

***Brometum commutati* – a new halophytic plant association in Central and South Serbia**

Original Article

Abstract:

During the phytocoenological studies in salt marshes of Central and South Serbia data were collected from 168 stands. After the data were entered into the vegetation database TURBOVEG, cluster analysis performed in FLORA software package has shown presence of 13 associations in the study area. At the sites of Oblačina and Bresničić salt marshes a new plant association was recorded and phytocoenologically described under the name *Brometum commutati* ass. new. Continuous monitoring of floristic composition during an entire vegetation season has shown that this association was built by 58 species. In addition to the dominant species *Bromus commutatus*, higher abundance and cover values were recorded for: *Hordeum geniculatum*, *Puccinellia distans*, *Cerastium dubium* and *Trifolium lappaceum*. The total cover value for stands at both localities was 100%. This association occupies a much greater surface area at Oblačina salt marsh, where 11 stands were recorded. Stands of this association alternate with stands of association *Puccinellietum limosae* Soó 1933. The sample also included three phytocoenologically described stands from Bresničić salt marsh. Although this plant community was recorded at the less halophytic soils, in the syntaxonomic sense it still belongs to the alliance *Puccinellion limosae* Soó 1933 due to the floristic similarity with other associations of that alliance.

Key words:

saline habitats, Southern Serbia, plant community, Oblačina salt areas, Bresničić salt area

Apstrakt:

***Brometum commutati* - nova halofitna asocijacija u centralnoj i južnoj Srbiji**

Tokom fitocenoloških istraživanja na slatinama centralne i južne Srbije prikupljeni su podaci sa 168 sastojina. Nakon unošenja podataka u vegetacijsku bazu TURBOVEG i urađenu klaster analizu u FLORA softver paketu, na istraživanom području konstatovano je 13 asocijacija. Na lokalitetima Oblačinska i Bresničićka slatina, konstatovana je i fitocenološki opisana nova biljna zajednica imenovana kao *Brometum commutati* ass. nova. Kontinuiranim praćenjem florističkog sastava tokom jedne vegetacione sezone, ustanovljeno je da u izgradnji zajednice učestvuju 58 vrsta. Pored dominantne vrste, *Bromus commutatus*, većom brojnošću i pokrovnošću individua ističu se: *Hordeum geniculatum*, *Puccinellia distans*, *Cerastium dubium* i *Trifolium lappaceum*. Ukupna pokrovnost sastojina na oba lokaliteta iznosi 100%. Asocijacija zauzima mnogo veće površine na Oblačinskoj slatini, gde je zabeleženo 11 sastojina. Sastojine ove asocijacije smenjuju se sa sastojinama asocijacije *Puccinellietum limosae* Soó 1933. Na Bresničićkoj slatini fitocenološki su opisane tri sastojine. Iako je ova biljna zajednica zabeležena na zemljištu nižeg saliniteta, u sintaksonomskom smislu ipak pripada svezi *Puccinellion limosae* Soó 1933 zbog florističke sličnosti sa drugim asocijacijama pomenute sveze.

Ključne reči:

slatine, južna Srbija, biljna zajednica, Oblačinska slatina, Bresničićka slatina

Introduction

Halomorphic (saline) soils are relatively widespread throughout the world and occupy 10% of the Earth's surface (O'Leary & Glenn, 1994). These are specific types of soil covered by the general terms

of salt marsh and dryland halomorphic soils. The main characteristic of saline habitats is saline or halomorphic soil suitable for development of specific flora and vegetation that is adapted to the conditions of increased salt concentration. At the same time, salt marshes are highly endangered habitats that occur in

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fragments, so the ranges of habitat-specific species are also characterized by marked fragmentation (Nedeljković et al., 2014).

Salines are unique ecosystems and often the last refugia for a large number of endemic and relict species. Plant associations represented on halomorphic soils are relatively poor in species. Species combinations are specific but very diverse, so the classification of halophyte associations is quite complex. Distribution of certain vegetation types is closely related to salt content, salt type and depth of soil horizons with higher salt concentration (Molnar & Borhidi, 2003). Globally speaking, salt marsh habitats occupy significant areas and appear naturally on about one million hectares in the world. They are mostly represented within the desert, semi-desert, steppe, chernozem and forest-steppe areas (Yadav, 2003).

