sand steppes of this territory (Dubyna, Neuhäuslová et Šeljag-Sosonko 1994), they are not given in the present paper.

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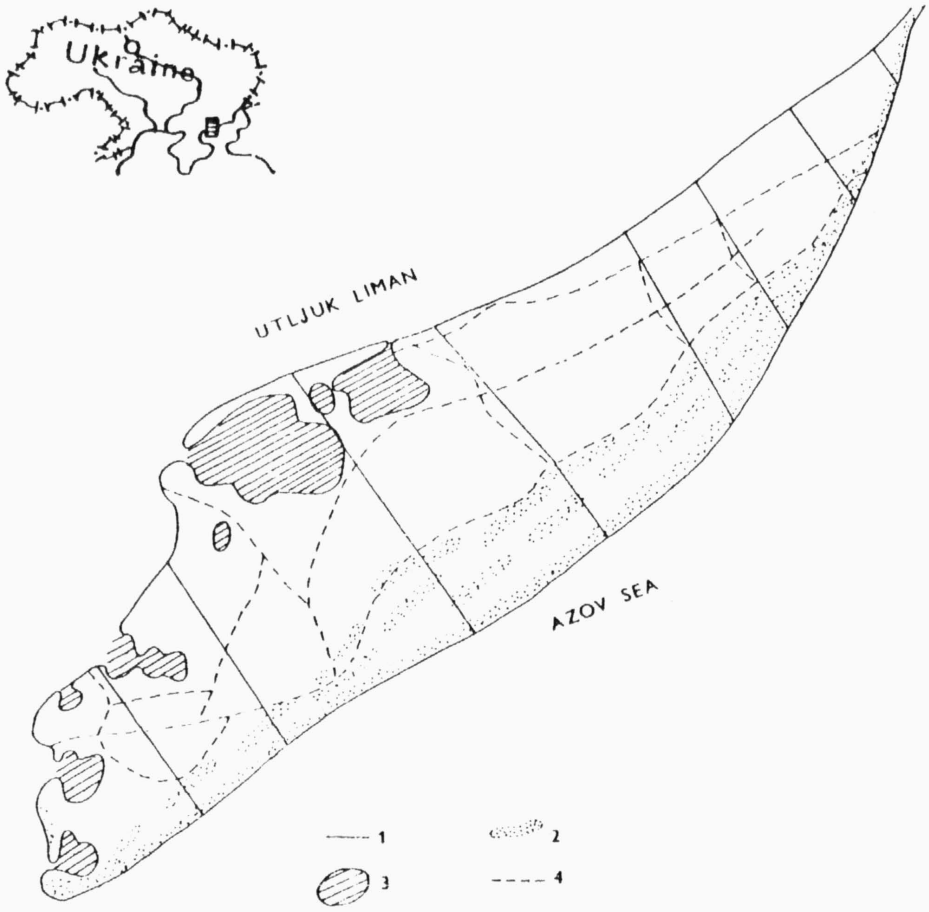

Fig. 1. - Sand dunes of the 'Birjučij Island' Spit. 1 - Profiles analyzed (numbered from SW to NE); 2 - Dunes; 3 - Inlets; 4 - Paths.

In 1927, a large area of the Spit was turned into the Azov-Sivaš Hunting Ground to acclimatize in it game, mainly red deer introduced to these parts. In April 1993, this Hunting Ground was registered as the fourth National Park of the Ukraine, called the Azov-Sivaš National Nature Park. A part of it was proclaimed a protected zone with a strictly regulated regime.

Methods

The vegetation was studied using the Braun-Blanquet approach (Braun-Blanquet 1964). The relevés were recorded on profiles orientated from S to N (see Fig. 1), on an area of 10 - 20 m^2 (on the fore-dunes and in the drift-zone) or 25 - 60 m^2 (on the white dunes). The communities distinguished in the territory under investigation were compared with the analogous communities of the Azov coast and Black Sea shore of the Ukraine, Rumania, Bulgaria and Greece (cf. Burduja 1957, Davidič 1947, Géhu, Roman et Boullet 1992, Korženevskij et al. 1984, Kotov 1928, Kotov et Prjanišnikov 1937, Lavrentiades 1964, 1975, Morariu 1957, 1959, 1967, Nyárády 1959, Pop 1970, Popescu et Sanda 1972, 1975, Popescu, Sanda et Doltu 1980, Serbanescu 1970, Vicherek 1971).

Higher plants were determined by D. V. Dubyna and V. V. Protopopova, mostly according to the handbook by Dobročaeva et al. (1987), lower plants according to different handbooks.

Coastal dunes and their characteristics

The coastal dunes, in the Russian literature often called "grivy", are specific formations as regards their origin, development and function. They originate in the peripheral zone of islands and spits. In sites with intensive accumulation processes, coastal dunes are larger both in extent and height. They are considerably smaller in sites with less intensive accumulation processes.

On the 'Birjučij Island' Spit and on other spits of the South Ukrainian seashore, transitional formations also occur established not so long ago by accumulation activities of the sea and again washed out recently. Part of the coastal dunes at the side facing the sea are "step-like" in shape. The accumulation activity of the sea is the main factor responsible for the formation of these "steps", their number, width and extent. Morphologically, the process of dune formation is evident mainly from the distribution of its vegetation. The factors influencing the formation, development and functions of the vegetation are height of dunes and speed of vertical growth in association with accumulation activity and aeolic sedimentation. In the first case, alluvia made up of coarse sand-and-shell substrate occur in altitudes between 0.5 and 1.5 m. In the second case, aeolic accumulation of conic dunes made up of fine-grain sand fractions and crushed shell material occur in altitudes above 1.5 m.

In the study area, coastal dunes are typical of the landscape in spite of the fact that they occupy about 200 ha only (Fig. 1). They are distributed irregularly and concentrated mainly along the shores of the Azov Sea. Only 5 % of these dunes are situated around the Utljuk Liman. The low northwestern shore of the spit facing the liman is dissected by numerous small inlets. There, low sandy-shell elevations overgrown with sand-steppe communities alternate regularly with depressions covered with solonchak vegetation. These coastal dunes form a continuous belt of varying width. They are widest in the northern and

Table 1. - *Euphorbion peplidis*

Association	*Cakilo euxinae-Euphorbietum peplidis*												
Subassociation	*inops*					*crambetosum ponticae*							
Variant						*typicum*					*Leym. s.*		
Relevé Nr.	1	2	3	4	5	6	7	8	9	10	11	12	%
Orientation	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	
Inclination	3	3	3	3	3	3	3	3	3	3	3	3	
Area analyzed (m)	15	15	15	15	15	15	15	15	15	15	15	20	
Total cover (%)	3	4	6	7	7	10	10	10	10	8	8	30	
Number of species	1	1	1	3	2	4	3	3	5	3	4	10	
Ch. D-*Cakiletea maritimae* and lower syntaxa													
Euphorbia peplis L.	1	1	2	2	2	2	2	2	1	1	1	r	100
Cakile euxina Pobed.	.	.	.	+	+	1	1	1	1	1	1	2	100
Salsola soda L.	.	.	.	.	.	.	.	.	.	.	.	r	11
Ch. D-*Honckenyo-Elymetea* and lower syntaxa													
Crambe pontica Steven ex Rupr.	.	.	.	+	.	+	+	+	+	.	+	1	78
Astrodaucus littoralis (Bieb.) Druce	.	.	.	.	.	+	.	.	+	+	+	.	44
Eryngium maritimum L.	.	.	.	.	.	.	.	.	.	.	.	1	11
Leymus sabulosus (Bieb.) Tzvelev	.	.	.	.	.	.	.	.	.	.	.	1	11
Ch-*Asteretea tripolii* and lower syntaxa													
Artemisia santonicum L.	.	.	.	.	.	.	.	.	.	.	.	1	11
Other accompanying species													
Plantago salsa Pall.	.	.	.	.	.	.	.	.	.	.	.	+	11
Xanthium strumarium L.	.	.	.	.	.	.	.	.	.	.	.	r	11

narrowest in the southern part owing to a more frequent wash-out. Sand dunes overlying the narrow shore of the Spit in these sites. Their height varies between 1.5 and 5 m.

