

OKANJ BARA-IMPORTANT CENTER OF FLORISTIC AND ECOSYSTEM DIVERSITY OF THE TISA RIVER BASIN (SERBIA)

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ABSTRACT. More than 75% of Vojvodina province (Serbia) are agricultural and mostly degraded landscape intermingled with more or less isolated remnants of natural and seminatural vegetation on areas which are unfavourable for amelioration into arable land (steep loess walls, sandy areas, saline marshes and meadows) or they are included within protected areas. Many of them were proved to be important centers of floristic and ecosystem diversity in Serbia and Pannonic region, especially for steppe and halophytic vegetation. Unfortunately, significant part of this valuable sites are unprotected and under great antropogenic influences which emphasize need for their protection. One of these important sites is saline lake Okanj bara near Tisa river in Vojvodina (Serbia) with specific and endangered types of saline habitats. Based on field research, herbarium and literature survey new floristical and ecological data are presented. In accordance with data from related literature more than 400 taxa and 58 syntaxonomical units (7 classes, 12 orders, 16 alliances, 20 associations) were observed. In group of protected and rare typical species as well as species with insufficiently known distribution in Serbia were recorded: *Plantago schwarzenbergiana* Schur, *Aster tripolium* L. subsp. *pannonicum* (Jacq.) Soó, *Cirsium brachycephalum* Juratzka, *Trifolium angulatum* Waldst. & Kit., *Allium atropurpureum* Waldst. & Kit., *Scilla autumnalis* L., *Silene viscosa* (L.) Pers., *Salvia austriaca* Jacq., *Salsola soda* L., *Scirpus lacustris* L. subsp. *tabernaemontani* (C. C. Gmelin) Syme in Sowerby, *Crypsis aculeata* (L.) Aiton, *Artemisia santonicum* L., *Limonium gmelinii* (Willd.) O. Kuntze and others.

Keywords: biodiversity, protection, Okanj bara, Lower Tisa, Banat.

INTRODUCTION

Okanj bara is located in middle Banat region (Vojvodina province, Serbia) along the left bank of Tisa river, about 15 km northwest from Zrenjanin (Fig. 1). Together with Slano Kopovo and Rusanda it is one of the last preserved big salt pans (shallow lakes) in pannonic part of Serbia with peculiar and endangered biodiversity. Lake bed is 4 km long, about 100-500m wide with average depth 1-1.5m and surrounded by mosaic of saline meadow and steppic vegetation, intermingled with agriculture landscape and net of channels and transport routes. Like other salt lakes in Banat region, Okanj bara lays in paleomeander of Tisa river on alluvial terrace (74-83m. a. s. l.). Relief is characterised by various accumulative structures like as former Tisa river beds (relief depressions), coast lines, mounds and flat fluvial deposits as well as microstructures (relief microdepressions and ridges). Geological substrat is represented with paleozoic and mezozoic rocks, pliocene deposits and loess sediments. Hydrological regime depends on affluence of ground and atmospheric waters and evaporation processes. Construction of drainage channel network, especially during the last 50 years, caused permanent loss of water from lake and its surroundings. Pedogenesis is under great influences of ground water and evaporation processes which results in vertical migration of alkali salts in ground and lastly to formation of characteristic halogenic types of soils, such are solonetz (most frequent) and solonchak. Other soil types are hydromorphic black limeless soil, calcareous (micelar) chernozem on loess terrace (NEJGEBAUER ET

AL., 1971). Observed area is under strong influence of modified continental (pannonic) climate with average precipitation of 609,8mm, generally 22.2 day with persisting snow. Average monthly temperatures vary from 0.08 to 22.03 °C with annual average of 11.06 °C. Average annual insolation is 2169h and relative humidity varies from 64 to 76% (EDS. PANJKOVIĆ ET KOVAČEV, 2008).

Pannonic part of Serbia belongs to the pannonic province within pannonic-valachian subregion and pontic-southsiberian floristic-vegetation region characterised by forest-steppe vegetation (alliance *Festucion rupicolae* Soó 1940 and *Aceri tatarico-Quercion* ZÓLY. ET JAKUCS, 1957) with intrazonal saline areas (alliances *Cypero-Spergularion*, *Puccinellion limosae* and *Puccinellion peisonis* (STEVANOVIĆ ET AL., 1999: 17).