In Serbia, halomorphic soils are mostly present in Vojvodina, while in the southern part of the country saline habitats are a real rarity and are reduced to a few small localities in the valley of rivers Južna Morava and Toplica. They represent specific ecosystems characterized by presence of characteristic flora and vegetation which is more or less specialized to this type of habitats (Zlatković et al., 2005). In that region these specific habitats develop in conditions of isolation and high anthropogenic pressure.

The first studies of these important areas were carried out by Pančić (1884) and Petrović (1885). Lalinac salt marsh is the best studied locality (Niketić, 1995; Milosavljević et al., 2002; Randelović et al., 2007). A significant contribution to research on this type of vegetation in the area of Vojvodina and southeastern Serbia was made by Slavnić (1940, 1948). There are also data on the

halophytic vegetation around Prokuplje (Randelović et al., 2000) while in 2005 a detailed study on salt marshes in this part of Serbia was published by the Institute for Nature Conservation. The authors presented the results of their research on flora but also on vegetation, which was not previously described in much detail (Zlatković et al., 2005). In 2014, a group of authors (Zlatković et al., 2014) combined the previous study results with their own research data for all salt marsh areas of Central and South Serbia. They recognized presence of 333 taxa classified into 176 genera and 46 families. The ecology and ecological affinities of selected halophytes from the salt marsh areas in Central and South Serbia were presented in a paper from 2019 (Zlatković et al., 2019a), while in the same year a new association, *Allio guttate-Limonietum gmelinii*, was described from the area of Lalinac and Lepaja salt marshes (Zlatković et al., 2019b).

Materials and Methods

Study area

The study area includes localities in Central and South Serbia (Tab. 1, Fig. 1), divided into 3 groups: Aleksandrovac saltmarsh area, Lalinac saltmarsh area and the salt marsh fragments in the valley of Toplica river (Zlatković et al., 2014). The Aleksandrovac salt marsh area includes several smaller localities (Aleksandrovac, Oslare, Levosoje, Bujanovac and Neradovac) with developed halomorphic soils and very interesting flora and vegetation. The largest surface area under halomorphic soils is present at the salt marsh near Aleksandrovac.

The Lalinac salt marsh area is situated at the foothills of Mali Jastrebac Mt. It includes several

Table 1. Overview of study sites with data on geographic position, altitude and general climate characteristics

ID	Locality	Longitude	Latitude	Altitude (m)	Mean annual air temperature (°C)	Total annual precipitation (mm)
1	Levosoje	42°25'50"	21°44'50"	400	11.2	553
2	Oslare	42°25'39"	21°43'21"	405	11.2	553
3	Bujanovac	42°27'	21°45'	395	11.2	550
4	Aleksandrovac	42°29'20"	21°54'12"	401	11.2	540
5	Neradovac	42°31'17"	21°52'56"	403	11	550
6	Lalinac	43°20'42"	21°44'45"	200	11.1	633
7	Oblačina	43°18'26"	21°40'54"	285	11.1	636
8	Lepaja	43°17'35"	21°39'50"	285	11.1	636
9	Suva Česma	43°13'58"	21°30'43"	257	10.9	655
10	Bresničić	43°14'50"	21°27'10"	293	10.8	670

salt marsh fragments. Lalinac salt marsh is the largest fragment while there are also Oblačina and Lepaja salt marsh.

In addition to these salt marshes, another important fragment is situated near the village Bresničić, about 1 km from the bed of river Toplica, on its left bank. Previously there were also several salt marsh fragments in the area between Prokuplje and Kuršumlija, in the alluvial plain of Toplica.

used to determine the diversity of halophyte communities in the researched area and their mutual syntaxonomic relationships. For these purposes, during 2013 year, data were collected from 168 stands with individual surface areas of 10-60 m². The phytocoenological research of the stands followed the Braun-Blanquet's (1951) approach.