Coastal dunes consist of a layer of compact shell material ("rakushechnik") covered with layers of fine-grained sand and tiny fragments of shells, both of aeolic and alluvial origin. Frequently, these layers alternate on high dunes. Their thickness indicates the degree of accumulation activity of the sea or wind over a relevant period. Firmly compacted shell material ("rakushechnik") retains atmospheric moisture ("verkhovodka") which is used by the vegetation of dunes. A compact layer of "rakushechnik" originates in those sites of the coastal area which are rich in crushed shells that are quickly buried by a layer of sand. The vegetation of the inundated seashore and coastal white dunes forms belts parallel to the shoreline which differ in dependence on ecological properties of dominant species.

Description of the vegetation

Class: *Cakiletea maritimae* R. Tüxen et Preising in R. Tüxen 1950

The vegetation of this class, colonizing inundated sea shores, is very poor in species. It consists of only those several species that are adapted to extreme conditions of requent and regular inundation and wash-out by sea water. In the open initial stands of he fore-dunes and the "drift zone", an important part is played mainly by these species of therophytes, alternating in dominance: *Euphorbia peplis*, *Cakile euxina* and *Salsola soda*. Their stages initiating colonization of loose sands are confined to a narrow, several meters wide shore belt of the lowest parts of the territory up to 1.5 m a.s.l. facing white dunes. Other therophytes such as *Xanthium strumarium* and *Atriplex hastata* were also present.

Communities of this class are confined to a specific environment. They represent a special form of permanent communities occurring sporadically as pioneer communities, always in new habitats permanently eroded by surf ("migratory communities" - Tansley 1939, "migratorische Dauer-Pioniergesellschaften" - Tüxen 1975). Simultaneously, these stands of annual species represent final stages of succession, because the surge permanently disturbing the habitat prevents the succession from proceeding any further (Thannheiser 1993).

Order: *Euphorbietalia peplidis* R. Tüxen 1950
Alliance: *Euphorbion peplidis* R. Tüxen 1950

***Cakilo euxinae-Euphorbietum peplidis* ass. nova hoc loco** (Table 1, rel. 1-12)

(Syn.: *Cakiletum maritimae euxinicum* Morariu 1967 nomen nudum, *Cakiletum frisicum* sensu Popescu, Sanda et Doltu 1980)

Nomenclatural type: Table 1, rel. 6 (holotypus)

Diagnostic species combination: *Euphorbia peplis*, *Cakile euxina*, *Crambe pontica*.

This association ist the only representative of the class *Cakiletea* in the territory under study. It forms open stands, poor in species. It was possible to distinguish two lower units: subass. *Cakilo-Euphorbietum peplidis inops* and *C.-E. peplidis crambetosum*, the latter with two variants.

***Cakilo euxinae-Euphorbietum peplidis inops* subass. nova hoc loco** (Table 1, rel. 1-5)

Nomenclatural type: Table 1, rel. 4 (holotypus)

This pioneer subassociation is very poor in species (2-3). It is formed by *Euphorbia peplis* with very low cover (3-6 %) and sporadic presence of *Cakile euxina* and *Crambe pontica*.

Individuals of *Euphorbia peplis* are the first plants to colonize newly denuded substrates on the seashore (initial stage of colonization). This species is a typical element of the sea littoral. Its very sparse stands form an incontinuous belt at the altitudes between 0.5 and 0.75 m on the shore of the Azov Sea and are confined to very frequently and regularly inundated sites with sufficient moisture all the year round. Often, they are found on alluvia consisting mostly of sand, in which organic remnants of inundated marine vegetation (*Zostera marina*) or drif-wood are poorly represented in comparison with the sand fraction. In ascending ground, the subassociation is replaced by the following syntaxon.

***Cakilo euxinae-Euphorbietum peplidis crambetosum ponticae* subass. nova hoc loco** (Table 1, rel. 6-12)

Nomenclatural type : Table 1, rel. 6 (holotypus)

Differential species: *Crambe pontica*, *Astrodaucus littoralis*.

Compared to the previous syntaxon, this subassociation is slightly richer in species (up to 10, cover 8-30%) and isolated plants of sandy dune species (*Crambe pontica*, *Astrodaucus littoralis*, *Eryngium maritimum*, *Leymus sabulosus*). In addition, two lower units of the subassociation, a typical variant and var. with *Leymus sabulosus* could be distinguished.

The typical variant (withouth differential species) forms very open stands poor in species (3-5, cover 8-10%). It occupies areas up to 1.5 m in width mainly in sites with intensively drifted out marine material. It is less frequent in sites where wash-out is slow. There are no distinct differences in the composition of the stands. Compared to *Euphorbia peplis*, *Cakile euxina* is relatively less hygrophilous, for which it occurs even on the peak of the dunes. The soil of this variant contains a higher percentage of buried organic component.

Similar to the *Cakilo-Euphorbietum inops*, this unit colonizes mainly fore-dunes in the southern coastal part of the 'Birjučij Island' Spit. Its occurrence in the northern part of the territory is rare.

In comparison with the previous variant, that with *Leymus sabulosus* is richer in species (10) and relatively more closed (total cover 30%). In addition to the dominant *Cakile*

euxina, covering 15% of the area under consideration, numerous elements of dune communities are present. *Euphorbia peplis*, abundant in the previous units, already distinctly recedes here. This community links up with the previous variant at its upper border (towards the white dunes) in the southern part of the territory, predominantly on the shore of the Azov Sea, less frequently along the shore-line of the Utljuk Liman. In ascending ground it is replaced by white-dunes communities. In contrast to *Euphorbia peplis*, *Cakile euxina* is able to grow also on disturbed substrates of other types of landscape structures.

The community colonizes loose, fresh to moist fore-dune sands. The percentage of organic remnants in the substrate is mostly rather high. It consists of decaying leaves of seaweeds, mainly *Zostera marina* and some algae, or of other plant remnants which form belts parallel to the shore-line.

Vicherek (1971) studied communities of this class on the Black Sea shore. He distinguished two new associations: *Cakilo euxinae-Salsoletum ruthenicae* and *Cakilo euxinae-Salsoletum tragi*. Both associations characterized by with *Salsola ruthenica* et *S. tragus* differ from *Cakilo-Euphorbietum peplidis* mainly in absence of *Euphorbia peplis* and in presence of both species of the genus *Salsola* as well as *Polygonum maritimum* and *Atriplex hastata*; all these species are missing from the relevés of the 'Birjučij Island' Spit. *Salsola ruthenica* is absent, *S. tragusis* very scarce in the investigated area. On the other hand, Korženevskij et al. (1984) reported the ass. *Cakilo-Salsoletum ruthenicae* from fore-dunes of the Kerčenskij peninsula.

Class: *Honckenyo-Elymetea* R. Tüxen 1966

The vegetation of coastal white dunes of the 'Birjučij Island' Spit is formed by open or half-closed communities dominated by *Leymus sabulosus* (height between 100 and 150 cm), with *Crambe pontica* (one of the endangered species in the Ukraine), the South--Pontic endemic *Helichrysum corymbiforme*, and possibly *Eryngium maritimum*, *Centaurea adpressa*, *Verbascum pinnatifidum* or *Melilotus albus*. Stands of the class *Honckenyo--Elymetea*, dominated by *Argusia sibirica* or *Salsola soda* (Table 2), are similar to the class *Cakiletea maritimae*. However, owing to frequent occurrence of numerous perennials, mainly the dominant *Argusia sibirica* or co-dominant *Leymus sabulosus*, they have also been placed in the *Honckenyo-Elymetea*. They make a transition to the fore-dune stands of the class *Cakiletea*.

In addition to the elements of the class *Honckenyo-Elymetea* and its lower syntaxa, the herb layer contains sand steppe species (class *Festucetea vaginatae*) with reduced dominance and abundance, ruderal species (class *Chenopodietea*) and those of non-succulent perennial communities of salt meadows (class *Asteretea tripolii*). The lowest--situated sites are colonized by species of the class *Cakiletea maritimae*. Because these sites are used as pastures of game animals introduced to the area, ruderal species occur with increased frequency in these sites. Apart from destabilization of dune sands and invasion by ruderal species, trampling and browsing are another negative factors reflected by the suppressed development of numerous species of the family *Fabaceae* and severe damage of *Ephedra distachya* and other species.

