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SYNTAXONOMY OF VEGETATION OF NATIONAL NATURE PARK «DZHARYLHATSKYI». THE CLASS *JUNCETEA MARITIMI*

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*The syntaxonomic structure of the class *Juncetea maritimi* Br.-Bl. in Br.-Bl. et al. 1952 on the territory of National Nature Park «Dzharylhatskyi» was specified. Six associations were identified, two of which are listed for the first time: *Juncetum maritimo-acuti* Horvatić 1934 is presented for the first time for the territory of the National Nature Park «Dzharylhatskyi» and *Juncetum littoralis* Popescu et. al. 1992 is presented for the first time for the territory of Ukraine. The article presents the classification scheme and prodromus of vegetation of the class *Juncetea maritimi*, as well as a map of the distribution of syntaxa found on the Dzharylhach Island at the association level. The results of processing geobotanical data obtained during 2017-2018 did not confirm the eight associations cited for the Dzharylhach Island: *Plantagini salsae-Juncetum maritimi* Shelyag-Sosonko et Solomakha 1987, *Tripolio pannonicarum-Caricetum extensae* Dubyna et Neuhäuslová 2000, *Limonio gmelinii-Aeluropodetum littoralis* Krausch 1965, *Plantagini salsae-Limonietum meyeri* Dubyna et al. 2007, *Limonio meyeri-Plantaginetum cornuti* Dubyna et al. 2007, *Artemisio santonicae-Juncetum maritimi* Shelyag-Sosonko, Dubyna et Neuhäuslová in Dubyna et Neuhäuslová 2000, *Carici distantis-Schoenetum nigricantis* Géhu et al. 1986, *Schoeno nigricantis-Plantaginetum maritimae* Rivas-Martínez 1984.*

*Some clarifications are given regarding the status of syntaxa in the class *Juncetea maritimi*, which are mentioned in recent summaries for the territory of Ukraine: alliance *Junco maritimi-Schoenion nigricantis* Dubyna et Dziuba 2019 and association *Junco maritimi-Schoenetum nigricantis* Dubyna et Dziuba 2019 are invalid; it is necessary to search for the protologue of the association *Junco maritimi-Schoenetum nigricantis* Provost 1975 to confirm or refute the case of homonymy according to the «International Code of Phytosociological Nomenclature». The relevance of further research in Ukraine to identify new localities of *Juncetum littoralis* is emphasized.*

Key words: halophytic communities, chorology, vegetation mapping, new syntaxon.

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СИНТАКСОНОМІЯ РОСЛИННОСТІ НАЦІОНАЛЬНОГО ПРИРОДНОГО ПАРКУ «ДЖАРИЛГАЦЬКИЙ». КЛАС *JUNCETEA MARITIMI*

*Уточнено синтаксономічну структуру класу *Juncetea maritimi* Br.-Bl. in Br.-Bl. et al. 1952 на території Національного природного парку «Джарилгацький». Виявлено шість асоціацій, дві з яких наводяться уперше: *Juncetum maritimo-acuti* Horvatić 1934 – уперше для Національного природного парку «Джарилгацький» та *Juncetum littoralis* Popescu et. al. 1992 – уперше для України. У статті наведено класифікаційну схему і продромус рослинності класу *Juncetea maritimi*, а також надано мапу поширення виявлених на острові Джарилгач синтаксонів на рівні асоціації. Результати обробки геоботанічних даних, отриманх протягом 2017-2018 років, не підтвердили вісім асоціацій, які наводилися для острова Джарилгач: *Plantagini salsae-Juncetum maritimi* Shelyag-Sosonko et Solomakha 1987, *Tripolio pannonicarum-Caricetum extensae* Dubyna et Neuhäuslová 2000, *Limonio gmelinii-Aeluropodetum littoralis* Krausch 1965, *Plantagini salsae-Limonietum meyeri* Dubyna et al. 2007, *Limonio meyeri-**

Plantaginetum cornuti Dubyna et al. 2007, *Artemisio santonicae-Juncetum maritimi* Shelyag-Sosonko, Dubyna et Neuhäuslová in Dubyna et Neuhäuslová 2000, *Carici distantis-Schoenetum nigricantis* Géhu et al. 1986, *Schoeno nigricantis-Plantaginetum maritimae* Rivas-Martínez 1984. Наведено деякі уточнення щодо статусу синтаксонів в складі класу *Juncetea maritimi*, які згадуються в останніх зведеннях для території України: союз *Juncetea maritimi-Schoenion nigricantis* Dubyna et Dziuba 2019 та асоціація *Juncetea maritimi-Schoenion nigricantis* Dubyna et Dziuba 2019 є невалідними; є необхідними пошуки протологу асоціації *Juncetea maritimi-Schoenion nigricantis* Provost 1975 для підтвердження або спростування випадку омонімії згідно «Міжнародного кодексу фітосоціологічної номенклатури». Підкреслено актуальність подальших досліджень на території України для виявлення нових локалітетів *Juncetea littoralis*.

