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PHYTOGEOGRAPHICAL AND ECOLOGICAL  
CHARACTERISTICS OF THE VEGETATION ALLIANCE  
*THERO-SALICORNION* Br.-Bl. 33 EM. Tx. 50 GROWING  
ON CONTINENTAL SALT-AFFECTED SOILS  
(BANAT—YUGOSLAVIA)

ABSTRACT: Synecology of the communities of the alliance *Thero-Salicornion* Br. - Bl. 33 em. Tx. 50 growing on continental salt-affected soils (Banat, Yugoslavia) has been characterized on the basis of area type percentages and life form explanations, using methods of indicative geobotany.

KEYWORDS: continental salt-affected soils, the alliance *Thero-Salicornion*, area type percentages, life forms, ecological indices

INTRODUCTION

Communities of the alliance *Thero-Salicornion* Br. - Bl. 33 em. Tx. 50 may be encountered practically along the entire Mediterranean coast, as an azonal type of vegetation. On continental salt-affected soils of the Pannonian Plain, however, they are a part of the intrazonal vegetation in the region of climazonal vegetation of the alliances *Aceri tatarico-Quercion* Zolyomi et Jakucs 57 and *Festucion rupicolae* Soó (40) 64 (Soó, 1973).

Although removed from their original habitats by human influence, those communities have found extremely good conditions for successful development in saltworks along the Mediterranean coast. In the continental regions of the Pannonian Plain, however, they are at the stage of rapid retreat, and most of their surviving stands have a limited habitat.

The aim of this paper was to characterize the synecology of the alliance *Thero-Salicornion* communities on the continental salt-affected soils (Banat,

Yugoslavia) using methods of indicative geobotany and area types and life forms as diagnostic criteria.

### INVESTIGATED AREA AND METHODS

The investigated area is located in the central part of Banat, near settlements Novi Bečej and Melenci, on the alluvion of the River Tisza (Figure 1).