Table 2.

Association	*Tournefortietum sibiricae*												
Community								*Salsola soda-Leymus sab.*					
Relevé Nr.	13	14	15	16	17	18	%	19	20	21	22	23	%
Orientation	SE	W	W	W	SW	SE		.	.	.	.	.	
Inclination	2	2	2	2	2	2		.	.	.	.	.	
Area analyzed (m)	10	10	10	10	10	10		10	10	10	10	10	
Total cover (%)	55	60	60	70	65	50		30	30	30	25	40	
Number of species	9	10	9	8	11	17		9	9	9	8	6	
Ch, D-Ass., comm.													
Argusia sibirica (L.) Dandy	3	4	4	4	4	3	100	.	.	.	.	.	0
Salsola soda L.	2	+	.	.	+	2	67	2	2	2	2	3	100
Ch, D-*Honckenyo-Elymetea* and lower syntaxa													
Eryngium maritimum L.	+	+	+	+	+	1	100	1	1	+	1	.	80
Leymus sabulosus (Bieb.) Tzvelev	2	.	+	+	.	2	67	2	2	2	1	2	100
Crambe pontica Steven ex Rupr.	+	.	.	.	+	+	50	.	.	.	.	.	0
Gypsophila perfoliata L.	.	+	.	.	+	+	50	.	.	.	.	.	0
Lactuca tatarica (L.) C. A. Meyer	.	.	.	.	+	+	33	.	.	.	.	.	0
Astrodaucus littoralis (Bieb.) Druce	.	.	.	.	.	.	0	.	.	+	.	+	40
Ch, D-*Cakiletea maritimae* and lower syntaxa													
Cakile euxina Pobed.	2	2	2	2	2	1	100	.	+	.	.	.	20
Suaeda prostrata Pall.	.	1	1	2	+	+	83	.	.	.	.	.	0
Salsola tragus L.	.	.	.	.	.	+	17	+	+	.	.	+	60
Euphorbia peplis L.	.	.	.	.	.	.	0	r	.	r	r	.	60
Euphorbia paralias L.	.	.	.	.	.	.	0	.	.	.	+	.	20
Ch, D-*Asteretea tripolii* and lower syntaxa													
Puccinellia distans (Jacq.) Parl.	.	1	2	2	2	+	83	.	.	.	.	.	0
Artemisia santonicum L.	.	.	.	.	.	.	0	+	+	1	+	1	100
Limonium platyphyllum Linch.	.	.	.	.	.	.	0	+	.	r	+	r	80
Bassia hirsuta (L.) Aschers.	.	.	.	.	.	+	17	.	.	.	.	.	0
Ch, D-*Chenopodietea* and lower syntaxa													
Bromus squarrosus L.	+	.	.	.	+	+	50	.	.	.	.	.	0
Other accompanying species													
Melilotus albus Medik.	+	1	1	1	1	+	100	+	+	.	.	.	40
Polygonum janatae Klokov	.	r	r	r	.	+	67	+	1	+	.	.	60
Salicornia europaea L.	1	1	1	.	.	+	67	.	.	.	.	.	0
Xanthium strumarium L.	.	.	.	.	.	.	0	.	2	+	1	.	60
Erigeron canadensis L.	.	.	.	.	.	+	17	.	.	.	.	.	0

Dunes are colonized by numerous protected and protection-needing species. Among the endangered species are *Crambe pontica*, *Astrodaucus littoralis* and *Asparagus litoralis* (the latter two listed in the Red Data Book of the Ukraine, a recently prepared 2nd, edition). The Pontic-Caspian endemics *Centaurea borysthenica* and *Corispermum ucrainicum*, the South-Pontic endemics *Helichrysum corymbiforme*, *Centaurea majorovii*, *Agropyron dasyanthum*, *Medicago kotovii*, *Odontites salina* and *Limonium meyeri* and the Pontic endemics *Centaurea odessana*, *C. paczoskii* and *Elytrigia pseudocaesia* are also protected. Other rare species of sand dunes are *Asparagus levinae*, *Festuca arundinacea*, *Echium biebersteinii*, etc.

Tournefortietum sibiricae Popescu et Sanda 1975 (Table 2, rel. 13-18)

Nomenclatural type: Popescu et Sanda 1975: 10-11, Table 1, rel. 2 (lectotypus hoc loco)

Diagnostic species combination: *Argusia sibirica*, *Cakile euxina*, *Eryngium maritimum*, *Leymus sabulosus*, *Melilotus albus*, *Polygonum janatae*, *Puccinellia distans*, *Salicornia europaea*, *Suaeda prostrata*.

This species-poor community is formed by elements of the classes *Cakiletea maritimae* and *Honckenyo-Elymetea* (very frequent and abundant), and *Asteretea tripolii*. The number of species in the relevé was mostly about 10; with the exception of relevé No. 18 (17 species), recorded from the upper border of the distribution of this association, displaying relationships with the association *Elymo-Astrodaucetum littoralis*.

The stands consist of upper and lower herb layers. The upper herb layer, formed by individual sand-dune species, is not closed. The lower herb layer determining the physiognomy of the stands attains a maximum height of 30 cm. It is dominated by the perennial *Argusia sibirica*, accompanied by species of the class *Cakiletea maritimae*. The height of the upper herb layer ranges between (60) 75 and 100 cm and is dominated by species of the class *Honckenyo-Elymetea*. In the vegetation profile of the investigated area, this community links up at its lower border with the ass. *Cakilo euxinae-Euphorbietum peplidis* and at its upper border with the ass. *Elymo-Astrodaucetum littoralis*. *Argusia sibirica* is resistant both to wind erosion and burying by sand.

The stands dominated by the melliferous species *Argusia sibirica* play an important part in fixing coastal sands and harbour species of small insects.

***Salsola soda-Leymus sabulosus* community** (Table 2, rel. 19-23)

Diagnostic species combination: *Salsola soda*, *Artemisia santonicum*, *Eryngium maritimum*, *Leymus sabulosus*, *Limonium platyphyllum*.

The community, poor in species, occurs relatively frequently in the investigated area. Regular presence of sand-dune species, mainly *Leymus sabulosus*, possibly *Eryngium maritimum*, is a typical feature. The relevés in Table 2 were recorded at the upper border of the *Euphorbia peplis-Cakile euxina* belt in local depressions and on slight elevations of

fore-dunes. This community is relatively resistant to deflation as well as to burying by sand. Small elevations not exceeding 30 cm in height and surrounding separate plants of *Salsola soda* were observed in sites of this community as a result of movement of sand material. The stands cover several square metres, up to 10 m^2.

Stands dominated by *Salsola soda*, but with very low presence of species of the class *Honckenyo-Elymetea*, occur at the lower border of the *Euphorbia peplis-Cakile euxina* belt, i.e. in the lowest-located and consequently very salty sites. Here, the dominant *Salsola soda*, a late-summer species that generally does not complete its life cycle, is not strictly confined to the immediate proximity of the seashore. Single plants grow on the top or the landward side of white dunes. Mature plants are often uprooted by wind and driven to distant sites (see also "runners" *Crambe pontica* and *Eryngium maritimum).*

Stands dominated by *Salsola soda* occur also on inundated places in the lower flat part of the investigated area, but less frequently than in "disturbed" habitats of fore-dunes. They attract many insects. Game animals feed on young plants of *Salsola soda.*

Elymo-Astrodaucetum littoralis Korženevskij et al. ex Dubyna, Neuhäuslová et Šeljag--Sosonko hoc loco[1)]

Nomenclatural type: Korženevskij et al. 1984, Table 4, rel. 1596 (holotypus hoc loco)

Diagnostic species combination: *Leymus sabulosus, Alyssum hirsutum, Artemisia santonicum, Astrodaucus littoralis, Bromus squarrosus, Crambe pontica, Eryngium maritimum, Seseli tortuosum.*

Communities with *Leymus sabulosus* are the most widely distributed and most important vegetation unit on stabilized sands of coastal white dunes in the studied area. They are formed by a well-developed herb layer with approximate height between 1 and 1.5 m. *Crambe pontica, Eryngium maritimum, Medicago kotovii, Melilotus albus, Centaurea adpressa* and sometimes *Phragmites australis* also occur occasionally as dominants in the upper herb layer. The species *Crambe pontica* and *Eryngium maritimum* are known as the so-called "runners" ("perekati-pole" in Ukrainian). These plants are driven by wind and thus, their seeds are spread over a large distance. The two remaining sublayers of the herb layer, (height of middle sublayer between 30 and 40 cm) with *Helichrysum corymbiforme* (most frequently occurring in the degradation phase of the association), *Seseli tortuosum, Artemisia santonicum, Gypsophila perfoliata, Linaria genistifolia, Verbascum pinnatifidum* etc. are less distinct. The lowest herb sublayer, usually less than 30 cm tall, is made up of annual grasses, *Galium humifusum, Alyssum hirsutum, Polygonum janatae* etc. In some stands, a ground layer formed by the species *Tortula ruralis* is slightly developed.