Okanj bara represents one of the last preserved areas with endangered ecosystems of salt pans and marshes, saline and steppic meadows with specific pannonic endemic diversity, involving primarily euhalophytic flora, rare insects, amphibians, birds and mammals. Because of its natural values Institute for Nature Conservation of Serbia proposed Okanj bara in the year 2008. for protection as exceptionally significant natural domain (EDS. PANJKOVIĆ ET KOVAČEV). Also, Okanj bara along with circumjacent Rusanda salt lake is in nomination procedure as Important Bird Area (PUZOVIĆ ET AL., *in press*) and it was distinguished as important botanical area (BOŽA ET ANAČKOV, 2005/2006).

In spite of its unquity, distinct diversity and even international significance as one of floristic diversity

centers in Serbia (STEVANOVIĆ ET AL., 1995), as well as its accessibility, Okanj bara has never been completely investigated. Most data concerning flora for example are fragmented and in many cases quite old or require a revision of herbarium material (if it exist) or on field. The aim of our research was to verify Okanj bara as important center for diversity of flora and vegetation in Serbia and to confirm and map rare and endangered plant taxa (especially those protected by national law) in order to make basis for its protection. During this process some important and hitherto undiscovered plant taxa were observed.

MATERIALS AND METHODS

Field researches of flora and vegetation of Okanj bara were carried out from 2006 to 2009. year mostly in Okanj bara and its surrounding (particularly Žugalj, Nadjoš and Crvenka ponds). Herbarium specimens are deposited in Herbarium of Institute for Nature Conservation of Vojvodina province in Novi Sad (HIPNS). Nomenclature basically follows TUTIN ET AL. (1968-1980; 1993). Syntaxonomical positions of plant communities are given according to PARABUĆSKI ET AL. (1986), PASSARGE (1996) and OBERDORFER (1998). Floristic elements are cited according to GAJIĆ (1980) and Soó (1964-1980).

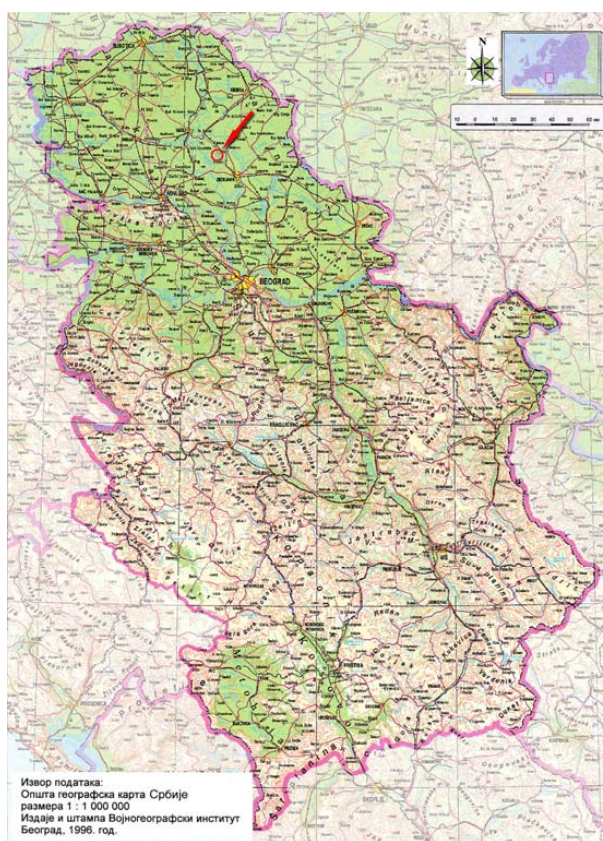


Fig. 1: Geographic position of Okanj bara in Serbia.

RESULTS AND DISCUSSIONS

Pannonic alkali flora and vegetation are strongly shaped by mutual effects of hydromorphic soils, pannonic climate extremes and specific hydrogeological conditions, particularly by water and amount of salt in soil and water (BOROS, 2003). Most important factor for formation of alkali soils, especially solonetz and solonchak, is fluctuation of the water level during year reflected in salt dynamics changes in groundwater and soil. Under these changes and partly by wind erosion alkali habitats have a fine scale geomorphology and this micro-topographical pattern (in particular salt content, type of the salts and depth of the soil layer with a higher salt concentration) is greatly correlated with the vegetation pattern (MOLNÁR

ET BORHIDI, 2003). Vegetation shows zonal distribution depending on flooding regime and salt content in water and soils.