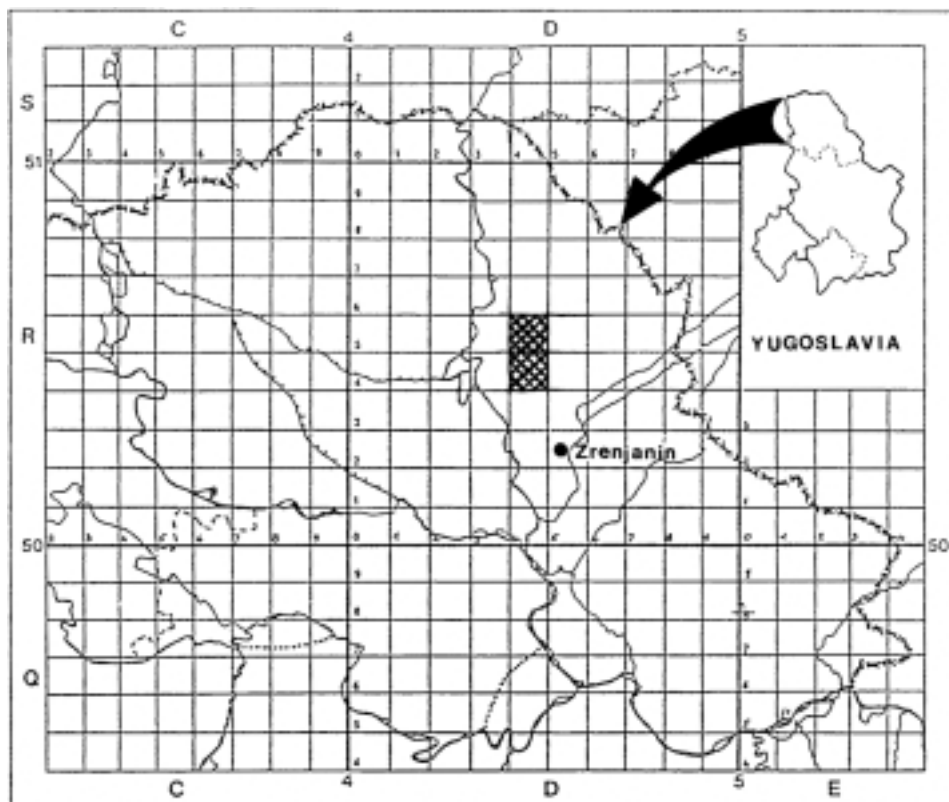


Figure 1. — Investigated area

The moderately continental climate of this area, influenced by the continental climate from the northeast, the Central European climate from the northwest, and the Mediterranean climate from the south, is alleviated by the presence of considerable bodies of water. The beginning of the vegetation period in these areas is characterized increases in precipitation and temperature, which are of crucial importance for plant growth. The precipitation, after reaching its maximum in June, starts an abrupt decrease. On the other hand, in the middle of the vegetation period, the temperature is relatively stable and its faster and more substantial decrease begins only after the intensive droughts in October.

Such relationship between precipitation and temperature results in the occurrence of semiarid or, in some years, arid periods unfavorable for the vegetation cover. These dry periods usually begin in July and continue till October (Figure 2) (Katić et al., 1979).

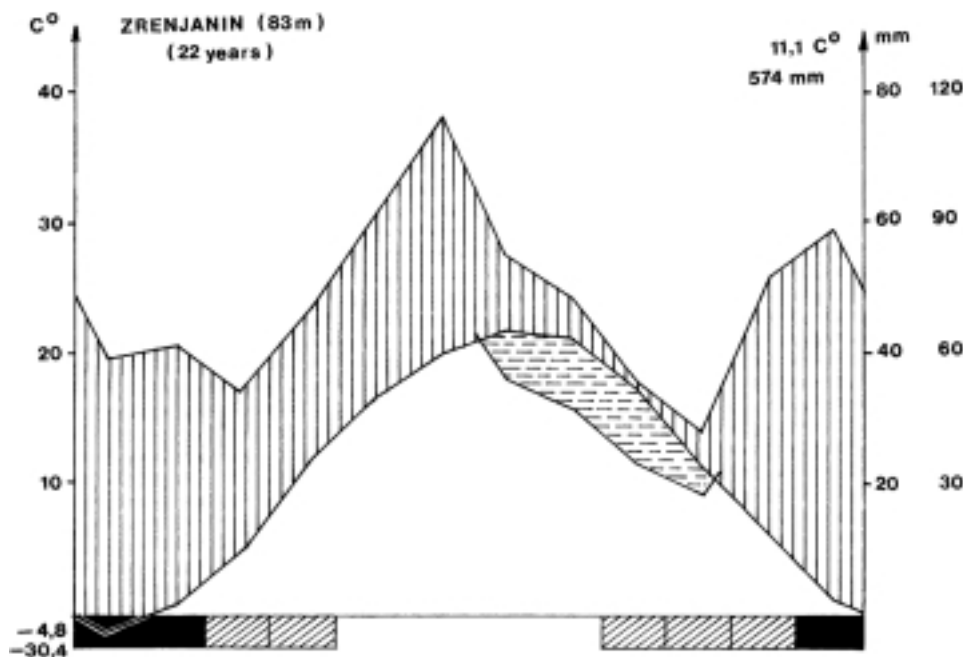


Figure 2. — Climate diagram after Walter for the meteorological station Zrenjanin

The swamps Slano Kopovo and Rusanda, formed by water accumulation in depressions, are located northeast of the town of Novi Bečej and northwest of the village of Melenci, in the zone of salt-affected pastures, on the solonchak-like solonetz and solonetz soils. Their strongly salinized margins, when exposed during semiarid and arid periods, become overgrown with the vegetation of the alliance *Thero-Salicornion*. Stands of the associations *Salicornieto-Suaedetum maritimae continentale* Knežević et Boža 88 and *Suaedetum maritimae* Soó 27 develop along the banks of Slano Kopovo, stands of the associations *Suaedetum maritimae* Soó 27, *Suaedetum pannonicae* (Soó 27) Wendel. 43 and *Salsoletum sodae* Slavnić (39) 48 along the banks of Rusanda (Knežević, Boža 1987, 1988).

