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Taxonomical, phytogeographical and ecological analysis of the salt marsh flora of Central and Southern Serbia

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Abstract:

Zlatković, I., Zlatković, B., Ranđelović, V., Jenačković, D., Amidžić, L.: ***Taxonomical, phytogeographical and ecological analysis of the salt marsh flora of Central and Southern Serbia. Biologica Nyssana, 5 (2), December 2014: 91-102.***

The floristic studies of salt marshes of Central and Southern Serbia in period 2000-2014 have shown presence of 333 taxa within 176 genera and 46 families. The phytogeographical structure is dominated by taxa with wide distribution (291 or 87.39%). The best represented chorological types are: Eurasian, Holarctic, Mediterranean-submediterranean and cosmopolitan. The analysis of representation of life forms has shown that salt marsh flora in this part of Serbia has therophytic character, with a significant participation of hemicryptophytes. Presence of a high number of threatened taxa, including some listed in "Red Book of Flora of Serbia, 1" as critically endangered (Cr) plant taxa, indicates pronounced importance of these habitats for biodiversity conservation.

Key words: flora, chorological type, halophyte, life form, salt marsh area

Apstrakt:

Zlatković, I., Zlatković, B., Ranđelović, V., Jenačković, D., Amidžić, L.: ***Taksonomska, fitogeografska i ekološka naliza flore slatina centralne i južne Srbije. Biologica Nyssana, 5 (2), Decembar 2014: 91-102.***

Florističkim istraživanjima slatina centralne i južne Srbije u periodu od 2000-2014. godine, utvrđeno je prisustvo 333 taksona svrstanih u 176 rodova i 46 familija. U fitogeografskom smislu dominiraju taksoni širokog rasprostranjenja (291, 87,39%). Najzastupljeniji horološki tipovi su: evroazijski, holarktički, mediteransko-submediteranski i kosmopolitski. Analiza zastupljenosti pojedinih životnih formi pokazala je da flora slatina ovog dela Srbije ima terofitski karakter, sa značajnim učešćem hemikriptofita. Prisustvo velikog broja ugroženih taksona, od kojih su neki našli svoje mesto i u „Crvenoj knjizi flore Srbije, 1" kao krajnje ugroženi (Cr) biljni taksoni, ukazuje na veliki značaj ovih staništa u smislu očuvanja biodiverziteta.

Key words: flora, horološki tip, halofite, životna forma, slatinska područja

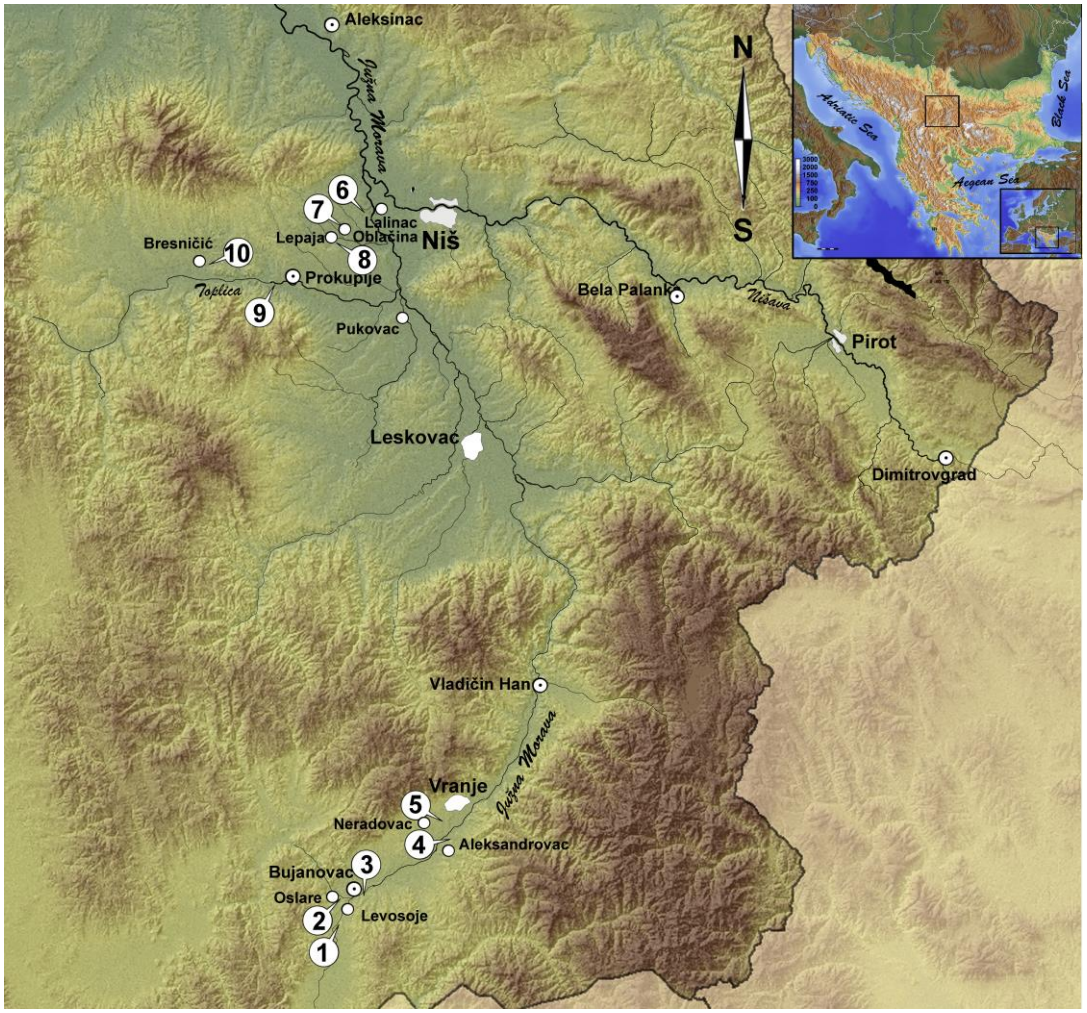

Fig 1. Geographical position of the investigated localities

Introduction

The continental salt marshes belong to fragile, highly threatened habitats. They occupy large areas in Pannonian and Walachian Plains and neighboring lowland regions. However, existence of halomorphic soil and salt marsh habitats is extremely rare in Serbia south of Vojvodina. In the area from the southern edge of Pannonian basin to Ovče Polje in Macedonia salt marshes include only a few small localities in river valleys of Južna Morava and Toplica. In this area the salt marshes represent the relict habitats, where characteristic flora and vegetation have developed under the conditions of isolation and high anthropogenous pressure.

Vegetation of continental salt marshes is well-developed in the Pannonian and Walachian Plains and neighboring lowland regions. The salt marsh areas of Central and Southern Serbia are different from salt marshes of Pannonian and Walachian basins in the phytogeographical sense, as shown by studies of their flora. Salt marsh flora in the study area was a subject of interest for many botanists, starting with Pančić (1884). There are some scarce and non-systematized literature data on salt marsh flora recorded in vicinity of Bujanovac, Oslare and Levosoje (Slavnić, 1940), Aleksandrovac (Slavnić, 1940; Zlatković et al., 2003), Lalinac and Oblačina salt marshes (Pančić, 1884; Niketić, 1993; Milosavljević et al., 2002). Halophyte vegetation of vicinity of Prokuplje was also studied (Ranđelović et al., 2000).