Like in other pannonic alkali habitats, number of plant species in Okanj bara and its surrounding is relatively poor (ŠEFFEROVÁ STANOVÁ ET AL., 2008). On the basis of list of plant taxa observed in investigated area, a list of 27 national and international important taxa (22 species and 5 subspecies) was composed. All these taxa are mentioned in national „Act standard for declaration and protection of strictly protected and protected willd species“ (Sl. Glasnik 5/10) whereby 6 of them are strictly protected. Also, according to National Red List (ED. STEVANOVIĆ, 2002) there is a considerable number (15)

of species in following IUCN categories: two critically endangered (CR), six endangered (EN), three vulnerable (VU) and four with combined categories (CR-VU, EN-LC, VU-LC), due to insufficient available informations (DD). However, some of the most threatened taxa limited

to saline areas like *Salsola soda* L. and *Scilla autumnalis* L. are missed from National Red List, probably due to data deficient. Two species are listed on IPA Appendix I (threatened species). (Tab. 1).

	Taxa	Strictly Protected	Protected	National Red List	IPA Appendix I
1	<i>Allium atropurpureum</i> Waldst. & Kit.		✓	EN	
2	<i>Artemisia santonicum</i> L.		✓	EN-LC (DD)	
3	<i>Aster sedifolius</i> L. subsp. <i>sedifolius</i>		✓	Not evaluated	
4	<i>Aster sedifolius</i> L. subsp. <i>canus</i> (Waldst. & Kit.) Merxm.		✓	VU	
5	<i>Aster tripolium</i> L. subsp. <i>pannonicus</i> (Jacq.) Soó		✓	VU	
6	<i>Beckmannia eruciformis</i> (L.) Host		✓	Not evaluated	
7	<i>Carex stenophylla</i> Wahlenb.		✓	VU-LC (DD)	
8	<i>Cirsium brachycephalum</i> Juratzka	✓		EN	✓
9	<i>Crypsis aculeata</i> (L.) Aiton		✓	VU-LC (DD)	
10	<i>Crypsis schoenoides</i> (L.) Lam.		✓	Not evaluated	
11	<i>Limonium gmelinii</i> (Willd.) O. Kuntze subsp. <i>hungaricum</i> (Klokov) Soó		✓	Not evaluated	✓
12	<i>Ornithogalum boucheanum</i> Asch.		✓	EN	
13	<i>Plantago schwarzenbergiana</i> Schur	✓		VU	
14	<i>Salsola soda</i> L.	✓		Not evaluated	
15	<i>Salvia austriaca</i> Jacq.		✓	VU	
16	<i>Scilla autumnalis</i> L.	✓		Not evaluated	
17	<i>Scirpus lacustris</i> L. subsp. <i>tabernaemontani</i> (C. C. Gmelin) Syme in Sowerby	✓		CR-VU (DD)	
18	<i>Scorzonera parviflora</i> Jacq.		✓	EN	
19	<i>Silene viscosa</i> (L.) Pers.		✓	EN	
20	<i>Suaeda maritima</i> (L.) Dumort. subsp. <i>maritima</i>		✓	Not evaluated	
21	<i>Suaeda maritima</i> (L.) Dumort. subsp. <i>pannonica</i> (Beck) Soó ex P. W. Ball	✓		CR	
22	<i>Trifolium ornithopodioides</i> L.		✓	EN	

Tab. 1: List of national and international important taxa observed on Okanj bara and adjacent areas.

Other important plant taxa recorded in Okanj bara are: *Chenopodium chenopodioides* (L.) Aellen, *Puccinellia distans* (L.) Parl. subsp. *distans* and subsp. *limosa* (Schur) Jáv. in Soó & Jáv., *Ranunculus pedatus* Waldst. & Kit., *Trifolium angulatum* Waldst. & Kit. (ŠEFFEROVÁ STANOVÁ ET AL., 2008), *Camphorosma annua* Pallas, *Juncus gerardi* Loisel. in Desv., *Festuca pseudovina* Hack. ex Wiesb., *Scorzonera cana* (C. A. Meyer) O. Hoffm. in Engler & Prantl, *Carex divisa* Hudson, *Hordeum hystrix* Roth (EC, 2007).