The plant material necessary for determination was collected from the surrounding stands in

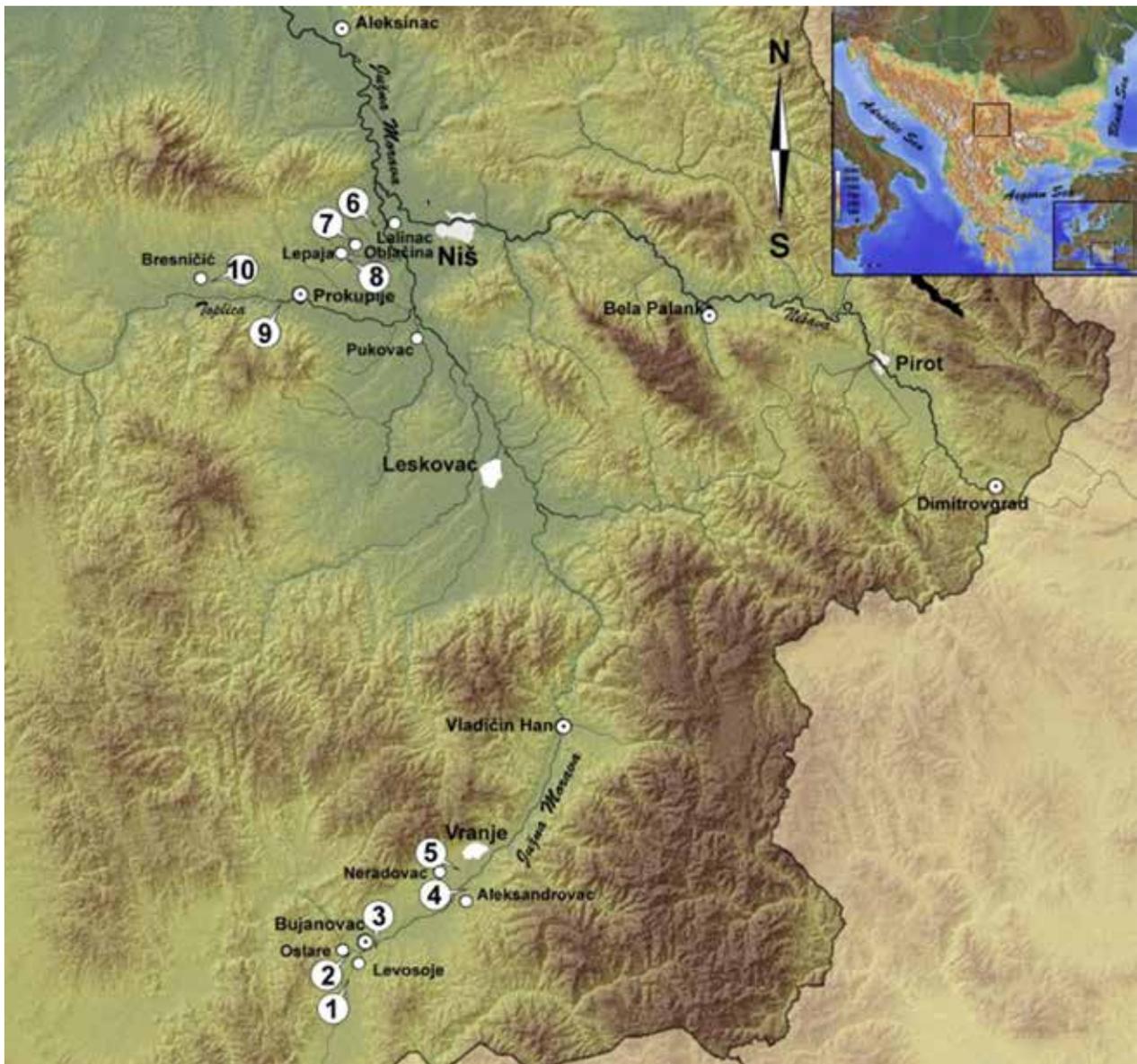


Fig. 1. Map of study area. The main data on geographic position and climate characteristics of study sites are presented in **Tab. 1**

Their soils have barely shown any halomorphic characteristics, and the flora and vegetation with halomorphic character were subsequently destroyed. The salt marsh near the village Bresničić remains as one of the better preserved salt marsh fragments.

The results of phytocoenological studies were

order not to disrupt the qualitative and quantitative composition of the studied vegetation plots. The material was herbarized, and the herbarium specimens were stored in the herbarium collection “Herbarium Moesiacum” of the Faculty of Sciences and Mathematics at the University in Niš (HMN).