The goal of this paper is to present in a systematic manner all available literature and herbarium data, as well as data gathered in our own research and to perform a floristic analysis of these interesting habitats.

Investigated area

The study area includes localities in Southern and Central Serbia (**Fig. 1**, **Tab. 1**), divided into three groups: Aleksandrovac salt marsh area, Lalinac salt marsh area and Bresničić salt marsh area.

Tabela 1. List of sites with geographical and climatic data (A – altitude, T - mean annual temperature, M – mean annual precipitation) (temperature and precipitation data taken from DIVA-GIS, 2002)

	Locality	N Latitude	E Longitude	A (m)	T (C°)	M (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	11,0	550
6.	Lalinac	43°20'42"	21°44'45"	200	11,2	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

The Aleksandrovac salt marsh area includes several smaller localities (Aleksandrovac, Oslare, Levosoje, Bujanovac and Neradovac) with developed halomorphic soil and very interesting flora and vegetation. The greatest surface area of salt marshes in this area is in vicinity of Aleksandrovac.

The Lalinac salt marsh area is situated at the foothills of Mt. Mali Jastrebac. This area includes Lalinačka, Oblačinska and Lepajska salt marshes.

In the valley of river Toplica, in the area between Prokuplje and Kuršumlija (Bresničić salt marsh area), there are several salt marsh fragments. This paper includes data on the better-preserved salt marsh fragments Suva Česma and salt marshes near Bresničić.

Material and methods

The floristic list was composed according to literature data (Slavnić, 1940; Niketić, 1995; Milosavljević et al., 2002; Zlatković et al., 2003), herbarium collections (HMN) and our own studies in period 2000-2014. The list of localities is included in **Tab. 1**. The collected material was herbarized and herbarium specimens stored in the herbarium collection "Herbarium Moesiacum" at the Faculty of Science and Mathematics in Niš (HMN).

Identification of plant material was performed by using keys in "Flora Europaea" (Tutin et al., 1964-1980), "Flora of Serbia" (Josifović (ed.), 1970-1978; Sarić (ed.), 1986, 1992) and "Flora of NR Bulgaria" (Jordanov (ed.) 1963-1979; Velčev 1979-1995). The nomenclature was correlated with Med-Checklist (Greuter et al., 1984-1989), Flora Europaea (Tutin et al., 1964-1980), and Euro+Med PlantBase (Euro+Med 2006).

The chorological types of plant taxa were defined by Meusel et al. (1965, 1978), Meusel and Jäger (1992) and Stevanović (1992).

The life forms were presented according to Raunkier's principles, further developed by Ellenberg and Mueller-Dombois (Ellenberg & Mueller-Dombois, 1967 in Mueller-Dombois & Ellenberg, 1974) and modified according to Stevanović (1992) in "Flora of Serbia". The abbreviations used for life forms follow the chart in "Flora of Serbia" (Stevanović, 1992b).

The list of taxa follows this scheme:
Name of taxon – **Life form** – Chorological type - (Number of locality according to literature data) Author (Year); (Number of locality in our study)

Results

List of vascular plant taxa

MAGNOLIOPHYTA

MAGNOLIOPSIDA

BORAGINACEAE

Asperugo procumbens L. - **T rept** - EA - (6)

Buglossoides arvensis (L.) I. M. Johnston - **T scap** - EA - (6, 10)

Heliotropium europaeum L. - **T scap** – E(W)A - (6)

H. supinum L. - T scap – E(W)A - (2, 3, 4, 5) Slavnić (1940) – (7)

Myosotis arvensis (L.) Hill - **T scap-ros** - EA - (6, 9)

M. stricta Link ex Roemer & Schultes - **T scap-ros** - EA - (4)

Nonea pallens Petrović - **T scap** – Pont/Balk - (6)

CAMPANULACEAE

Legousia speculum-veneris (L.) Chaix - **T scap** – CE-Med-Pont - (6)

CARYOPHYLLACEAE

Cerastium brachypetalum Pers. - **T scap** – E(W)A - (6)

C. dubium (Bast.) O. Schwartz - **T caesp** - CE - (4, 6, 9)

C. glomeratum Thuill. - **T caesp** - Cosm - (4, 6)

C. pumilum Curtis - **T scap-ros** – CE-Med-Pont - (4, 5, 6)

C. semidecandrum L. - **T scap** – E(W)A - (4, 6)

Dianthus monadelphus Vent. subsp. *pallens* (Sibth. & Sm.) W. Greuter & Burdet - **Ch caesp** – Med-Smed/Balk - (6) Niketić (1995);

D. pinifolius Sibth. & Sm. - **Ch caesp** – Med-Smed/Balk - (6) Niketić (1995);
D. viscidus Bory & Chaub - **T scap** – Med-Smed/Balk - (2, 3, 4, 5) Slavnić (1940); (4)
Gypsophila muralis L. - **T caesp** - EA - (4, 7)
Holosteum umbellatum L. - **T scap** – EA - (4)
Minuartia viscosa (Schreber) Schinz & Thell. - **T caesp** – E(W)A - (4)
Moenchia graeca Boiss. & Heldr. - **T caesp** – Med-Smed/Balk - (4)
M. mantica (L.) Bartl. - **T scap** – E(W)A - (4, 6)
Petrorhagia prolifera (L.) P. W. Ball & Heywood - **T scap** – E(W)A - (6, 7, 10)
Scleranthus annuus L. - **T caesp** - CE-Med - (6)
S. polycarpos L. - **T caesp** - CE-Med - (4)
Spergula arvensis L. - **T scap** - Cosm - (4)
Spergularia rubra (L.) J. & C. Presl - **T caesp** - Cosm - (2, 3, 4, 5) Slavnić (1940); (1, 4)
Vaccaria pyramidata Medicus - **T scap** - Cosm - (6)

CHENOPODIACEAE
Atriplex prostrata Boucher ex DC. - **T scap** - Hol - (5) Slavinić (1940); (6, 9)
A. rosea L. - **T scap** – EA - (2) Slavinić (1940)
A. tatarica L. - **T scap** - EA - (2) Slavinić (1940); (4, 10)
Camphorosma monspeliaca L. - **Ch suffr caesp** - Med-Pont - (6) Niketić (1995); (6) Milosavljević & al. (2002); (6)
Chenopodium glaucum L. - **T scap** - EA - (2, 3, 4, 5) Slavnić (1940); (7, 9)
C. hybridum L. - **T scap** - Hol - (4)
C. rubrum L. - **T scap** - Hol - (1, 4, 10)
C. urbicum L. - **T scap** - EA - (10)
Polycnemum arvense L. - **T rept** - EA - (6)
Salsola kali L. - **T scap** - EA - (6)