In this study, the association *Salicornieto-Suaedetum maritimae continentale* from Slano Kopovo and the associations *Suaedetum maritimae*, *Suaedetum pannonicae* and *Salsoletum sodae* from Rusanda were analyzed from the phytogeographical and ecological points using floral elements after Gajić (Gajić, 1980), life forms after Raunkiaer (Soó, 1966—1973), and ecological indices after Landolt (Landolt, 1977, Knežević 1994).

The floristic composition of the associations, with the degree of presence and quantitative participation of their members, is given as an abridged comparative table (Table 1).

Table 1. — Comparative table of the investigated associations *Salicornieto-Suaedetum maritimae continentale* (I), *Suaedetum maritimae* (II), *Suaedetum pannonicae* (III) and *Salsoletum sodae* (IV)

Floristic element	Life form		I	II	III	IV
<b>Association character species</b>						
Cosm.	T	<i>Salicornia europaea</i> L.	V +—2	—	—	—
Cosm.	T	<i>Suaeda maritima</i> L.	V 1—3	V 2—3	—	—
Pan. subend.	T	<i>Suaeda pannonica</i> Beck	—	—	V 2—4	II +
Eurasian	T	<i>Salsola soda</i> L.	—	II +	—	V 2—3
<b>Cypero — Spergularion</b>						
Subsouthern. Siberian	T	<i>Crypsis aculeata</i> (L.) Aitt.	—	I +	—	—
<b>Festuco-Puccinellietea</b>						
Sub-Pannon.	H	<i>Puccinellia limosa</i> (Schur) Holmb.	V +—3	V +—1	V 1—2	V 1—2
Pannonian	H	<i>Aster tripolium</i> L. var. <i>pannonicus</i> Jacq.	IV +—1	V +	IV +—1	IV +—1
Eurasian	T	<i>Atriplex litoralis</i> L.	II +	IV +	V +—2	V +—2
SubPontic- SubMediterr.	T	<i>Bupleurum tenuissimum</i> L.	I +	—	—	—
SubPontic- Central Asian	H	<i>Taraxacum serotinum</i> W. et K. subsp. <i>bessarabicum</i> (Horn.) H. - M.	I +	—	—	—
Pont.-Pannon	T	<i>Camphorosma annua</i> Pall.	—	—	I +	—
<b>Other species</b>						
Cosm.	H	<i>Spergularia media</i> (L.) Presl.	II +—1	—	—	—
SubPon.-Sub Centr. Asian.- Sub. Mediterr.	T	<i>Heleochoa alopecuroides</i> (P. et M.) Host.	I +	—	—	—
European	T	<i>Lepidium ruderale</i> L.	I +	—	—	—
SubPontic.- SubMediterr.	T	<i>Lactuca salina</i> L.	I +	—	—	—
Cosm.	H	<i>Bolboschoenus maritimus</i> (L.) Pall.	I +	I +	—	—
Cosm.	H	<i>Phragmites communis</i> Trin.	—	II +	—	—
Eurasian	H	<i>Taraxacum officinale</i> Weber.	—	—	II +—1	—
Cosm.	T	<i>Polygonum aviculare</i> L.	—	—	I +	—
Eurasian	T	<i>Chenopodium urbicum</i> L.	—	—	II +	II +