Relevant dichotomous keys (Tutin et al. (ed.) 1964-1980; Josifović (ed.) 1970-1980) and “Флора на НР България” (Јорданов (ед.), 1963-1979, Велчев, 1979-1995) were used for determination of plant material. Nomenclature of recorded taxa was matched to the Euro+Med database at the following link <http://ww2.bgbm.org/EuroPlusMed/query.asp>. The taxa that were not determined to species level were excluded from the analysis, as well as the mosses and lichens.

The collected data were imported into the vegetation database TURBOVEG (Hennekens & Schaminee, 2001). Cluster analysis was performed in FLORA software package in order to define associations and determine the floristic similarities between associations (Karadžić & Marinković, 2009; Karadžić, 2013).

Results and discussion

The results of this research have shown that salt marshes of Central and South Serbia host 13 associations from three classes: *Thero-Salicornietea* Tx. in Tx. et Oberd. 1958, *Festuco-Puccinellietea* Soó ex Vicherek 1973 and *Molinio-Arrhenatheretea* Tx. They include an association with the species *Bromus commutatus*, which was described for the first time as *Brometum commutati* ass. new (Fig. 2, Appendix 1).

This association was recorded at Oblačina and Bresničić salt marshes at altitudes of 289-308 m above sea level. Vegetation cover was 100% at both sites. In addition to the dominant species *Bromus commutatus*, following species have also shown significant values of cover: *Hordeum geniculatum*, *Puccinellia distans*, *Cerastium dubium* and *Trifolium lappaceum*. Due to the grazing intensity and vicinity of cultivated areas, the association also includes a high number of ruderal species. The surface areas under this association are much greater at Oblačina salt marsh, where 11 stands were recorded. The sizes of test plots were 30-50 m². The stands of this association are interspersed with stands of association *Puccinellietum limosae* Soó 1933. At the Bresničić salt marsh there were three stands for which phytocenological data were collected, with surface area of 20 m². The species *Bromus commutatus* was also recorded at localities: Aleksandrovac, in associations *Puccinellietum convolutae* Micevski 1965 and *Hordeetum hystricis* Wendelbg. 1943; Lalinac, in associations: *Puccinellietum limosae* Soó 1933, *Camphorosmetum monspeliacae* Micevski 1965, *Caricetum divisae* Slavnić 1948, *Juncetum compressi* Br.-Bl. 1918 ex Libb, *Scorzonero parviflorae-Juncetum gerardii* (Wenzl 1934) Wendelberger 1943 and *Allio guttate-Limonietum*