COMPOSITAE
Achillea collina J. Becker ex Reichenb. - **H scap** - EA - (6)
A. crithmifolia Waldst. & Kit. - **H scap** – Med-Pont - (9)
Aster oleifolius (Lam.) Wagenitz - **H scap** - Pont - (6) Niketić (1995); (6)
A. sedifolius L. subsp. *canus* (Waldst.& Kit.) Merxm. - **H scap** – Med-Pont/Balk - (6) Niketić (1995); (6)
Bellis perennis L. - **H ros** - CE-Med - (2, 3, 4, 5) Slavinić (1940); (4)
Bidens tripartita L. - **T scap** - EA - (4,5,2,3) Slavinić (1940)
Carduus crispus L. - **T/H scap bienn** - EA - (6)
Carthamus lanatus L. - **H scap** - CE-Med-Pont - (6)
Centaurea pannonica (Heuffel) Simonkai - **H scap** - CE - (6) Niketić (1995); (4)
C. salonitana Vis. - **H scap** - Pont - (6)
C. solsticialis L. - **T scap** - Med-Pont - (6, 10)
Chamomilla recutita (L.) Rauschert - **T scap** - EA - (4, 6, 9)
Chondrilla juncea L. - **H scap** – E(W)A - (2, 3, 4, 5) Slavnić (1940)
Cichorium intybus L. - **H scap** - Cosm - (4)
Cirsium arvense (L.) Scop. - **H scap** - EA - (6)
Crepis setosa Haller fil. - **T scap** - Med-Smed - (9)
Filaginella uliginosa (L.) Opiz - **T scap** - EA - (4,5,2,3) Slavnić (1940);
Hypochoeris radicata L. - **H ros** – E(W)A - (4)
Inula britannica L. - **H scap** - EA - (1, 6, 7)
I. oculus-christi L. - **H scap-semiros** – Med-Pont - (6)
Lactuca saligna L. - **T/H scap bienn** - CE-Med-Pont - (4)
Leucanthemum vulgare Lam. - **H scap** - EA - (6)
Onopordum acanthium L. - **T scap** – E(W)A - (6)
Picris echioides L. - **H scap** - Med-Smed - (6) Niketić (1995); (6,10)
P. hieracioides L. - **T/H scap bienn** - E(W)A - (6)
Pulicaria dysenterica (L.) Bernh. - **H scap** - E(W)A - (4)
Scorzonera cana (C. A. Meyer) O. Hoffm. - **H scap** – CE-Med-Pont - (6) Niketić (1995); (6) Milosavljević & al (2002); (4, 2, 1, 6, 9, 10)
Senecio aquaticus Hill subsp. *barbareifolius* (Wimmern & Grab) - **H scap** - CE-Med - (1, 6)
S. erucifolius L.- **H scap** - CE-Med - (6)
S. vernalis Waldst. & Kit. - **T scap** - CE-Med - (6, 10)
S. vulgaris L. - **T scap** - EA - (6)
Sonchus asper (L.) Hill - **T/H scap bienn** - EA - (8)
S. oleraceus L. - **T/H scap bienn** - EA - (10)
Taraxacum erythrospermum Andraz. ex Besser - **H ros** - Med-Pont - (4)
T. palustre (Lyons) Symons - **H ros** - CE - (4, 5)
T. serotinum (Waldst. & Kit.) Poiret - **H ros** - Med-Pont - (4)
Tragopogon pratensis L. - **H scap** - CE-Med-Pont - (4)
Xanthium strumarium L. - **T scap** - Antrop - (2, 3, 4, 5) Slavnić (1940)
Xeranthemum annuum L. - **T scap** - Med-Smed - (6)
X. cylindraceum Sibth. & Sm. - **T scap** - Med-Pont - (6)
CRASSULACEAE
Sedum caespitosum (Cav.) DC. - **T succ** - CE-Med - (4, 6, 10)
CRUCIFERAE
Berteroa incana (L.) DC. - **T/H scap bienn** - EA - (2, 3, 4, 5) Slavnić (1940)
Bunias erucago L. - **T scap** - Med-Pont - (6, 9)
Calepina irregularis (Asso) Thell. - **H scap** - Med-Pont - (9)
Camelina sativa (L.) Crantz - **T scap** - CE-Med-Pont - (6)
Capsella bursa-pastoris (L.) Medicus - **T scap-ros** - Cosm - (6)
Cardamine hirsuta L. - **T scap-ros** - EA - (4, 6)
Cardaria draba (L.) Desv. - **H scap** - CE-Med - (9)
Coronopus didymus (L.) Sm. - **H scap** - CE-Med - (6)
Erophila verna (L.) Chevall. - **T ros** - E(W)A - (4, 6)
Erysimum repandum L. - **T scap** - E(W)A - (6)
Lepidium perfoliatum L. - **T scap-ros** - CE-Med-Pont - (6) Milosavljević & al (2002); (4) Zlatković & al (2003); (4, 6, 9, 10)
L. ruderale L. - **T scap-ros** - E(W)A - (1, 4, 6 ,7, 8, 10)
Myagrum perfoliatum L. - **T scap** - Med-Pont - (6)
Neslia paniculata (L.) Desv. subsp. thracica (Velen.) Bornm. - **T scap** - EA - (6)
Rorippa sylvestris (L.) Besser - **H scap-semiros** - EA - (9)
Teesdalia coronopifolia (J. P. Berg.) Thell. - **T scap-ros** - CE-Med-Pont - (4)
Thlaspi arvense L. - **T scap** - EA - (10)

DIPSACACEAE
Dipsacus fullonum L. - **T/H scap bienn** - E(W)A - (6)
Knautia arvensis (L.) Coulter - **T/H scap bienn** - E(W)A - (6)

EUPHORBIACEAE
Euphorbia chamaesyce L. - **T scap** – EA - (6)

E. falcata L. - **T scap** – EA - (6)
E. helioscopia L. - **T scap** – EA - (4, 6)
E. salicifolia Host - **H scap** - CE - (10)

GENTIANACEAE
Centaurium erythraea Rafin. - **T scap** – Med-Pont - (6, 7)
C. littorale (D. Turner) Gilmour subsp. *uliginosum* (Waldst. & Kit.) Rothm. - **T scap** -- CE-Pont - (6, 8)
C. pulchellum (Swartz) Druce - **T scap** - CE-Pont - (4, 8)

GERANIACEAE
Erodium cicutarium (L) L'Her. - **T scap-ros** - Cosm - (4, 6)
Geranium dissectum L. - **T scap** - E(W)A - (10)
G. molle L. - **T scap** - E(W)A - (10)

GUTTIFERAE
Hypericum elegans Stephan ex Willd. - **H scap** - EA - (6)

HALORAGACEAE
Myriophyllum spicatum L. - **HydT rad** - Hol - (4)