I *Salicornieto-Suaedetum maritimae continentale*

II *Suaedetum maritimae*

III *Suaedetum pannonicae*

IV *Salsoletum sodae*

## RESULTS AND DISCUSSION

The phytogeographical analyses of the investigated communities indicated the dominant role of the Pontic-Central Asian species, with the euhalophytes of the Pannonian floral element prevailing (from 16.66% in Ass. *Salicornieto-Suaedetum maritimae continentale* to 50.0% in Ass. *Salsoletum sodae*) (Table 2). The analyses provided proof of the extent of adaptation of the investigated communities to the continental climate of the eastern arid regions, of their distribution limited to the Pannonian Plain and of their adaptation to a certain soil type. Even the widespread species (Euro-Asian, circumpolar and cosmopolitan) present in the floristic composition typically prefer saline sites. The other floral elements were represented by a single species, *Lepidium rudemale* L., a sub-Central European element, having minimal abundance in only one phytocoenological sample within the area types of the association *Salicornieto-Suaedetum maritimae continentale* (Knežević, Božić, 1988).

Table 2. — Area type percentages of the investigated associations *Salicornieto-Suaedetum maritimae continentale* (I), *Suaedetum maritimae* (II), *Suaedetum pannonicae* (III) and *Salsoletum sodae* (IV).

Floristic element	I (%)	II (%)	III (%)	IV (%)
Pontic — Central Asian (Pannonian)	50 (16.66)	25 (25)	50 (37.5)	50 (50)
Eurasian	8.33	37.5	37.5	50
Circumpolar and cosmopolitan	33.34	37.5		
Central European	8.33			

There were no sub-Mediterranean species in the floristic composition of the stands of analyzed communities because they have not been able to penetrate the already formed communities of Pontic-Central Asian species which had inhabited the primary solonchak soils of Banat earlier, during the warm and arid boreal.

Study of life forms provides a reliable picture of habitat characteristics and its phytocoenological specificities. Concerning the analyzed communities, the study showed the dominance of therophytes, a significant participation of hemicryptophytes and absence of the other life forms, indicating the hemicryptophytic-therophytic character of these communities (Figure 3). Only in the association *Suaedetum maritimae* was a proportional participation of therophytes and hemicryptophytes registered, obviously in consequence to increased humidity in the habitats of certain stands. However, most of the stands of this community had a strongly expressed therophytic character, the quantitative participation of the hemicryptophytes practically being insignificant (Knežević, Božić 1987, 1988). The increased quantitative and proportional participation of the therophytes in the floristic composition does not imply the spreading to the unoccupied space but the evolutionary adaptation of the investigated stands to high salinity, poor soil physical properties and considerable reduction of soil moisture towards the end of the vegetation period. In conse-