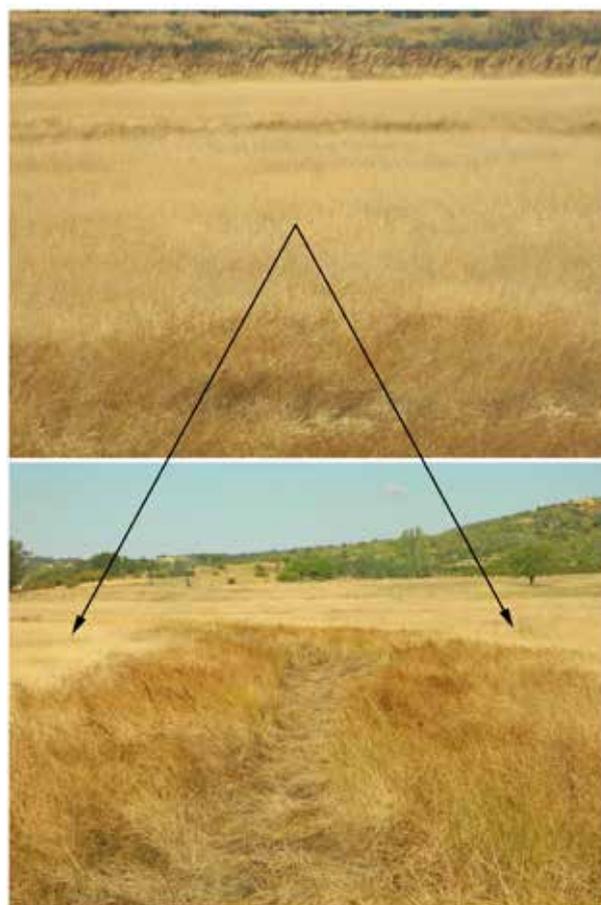


Fig. 2. Photos of *Brometum commutati* ass. new. Oblačina salt marsh, July 2013

gmelinii ass. new; and Lepaja, in association *Allio guttate-Limonietum gmelinii* ass. new. At Oblačina salt marsh, in addition to creating the association *Brometum commutati* ass. new, it was also recorded within the following associations: *Puccinellietum limosae* Soó 1933, *Hordeo-Caricetum distantis* Micevski 1957 and *Caricetum divisae* Slavnić 1948, while at Bresničić salt marsh it was recorded within the associations *Puccinellietum limosae* Soó 1933 and *Caricetum divisae* Slavnić 1948. However, its presence is not of any significant diagnostic level in any of these associations.

Micevski (1965) described the association *Bromo-Alopecuretum* K. Micevski 1957 from the higher, drier habitats of Ovče Polje as a therophyte community representing the most arid type of meadows at Ovče Polje. This association belongs to the alliance *Trifolion resupinati* K. Micevski 1957 and it is almost void of any halophytic plants. In addition, Randelović & Zlatković (2005) stated in the syntaxonomic overview that at the salt marshes of Central and South Serbia there is an association *Bromo-Alopecuretum* K. Micevski 1957, composed of species *Bromus commutatus* and *Alopecurus*