[1)] The association name by Korženevskij et al. (1984) was not validly published (nomenclatural type missing), so that it was necessary to validate it here.

In the association mentioned above, three lower units can be distinguished: subass. *Elymo-Astrodaucetum littoralis cakiletosum euxinae*, *E.-A. typicum* and *E.-A. caricetosum colchicae*.

Elymo-Astrodaucetum littoralis cakiletosum euxinae subass. nova hoc loco

Nomenclatural type: identical with the type of the association name (holotypus).

Differential species: *Cakile euxina*, *Salsola tragus*, *S. soda*, *Euphorbia paralias*, *E. peplis*

This subassociation is differentiated by the presence of the fore-dune species of the *Cakiletea maritimae* class.

Eryngium maritimum, the remarkable dominant of the analyzed stands, achieves one of its ecological and phytosociological optimas in this community. Similar to *Leymus sabulosus*, this species is resistant to wind erosion, burying by sand and wash-out of the substrate. It grows on the slopes of dunes and in depressions among them. *Eryngium maritimum* occurs mainly in sites where the dune-forming process is less intensive and the height of dunes does not exceed 1.5 m a.s.l. Occasionally, it produces facies in relatively higher-located parts of coastal white dunes. It prefers areas gently sloping towards the sea with substrate composed of sand and crushed shells. It avoids coarse-shell substrate ("rakushechnik") and occurs frequently in areas heavily disturbed by trampling.

Elymo-Astrodaucetum littoralis typicum subass. nova hoc loco

Nomenclatural type: Table 3, rel. 33 (holotypus)

Characteristics of this syntaxon correspond to those of the association. It occupies top parts of white dunes and their slopes facing the sea or liman.

Stands with *Leymus sabulosus*, capable of rapid colonization of freshly drifted sandy substrate, play an important part in the stabilization of sand dunes. The species is very resistant both to deflation and burying by sand and to "injuring" by fine-grain material. It is tolerant to flooding and wash-out. It forms continuous stands or grows individually on dune slopes, in depressions among dunes and on elevations in the central flat part of the territory. It responds to soil damage with a vigorous growth analogous to that of *Crambe pontica*. Seeds of *Leymus sabulosus* are the main food of rodents during the winter season.

Besides *Leymus sabulosus*, *Helichrysum corymbiforme*, *Verbascum pinnatifidum* or *Centaurea adpressa* also prevail locally.

The stands dominated by *Helichrysum corymbiforme*, preferring drier sites (Tab. 3, rel. 38-42), represent a degradation phase of the typical subassociation. This phase arises in sites intensively trampled by deer or exposed to wind erosion. It can be distinguished by a regular occurrence of *Euphorbia seguieriana*, the distribution of which is encouraged

Table 3. - *Elymo-Astrodaucetum littoralis*

Subassociation	*cakiletosum*					*typicum*																*caricetosum colch.*					
Phase														*Helichrysum cor.*					pasture degrad.									
Relevé Nr.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	%
Orientation	SE	W	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	-	-	-	-	-	E	SE	SE	NW	SE	SE	SE	S	S	
Inclination	2	2	2	2	2	2	2	2	2	2	1	2	2	2	-	-	-	-	-	1	2	2	1	4	3	3	3	3	
Area analyzed (m²)	25	25	25	25	25	25	50	25	50	60	60	25	25	25	30	30	30	30	20	25	25	25	25	50	50	50	50	50	
Total cover (%)	40	45	50	55	65	50	75	55	65	80	75	70	40	40	40	45	50	55	65	55	60	50	70	65	55	50	45	40	
Number of species	19	11	22	15	11	28	23	21	17	17	15	21	14	13	27	27	25	22	21	12	8	8	7	25	21	20	13	16	
Ch, D-Ass.																													
Leymus sabulosus (Bieb.) Tzvelev	2	2	1	2	2	3	2	3	3	4	4	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	2	100
Astrodaucus littoralis (Bieb.) Druce	+	.	+	+	.	+	2	r	.	1	.	1	+	+	+	+	+	+	.	.	.	.	.	r	r	r	.	r	64
D-Subass.																													
Salsola soda L.	2	+	+	+	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	29
Cakile euxina Pobed.	1	1	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18
Salsola tragus L.	+	.	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
Euphorbia peplis L.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Euphorbia paralias L.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Polygonum maritimum L.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Seseli tortuosum L.	+	.	r	.	.	+	+	.	1	+	1	1	.	.	+	+	+	+	.	+	.	.	.	+	2	2	+	+	64
Euphorbia seguieriana Neck.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	r	+	r	r	r	1	.	.	.	2	2	1	1	1	46
Carex colchica J. Gay	.	+	.	.	.	.	r	.	.	.	.	.	.	.	+	+	+	r	.	.	.	.	.	1	1	2	2	2	39
Galium humifusum Bieb.	.	.	.	.	.	r	.	1	.	.	.	+	.	.	.	+	+	.	2	.	.	.	.	+	+	+	+	+	39
Scirpoides holoschoenus (L.) Soják	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	18
Ch, D-*Honckenyo-Elymetea* and lower syntaxa																													
Eryngium maritimum L.	4	4	3	3	4	1	+	r	.	1	1	r	+	+	+	+	+	r	+	1	.	.	.	+	+	+	+	+	86
Crambe pontica Steven ex Rupr.	+	+	1	+	.	2	2	2	2	.	2	2	.	1	.	.	.	.	r	2	.	.	.	3	2	2	3	2	64
Gypsophila perfoliata L.	1	.	+	.	.	1	+	+	1	1	+	r	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	54
Lactuca tatarica (L.) C. A. Meyer	1	1	2	2	2	1	.	r	.	.	.	r	+	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	43
Linaria genistifolia (L.) Mill.	.	.	.	.	.	2	2	.	r	.	.	.	+	+	+	+	+	+	1	1	.	.	.	.	.	.	.	.	39
Helichrysum corymbiforme Opperm. ex Katina	.	.	.	.	.	.	.	.	r	1	r	.	.	+	1	2	2	1	3	.	.	+	.	.	.	.	.	.	36
Asparagus levinae Klokov	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	7
Ch, D-*Festucetea vaginatae* and lower syntaxa																													
Chondrilla juncea L.	+	.	r	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	r	.	.	21
Silene subconica Friv.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Artemisia taurica Willd.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Secale sylvestre Host	.	.	.	.	.	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Syrenia cana (Pill. et Mitt.) Neilr.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	7
Centaurea odessana Prod.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Ch, D-*Asteretea tripolii* and lower syntaxa																													
Artemisia santonicum L.	.	.	.	.	.	1	2	2	2	.	1	2	.	.	1	1	1	2	.	+	+	.	.	1	1	2	+	2	61
Elytrigia elongata (Host) Beauv.	1	2	.	.	+	.	1	+	.	.	1	+	.	.	+	1	1	1	.	.	2	2	2	.	.	.	.	.	46