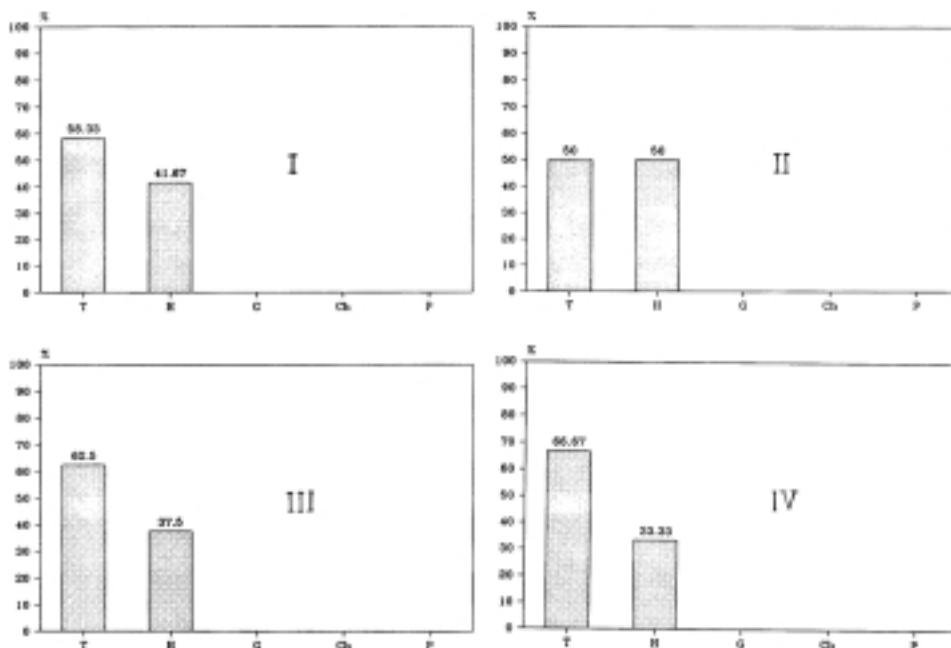


Figure 3. — Life forms of the associations *Salicornieto-Suaedetum maritimae continentale* (I), *Suaedetum maritimae* (II), *Suaedetum pannonicae* (III) and *Salsoletum sodae* (IV)

quence to such conditions, the investigated stands exhibited low species diversity and low plant coverage, which makes them similar to stands of the semi-desert character (Knežević, Božić, 1987, 1988).

On the basis of the average values of ecological indices, it was concluded that at the time of full vegetation the habitats of the investigated stands were semihumid (F-3.22 — Ass. *Salicornieto-Suaedetum maritimae continentale*; F-3.16 — Ass. *Suaedetum maritimae*) to semiarid (F-2.88 — Ass. *Suaedetum pannonicae*; F-2.68 — Ass. *Salsoletum sodae*) [Figure 4, (F)].

A specificity of the sites was a high salt content found in the rhizosphere layers. Therefore, the taxa bearing the ecological index “S —” were present in low percentages in the stands of the analyzed communities. In the stands of the association *Suaedetum maritimae*, these taxa were completely absent [Figure 4, (S)].

On the basis of the average values of soil chemical reaction, which varied from R-3.61 (Ass. *Suaedetum pannonicae*) to R-3.83 (Ass. *Salicornieto-Suaedetum maritimae continentale*), the analyzed sites were determined to have predominantly alkaline to strongly alkaline soils [Figure 4, (R)].

In addition to the poor floristic composition caused by extreme salinity and alkalinity, the stands of the alliance *Thero-Salicornion* were also characterized by low organic production. This low organic production was due to the paucity of nutrients at the analyzed sites, whose average contents varied from N-2.64 (Ass. *Suaedetum maritimae*) to N-2.79 (Ass. *Salicornieto-Suaedetum maritimae continentale*) [Figure 4, (N)].