Ключові слова: галофітні угруповання, хорологія, картування рослинності, новий синтаксон.

INTRODUCTION

The National Nature Park «Dzharylhatskyi» is located in the southern part of Ukraine, in Skadovsk district of Kherson region (Fig. 1). Its territory consists of the Dzharylhach Island, four mainland areas and a part of Dzharylhach Bay. The total area of the NNP is 10,000 hectares, in particular the Dzharylhach Island – 5065 hectares [2].



Fig. 1. Map of the research area (the territory of the National Nature Park «Dzharylhatskyi» is marked by red colour)

The research of the vegetation of this territory has been considered in numerous papers by various authors during the 20th and 21st centuries, in particular, J.K. Paczoski, N. Desyatova-Shostenko and F. Levina, S.O. Illichevskiy, D.V. Dubyna and Yu.R. Shelyag-Sosonko, D.V. Dubyna and T.P. Dziuba, A.O. Davydova [4, 5, 9, 10, 14, 16]. The predominant vegetation types are aquatic vegetation of saline water bodies, halophytic meadows and psammophytic communities.

In this paper we will focus on the class *Juncetea maritimi* Br.-Bl. in Br.-Bl. et al. 1952, represented by tall saline perennial grasslands and swamps of coastal areas with sandy-muddy soils (salt marshes). The aim of the work is to present the data of studied syntaxa, which indicate specific conditions of the vegetation formation on the territory of the Dzharylhach Island.

MATERIAL AND METHODS

The materials for analysis were 67 relevés made by the author during 2017–2018. All relevés were carried out on plot sizes from 4 to 25 m² sampling on studied area according to the J. Braun-Blanquet's approach [3]. All relevés were entered into a separate database in TURBOVEG software version 2.142 [13]. The classification of the vegetation was conducted by Modified TWINSpan algorithm [17], implemented in JUICE software [20]. At the first stage, the database of the halophytic vegetation of the National Nature Park «Dzharylhatskyi» which includes 415 relevés was analyzed, and then relevés from *Juncetea maritimi* class was separated and analyzed to the association level. The phi fidelity index was used to identify diagnostic species. Non-essential values of fidelity ($P < 0,001$) were removed based on Fischer's exact test. The fidelity threshold for the allocation of diagnostic species is at least 25 %, for highly diagnostic species – 50% (these species in the prodromus of the vegetation are highlighted in bold). «Pseudospecies» cut level was accepted as 0, 5, 15, 25%. B.M. Mirkin's (2001) modified cover scale was used to estimate the vegetation cover on plots: + – < 1 %, 1 – 1-5 %, 2 – 6-15 %, 3 – 16-25 %, 4 – 26-50 %, 5 – > 50 % [15].

The syntaxonomic structure of the class *Juncetea maritimi* were accepted according to the recent «Prodrome of the vegetation of Ukraine» [8] with several corrections. The nomenclature of taxa is given in according to Euro+Med PlantBase [18]. The QGIS 3.22.5 program was used for the mapping of plant communities on the Dzharylhach Island.

RESULTS AND DISCUSSION

Communities of *Juncus maritimus* and *Juncus littoralis* according to the dominant approach were mentioned in papers of N. Desyatova-Shostenko and F. Levina, and S.O. Ilichevskyi [6, 14]. Based on principles of the floristic-ecological classification have been firstly indicated for the Dzharylhach Island by D.V. Dubyna and T.P. Dziuba, who cited four associations from the class *Juncetea maritimi* [9]. Later the syntaxonomical research of *Juncetea maritimi* in Ukraine was presented in the monographic book «Halophytic Vegetation», where this class included 10 associations belonging to the one alliance and the one order [12]. New data were proposed in the «Prodrome of the Vegetation of Ukraine» and the class *Juncetea maritimi* consists of 13 associations, three of them were transferred to the new alliance *Junco maritimi-Schoenion nigricantis* Dubyna et Dziuba 2019 described in the same paper [8].