Medicago kotovii Wissjul.	r	.	+	+	.	.	.	.	1	r	.	.	.	.	+	+	1	1	2	.	+	.	2	.	.	1	.	.	46
Limonium meyeri (Boiss.) O. Kuntze	.	.	.	.	.	+	+	.	.	+	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	21
Bassia hirsuta (L.) Aschers.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	18
Apera maritima Klokov	.	.	+	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Puccinellia gigantea (Grossh.) Grossh.	.	.	.	.	.	r	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Odontites salina (Kotov) Kotov	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	4
Ch, D-*Chenopodietea* and lower syntaxa																														
Bromus squarrosus L.	.	.	+	+	.	+	1	2	+	2	+	2	+	+	+	+	.	.	1	.	.	.	.	+	+	+	+	r	68
Senecio vernalis Waldst. et Kit.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	+	.	+	+	21
Consolida regalis S. F. Gray	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	r	r	.	.	.	.	.	r	r	.	.	.	21
Sisymbrium altissimum L.	.	.	.	.	.	1	.	r	.	.	.	.	.	.	r	+	.	.	+	.	.	.	.	.	.	.	.	.	18
Bromus japonicus Thunb.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	14
Lepidium campestre (L.) R. Br.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
Cynodon dactylon (L.) Pers.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Eragrostis minor Host	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	7
Other accompanying species																														
Alyssum hirsutum Bieb.	1	1	+	+	2	+	.	1	.	r	+	2	.	+	+	+	+	+	1	+	.	.	.	.	.	.	.	.	61
Melilotus albus Medik.	2	+	1	2	.	2	+	.	2	1	1	.	.	.	+	+	.	r	1	+	.	.	.	+	.	.	.	.	54
Calamagrostis epigeios (L.) Roth	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	1	.	1	2	2	1	+	+	39
Centaurea adpressa Ledeb.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	1	1	1	1	.	.	2	2	3	+	+	+	.	+	43
Centaurea diffusa Lam.	.	.	.	.	.	r	+	2	1	+	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	25
Polygonum janatae Klokov	+	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	+	r	r	.	.	.	.	r	r	r	r	r	43
Verbascum pinnatifidum Vahl	.	.	+	1	+	.	.	r	.	.	.	1	.	.	1	+	+	1	.	2	+	.	r	.	.	.	.	.	43
Picris hieracioides L.	.	.	+	.	.	r	r	+	.	r	.	.	.	.	+	+	+	.	r	.	.	.	.	.	.	.	.	.	32
Lepidium latifolium L.	.	.	.	.	.	.	1	.	.	r	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	18
Plantago scabra Moench	.	.	.	.	.	1	1	.	.	+	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	18
Asparagus litoralis Steven	.	.	.	.	.	.	r	.	.	.	.	.	.	.	+	r	+	1	.	.	.	.	.	.	.	.	.	.	18
Plantago salsa Pall.	.	.	.	.	.	.	+	.	+	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
Dianthus pseudoarmeria Bieb.	.	.	.	.	.	r	.	.	.	.	+	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
Plantago maritima L.	.	.	.	.	.	+	.	+	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
Phragmites australis (Cav.) Trin. ex Steud.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	r	r	.	+	.	.	.	.	.	.	.	14
Xanthium strumarium L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	1	+	.	.	14
Cerastium syvaschicum Kleopov	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
Astragalus cicer L.	.	.	.	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	11
Achillea euxina Klokov	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	11
Ephedra distachya L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	r	.	.	.	.	.	.	.	.	.	.	11
Cirsium alatum (S. G. Gmel.) Bobr.	.	.	.	.	.	.	.	+	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
Camelina microcarpa Andrz.	.	.	+	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
Linum austriacum L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	7
Agropyron pectinatum (Bieb.) Beauv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	7
Erigeron canadensis L.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Festuca arundinacea Schreb.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	7
Consolida paniculata (Host) Schur	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	7
Reseda lutea L.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Orobanche sp.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Xanthium strumarium L.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Rumex stenophyllus Ledeb.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Agropyron lavrenkoanum Prokud.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	4
E_0																														
Tortula ruralis (Hedw.) Gaertn. et al.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4

by pasture, and by numerous ruderal species of the class *Chenopodietea* (*Bromus japonicus*, *Sisymbrium altissimum*, *Eragrostis minor*, *Consolida regalis* and *C. paniculata*).

Verbascum pinnatifidum forms locally conspicuous yellow spots on landward-facing dune slopes (Table 3, rel. 43). It occurs less frequently on peaks of white dunes, where it is confined to local depressions. The species is sensitive to wind erosion, burying by sand and frequent trampling, but relatively tolerant to the accumulation of sea material and wash-out. Its spreading is hampered by deer-browsing; the animals which use it as part of their diet. Its flowers are prefered by bees and other insects.

Centaurea adpressa forms facies usually on slopes of landward-facing coastal dunes (reaching the height 1-1.5 m). It is confined to the sites in which the soil-forming process is slow. It occurs in habitats sheltered from strong wind or burying by sand, without wash-out and accumulation of sea material. The species forms stripes 1-3 m in width and 150-250 m in length in sites which are not exposed to intensive trampling. Single plants are only rarely to be found. This facies appears in the northern part of the territory, more frequently on dunes along the sea than on the liman shores. The seeds of the species are gathered and consumed by rodents during the winter season, the leaves and young stalks serve as game food. The stands, poor in species (Table 3, rel. 44-46) witness heavy damages caused by browsing and leisure-time activities. They occur in a habitat occupied by many small mammals and birds.

Also *Polygonum janatae*, a frequent species of coastal dunes, forms local groups covering areas of about 1-3 m^2. This species with shoots up to 50 cm long, tolerates burying by sand and is also resistant to wind erosion. It grows well when protected by species capable to retain sand.

Elymo-Astrodaucetum littoralis caricetosum colchicae subass. nova hoc loco

Nomenclatural type: Table 3, rel. 51 (holotypus)

Differential species: *Carex colchica*, *Artemisia santonicum*, *Euphorbia seguieriana*, *Seseli tortuosum*, *Galium humifusum*, *Scirpoides holoschoenus*.

This subassociation can be identified by the presence of species colonizing relatively drier, higher-situated sites of sand-steppe communities (see differential species), as well as by the presence of *Calamagrostis epigeios* and *Centaurea adpressa*. *Crambe pontica*, a typical element of coastal dunes, forms facies in this subassociation. However, this species is also frequent and (sub)dominant in stands of the typical subassociation.

The stands dominated by *Crambe pontica* are typical of both the 'Birjučij Island' Spit and other spits of the Azov Sea and the Black Sea. They occur most frequently in habitats exposed to wash-out but also in higher sites of the dunes. Owing to the permanent production of leaves and shoots, the dominant species *Crambe pontica* can grow even in habitats exposed to very strong aeolic processes. It also appears at the border of the association *Cakilo euxinae-Euphorbietum peplidis* in sites where the above-mentioned species of the class *Cakiletea maritimae* are not able to compete with invading sand-dune species. *Crambe pontica* occasionally appears also in other types of stands. Remarkable amounts of viable offshoots and seeds of this species were found on the dunes as well as in higher-situated depressions among them in the territory under study. When

the upper soil layer has been loosened (e.g. by planting of forest cultures), the mass germination of *Crambe pontica* is initiated, resulting in 40-75(80) % cover. Together with *Crambe pontica*, other species of "injured" habitats also appear in such sites, such as *Heliotropium dolosum*, and other elements of the class *Chenopodietea*.

Crambe pontica also plays an important part as a food plant. Many rodents and birds feed on its seeds. It is visited by bees and other insects during the blooming period.

Stands with *Crambe pontica* cover large areas in the southern peripheral part of the spit. They are relatively well-preserved in this area. On the other hand, they are heavily degraded on coastal dunes surrounding the Utljuk Liman.

The association *Elymo-Astrodaucetum littoralis* occurs more frequently on coastal dunes in the northern part of the 'Birjučij Island' Spit. Its less frequent occurrence in the southern part of the spit is due to intensive wash-out of dunes. Relatively extensive stands of this community are to be found also on coastal dunes around the Utljuk Liman.

In addition to their shore- and soil-protecting function, these communities are of great importance as fodder, especially in their early stage of development, and harbour many small animals.