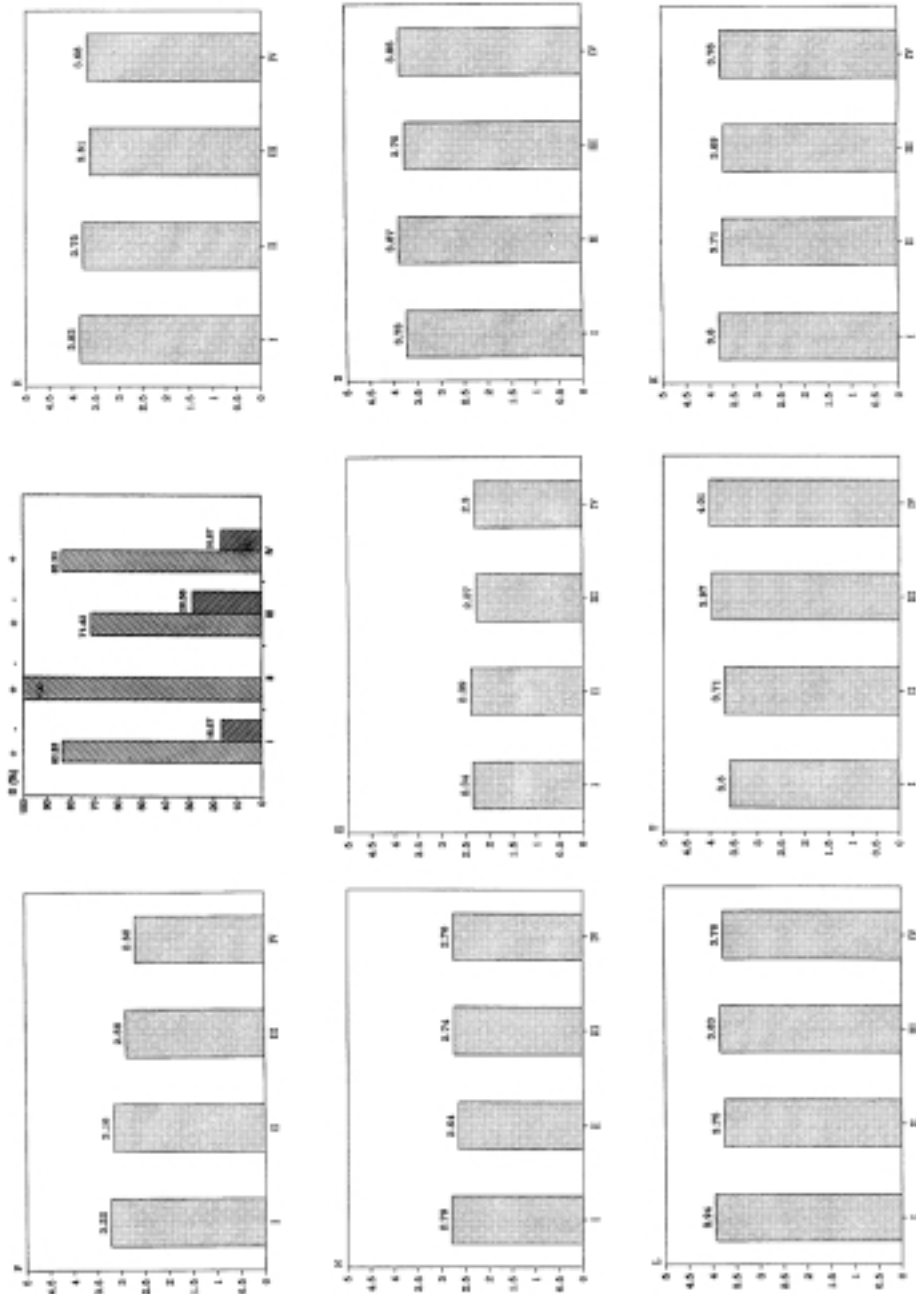


Figure 4. — Average values of ecological indices for soil moisture (F), soil salinity (S), soil chemical reaction (R), soil nutrients content (N), soil humus content (H), soil porosity /aeration/ (D), light (L), temperature (T) and continentality (K) in the associations: *Salicornieto-Suaedetum maritimae continentale* (I), *Suaedetum maritimae* (II), *Suaedetum pannonicae* (III) and *Salsoletum sodae* (IV).

The average ecological indices for humus content, ranging from H-2.27 (Ass. *Suaedetum pannonica*) to H-2.39 (Ass. *Suaedetum maritimae*), indicated that these stands developed on soils low in humus [Figure 4, (H)].

The mechanical composition of soil was not so unfavorable, on account of considerable sand contents, from D-3.73 (Ass. *Salicornieto-Suaedetum maritimae continentale*) to D-3.87 (Ass. *Suaedetum maritimae*) [Figure 4, (D)]. However, because of high salt content and intensive drought, only a limited number of succulent halophilous and haloxerophilous species was able to develop. Because of that the stands were characterized by the low coverage and by development in the conditions of considerably high light intensity. The values from L-3.67 (Ass. *Salsoletum sodae*) to L-3.95 (Ass. *Salicornieto-Suaedetum maritimae continentale*) are reliable indicators that most of the species were heliophilous [Figure 4, (L)].