Majority of important taxa (Tab. 1) are obligate or facultative halophytes restricted to narrow area within the limits of Okanj lake bed and its adjacency, where some of them (like *Suaeda maritima* (L.) Dumort. subsp. *pannonica* (Beck) Soó ex P. W. Ball, *Salsola soda* L.) were found only on few square meters on north lake end. Finding of *Suaeda maritima* (L.) Dumort. subsp. *pannonica* (Beck) Soó ex P. W. Ball represent third confirmed locality where this critically endangered species grows in Serbia (BOŽA, 1999). Considering the fact that its known subpopulations show significant fluctuations in number of individuals and that subpopulation on Okanj bara represent probably the smallest one in Serbia, this emphasises necessity for protection of this locality. Okanj bara, especially their northern part, proved as very important botanical site because of presence of stabile populations of important threatened species occurring on somewhat higher elevations like *Scilla autumnalis* L. (estimated to few thousand individuals), *Plantago schwarzenbergiana* Schur (not estimated) or *Allium atropurpureum* Waldst. & Kit., discovered on steppe patches near railroad Melenci-Elemir (approximately 50 individuals). Postglacial relict species *Scilla autumnalis* L. was in last hundred years observed on about 20 localities in Vojvodina province (KNEŽEVIĆ ET AL., 1997). According to our field data collected in last decade population size reduction is observed or suspected on many of these localities. Similar trend is noticed among populations of *Plantago schwarzenbergiana* Schur. Both species are well established on solonetz soils around Okanj lake. Endangered *Allium atropurpureum* Waldst. & Kit. was observed on about 30 localities in Serbia, predominantly more than 20 years ago in Vojvodina province, including Okanj bara also (ANAČKOV, 2009). On salt meadows and *Bolboschoenetalia maritimi* Hejny 1967 marshes were discovered small fragments of *Cirsium brachycephalum* Juratzka, *Scirpus lacustris* L. subsp. *tabernaemontani* (C. C. Gmelin) Syme in Sowerby and *Beckmannia eruciformis* (L.) Host. Pannonic endem *Cirsium brachycephalum* Juratzka is generally distributed in northern parts of Vojvodina province on small number of localities (PARABUČSKI ET PEKANOVIĆ, 1980). Population in Okanj bara is one the outmost southern parts of its areal noticed in Serbia recently. Also, small groups of this species are discovered on Nadjoš and Žugalj pond close

to Okanj bara. Data about distribution of *Beckmannia eruciformis* (L.) Host. in Serbia are very insufficient and quite old (SLAVNIĆ, 1953; ATANACKOVIĆ 1958; OBRADOVIĆ 1986; KNEŽEVIĆ, 1996) so this rare grass was not evaluated in National Red List (ED. STEVANOVIĆ, 2002). Recent findings of *Beckmannia eruciformis* (L.) Host. in northern part of Okanj bara and some other localities in Tisa basin (KNEŽEVIĆ J., pers. comm.) improve our critical knowledge about its actual distribution in Serbia and make possible some preliminary conservation status evaluation. Our preliminary observations from Okanj bara and salt marshes in north and central parts of Vojvodina province show that *Scirpus lacustris* L. subsp. *tabernaemontani* (C. C. Gmelin) Syme in Sowerby is fairly common in these areas and on national level rather vulnerable taxon (ED. STEVANOVIĆ, 2002). Elevated northern-northwestern bank of Okanj bara is habitat of rare *Trifolium ornithopodioides* L. which was detected only in april 2007. (on few square meters) as well as *Silene viscosa* (L.) Pers. (7 individuals in 2008.).

On the basis of preliminary field results in Okanj bara and its adjacency 58 syntaxonomical units within 7 classes, 12 orders, 16 alliances, 3 association groups and 20 plant communities were evidenced. Most characteristic communities belongs to class *Thero-Salicornietea strictae* Tüxen in Tüxen et Oberdorfer 1958: ass. *Salsolietum sodae* Slavnić (1939) 1948 observed sporadically along Okanj lake bed and in lateral channels and *Crypsidetum aculeatae* Bojko (1932) Wendelberger 1943 (*Crypsidetea aculeatae* Vicherek 1973 according to ŠEFFEROVÁ STANOVÁ ET AL., 2008), latter is alongside with *Chenopodium-Atriplex salina* Slavnić (1939) 1948 very common on lake bed during arid season. On few square meters on north-northwestern bank of Okanj lake was founded most likely ass. *Suaedetum pannonicae* (Soó 1927) Wendelberger 1943, but this fact requires further field study. Within class *Phragmitetea* Tüxen et Prsg. most dominant salt marshes communities in Okanj bara were ass. *Phragmitetum communis* Schmale 1939, ass. *Schoenoplectetum lacustris* Chouard 1924 and ass. *Bolboschoenetum maritimi continentale* Soó (1927) 1957. On less saline drier soils affected with grazing and trampling develops vegetation of continental alkali steppes and meadows (*Festuco-Puccinellietea* Soó 1968). Typical vegetation of alkali steppes (MOLNÁR ET BORHIDI, 2003) are mostly in seminatural condition i. e. with dominant secondary *Achillea* steppe (*Festuca pseudovina* Hack. ex Wiesb. with *Achillea pannonica* Scheele, *Scorzonera cana* (C. A. Meyer) O. Hoffm. in Engler & Prantl, *Inula britannica* L., *Gypsophila muralis* L., *Cerastium dubium* (Bastard) Guépin), intermingled with *Artemisia* primary steppe (*Festuca pseudovina* Hack. ex Wiesb., *Limonium gmelinii* (Willd.) O. Kuntze subsp. *hungaricum* (Klokov) Soó, *Artemisia santonicum* L.) due to antropogenic factor. On *Achillea* steppe fragments were discovered important *Trifolium* species