Class: *Agropyretea pungentis* J.-M. Géhu et J. Géhu 1969

Order: *Lepidietalia latifolii* Golub et V. Solomacha ex Dubyna, Neuhäuslová et Šeljag-Sosonko hoc loco

Nomenclatural type: *Lepidion latifolii* Golub et Mirkin ex Dubyna, Neuhäuslová et Šeljag-Sosonko

Alliance: *Lepidion latifolii* Golub et Mirkin ex Dubyna, Neuhäuslová et Šeljag-Sosonko hoc loco

Nomenclatural type: *Cynancho acuti-Lepidietum latifolii* Dubyna, Neuhäuslová et Šeljag-Sosonko

***Cynancho acuti-Lepidietum latifolii* ass. nova hoc loco** (Table 4, rel. 52-56)

Nomenclatural type: Table 4, rel. 52 (holotypus)

Diagnostic species combination: *Lepidium latifolium*, *Atriplex littoralis*, *Bassia hirsuta*, *Bromus squarrosus*, *Cynanchum acutum*, *Elytrigia elongata*, *E. repens*, *Lactuca tatarica*, *Polygonum janatae*, *Sinapis alba*.

This community covering up to 75 % of the study area is formed by ca. 20 species. The number of species in the relevés is relatively steady, it fluctuates mostly between 11 and 15. The dominant species *Lepidium latifolium* covers more than a half of the area occupied by the analyzed stands. Frequently, *Cynanchum acutum* occurs as a subdominant (cover 10 %). Salt-meadow species of the class *Asteretea tripolii* occur almost regularly. The presence of sand-steppe elements in this community is negligible.

This association is represented by two-layer stands covering several square meters (3-5 m^2, rarely up to 10 m^2). The upper herb layer determining the physiognomy of the stands (height between 75 and 100 cm) is formed by *Lepidium latifolium*, *Cynanchum*

Table 4. - *Cynancho acuti-Lepidietum latifolii* ass. nova

Relevé Nr.	52	53	54	55	56	%
Orientation	-	-	-	-	-	
Inclination	-	-	-	-	-	
Area analyzed (m)	10	10	10	10	10	
Total cover (%)	70	70	75	65	35	
Number of species	15	14	11	11	11	
Ch, D-Ass.						
Lepidium latifolium L.	4	3	4	4	3	100
Cynanchum acutum L.	2	2	2	1	1	100
Ch-*Cakiletea maritimae* and lower syntaxa						
Atriplex littoralis L.	+	+	+	+	+	100
D-*Honckenyo-Elymetea* and lower syntaxa						
Lactuca tatarica (L.) C. A. Meyer	+	+	+	+	+	100
Argusia sibirica (L.) Dandy	.	2	.	.	.	20
Ch, D-*Asteretea tripolii* and lower syntaxa						
Elytrigia elongata (Host) Beauv.	1	1	+	+	+	100
Bassia hirsuta (L.) Aschers.	+	+	r	r	.	80
Bassia sedoides (Pall.) Aschers.	r	r	+	.	.	60
Artemisia santonicum L.	+	+	.	.	.	40
Ch-*Festucetea vaginatae* and lower syntaxa						
Chondrilla juncea L.	+	.	.	.	.	20
Ch, D-*Chenopodietea* and lower syntaxa						
Bromus squarrosus L.	+	+	+	+	+	100
Bromus japonicus Thunb.	.	+	.	.	.	20
Other accompanying species						
Elytrigia repens (L.) Nevski	+	+	2	+	+	100
Sinapis alba L.	+	+	1	+	+	100
Polygonum janatae Klokov	r	r	r	.	+	80
Plantago scabra Moench	+	.	.	+	.	40
Melilotus albus Medik.	.	.	.	+	+	40
Plantago salsa Pall.	+	.	.	.	.	20
Erysimum repandum L.	.	.	.	.	+	20

acutum, occasionally by *Elytrigia elongata* and *E. repens*. The lower herb layer (ca. 30 cm tall) is slightly developed, its most important components are *Bassia* and *Bromus* species, furthermore *Argusia sibirica*, *Sinapis alba* and *Polygonum janatae*.

This community occurs in non-inundated places of the plain and relatively higher-situated depressions between the dunes. In the area of fore-dunes, it appears mostly on substrates with higher percentage of buried organic material (*Zostera marina* etc.) in the southern part of the study area. It occurs more frequently on slight elevations in sites facing the Utljuk Liman. It is absent from higher-situated places and from those steadily disturbed by accumulating sea material.

The community may be important as wildlife fodder. Its dense stands provide a habitat and/or shelter for small mammals and birds.

Discussion

The classification of the vegetation of coastal dunes and fore-dunes (incl. the "drift zone") has been the subject of intensive research in the last 40 years (see: Géhu 1971, 1993, Géhu et al. 1986, Géhu et Géhu 1969, Géhu, Roman et Boullet 1972, Géhu et Tüxen 1975, Géhu et Uslu 1989, Hadač 1970, Popescu, Sanda et Doltu 1980, Rivas Goday et Rivas Martínez 1958, Thannheiser 1993, Tüxen 1950, 1966, 1970, 1975, Tüxen et Böttcher 1971, 1972, Tüxen et Géhu 1971, Vicherek 1971). Some problems such as the incorporation of lower vegetational units into higher syntaxa and determination of the width of individual classes still remains to be sorted out in order to unify the classification and evaluation of this vegetation within the framework of preparatory work on the "Vegetation Survey of Europe". The aim of the present paper is to contribute to the solution of this question from the viewpoint of conditions of the eastern and southeastern continental part of Europe.

In 1950, Tüxen (1950) determined the coastal vegetation of fore-dunes including the drift-zone as a separate class, *Cakiletea maritimae*, which unifies species-poor, natural, open communities of obligatory halophilous and nitrophilous therophytes distributed throughout northern and western Europe and the Mediterranean region. Both in this and the next papers, the author drew attention to the specificity of these communities (cf. Tüxen 1950:99, 1975).

The classification of the communities of fore-dunes and the drift-zone of the 'Birjučij Island' Spit into a separate class *Cakiletea maritimae* may be regarded as convenient for the territory in question.

In contrast, Hadač (1970) refused to recognize Tüxen's separation of the class *Cakiletea maritimae* as an independent higher syntaxon. In his opinion, "the syntaxonomic differences between natural nitrophilous communities and the corresponding synanthropic vegetation units are sufficiently classified at the level of different orders." On the basis of floristic similarity of his relevé material of the alliance *Atriplicion littoralis* Nordhagen 1940 to the stands of the class *Chenopodietea* characterized by the presence of many synanthropic species, Hadač (1970) placed communities of fore-dunes and seashores in the order

Cakiletalia maritimae R. Tüxen apud Oberdorfer 1949 and the class *Chenopodietea*. However, this classification is quite unacceptable for most communities described up to now. Also the stands treated in the present paper show a substantially closer affinity to the sand dune communities of the class *Honckenyo-Elymetea* than to those of the class *Chenopodietea*.

The association *Tournefortietum sibiricae* was placed in to the alliance *Cakilion maritimae* Morariu 1967 (= *Cakilion euxinae* Géhu, Roman et Boullet 1992) and the class *Cakiletea maritimae* according to Rumanian geobotanists. Taking into account the strong dominance of the perennial *Argusia sibirica* in this association, Géhu (pers. comm.) proposed to incorporate this association into the class *Honckenyo-Elymetea*. The association should be considered as a transitional type between *Cakiletea maritimae* and *Chenopodietea*.

However, the position of the ass. *Cynancho acuti-Lepidietum latifolii* in the phytosociological system is not quite clear. Despite certain floristic similarity to other vegetation units of the class *Cakiletea maritimae* into similar "*Lepidieta latifolii*" have been generally included, this association is very different from the ecological point of view.

Géhu et Géhu (1969) proposed to arrange such communities into *Agropyretea pungentis*, the class they had described. However, in the study area, almost all diagnostic species of these syntaxa are missing. The same author (Géhu pers. comm.) prefers the incorporation of this association into the class *Agropyretea intermedio-repentis* (Oberdorfer et al. 1967) Müller et Görs 1969.