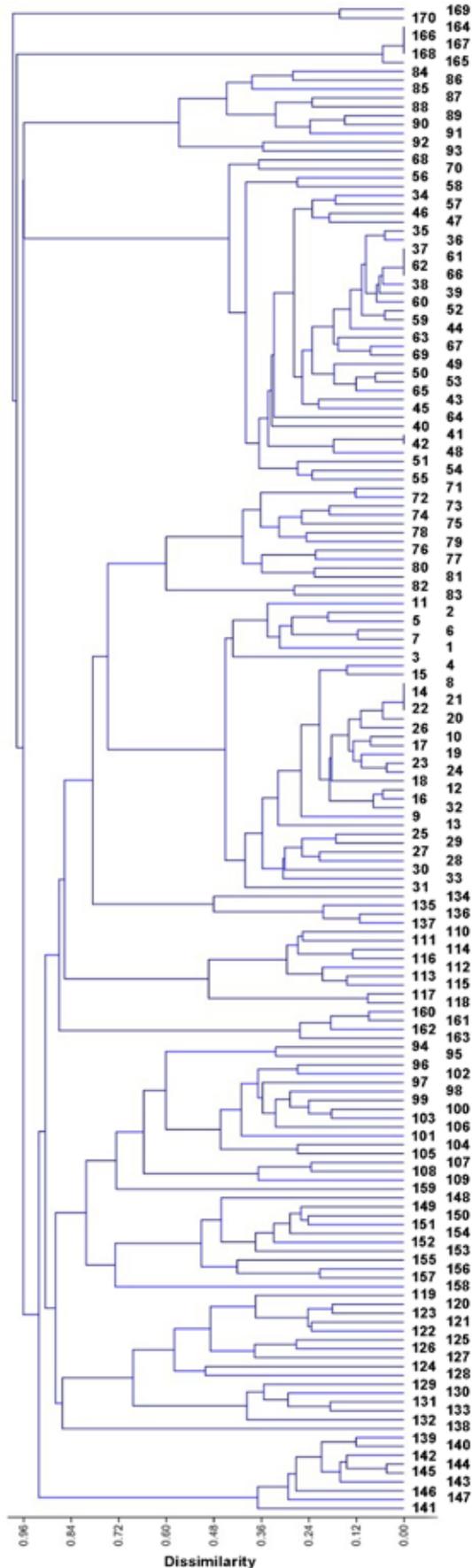


Fig. 3. Dendrogram of halophyte vegetation of Central and South Serbia (1-33 *Puccinellietum limosae* Soó 1933; 34-70 *Caricetum divise* Slavnić 1948; 71-83 *Brometum commutati* ass. new; 84-93 *Hordeo-Caricetum distantis* Micevski 1957 ; 94-109 *Hordeetum hystricis* Wendelberger 1943; 110-118 *Camphorosmetum monspeliacae* Micevski 1965; 119-133 *Allio guttate-Limonietum gmelinii* ass. new; 134-137 *Juncetum compressi* Br.-Bl. 1918 ex Libb. 1932; 138 *Scorzonero parviflorae-Juncetum gerardii* (Wenzl 1934) Wendelberger 1943; 139-147 *Puccinellietum convolutae* Micevski 1965; 148-154 *Plantaginietum coronopi* Gillham 1953; 155-157 *Cynodetum dactyli* Méndez 1983; 158 community with species dominance *Taeniatherum caput-medusae* and *Bromus commutatus*; 159 community with species dominance *Trifolium fragiferum*; 160-163 community with species dominance *Trifolium lappaceum*; 164-168 *Crypsietum aculeatae* Wenzl 1934; 169-170 *Heleochoetum schoenoidis* Topa 1939)

utriculatus, from class *Molinio-Arrhenatheretea* Tx. 1937 and alliance *Trifolion resupinati* K. Micevski 1957. However, in a different study several years later, presence of species *Alopecurus utriculatus* was not recorded in stands of this association, while significantly higher number of typical halophytes (*Hordeum geniculatum*, *Puccinellia distans*, *Podospermum canum*) were present, so we believe that this association belongs to the alliance *Puccinellion limosae* Soó 1933. In the dendrogram it is situated immediately next to the association *Puccinellietum limosae* Soó 1933 (Fig. 3).

Conclusions

Association *Brometum commutati* ass. new is a particularly interesting and important newly discovered halophytic association. It covers large areas at Oblačina salt marsh and smaller areas at Bresničić salt marsh. As the salt marsh areas in Central and South Serbia occupy small areas and experience strong anthropogenic impact, it is necessary to continue with appropriate conservation measures. These areas are important biodiversity centers, which is recognized as the continental salt marshes throughout Europe are protected with the network Natura 2000 (Interpretation Manual of European Union Habitats 1999; Piernik et al. 2006). Bresničić salt marsh is a protected area of the IV degree under the IUCN guidelines (IUCN Category IV – Protected Area managed for conservation through management). According to classification of the national legislative, it belongs to the third category of protection, Protected Areas of Local Character, and represents a Protected Habitat. It was also included in the group of rare and fragile habitats (Ret/Frag (A)) and the list of EMERALD habitats, as a potential NATURA 2000 habitat (Nedeljković et al., 2014). It is necessary to implement appropriate measures so Oblačina salt marsh would be assigned a protection category as well.

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Appendix

Appendix 1. Phytocoenological table of *Brometum commutati* ass. new

Locality	Oblačina salt marsh						Bresnić salt marsh				Degree of presence	
	21 May		23 Jun		21 May		23 Jun		6 Jul			27 May
Date of recording	30	50	50	50	50	30	30	30	30	20	20	25 Sep
Surface (m ²)	30	100	100	100	100	100	100	100	100	100	100	100
Coverage (%)	100	100	100	100	100	100	100	100	100	100	100	100
Altitude (m)	289	291	291	290	308	305	292	295	292	291	299	298
Longitude	43° 18,552'	43° 18,550'	43° 18,432'	43° 18,438'	43° 18,462'	43° 18,450'	43° 18,404'	43° 18,467'	43° 18,474'	43° 18,471'	43° 14,862'	43° 14,859'
Latitude	21° 41,078'	21° 41,076'	21° 40,954'	21° 40,952'	21° 40,939'	21° 40,961'	21° 40,989'	21° 40,996'	21° 40,998'	21° 41,018'	21° 27,247'	21° 27,250'
Number of species	10	7	8	6	13	14	11	15	8	6	15	7
Diagnostic species of class <i>Molinio-Arrhenatheretea</i>												
<i>Bromus commutatus</i> Schrader	5	5	5	5	5	5	5	5	5	5	5	5
<i>Trifolium lappaceum</i> L.	r	+	1	1	2	r	r	1	r	r	r	r
<i>Juncus compressus</i> Jacq.	r	r	r	r	r	r	r	r	r	r	r	r
<i>Tragopogon pratensis</i> L.	+	+	r	r	r	r	r	r	r	r	r	r
<i>Poa pratensis</i> L.						r	r	r				
<i>Ranunculus sardous</i> Crantz						r	r					
<i>Achillea millefolium</i> L.												r
<i>Trifolium hybridum</i> L.										r		
<i>Salvia pratensis</i> L.											r	
<i>Rumex crispus</i> L.	r											