Since the sites of the stands are inundated most of the time, they are characterized by a specific hydrothermic regimen. On the basis of the average values from T-3.60 (Ass. *Salicornieto-Suaedetum maritimae continentale*) to T-4.01 (Ass. *Salsoletum sodae*), it was concluded that during the period of most intensive vegetation development the sites provided a favorable thermic regimen [Figure 4, (T)].

Plants of continental regions were predominant in the analyzed stands. The narrow interval of average values from K-3.69 (Ass. *Suaedetum pannonicae*) to K-3.80 (Ass. *Salicornieto-Suaedetum maritimae continentale*) shows the adaptation of these plants to the high annual temperature variation, minimal air humidity and a relatively low precipitation [Figure 4, (K)].

## CONCLUSION

The alliance *Thero-Salicornion* Br.-Bl. 33 em. Tx. 55 is represented on the continental salt-affected soils of Banat with the associations *Salicornieto-Suaedetum maritimae continentale* K ne ž e v i ć et B o ž a 88, *Suaedetum maritimae* S o ó 27, *Suaedetum pannonicae* (S o ó 27) W e n d e l. 43 and *Salsoletum sodae* S l a v n i ć (39) 48. The domination of Pannonian euhalophytes among the phytogeographically characteristic Pontic-Central Asian species provides evidence of the habitats of these associations being limited to the area of the Pannonian Plain, of the dominant influence of the arid continental climate, and of their development under specific edaphic conditions.

The hemicytrophitic-therophytic character of these communities is a result of the evolutionary adaptation to the overgrowing of saline margins of swamps only after withdrawal of water, during semiarid and arid periods.

Because of a gradual drying of the soil, the sites are semihumid to semiarid at the time when the vegetation is fully formed. Because of a high salt content in the rhizosphere layer, the sites are predominantly alkaline in character and they permit almost exclusively the development of halophytes. Although their mechanical composition is basically not unfavorable, the organic production is low because of the low contents of nutrients and humus. The si-



tes are exposed to a high light intensity, in which heliophilous and therophytic species of arid continental regions are predominant.

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#### БИЈНОГЕОГРАФСКЕ И ЕКОЛОШКЕ КАРАКТЕРИСТИКЕ ВЕГЕТАЦИЈЕ СВЕЗЕ *THERO-SALICORNION* BR.-BL. 33 EM. TX. 50 СА КОНТИНЕНТАЛНИХ СЛАТИНА (БАНАТ — ЈУГОСЛАВИЈА)

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#### Резиме

Вегетација свезе *Thero-Salicornion* Br.-Bl. 33 em. Tx 55 заступљена је на континенталним слатинама Баната заједницама *Salicornieto-Suaedetum maritimae continentale* Кнежевић et Божа 88, *Suaedetum maritimae* Soó 27, *Suaedetum pannonicae* (Soó 27) Wendel. 43 i *Salsolaetum sodae* Slavnić (39) 48. Доминанција панонских еухалофита међу биљногеографски карактеристичним понтско-централноазијским биљкама сведочи о ареалу заједница ограниченог на простору Панонске низије, доминантним утицајима аридне континенталне климе и развоју под специфичним едафским приликама.

Њихов хемикриптофито-терофитски карактер последица је еволуционе прилагођености обрастања заслањених обода бара тек након повлачења воде у полусушном и сушном периоду.

Услед постепеног пресушивања у доба потпуно формираног биљног покривача то су умерено влажна до умерено сува станишта. Због акумулације соли у

ризосферним слојевима имају претежно базан карактер и обрастају претежно халофитама. Иако у основи немају механички састав слабе су органске продукције због малог садржаја хранљивих материја и хумуса. Добро су осветљене површине на којима преовлађују хелиофилне и термофилне биљке сушних, континенталних предела.