Solomešč et al. (1988) placed analogous communities in the alliance *Lepidion latifolii* Golub et Mirkin 1986 (nomenclatural type missing due to invalidly published association names) of the order *Lepidietalia latifolii* Golub et V. Solomacha 1988 (based on the invalidly published alliance name) and the class *Crypsietea aculeatae* Vicherek 1973. This class includes communities of mostly annual plants in steppe and desert zones, characterized by very changeable regime of soil moisture and degree of salinity in the upper soil horizons (see Solomešč et al. 1988). However, all diagnostic species of the class *Crypsietea aculeatae* are also missing from the ass. *Cynancho-Lepidietum latifolii* at the 'Birjučij Island' Spit. The final phytosociological evaluation and classification of analogous syntaxa requires general syntaxonomical revision of corresponding units from the whole southeastern Europe.

Earlier phytosociological studies treated all the communities of European dunes within the class *Ammophiletea* Braun-Blanquet et Tüxen 1943. Later on, Tüxen (1966) arranged coastal dune communities of the cooler part of Europe into a new class *Honckenyo peploidis-Elymetea arenarii* Tüxen 1966 (see also Tüxen et Böttcher 1971). This separation of the vegetation of coastal dunes was also recognized by Géhu (1993) who placed the dividing line between the two classes into the region of southern Bulgaria (see: Géhu 1973: 87). For the Mediterranean-Atlantic class, he proposed the name *Euphorbio--Ammophiletea* Géhu et Géhu-Franck 1988.

The establishment of two classes in the region of the West Pontic coast resulted in the re-evaluation of several syntaxa. This concerned mainly the delimitation of the alliance

Elymion gigantei Morariu 1957 (see also Géhu et al. 1992), which according to Vicherek (1971) unified syntaxa of the coastal dunes in the Submediterranean and in the Pontic part of the Black Sea and the Azov Sea. The transition between the classes *Euphorbio-Ammophiletea* and *Honckenyo peploidis-Elymetea arenarii* is represented mainly by the association *Ammophilo arundinaceae-Elymetum gigantei* Vicherek 1971; its diagnostic species occur in the Mediterranean region. J.-M. Géhu (pers. comm.) regards this association as a syntaxon of the class *Euphorbio-Ammophiletea*.

The order *Elymetalia gigantei* as delimited by Vicherek (1971), however, perfectly corresponds to the newly suggested differentiation of both classes. This order includes the syntaxa of coastal dunes of the continental southeastern and eastern Europe. Vicherek (1971) distinguished several vicarizing associations of the alliance *Elymion gigantei* Morariu 1957 on the Black Sea shores:

1. *Ammophilo arundinaceae-Elymetum gigantei* Vicherek 1971 on the coasts of Bulgaria (see above),

2. *Elymetum gigantei* Morariu 1957 on the Black Sea coast in Rumania.

The following species are typical of the association: *Elymus giganteus*, *Centaurea arenaria*, *Gypsophila scorzonerifolia*, *Convolvulus lineatus*, *Medicago falcata*, *Xanthium italicum*, *Salsola ruthenica*, and other species, which are common with the communities at the territory under our investigation. In the opinion of Rumanian geobotanists (Popescu, Sanda and Doltu 1980, Ivan et al. 1993), the Rumanian species *Elymus giganteus* is identical with *Leymus sabulosus*. Except for the species mentioned above, which are replaced in the 'Birjučij Island' Spit by other, sometimes vicarizing species (*Centaurea adpressa*, *Medicago kotovii*), the rest of the species set of both communities is very similar.

The community *Elymetum gigantei*, as given by Morariu (1959), differs from our sand-dune association by the presence of *Melica ciliata*, *Alyssum borzaeanum*, *Stachys sideritioides*, *Salvia aethiopis*, *Scabiosa ucranica*, *Achillea pannonica*, and *Onopordon tauricum*.

A related community was reported by Puscaru-Soroceanu et al. (1963) in the form of a synthetic table under the name as. *Elymus sabulosus* + *Crambe maritima* + *Eryngium maritimum*. This Rumanian community differs from the Azov association by the presence of *Elymus asper*, *Ammophila australis*, *Festuca vaginata*, *Medicago marina*, *Silene pontica*, *Gypsophila scorzonerifolia*, *Alyssum borzaeanum*, *Elytrigia juncea*, *Convolvulus lineatus*, *C. persicus*, *Marrubium remotum* etc. It belongs to the association described by Morariu (1957). According to Géhu et al. (1992) the white-dune communities of Rumania can be placed in the following association distributed in Rumania and the Ukraine:

3. *Centaureo odessanae-Elymetum gigantei* Vicherek 1971

(Syn.: *Elymus sabulosus* + *Centaurea odessana* + *Artemisia trautvetteriana* ass. Davidič 1947 ms.) distributed on the Pontic shores NE of the Danube Delta (excluding the southern coast of the Crimea) and on the shores of the Azov Sea.

According to the Ukrainian flora (Dobročaeva et al. 1987), *Elymus giganteus* Vahl is rarely distributed only in the NE part of the Steppe whereas from the shores of the Black Sea and the Azov Sea, *Leymus sabulosus* is reported. Consequently, *Elymus giganteus* in the relevés of Vicherek (1971) is identical with *Leymus sabulosus* of Ukrainian authors.

The occurrence of *Agropyron junceum*, *A. maeoticum* and *Galium tenderiense* in the relevés by Vicherek (1971) and, on the contrary, the presence of *Astrodaucus littoralis* as

well as of many species of the classes *Asteretea tripolii* (*Artemisia santonicum*, *Limonium meyeri*, *Bassia hirsuta* etc.) and *Chenopodietea* and many accompanying species (*Alyssum hirsutum*, *Centaurea diffusa*, *Dianthus pseudoarmeria* etc., cf. Table 3) are the most important differences between these two groups of relevés which can be evaluated as vicariant associations. Also the occurrence of *Centaurea odessana* in the relevés from the 'Birjučij Island' Spit is negligible in comparison with the association of Vicherek.

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Souhrn

V předložené práci jsou shrnuty výsledky studia pobřežní vegetace mořské kosy 'Ostrov Birjučij', vybíhající do Azovského moře v jeho severozápadní části. Nejnižší polohy této kosy bývají přeplavovány mořskou vodou, takže zbývající nejvýše 5 m n.m. ležící část území tvoří zdánlivý ostrov. To bylo důvodem označení tohoto území názvem 'Ostrov Birjučij'. Velmi podrobná fyzicko-geografická charakteristika tohoto území, ležícího v jihovýchodní kontinentální části Ukrajiny, je uvedena ve studii Dubyna et al. (1994).

V území byly zaznamenány tyto vegetační jednotky:

Třída: *Cakiletea maritimae* R. Tüxen et Preising in R. Tüxen 1950
Řád: *Euphorbietalia peplidis* R. Tüxen 1950
Svaz: *Euphorbion peplidis* R. Tüxen 1950

Asociace: *Cakilo euxinae-Euphorbietum peplidis* Dubyna, Neuhäuslová et Šeljag-Sosonko (Tab. 1, sn. 1-12)
Druhově chudá asociace nejnižší části mořského pobřeží, tvořená druhy, přizpůsobenými k životu v extrémních podmínkách akumulace mořských sedimentů a jejich rozmyvu mořskou vodou. Osidluje úzký pobřežní pás do výšky 1.5 m n.m.

Cakilo euxinae-Euphorbietum peplidis inops Dubyna, Neuhäuslová et Šeljag-Sosonko, druhově velmi chudé, je vázáno na nižší, častěji přeplavované polohy. Druhově bohatší *Cakilo euxinae-Euphorbietum peplidis crambetosum* Dubyna, Neuhäuslová et Šeljag-Sosonko je pojítkem k fytocenózám třídy *Honckenyo-Elymetea*.