LABIATAE
Lamium amplexicaule L. - **T scap** – E(W)A - (6)
Mentha aquatica L. - **H scap** -Cosm – (4)
M. pulegium L. - **H scap** - EA - (4, 6)
M. spicata L. - **H scap** - Antrop - (6)
Phlomis tuberosa L. - **G tub/H scap** – Med-Pont - (6) Niketić (1995); (6)
Salvia aethiopis L. - **T/H scap bienn** - EA - (6, 7, 10)
S. pratensis L. - **H scap** – CE - (6, 9, 10)
Stachys cassia (Boiss.) Boiss. - **H scap** – Med-Smed - (6) Niketić (1995);
S. germanica L. - **H scap** – Ce-Med-Pont - (6)
S. milanii Petrović - **T scap** – Med-Smed/Balk - (6) Niketić (1995); (6) Milosavljević & al (2002.); (6)
Teucrium chamaedrys L. - **Ch suffr caesp** - E(W)A - (6)
T. polium L. - **Ch suffr caesp** – Med-Pont - (6)
T. scordium L. subsp. *scordioides* (Schreber) Maire & Petitmengin - **H scap** – Med-Smed - (4, 6, 7,8)
Thymus pannonicus All. - **Ch suffr rept** - CE - (10)
Galega officinalis L. - **H scap** - E(W)A - (6)
Lathyrus aphaca L - **T scap** - Hol - (6)
L. hirsutus L. - **T scap** - CE-Med - (4, 6, 10)
L. tuberosus L. - **G tub rept** - EA - (6)
Lotus angustissimus L. - **T scap** – Med-Pont - (4, 6, 10)
L. corniculatus L. - **H scap** - CE-Med - (6)
L. tenuis Waldst. & Kit. ex Willd. - **H scap** – CE-Med - (2, 3, 4, 5) Slavnić (1940)
Medicago arabica (L.) Hudson - **T/H scap** – Med-Pont - (9)
M. lupulina L. - **T scap** - EA - (6)
M. minima (L.) Bartal. - **T scap** - EA - (4, 6)
M. rigidula (L.) All. - **T scap** - CE-Med-Pont - (4, 6)
M. officinalis (L.) Pallas - **T/H scap bienn** - EA - (6)
Ononis arvensis L. - **Ch suffr caesp** - EA - (4)
O. spinosa L. - **Ch suffr caesp** - EA - (6)
Pisum sativum L. subsp. *arvense* (L.) Asch. & Graebn. - **T scap** - CE- Med-Pont - (6)
Trifolium dubium Sibth. - **T scap** - CE-Med-Pont - (10)
T. echinatum Bieb. - **H scap** - Med-Pont - (6, 7, 8, 10)
T. fragiferum L. - **H rept** - EA - (4)
T. incarnatum L. - **T scap** - Med-Smed - (9)
T. lappaceum L. - **T scap** - Med-Smed - (6, 7, 10)
T. nigrescens Viv. - **T scap** - CE-Med - (4, 10)
T. patens Schreber - **T scap** - CE-Med - (6)
T. pratense L. - **H scap** - EA - (6)
T. repens L. - **H rept** - Hol - (6)
T. resupinatum L. - **H scap** - Med-Pont - (4, 6, 9, 10)
T. striatum L. - **H scap** - CE-Med-pon - (4)
T. strictum L. - **H scap** - EA - (6)
T. subterraneum L. - **T rept** - Med-Pont - (4)
Vicia grandiflora Scop. - **T scap** - CE-Med-Pont - (9)
V. hirsuta (L.) S. F. Gray - **T scap** - CE-Med - (9)
V. narborensis L. - **T scap** - CE-Med-Pont - (6)
V. serratifolia Jacq. - **T scap** - CE-Med-Pont - (6, 10)

LINACEAE
Linum corymbulosum Reichenb. - **T scap** - Med-Smed - (6)

LYTHRACEAE
Lythrum hyssopifolia L. - **T scap** - Cosm - (1, 4)
L. salicaria L. - **H scap** - EA - (6)

MALVACEAE
Althaea hirsuta L. - **T scap** - Med-Pont - (1, 6)
A. officinalis L. - **H scap** - EA - (1, 6)

ONAGRACEAE
Epilobium tetragonum L. - **H scap** - Hol - (10)

PAPAVERACEAE
Fumaria officinalis L. - **T scap** - EA - (6, 9)
F. parviflora Lam. - **T scap** – Phol-Ptrop - (6)
F. vaillantii Loisel. - **T scap** - EA - (9)
Papaver dubium L. - **T scap** – Med-Pont - (2, 3, 4, 5) Slavnić (1940)
P. rhoeas L. - **T scap** – Med-Pont - (2, 3, 4, 5) Slavnić (1940)

PLANTAGINACEAE
Plantago coronopus L. - **T ros** - CE-Med - (2, 3, 4, 5) Slavnić (1940); (4) Zlatković & al (2003); (4)
P. lanceolata L. - **H ros** - EA - (4, 6, 9, 10)
P. major L. subsp. *intermedia* (DC.) Arcangeli - **H ros** - Hol - (3) Slavnić (1940); (4)
P. media L. - **H ros** - EA - (8, 9)

PLUMBAGINACEAE
Limonium gmelinii (Willd.) O. Kuntze - **H scap-ros/Ch herb succ** - EA - (6) Niketić (1995); (6) Milosavljević & al (2002.); (6, 7, 10)

POLYGONACEAE
Polygonum amphibium L. - **HydG rhiz** - Hol - (3) Slavnić (1940)
P. lapathifolium L. - **T scap** - Hol - (4) Slavnić (1940)
P. patulum Bieb. - **T scap** - Hol - (2, 3, 4, 5) Slavnić (1940); (4)
Rumex conglomeratus Murray - **H scap** - EA - (4, 6, 7)
R. palustris Sm. - **T scap** - EA - (1, 7, 9)
R. sanguineus L. - **H scap** – Med-Pont - (10)
R. stenophyllus Ledeb. - **H scap** - EA - (7)

PORTULACACEAE
Montia fontana L. subsp. *chondrosperma* (Fenzl) Walters - **T rept** - Cosm - (4)

RANUNCULACEAE
Adonis aestivalis L - **T scap** - Med-Pont - (9)
A. flammea Jacq. - **T scap** - Med-Pont - (6)

A. vernalis L. - **G rhiz caesp** - Med-Pont - (6) Niketić (1995); (10)
Consolida orientalis (Gay) Schodinger - **T scap** - E-Med-Smed-pon - (2, 3, 4, 5) Slavnić (1940); (6)
C regalis S. F. Gray - **T scap** - Med-Pont - (2, 3, 4, 5) Slavnić (1940); (6)
Myosurus minimus L. - **T ros** - Med-Pont – (4) Zlatković & al (2003); (4, 6, 7)
Ranunculus acris L. - **H scap-semiros** - Hol - (4, 6)
R. circinatus Sibth. – **HydT** - EA - (4)
R. ficaria L. subsp. *calthifolius* (Reichenb.) Arcangeli - **G tub rept** - EA - (4)
R. fluitans Lam. – **HydT** - EA - (4) Slavnić (1940);
R. marginatus D'Urv. - **T scap** – CE-Med-Pont - (4)
R. ophioglossifolius Vill. - **T/H scap bienn** – Med-Smed - (4) Slavnić (1940)
R. pedatus Waldst. & Kit. - **G tub/H scap** - EA - (4, 6, 7, 9, 10)
R. repens L. - **H rept** - EA - (4, 6)
R. sardous Crantz - **T scap** - Med-Pon - (9, 10)
R. sceleratus L. - **T scap** - EA - (7, 10)
R. serbicus Vis. - **H /G rhiz scap** – Med-Smed/Apembalk - (6)
R. trichophyllus Chaix - **HydT** - Cosm - (4) Slavnić (1940); (6)
R. velutinus Ten. - **H scap** - Med-Smed - (4)
Thalictrum lucidum L. - **H scap** - CE - (6)
T. minus L. - **H scap** - EA - (6)