The distribution of syntaxa from the class *Juncetea maritimi* on the territory of Dzharylhach Island was mapped (Fig. 2). Vegetation mapping was not carried out on the mainland areas of the park due to the predominance of artificial forest plantations and ruderal communities though these communities are occasionally present there. Phytocoenoses with small areas were indicated as points on the map, since their outlines would not be noticeable in this scale.

Syntaxonomic scheme of the class *Juncetea maritimi*:

Cl. *Juncetea maritimi* Br.-Bl. in Br.-Bl. et al. 1952

Ord. *Juncetalia maritimi* Br.-Bl. ex Horvatić 1934

All. *Juncion maritimi* Br.-Bl. ex Horvatić 1934

Ass. *Phragmito-Juncetum maritimi* Korzhenevsky et Klyukin in Dubyna et al. 2007

Ass. *Juncetum maritimi* (Soó 1930) Borchidi 1958

Ass. *Junco maritimi-Caricetum extensae* (Corillion 1953) Géhu 1976

Ass. *Juncetum maritimo-acuti* Horvatić 1934

Ass. *Juncetum littoralis* Popescu et. al. 1992

All. *Junco maritimi-Schoenion nigricantis* Dubyna et Dziuba 2019 nom.inval.

Ass. *Junco maritimi-Schoenetum nigricantis* Dubyna et Dziuba 2019 nom.inval.

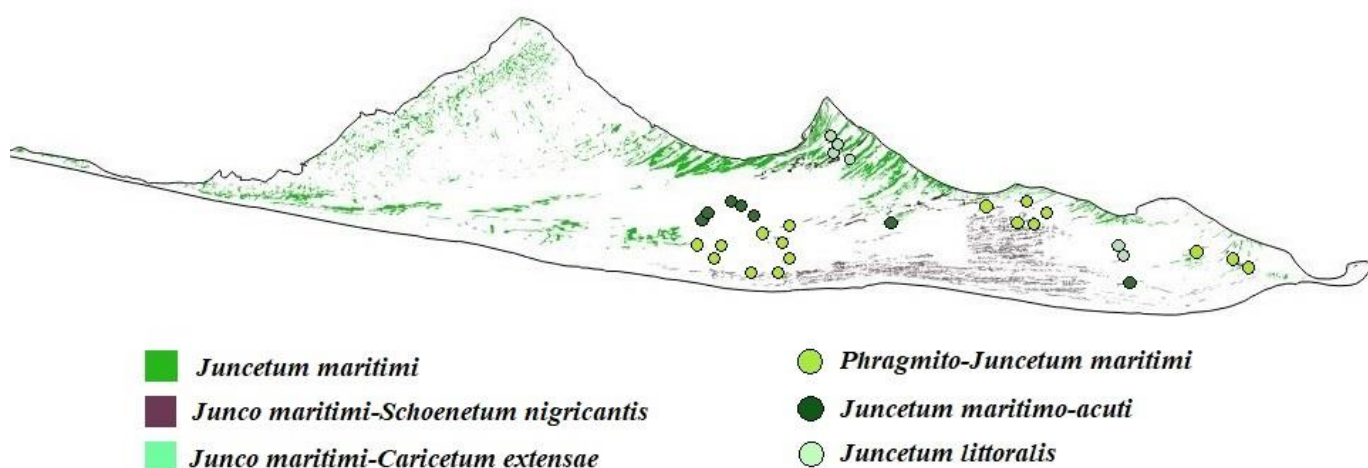


Fig. 2. Map of the distribution of *Juncetea maritimi* communities on the Dzharylhach Island

Association *Phragmito-Juncetum maritimi*

Diagnostic species: *Juncus maritimus*, *Phragmites australis*.

Constant species: *Suaeda prostrata*; *Aeluropus littoralis*, *Halimione verrucifera*, *Cynanchum acutum*, *Elytrigia elongata*, *Limonium gmelinii*, *Puccinellia gigantea*.

Dominant species: *Juncus maritimus*, *Phragmites australis*.

Communities of wet depressions with the salinization in the central part of the island and on silty-shell areas of the coast of Dzharylhach Bay. They have sporadic distribution.

Association *Juncetum maritimi*

Diagnostic species: *Suaeda prostrata*; *Juncus maritimus*.

Constant species: *Artemisia santonicum*, *Halimione verrucifera*, *Limonium bellidifolium*, *Limonium gmelinii*, *Puccinellia gigantea*, *Salicornia perennans*.