Diagnostic species of class <i>Festuco-Puccinellietea</i>													
<i>Hordeum geniculatum</i> All.	3	3	2	+	+	+	+	+	+	r	V		
<i>Puccinellia distans</i> (L.) Parl.	1	1	1	1	1	1	1	1	2	4	r	V	
<i>Podospermum canum</i> C.A. Meyer				r	r	r	r	r	+	1	+	r	IV
<i>Carex divisa</i> Hudson			r	r	r	r	r					II	
<i>Pholurus pannonicus</i> (Host) Trin.				r	r	r	r	r	r	r		II	
<i>Juncus gerardii</i> Loisel.				r								I	
<i>Lotus tenuis</i> Waldst. & Kit. ex Willd.									r			I	
Diagnostic species of class <i>Festuco-Brometea</i>													
<i>Trifolium campestre</i> Schreber										3		I	
<i>Trifolium nigrescens</i> Viv.										r		I	
<i>Plantago lanceolata</i> L.									r	r		I	
<i>Prospero autumnale</i> (L.) Speta											r	I	
<i>Xeranthemum annuum</i> L.										r		I	
Diagnostic species of class <i>Papaveretea rhoeadis</i>													
<i>Matricaria chamomilla</i> L.		r	+	r						r		II	
<i>Myosotis arvensis</i> (L.) Hill										+		I	
<i>Crepis setosa</i> Haller fil.										r		I	
<i>Vicia pannonica</i> Crantz										+		I	
<i>Anthemis arvensis</i> L.											r	I	
Diagnostic species of class <i>Phragmitetea communis</i>													
<i>Phragmites australis</i> (Cav.) Steud.											r	I	
<i>Bolboschoenus maritimus</i> (L.) Palla											r	I	
<i>Eleocharis palustris</i> (L.) Roemer & Schultes										r		I	
<i>Eleocharis palustris</i> (L.)											r	I	

Diagnostic species of class <i>Artemisietea vulgaris</i>					
<i>Cichorium intybus</i> L.			+		I
<i>Linaria vulgaris</i> Mill.				r	I
<i>Centaurea solstitialis</i> L.				r	I
<i>Melilotus officinalis</i> (L.) Lam.					I
<i>Sonchus arvensis</i> L.				r	I
<i>Rumex patientia</i> L.		r			I
Diagnostic species of class <i>Cakiletea maritima</i>					
<i>Atriplex prostrata</i> Boucher ex DC.		r			I
Diagnostic species of class <i>Sisymbrietea</i>					
<i>Lactuca serriola</i> L.		r	r	+	II
<i>Hordeum murinum</i> L.				r	I
<i>Crepis pulchra</i> L.				r	I
<i>Geranium dissectum</i> L.				+	I
<i>Geranium molle</i> L.					r
Diagnostic species of class <i>Polygono-Poetea annuae</i>					
<i>Cynodon dactylon</i> (L.) Pers.				r	I
<i>Polygonum aviculare</i> L.		r	r	+	r
Diagnostic species of class <i>Isöeto-Nanojuncetea</i>					
<i>Cerastium dubium</i> (Bast.) O. Schwartz	3	3	1	3	+
<i>Mentha pulegium</i> L.			r		r
Diagnostic species of class <i>Chenopodietea</i>					
<i>Trifolium echinatum</i> Bieb.			1	+	+
<i>Medicago arabica</i> (L.) Hud.					r
<i>Avena fatua</i> L.					r
Diagnostic species of class <i>Trifolio-Geranietea sanguinei</i>					
<i>Campanula rapunculus</i> L.				r	I

Diagnostic species of class <i>Helianthemetea guttati</i>	
<i>Trifolium striatum</i> L.	r I
Diagnostic species of class <i>Sedo-Scleranthetea</i>	
<i>Cerastium brachypetalum</i> Pers.	2 I
<i>Medicago minima</i> (L.) L.	r I
Unspecified species	
<i>Taraxacum officinale</i> Weber	r I
<i>Bromus mollis</i> L.	r r I
<i>Bupleurum tenuissimum</i> L.	+ r I
<i>Agrostemma githago</i> L.	+ I
<i>Galium tenuissimum</i> M. Bieb.	r I