ROSACEAE
Potentilla reptans L. - **H rept** - EA - (6)

RUBIACEAE
Asperula purpurea (L.) Ehrend. - **Ch suffr caesp** - Med-Smed - (6)
Galium parisiense L. - **T scap** - CE-Med - (4)
G. tenuissimum Bieb. - **T scap** - Med-Pont - (6, 10)
G. tricornutum Dandy - **T scap** - EA - (6)
G. verum L. - **H scap** - EA - (6, 10)
Sherardia arvensis L. - **T rept** - EA - (4, 6)

SANTALACEAE
Comandra elegans (Rochel ex Reichenb.) Reichenb. fil. - **Ch suffr caesp** – Pont/Balk - (6) Niketić (1995)

SCROPHULARIACEAE
Kickxia elatine (L.) Dumort. - **T rept** - E(W)A - (2, 3, 4, 5) Slavnić (1940); (4, 7, 10)
K. spuria (L.) Dumort. - **T rept** - E(W)A - (2, 3, 4, 5) Slavnić (1940); (4, 10)
Melampyrum arvense L. - **T scap** - CE-Med - (6)
Parentucellia latifolia (L.) Caruel - **T scap** - CE-Med-Pont - (4)
Verbascum blattaria L. - **T/H scap bienn** - EA - (6, 10)
Veronica acinifolia L. - **T scap** - EA - (4, 6)
V. anagallis-aquatica L. - **H scap** - EA - (1, 7, 8)
V. arvensis L. - **T scap** - EA - (6)
V. beccabunga L. - **H rept** - EA - (4)
V. hederifolia L. - **T caesp** - Med-Smed - (6)
V. polita Fries - **T caesp** - EA - (6)
V. verna L. - **T caesp** - EA - (10)

UMBELLIFERAE
Anthriscus sylvestris (L.) Hoffm. - **H scap** - CE - (9)
Bifora radians Bieb. - **T scap** - CE-Med-Pont - (6)
Bupleurum rotundifolium L. - **T scap** - EA - (6)
B. tenuissimum L. - **T scap** - CE-Med-Pont - (2, 3, 4, 5) Slavnić (1940); (4, 6, 7, 10)
Oenanthe fistulosa L. - **H scap** - CE-Med - (1)
O. silaifolia Bieb - **H scap** - CE-Med - (4, 6, 10)
Pastinaca sativa L. - **T/H scap bienn** - EA - (6)
Torilis nodosa (L.) Gaertner -**T scap** - CE-Med-Pont - (7)
Turgenia latifolia (L.) Hoffm. - **T scap** - CE-Med-Pont - (6)

VALERIANACEAE
Valerianella carinata Loisel. - **T scap** - CE-Med - (9)
V. dentata (L.) Pollich - **T scap** - CE-Med - (6)
V. locusta (L.) Laterrade - **T scap** - CE-Med - (4, 6)

VIOLACEAE
Viola kitaibeliana Schultes - **T caesp** - CE-Med - (6)

MONOCOTYLEDONES

ALISMATACEAE
Alisma plantago-aquatica L. - **HydG rhiz** - Hol - (4) Slavnić (1940); (4, 8)

AMARYLLIDACEAE
Leucojum aestivum L. - **G bulb** – E(W)A - (9)

ARACEAE
Arum orientale Bieb. - **G rhiz caesp** - E(W)A - (6)

BUTOMACEAE
Butomus umbellatus L. - **HydG rhiz** - EA - (1, 4)

CYPERACEAE
Carex distans L. - **H caesp** - EA - (1, 4, 5, 6, 9, 10)
C. divisa Hudson - **G rhiz caesp** - E(W)A - (4, 3) Slavnić (1940); (1, 4, 6, 7, 8, 9, 10)
C. elata All. - **H caesp** - CE - (4) Slavinić (1940)
C. hirta L. - **G rhiz caesp** - Hol - (9)
C. hordeistichos Vill. - **G rhiz caesp** - Hol - (7)
C. otrubae Podp. - **H/G rhiz caesp** – E(W)A - (4, 6, 9)
C. tomentosa L. - **H/G rhiz caesp** - E(W)A - (4, 6)
C. vulpina L. - **H/G rhiz caesp** - E(W)A - (1, 4, 6, 9, 10)
Cyperus flavescens L. - **T caesp** - Cosm - (2, 3, 4, 5) Slavnić (1940); (8)
C. fuscus L. - **T caesp** - Hol - (2, 3, 4, 5) Slavnić (1940); (4, 7, 8, 9)
C. longus L. - **G rhiz caesp** - EA - (4) Slavinić (1940); (1, 2)
C. pannonicus Jacq. - **T caesp** - CE-Pont - (4, 3) Slavinić (1940); (4, 6, 9, 10)
Eleocharis palustris (L.) Roemer & Schultes - **HydG rhyz** - Cosm - (2, 3, 4, 5) Slavnić (1940); (4, 6, 7)
Fimbristylis bisumbellata (Forskål) Bubani - **T caesp** - Cosm - (4) Slavnić (1940); (4) Zlatković & al (2003)
Scirpoides holoschoenus (L.) Soják – **H caesp/G rhiz** - EA - (1)
Scirpus lacustris L. subsp. *lacustris* - **G rhiz caesp** - EA - (4) Slavnić (1940);
S. lacustris L. subsp. *tabenaemontani* (C. C. Gmelin) Syme - EA - (4, 2, 6, 7, 8, 10)
Bolboschoenus maritimus (L.) Palla - **G rhiz ceasp** - Cosm - (2, 3, 4, 5) Slavnić (1940); (6) Niketić (1995); (4) Zlatković (2003); (1, 4, 6, 7, 9, 10)
B. glaucus (Lam.) S.G. Sm. - **G rhiz ceasp** - Cosm - (6).