Třída: *Honckenyo peploidis-Elymetea arenarii* R. Tüxen 1966
Řád: *Elymetalia gigantei* (= *Leymetalia sabulosi*) Vicherek 1971
Svaz: *Elymion gigantei* (= *Leymion sabulosi*) Morariu 1957 em. Géhu, Roman et Boullet 1992

Asociace: *Tournefortietum sibiricae* Popescu et Sanda 1975 (Tab. 2, sn. 13-18)
Dvouvrstevné fytocenózy této asociace jsou tvořeny řídkou svrchní bylinnou vrstvou a hustě zapojenou spodní vrstvou s dominantní *Argusia sibirica*, druhem odolným proti větrné erozi i zavátí pískem. Nahrazují předchozí asociaci v polohách kolem 1.5 m n.m. a výše při horní hranici častých přílivů.

Společenstvo: *Salsola soda-Leymus sabulosus* (Tab. 2, sn. 19-23)
Druhově chudé fytocenózy předdun s kopečkovitým mikroreliéfem, tvořeným mírnými elevacemi výšky do 30 cm, obklopujícími jednotlivé rostliny *Salsola soda*, a lokálními sníženinami mezi nimi. Jsou poměrně odolné vůči rozmyvu i zavátí pískem.

Asociace: *Elymo-Astrodaucetum littoralis* Korženevskij et al. ex Dubyna, Neuhäuslová et Šeljag-Sosonko (Tab. 3, sn. 24-51). Toto typické společenstvo zpevněných písků bílých dun tvoří slabě až středně zapojené, 1-1.5 m vysoké porosty, v nichž většinou převládá *Leymus sabulosus*. V rámci této asociace byly vyšlechtěny tři subasociace, svým složením i vlastnostmi stanoviště obdobné vikarizující černomořské asociaci *Centaureo odessanae-Elymetum gigantei* Vicherek 1971. *Elymo-Astrodaucetum littoralis cakiletosum euxinae* Dubyna, Neuhäuslová et Šeljag-Sosonko je diferencováno přítomností druhů třídy *Cakiletea maritimae*. Častou dominantou bývá *Eryngium maritimum*. Subasociace je vázána na nejnižší polohy na stanovištích dané asociace. *Elymo-Astrodaucetum littoralis typicum* Dubyna, Neuhäuslová et Šeljag-Sosonko se vyskytuje na vrcholech bílých dun i jejich sklonech různé orientace. Na místech vystavených intenzívnímu sešlapu zvěří nebo silné větrné erozi dochází ke vzniku degradačních fází, např. časté fáze s *Helichrysum corymbiforme* s mnohými prvky synantropní vegetace. *Elymo-Astrodaucetum littoralis caricetosum colchicae* Dubyna, Neuhäuslová et Šeljag-Sosonko je diferencováno výskytem některých prvků písčitých stepí (*Carex colchica*, *Seseli tortuosum*, *Euphorbia seguieriana* aj.), na něž zpravidla navazuje.

Společenstva třídy *Honckenyo-Elymetea* se vyskytují především v severní části území, vystavené slabší akumulační činnosti moře i mírnému rozmyvu dun. Naproti tomu fytocenózy třídy *Cakiletea maritimae* mají centrum rozšíření v jižní části území, narušované nanášením mořských sedimentů i jejich intenzívním rozmyvem.

Třída: *Agropyretea pungentis* J.-M. Géhu et J. Géhu 1969
Řád: *Lepidietalia latifolii* Golub et V. Solomacha ex Dubyna, Neuhäuslová et Šeljag-Sosonko
Nomenklatorický typ: *Lepidion latifolii* Golub et Mirkin ex Dubyna, Neuhäuslová et Šeljag-Sosonko
Svaz: *Lepidion latifolii* Golub et Mirkin ex Dubyna, Neuhäuslová et Šeljag-Sosonko
Nomenklatorický typ: *Cynancho acuti-Lepidietum latifolii* Dubyna, Neuhäuslová et Šeljag-Sosonko

Asociace: *Cynancho acuti-Lepidietum latifolii* Dubyna, Neuhäuslová et Šeljag-Sosonko (Tab. 4, sn. 52-56). Nitrofilní, až 1 m vysoké fytocenózy této asociace s dominantním druhem *Lepidium latifolium*, častým výskytem druhů slaných luk třídy *Asteretea tripolii* a nepatrným zastoupením druhů písčitých stepí třídy *Festucetea vaginatae*. Osidlují nezaplavované ruderalizované rovinné části území a výše položené mezidunové sníženiny. V pásu předdun v jižní části území jsou většinou vázány na substráty s větším nahromaděním organického materiálu (*Zostera marina* aj.). Vyhýbají se polohám často narušovaným akumulací mořského materiálu i výše položeným místům. Jsou časté v jižní části území poblíž Utljuckého limanu.

V diskusi je věnována pozornost pojetí třídy *Cakiletea maritimae* a zařazení nově popsané as. *Cynancho acuti-Lepidietum latifolii* do fytocenologického systému. I když její řazení na úrovni svazu a řádu odpovídá klasifikaci ruských a ukrajinských autorů, klasifikace na úrovni třídy zůstává nadále problematická. K jejímu konečnému vyřešení je třeba provést syntézu analogických společenstev z kontinentální části celé jihovýchodní Evropy.

Pozornost je též věnována odlišení tříd *Euphorbio-Ammophiletea* a *Honckenyo-Elymetea* a diferenciaci vikarizujících asociací svazu *Elymion gigantei* (= *Leymion sabulosi*) v západopontické a severopontické oblasti Evropy.

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Appendix 1.

Localities of relevés

Table 1. *Euphorbion peplidis*

Rel. 1-5. SE coast of the 'Birjučij Island' Spit, lowest part of the seashores of all profiles, Dubyna 1989, 1991.
6-11. The same locality, middle part of the seashores of all profiles, Dubyna 1991.
12. Fedotova kosa Spit, coast of the Azov Sea, rel. 65 by Neuhäuslová and Dubyna 1991.

Table 2. *Tournefortietum sibiricae* and *Salsola soda-Leymus sabulosus* community

Rel. 13-14. SE coast of the "Birjučij Island" Spit, Dubyna 1989-1991.
15-17. W part of the "Birjučij Island" Spit, Dubyna 1989-1991.
18. The same locality, SW part of the Spit, Dubyna 1991.
19. NE coast of the Spit, Dubyna 1991.
20. Fedotova kosa Spit, Dubyna 1991.
21. NE part of the Fedotova kosa Spit, coast of the Azov Sea, Dubyna 1991.

22. E part of the Fedotova kosa Spit, coast of the Azov Sea, Dubyna 1991.
23. SW coast of the 'Birjučij Island' Spit, coast of the Utljuk Liman, Dubyna 1991.

Table 3. *Elymo-Astrodaucetum littoralis*

Rel. 24-25. SW and W coast of the 'Birjučij Island' Spit, white dunes facing the Utljuk Liman, Dubyna 1991.
26-28. SE, E and NE coast of the 'Birjučij Island' Spit, white dunes facing the Azov Sea, Dubyna 1991.
29-30. Fedotova kosa Spit, dunes facing the Azov Sea, rel. 32 and 39 by Neuhäuslová and Dubyna 1991.
31. 'Birjučij Island' Spit, profile 2, dunes facing the Utljuk Liman, rel. 16 by Neuhäuslová and Dubyna 1991.
32-33. The same locality, dunes facing the Azov Sea, rel. 38 and 54 by Dubyna and Neuhäuslová 1991.
34. Fedotova kosa Spit, 2 km from the village to the reserve, rel. 64 by Dubyna and Neuhäuslová 1991.
35-37. 'Birjučij Island' Spit, rel. 110, 109 and 113 by Husák 1991.
38-42. 'Birjučij Island' Spit, white dunes of the E coast, rel. 73-76 by Dubyna 1991.
43. The same locality, white dunes of the NE coast, rel. 14 by Dubyna 1991.
44-45. Fedotova kosa Spit, white dunes facing the Azov Sea, rel. 28 and 29 by Dubyna 1991.
46. 'Birjučij Island' Spit, dunes facing the Utljuk Liman, rel. 30 by Dubyna 1991.
47-51. "Birjučij Island" Spit, rel.1-5 by Dubyna 1991.

Table 4. *Cynancho acuti-Lepidietum latifolii*

Rel. 52-56. SE part of the 'Birjučij Island' Spit, profiles 1 and 2, Dubyna 1991.