like *T. angulatum* Waldst. & Kit., *Trifolium retusum* L., *T. ornithopodioides* L. and *Trifolium striatum* L. On slightly elevated habitats develops vegetation of salt steppic meadows and tall herb salt meadows with *Aster sedifolius* L. subsp. *sedifolius* and subsp. *canus* (Waldst. & Kit.) Merxm., *Scilla autumnalis* L., *Silene viscosa* (L.) Pers. Lower salt meadows on salt steppes are dominated by combined vegetation from alliances *Juncion gerardi* Wendelberger 1943 and *Beckmannion eruciformis* Soó 1933 with *Alopecurus pratensis* L., *Agrostis stolonifera*, *Carex distans* L., *Carex divisa* Hudson and *Beckmannia eruciformis* (L.) Host. On alkali microrelief depressions occur ass. *Puccinellietum limosae* (Rapcs. 1927) Soó 1930, ass. *Camphorosmetum annuae* Topa 1939 and fragments of annual salt pioneer sward vegetation. On disturbed habitats grows species like *Carduus nutans* L., *Cynodon dactylon* (L.) Pers., *Erophila verna* (L.) Chevall., *Hordeum hystrix* Roth (ass. *Hordeetum hystricis* (Soó 1939) Wendelberger 1943), *Bromus hordaceus* L., *Lepidium perfoliatum* L., *Mentha aquatica* L., *Phragmites australis* (Cav.) Trin. ex Steud.

Flora and vegetation of observed area are under great human pressure where as main threatening factors can be pointed out: drainage of groundwaters, overgrazing and trampling, eutrophication and pollution from adjacent fields, absence of traditional landuse forms, invasive plant species (*Phragmites australis* (Cav.) Trin. ex Steud., *Amorpha fruticosa* L.), illegal landfills.

CONCLUSIONS

Based on floristic investigations of Okanj bara and its surrounding 27 important plant taxa (22 species and 5 subspecies) were evidenced. All important taxa which were previously cited for Okanj bara or its vicinity were reconfirmed, while at least 10 species and 2 subspecies (*Beckmannia eruciformis* (L.) Host, *Cirsium brachycephalum* Juratzka, *Crypsis schoenoides* (L.) Lam., *Ornithogalum boucheanum* Asch., *Plantago schwarzenbergiana* Schur, *Salsola soda* L., *Salvia austriaca* Jacq., *Scirpus lacustris* L. subsp. *tabernaemontani* (C. C. Gmelin) Syme in Sowerby, *Silene viscosa* (L.) Pers., *Suaeda maritima* (L.) Dumort. subsp. *pannonica* (Beck) Soó ex P. W. Ball and *Trifolium ornithopodioides* L.) were new discovered for this area. Majority of them are strictly delimited to pannonic alkali habitats or they are on utmost of its areal. Discovery of some of the most threatened taxa like as *Suaeda maritima* (L.) Dumort. subsp. *pannonica* (Beck) Soó ex P. W. Ball is important contribution to their chorology. Considering the fact that some important taxa like *Beckmannia eruciformis* (L.) Host, *Salsola soda* L., *Scilla autumnalis* L. due to insufficient information about their distribution pattern in Serbia were not evaluated in National Red List (ED. STEVANOVIĆ, 2002), new or reconfirmed distribution data are substantial for some subsequent protection measures. Beside a relative great amount of floristical

and phytocoenological data refer to alkali habitats in Serbia, our new data indicate that these habitats are still partially unknown or neglected in recent times.

Being located in Vojvodina region with biggest concentration of extincted or threatened plant taxa in Serbia (NIKETIĆ ET STEVANOVIĆ, 1999) and due to strong and increased human negative impacts, especially in last 50 years, alkali habitats described as one of centers of floristic diversity in Serbia (STEVANOVIĆ ET AL., 1995) require particular attention and detailed monitoring in order to decrease risk of further biodiversity loss on global and national level.

On the basis of all aforementioned facts Okanj bara and its adjacency can be distinguished as important center of floristic and ecosystem diversity in Tisa river basin which justify its protection as exceptionally significant natural domain.

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