GRAMINEAE

Agropyron cristatum (L.) Gaertner - **G rhiz caesp** - CE-Med-Pont - (6) Niketić (1995); (6)

Agrostis capillaris L. - **H caesp** - Hol - (4)

A. stolonifera L. - **H caesp** - Hol - (2, 3, 4, 5) Slavnić (1940);

Alopecurus aequalis Sobol. - **T rept** - EA - (6)

A. myosuroides Hudson - **T rept** - E(W)A - (6)

A. pratensis L. - **H caesp** - EA - (10)

A. rendlei Eig. - **T rept** - Hol - (4, 6, 9)

A. odoratum L. - **H caesp** - EA - (4)

Arrhenatherum elatius (L.) Beauv. ex J. & C. Presl - **H caesp** – E(W)A - (9)

Beckmannia eruciformis (L.) Host - **H caesp** - Hol - (1)

Bromus arvensis L. - **T scap** - EA - (4)

B. commutatus Schrader - **T scap** - CE-med - (4)

B. hordeaceus L. - **T scap** - Hol - (4, 9, 10)

B. racemosus L. - **T scap** - CE - (4)

B. scoparius L. - **T scap** - Med-Pont-S sib - (6)

B. squarrosus L. - **T/H caesp bienn** - Med-Smed - (6)

B. tectorum L. - **T scap** - CE - (9)

Calamagrostis arundinacea (L.) Roth - **G rhiz caesp** - CE-Pont - (1)

Catabrosa aquatica (L.) Beauv. - **G rhiz caesp** - Hol - (6, 8)

Crypsis aculeata (L.) Aiton - **T caesp** - Med-Pont - (2, 3) Slavinić (1940); (4) Zlatković & al (2003); (6, 10)

C. alopecuroides (Piller & Mitt.) Schrader - **T caesp** - CE-Med-Pont - (4, 2, 3) Slavinić (1940); (4, 8)

C. schoenoides (L.) Lam. - **T caesp** - Med-Pont - (2, 3, 4, 5) Slavinić (1940); (4, 6, 10)

Cynodon dactylon (L.) Pers. - **G rhiz rept** - Cosm - (4, 6, 10)

Echinochloa crus-galli (L.) Beauv. - **T caesp** - Cosm - (4, 3) Slavinić (1940);

Eragrostis cilianensis (All.) F. T. Hubbard - **T caesp** - EA - (6)

E. minor Host - **T caesp** - Hol - (4)

E. pilosa (L.) Beauv. - **T caesp** - Cosm - (4, 10)

Festuca valesiaca Schleicher ex Gaudin - **H caesp** - CE-Med - (7, 10)

Hordeum hystrix Roth - **H caesp** - CE-Med-Pont - (2, 3, 4, 5) Slavinić (1940); (6) Milosavljević & al (2002.); (4, 6, 8, 9, 10)

H. murinum L. - **H caesp** - CE-Med-Pont - (9)

H. secalinum Schreber - **H caesp** - Hol - (6, 7, 8, 10)

Lolium perenne L. - **H caesp** - EA - (9)

L. rigidum Gaudin - **T caesp** – Med-Smed - (4, 10)

Melica transsilvanica Schu - **H caesp** - CE - (6)

Molineriella minuta (L.) Rouy - **T scap** - Med-Smed/Balk - (4)

Phleum pratense L. subsp. *bertolonii* (DC) Bornm - **H caesp** - CE-Med - (4)

Pholiurus pannonicus (Host) Trin. - **T caesp** - CE-Med-Pont - (4) Zlatković & al (2003); (4, 6, 7, 8, 10)

Phragmites australis (Cav.) Trin. Ex Steudel - **HydG rhiz** - Cosm - (4) Slavnić (1940); (4, 6, 8, 9)

Poa annua L. - **T caesp** - Cosm - (4, 6)

P. bulbosa L. - **H caesp** - EA - (4, 9)

P. palustris L. - **H caesp** - Hol - (9)

Puccinellia distans (L.) Parl. - **H caesp** - Hol - (2, 3, 4, 5) Slavinić (1940); (6) Niketić (1995); (6) Milosavljević & al (2002.); (4, 6, 7, 8, 9, 10)

P. festuciformis (Host) Parl. *subsp. convoluta* (Hoernm.) W.E. Hughes - **H caesp** - Med-Pont - (4) Zlatković & al (2003); (2, 1)

Sclerochloa dura (L.) Beauv. - **T caesp** - EA- (9)

Taeniatherum caput-medusae (L.) Nevski - **T scap** - Med-Pont - (10)

Tragus racemosus (L.) All. - **T caesp** - Cosm - (4)

Vulpia bromoides (L.) S. F. Gray - **T scap** - Med-Pont - (4)

V. myuros (L.) C. C. Gmelin - **T scap** - CE-Med-Pont - (4, 6, 10)

IRIDACEAE

Crocus chrysanthus (Herbert) Herbert - **G bulb** – Med-Smed/Balk-Anat - (6) Niketić (1995);

JUNCACEAE

Juncus articulatus L. - **G rhiz caesp** - Hol - (4, 3) Slavinić (1940); (1, 4)

J. bufonius L. - **T caesp** - Hol - (2, 3, 4, 5) Slavinić (1940); (1, 4)

J. compressus Jacq. - **G rhiz caesp** - EA - (6, 7, 9, 10)

J. effusus L. - **G rhiz caesp** - Cosm - (6)

J. gerardii Loisel. - **G rhiz caesp** - Hol - (3, 4) Slavnić (1940); (4, 6, 8, 10)

J. inflexus L. - **G rhiz caesp** - Hol - (4) Slavnić (1940); (6)

J. ranarius Song. & Perr. - **T caesp** - CE-Med-Pont - (2, 3, 4, 5) Slavinić (1940); (7, 8)

J. tenageia L. fil. - **T caesp** - E(W)A - (1)

LEMNACEAE

Lemna gibba L. - **Hyd T** - Cosm - (7, 10)

L. minor L. - **Hyd T** - Cosm - (4) Slavnić (1940);

LILIACEAE

Allium cupani Rafin. - **G bulb** – Med-Smed/Apen-Balk - (6) Niketić (1995);

A. guttatum Steven subsp. *dalmaticum* (A. Kerner ex Janchen) - **G bulb** - Med-Smed/Balk - (6) Niketić (1995); (4, 6, 10)

A. scorodoprasum L. - **G bulb** - CE-Med-Pont - (6) Niketić (1995); (6)

A. spaerocephalon L. - **G bulb** - CE-Med-Pont - (6)

A. vineale L. - **G bulb** - Hol - (6)

Muscari tenuiflorum Tausch - **G bulb** - Med-Pont - (6)

Ornithogalum divergens Boreau - **G bulb** - CE-Med-Pont - (5)

O. pyramidale L. - **G bulb** - Med-Pont - (6, 10)

O. refractum Kit. ex Schlecht. - **G bulb** - Med-Pont - (6)

Scilla autumnalis L. - **G bulb** - Med-Pont - (4, 6)

Sternbergia colchiciflora Waldst. & Kit. - **G bulb** - CE-Med-Pont - (6) Niketić (1995);

ORCHIDACEAE

Orchis morio L. - **G tub scap** - CE-Med-Pont - (4)

Spiranthes spiralis (L.) Chevall. - **G tub scap** - CE-Med-Pont - (4)

POTAMOGETONACEAE

Potamogeton pectinatus L. - **HydT** - Cosm - (4) Slavnić (1940);

P. polygonifolius Pourret - **HydT** - Cosm - (4) Slavnić (1940);

SPARGANIACEAE
Sparganium erectum L. - **HydG rhiz** - EA - (4) Slavnić (1940);

TYPHACEAE
Typha angustifolia L. - **HydG rhiz** - Cosm - (4) Slavnić (1940);
T. latifolia L. - **HydG rhiz** - Cosm - (4) Slavnić (1940); (7, 10)

ZANNICHELLIACEAE
Zannichellia palustris L. - **HydT** - Cosm - (10)

Discussion

The results of original studies performed in salt marsh fragments of Central and Southern Serbia have shown presence of 334 taxa at species and subspecies level, belonging to 177 genera and 46 families. All taxa belong to division Magnoliophyta. Class Magnoliopsida includes 232 species or 69.46% of total flora, while class Liliopsida includes 102 species or 30.54% of flora in the study area.