Dominant species: *Halimione verrucifera*, *Juncus maritimus*.

Communities of wet and flooded areas on shell-silty saline soils, large areas of them are concentrated on the spit in the northern part of the island. They occasionally occur on mainland areas.

Association *Junco maritimi-Caricetum extensae*

Diagnostic species: *Atriplex prostrata*, *Carex extensa*, *Juncus maritimus*.

Constant species: *Artemisia santonicum*, *Elytrigia elongata*, *Limonium gmelinii*, *Phragmites australis*, *Puccinellia gigantea*.

Dominant species: *Carex extensa*, *Juncus maritimus*.

Communities of wet sandy-shell depressions of spits on the northern part of the island. Rare association.

Association *Juncetum maritimo-acuti*

Diagnostic species: *Juncus littoralis*, *Juncus maritimus*.

Constant species: *Aeluropus littoralis*, *Apera maritima*, *Artemisia santonicum*, *Elytrigia elongata*, *Juncus gerardi*, *Phragmites australis*, *Puccinellia fominii*.

Dominant species: *Carex distans*, *Elytrigia elongata*, *Juncus littoralis*, *Juncus maritimus*.

Communities of wet depressions among psammophytic leveled areas. Rare association, it was found in the central part of the island. This syntaxon is firstly indicated for the territory of the National Nature Park «Dzharylhatskyi».

Association *Juncetum littoralis*

Diagnostic species: *Cirsium alatum*, *Juncus littoralis*.

Constant species: *Apera maritima*, *Artemisia santonicum*, *Cynanchum acutum*, *Elytrigia elongata*, *Phragmites australis*, *Puccinellia fominii*.

Dominant species: *Elytrigia elongata*, *Juncus littoralis*.

Communities of psammophytic-steppe areas with noticeable salinity. It has sporadic distribution in the central part of the island. This syntaxon is firstly indicated for the territory of Ukraine.

Association *Junco maritimi-Schoenetum nigricantis*

Diagnostic species: *Calamagrostis epigejos*, *Schoenus nigricans*.

Constant species: *Agrostis maeotica*, *Apera maritima*, *Cynanchum acutum*, *Elytrigia elongata*, *Gypsophila perfoliata*, *Juncus littoralis*, *Juncus maritimus*, *Limonium gmelinii*, *Phragmites australis*.

Dominant species: *Calamagrostis epigejos*, *Elytrigia elongata*, *Mentha aquatica*, *Schoenus nigricans*.

Meadow-halophytic communities in depressions between sloping dunes. Widespread association in the southern part of the Dzharylhach Island.

The comparison of the results of our analysis and data from literature sources showed that several syntaxa were not recorded in the territory of the Dzharylhach Island during our research in 2017–2018, though their diagnostic species are present in the flora of the National Nature Park «Dzharylhatskyi» but do not form communities: *Plantagini salsae-Juncetum maritimi* Shelyag-Sosonko et Solomakha 1987, *Tripolio pannonicum-Caricetum extensae* Dubyna et Neuhäuslová 2000, *Limonium gmelinii-Aeluropodetum littoralis* Krausch 1965, *Plantagini salsae-Limonietum meyeri* Dubyna et al. 2007, *Limonium meyeri-Plantaginetum cornuti* Dubyna et al. 2007, *Artemisia santonicae-Juncetum maritimi* Shelyag-Sosonko, Dubyna et Neuhäuslová in Dubyna et Neuhäuslová 2000, *Carici distantis-Schoenetum nigricantis* Géhu et al. 1986, *Schoeno nigricantis-Plantaginetum maritimae* Rivas-Martínez 1984. All these syntaxa were not confirmed by our data so they are excluded from the classification scheme.

Provisionally described new alliance *Junco maritimi-Schoenion nigricantis* Dubyna et Dziuba 2019 with the association *Junco maritimi-Schoenetum nigricantis* Dubyna et Dziuba 2019 are invalid and published without the type designation [8, 19]. It has been also found that the latter association probably is a homonym of *Junco maritimi-Schoenetum nigricantis* Provost 1975, cited in several French phytosociological papers devoted to the class *Scheuchzerio palustris-Caricetea fuscae* Tüxen 1937 [1, 11]. Unfortunately, the author could not find a protologue of this name, so the question of whether these two associations are homonymous needs further clarification.

It should be noticed that the name *Juncetum acuti-maritimi* Popescu et Sanda 1972 accepted in «The Prodrome of the Vegetation of Ukraine» [8] is a later synonym so it should be corrected to *Juncetum maritimo-acuti* Horvatić 1934.