Detailed taxonomic analysis was used to determine number of species and subspecies, genera and families in each salt marsh area (**Tab. 2**). As expected, most species were recorded at Lalinac salt marsh area (207 species) which includes the best-preserved and so far best-studied fragments of salt marsh areas in Serbia south of the Pannonian basin.

Table 2. Total taxa (Nt), genera (Ng) and families (Nf) in salt marsh areas of Central and Southern Serbia

Salt marsh area	Nt	Ng	Nf
Aleksandrovac	168	102	34
Lalinac	207	126	39
Bresničić	114	76	30

The analysis of representation of genera (**Tab. 3**) and species in certain families (**Fig. 2**) has shown that family Gramineae has the highest number of taxa at Aleksandrovac (19 genera, 27 species) and Bresničić salt marsh areas (16 genera, 23 species), while family Compositae had the highest number of taxa at Lalinac salt marsh area (15 genera, 25 species). The pronounced diversity of family Gramineae is attributed to strong steppe influence on formation of salt marsh flora. The high number of taxa from family Compositae was expected as this family is richest in taxa both in Balkan Peninsula and in Europe (Turill 1929). Analysis of representation of species in certain genera (**Fig. 3**) has shown that the largest genera were *Ranunculus, Trifolium, Carex* and *Juncus*.

Table 3. Comparative overview of families with the highest number of species in a salt marsh areas of central and southern Serbia (A – Aleksandrovac, L – Lalinac, B – Bresničić)

	A	L	B
Gramineae	30	21	23
Compositae	18	24	9
Cyperaceae	16	13	9
Caryophyllaceae	13	12	3
Ranunculaceae	13	13	5
Legumonosae	11	21	12
Cruciferae	6	11	7
Liliaceae	3	10	5
Labiatae	3	12	3

One important characteristic of flora in all three salt marsh areas is complete absence of highly halophilic genera such as *Suaeda* and *Salicornia*, in contrast to salt marshes of Macedonia and Pannonian Plain.

The phytogeographical analysis (**Tab. 4**) has shown that floras of all three salt marsh areas are dominated by species with wide distribution, as a consequence of floristic uniformity of this habitat type as well as the pronounced anthropogenous influences on the broader regions. The dominance of taxa with Eurasian range types indicates continental character of these areas.

Although they are few in number, the species of Mediterranean-submediterranean distribution type play an important role in structure of the flora of Aleksandrovac salt marsh area. This group also includes two endemic (*Allium guttatum* subsp. *dalmaticum* and *Dianthus viscidus*) and one subendemic taxon (*Moenchia graeca*). *Dianthus viscidus* and *Moenchia graeca* are differential species in comparison to salt marshes of Jastrebac foothills (Bresničić and Lalinac salt marsh area). Group of differential species also includes the Mediterranean- Macedonian- Thracian species *Molineriella minuta*, which was first recorded in Serbia during the studies of salt marshes of Aleksandrovac area (Zlatković et al., 2005). Species *Puccinellia festuciformis* also has a significant differential role, appearing as a dominant and characteristic species of association *Montio-Puccinellietum festuciformis* at the salt marshes in vicinity of Vranje and Bujanovac.

Flora of Lalinac salt marsh area is predominantly characterized by species of Pontian-South Siberian range type, with a differential character in comparison to Aleksandrovac and Bresničić salt marsh area. Analysis of flora of Lalinac salt marsh area has shown presence of the greatest number of endemics (*Stachys milanii* and

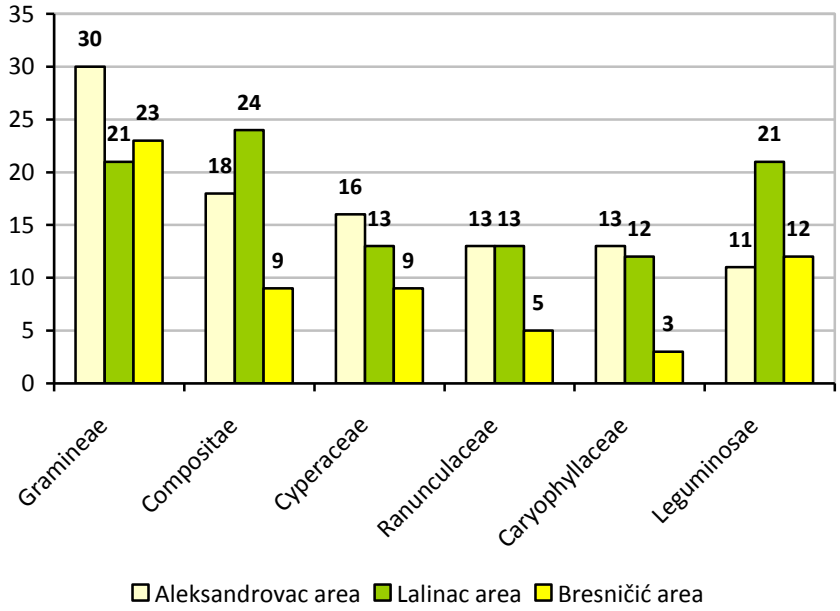

Fig. 2. Comparative overview of families with the highest number of species in a salt marsh areas of central and southern Serbia

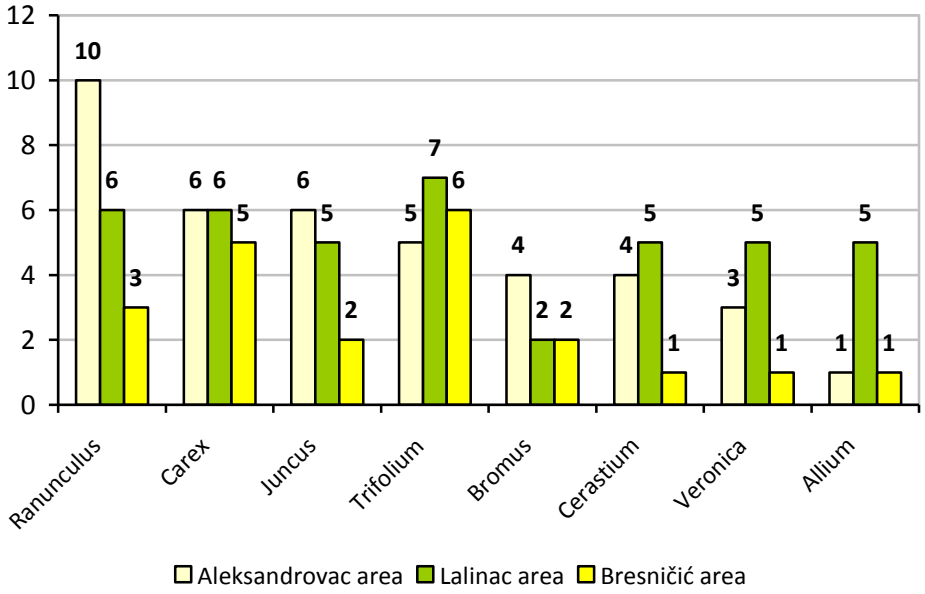

Fig. 3. Comparative overview of genera with the highest number of species in a salt marsh areas of central and southern Serbia

Allium guttatum subsp. *dalmaticum*) and subendemics (*Dianthus pinifolius, Allium cupanii, Ranunculus serbicus* and *Achillea crithmifolia*) in comparison to other salt marshes of Central and Southern Serbia. This group may also include the species with ranges including part of Balkan Peninsula, Pannonian Plain and the western part of Pontian-South Siberian floristic region (*Comandra elegans, Dianthus monadelphus, Aster sedifolius, Aster oleifolius, Centaurea salonitana* and *Nonea pallens*). The greatest phytogeographical significance is certainly that of the endemic species *Stachys milanii*. In addition, the Lalinac salt marsh area also hosts another critically endangered species of Serbian flora, *Camphorosma monspeliaca*, creating characteristic chamaephyte associations.

The Bresničić salt marsh area was characterized by absence of any taxa of Pontian-South Siberian range types, although the steppe influence is reflected in presence of 31 taxa with ranges mostly occupying the Pontian-South Siberian region. At the salt marshes of this area there was

Table 4. Comparative overview of presence of chorological types in the flora of salt marshes of Central and Southern Serbia (N – number of species)

	Salt march area					
	Aleksandrovac		Lalinac		Bresničić	
Chorological Type	**N**	**%**	**N**	**%**	**N**	**%**
Cosmopolitan (Cosm)	24	14.29	15	7.25	10	8.77
Antropohoric (Antrop)	1	0.60	1	0.48	0	0.00
Holarctic (Hol)	22	13.10	14	6.76	11	9.65
Paleoholarctic-Paleothropic (Ph-Pt)	0	0.00	1	0.48	0	0.00
Eurasian (EA)	41	24.40	59	28.50	30	26.32
Euro-West Asian (E(W)A)	16	9.52	22	10.63	11	9.65
Central European-Mediterranean-Pontic (CE-Med-Pont)	19	11.31	25	12.08	13	11.40
Central European-Pontic (CE-Pont)	2	1.19	3	1.45	1	0.88
Mediterranean-Submediterranean-Pontic (Med-Pont)	17	10.12	27	13.04	17	14.91
Pontic-South Siberian (Pont)	0	0.00	4	1.93	0	0.00
Central European (CE)	5	2.98	5	2.42	6	5.26
Central European-Mediterranean (CE-Med)	13	7.74	15	7.25	9	7.89
Mediterranean-Submediterranean (Med-Smed)	8	4.76	16	7.73	6	5.26

only one endemic (*Allium guttatum* subsp. *dalmaticum*) and one subendemic taxon (*Achillea crithmifolia*).

Flora of salt marshes of Central and Southern Serbia includes 6 main (**Fig. 4**) and two transitional life forms of plants. Characteristic feature is significant participation of therophytes (about 50% of total flora in all three salt marsh areas) and complete absence of phanerophytes. The therophyte character of flora in these habitats is explained by presence of relatively arid and unsuitable habitats for plant life. Additional factor favoring presence of therophytes and reducing the other ecological groups is substrate salinity. High levels of presence of therophytes within the spectrum of life forms of salt marsh flora are also contributed to by strong influence of the anthropogenous factor.

In all salt marsh areas the hemicryptophytes

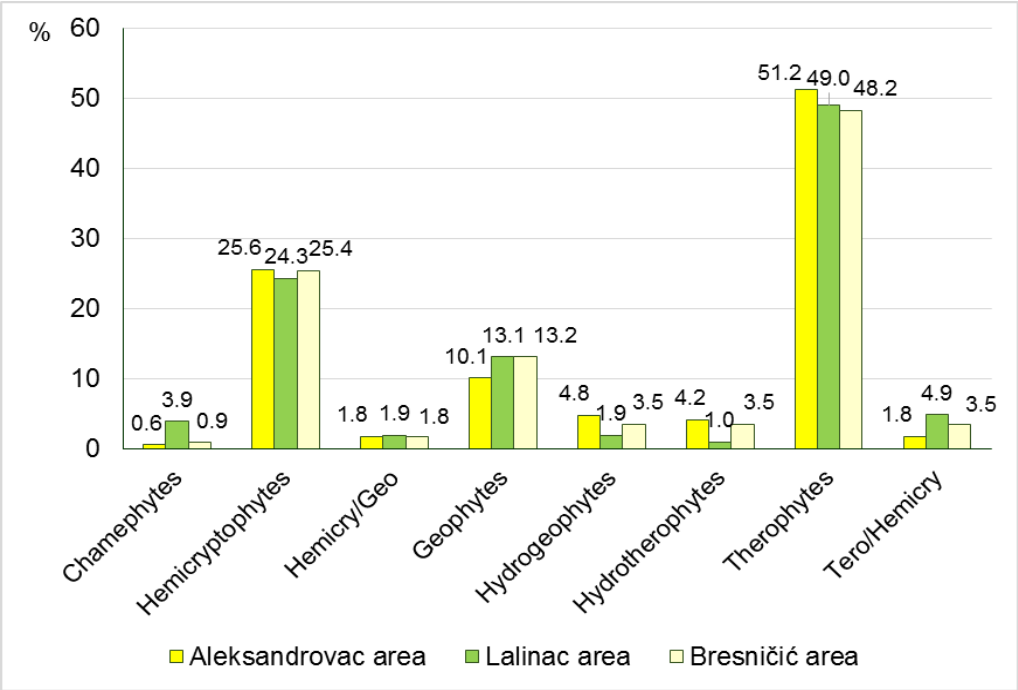

Fig. 4. Comparative overview of the percentage representation of life forms in the flora of the investigated salt march areas

occupy the second place by number of species.

The third place is occupied by the life form of geophytes. The pronounced presence of geophytes in salt marsh habitats is explained by their adaptation to unfavorable habitat and climate conditions, primarily during the arid summer period. Presence of deeper water level in spring period and deeper temporary and permanent ponds enables appearance of hydrotherophytes and hydrogeophytes.

The real hydrophytes were best represented at the Aleksandrovac salt marsh area, due to proximity of accumulation lake. The water from the accumulation floods the coastal part of salt marsh in spring months, remaining for several months and enabling development of marsh vegetation of saline terrain.

Salt marshes are characterized by specific water regime. During the vegetation period they are flooded for a certain period of time. These conditions are not suitable for development of most chamaephytes. The percentage of chamaephytes is somewhat greater at Lalinac salt marsh area than in other habitats, as a consequence of presence of well-developed steppe habitats. Furthermore, the salt marshes of Lalinac area are the only site where exclusively chamaephyte phytocoenoses of halophyte *Camhorosma mospelliaca* were recorded.

Regarding the taxonomic diversity and endemism of flora, the salt marsh areas of Central and Southern Serbia may be considered to be one of the more important centers of diversity for salt marsh flora and vegetation in the region south of the Pannonian Plain. As all three salt marsh areas are under strong anthropogenous influence, it is necessary to implement appropriate measure for conservation and protection of their flora and vegetation.

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