Table 1

Phytocoenotic characteristics of syntaxa from the class *Juncetea maritimi* (1 part)

Relevés №:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Relevés area, m ²	12	15	9	20	15	6	5	9	4	25	10	9	9	9	12	15	10	12	9	6	9	9	9
Number of species	6	5	8	5	6	7	7	6	7	6	4	4	5	4	4	7	7	9	8	6	8	6	6
Total cover, %	80	60	80	90	90	50	70	80	60	90	80	90	90	90	90	70	70	80	80	75	80	90	80
Syntaxa	<i>Phragmito-Juncetum maritimi</i>						<i>Juncetum maritimi</i>						<i>Junco maritimi-Caricetum extensae</i>										
	D.s. <i>Juncetum maritimi</i>																						
<i>Juncus maritimus</i>	1	1	2	5	2	1	5	5	4	5	5	5	5	5	5	1	2	4	4	2	4	5	4
<i>Suaeda prostrata</i>	.	2	.	.	1	2	1	1	1	2	2	1	1	2	.	.	.	.	.	2	.	.	.
	D.s. <i>Phragmito-Juncetum maritimi</i>																						
<i>Phragmites australis</i>	4	2	4	2	4	2	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.
	D.s. <i>Junco maritimi-Caricetum extensae</i>																						
<i>Carex extensa</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2	4	4	4	4	2	4	4	4
<i>Atriplex prostrata</i>	.	.	1	.	.	.	.	.	1	.	.	2	.	.	2	.	.	+	.	.	1	1	1
	Other species																						
<i>Aeluropus littoralis</i>	.	.	2	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
<i>Apera maritima</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Artemisia santonicum</i>	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	1	2	.	.	1	1
<i>Atriplex tatarica</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Bassia hirsuta</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
<i>Carex distans</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cirsium arvense</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.
<i>Cirsium vulgare</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cynanchum acutum</i>	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
<i>Elytrigia elongata</i>	.	.	.	1	.	2	.	.	.	.	.	.	.	.	1	1	.	.	2	.	.	1	1
<i>Halimione pedunculata</i>	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
<i>Halimione verrucifera</i>	.	.	.	.	3	2	2	.	2	2	.	1	2	1	.	.	.	.	1	.	.	.	.
<i>Lactuca tatarica</i>	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
<i>Limonium bellidifolium</i>	.	.	.	.	.	.	2	.	.	1	.	.	1	.	.	2	.	.	2	.	.	.	.
<i>Limonium gmelinii</i>	.	.	1	.	1	.	.	2	1	2	1	.	.	1	.	2	1	2	1	2	.	2	2
<i>Puccinellia gigantea</i>	.	2	1	.	.	1	2	1	1	.	.	.	.	.	.	.	2	1	.	2	2	.	.

Relevés №:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
<i>Puccinellia fominii</i>	1	.	.	.	.	.	.	.
<i>Salicornia perennans</i>	1	.	2	.	1	.	1	.	.	.	.	.	.	1	.	.	.
<i>Sonchus arvensis</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Tripolium pannonicum</i>	1	1	.	.	.	.	1	.

Table 2

Phytocoenotic characteristics of syntaxa from the class *Juncetea maritimi* (2 part)

Relevés №:	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Relevés area, m ²	6	4	16	9	6	7	16	16	25	16	9	12	25	16	25	16	25	25	25	25	25	10
Number of species	5	6	7	4	8	9	10	9	8	7	7	8	5	7	10	21	13	5	6	6	6	8
Total cover, %	90	80	85	90	65	80	80	75	70	75	75	75	70	70	90	90	80	90	90	90	90	90
Cover of herb layer, %	90	80	85	90	65	80	80	75	70	75	75	75	70	70	90	75	80	90	90	90	90	90
Cover of lichen layer, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-
Tree-shrub layer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,1	-	-	-	-	-	-
Syntaxa	<i>Juncetum maritimo-acuti</i>						<i>Juncetum littoralis</i>						<i>Juncetea maritimi-Schoenetum nigricantis</i>									
D.s. <i>Juncetum littoralis</i>																						
<i>Juncus littoralis</i>	4	4	4	5	4	5	4	4	2	4	4	2	4	2	2	.	2	.	.	.	.	1
D.s. <i>Juncetea acuti-maritimi</i>																						
<i>Juncus maritimus</i>	3	2	2	3	3	3	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.
D.s. <i>Juncetea maritimi-Schoenetum nigricantis</i>																						
<i>Calamagrostis epigejos</i>	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	1	1	2	1	3	.
<i>Schoenus nigricans</i>	.	.	.	.	.	.	2	.	2	.	.	.	.	.	4	4	4	5	5	5	2	.
D.s. <i>Juncetea maritimi</i>																						
<i>Carex extensa</i>	.	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Other species																						
<i>Agrostis maeotica</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	1	.	.
<i>Aeluropus littoralis</i>	2	2	.	2	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.
<i>Anacamptis palustris</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+

Relevés №:	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
<i>Apera maritima</i>	1	1	.	1	.	2	+	2	.	1	.	1	1	.	.	.	.
<i>Arenaria serpyllifolia</i>	+
<i>Artemisia santonicum</i>	1	1	.	.	1	.	1	2	2	.	2	.	.	.	.	.	.
<i>Asparagus maritimus</i>	+
<i>Bromus squarrosus</i>	1	.	1	.	.	.	.	.
<i>Carex distans</i>	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Centaurium erythraea</i>	1	.	.
<i>Cerastium syvaschicum</i>	1	.	.	.	+	.	.	.	.	.
<i>Cirsium alatum</i>	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cirsium vulgare</i>	2	.	.	.	.	.	.	.	.
<i>Convolvulus lineatus</i>	+
<i>Crepis ramosissima</i>
<i>Cynanchum acutum</i>	1	.	.	.	1	2	.	1	1	1	.	1	.	.	1	.
<i>Daucus carota</i>	.	.	+
<i>Elytrigia elongata</i>	.	3	2	.	2	2	.	2	2	3	2	2	.	2	+	.	1	2	.	.	.
<i>Elytrigia repens</i>	2	.	.	.	.	.
<i>Euphorbia seguierana</i>	1	.	.	.	.
<i>Gypsophila perfoliata</i>	1	+	1	.	.	.	.
<i>Halimione verrucifera</i>	2	.	.	2	.	.	.	2	.	.	.	.	.	.	.	.	.
<i>Jacobaea borysthena</i>	+
<i>Juncus gerardi</i>	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Limonium gmelinii</i>	1	.	.	1	.	.	.	1	.	.	+	+	1	1	.	.	.
<i>Melilotus alba</i>	1	.	.	.	.	.	.	.	.
<i>Mentha aquatica</i>	5	.	.	.	.	.	.	.	.	.	.	.	.	.	2
<i>Milium vernale</i>	+	1	.	.	.
<i>Myosotis stricta</i>	+
<i>Odontites salina</i>	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Plantago lanceolata</i>	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
<i>Plantago maritima</i>	+
<i>Phragmites australis</i>	2	.	2	2	.	.	2	.	2	.	.	.	2	.	1	.	.	.	2	2	1

Relevés №:	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
<i>Poa angustifolia</i>	2	.	.	.	.	.
<i>Poacynum rusanovii</i>	1	.	2	.	.	.	.	.	.	.	.	.	.	.	2
<i>Puccinellia fominii</i>	.	1	.	.	1	.	.	2	.	1	1	2	.	1	.	.	.	.	.	.	.
<i>Pulicaria dysenterica</i>	1	.	.	.	.	.	.	.	.	.	1	.	.
<i>Rumex acetosella</i>	+
<i>Rumex stenophyllus</i>	+
<i>Salicornia perennans</i>	+
<i>Scirpoides holoschoenus</i>	2	.	.	.	.	.
<i>Sisymbrium polymorphum</i>	1	.	.	.	.
<i>Suaeda altissima</i>	1	.	.	.	.	.	.	.	.	.	.	.
<i>Veronica praecox</i>	+
<i>Cladonia foliacea</i>	+
<i>Cladonia rangiformis</i>	2	.	.	.	.	.
<i>Elaeagnus angustifolia</i>	1	.	.	.	.	.	.

CONCLUSIONS

Thus, on the territory of the National Nature Park «Dzharylhatskyi» we found and described six associations from the class *Juncetea maritimi*. The one of them (*Juncetum maritimo-acuti*) is new for the research territory, and the other one (*Juncetum littoralis*) is new for Ukraine. Eight associations which were mentioned for the Dzharylhach Island previously have not been confirmed. Several clarifications of syntaxa names and positions of the lower syntaxa were mentioned too. For further research it is necessary to study these communities in other regions of the Northern Black Sea Region to identify new locations for these syntaxa and clarify the status of separate associations.

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