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Current distribution and stage of community *Artemisio santonici-Festucetum pseudovinae* in Slovakia

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Abstract: Association *Artemisio santonici-Festucetum pseudovinae* SOÓ in MÁTHÉ 1933 corr. BORHIDI 1996 is considered as one of the most abundant plant communities of saline habitats in the Pannonian Plain. The paper presents information about its current distribution in Slovakia. The obtained results were compared with historical data. Vegetation changes and the overall state of association in the past and today are commented. Although the association is considered to be primarily community of salt soils, the vegetation is able to create also on the largely disturbed places. Primary and secondary vegetation are comparable. Both were characterized by dominance of the two taxa: *Artemisia santonicum* subsp. *patens* and *Festuca pseudovina*. Secondary vegetation currently prevails in Slovakia. The natural communities we have sampled only on a few places (the Mostové Nature Reserve, Jatov, Kamenín, Kamenný Most). Due to the current state of saline habitats and absence of conservation management, we consider the association as critically endangered in Slovakia.

Keywords: *Artemisia santonicum* subsp. *patens, Festuca pseudovina,* saline habitats, Slovakia.

Introduction

Only a few fragments of halophytic vegetation remained after a considerable reduction of saline habitats in Slovakia in the second half of the 20. century (SÁDOVSKÝ et al. 2004). Numerous plant communities of saline habitats have recently got into a border of extinction – for instance, *Crypsidetum aculeate* (ELIÁŠ jun. et al. 2007), *Camphorosmetum annuae* (DÍTĚ et al. 2008) and *Puccinellietum limosae* (DÍTĚ et al. 2009), or their occurrence completely vanished like *Acorelletum pannonicae* (ELIÁŠ jun. et al. 2003).

Those few halophytic communities, which are still found in several localities of south Slovakia, are represented mainly by alliance *Festucion pseudovinae* SOÓ 1933. The most essential ecological factor, which determines species composition of the community, is the salt content in the soil (cf. KRIPPELOVÁ 1965). As a species-poor formation it has moderately closed or closed stands where bryophytes are quite abundant. There are two dominant species in the association: *Artemisia santonicum* subsp. *patens* (syn. *Artemisia monogyna*) and *Festuca pseudovina*. The natural vegetation is species-poor, for example KRIPPELOVÁ (1965) recorded in her relevés from 7 to 9 species, incl. bryophytes.

The seasonality of vegetation cover is considerable phenomenon of these habitats. Spring is more species-rich, inasmuch as there are growing many therophytes, which are already not found in the autumn stands.

Association is regarded as a natural habitat of salt steppes (KRIPPELOVÁ 1965, MUCINA 1993; MOLNÁR & BORHIDI 2003). According to BORHIDI (2003) it is the second largest halophytic plant community of the Pannonian Lowland. It is developing on flat parts of saline habitats, and often interlocking with assoc. *Camphorosmetum annuae*, which occupies soils with the highest salinity (cf. KRIPPELOVÁ 1965; DÍTĚ et al. 2008). Soils are heavy, typically clayey solonetz with higher salinity and low humus content (cf. WENDELBERGER 1950, VICHEREK 1973, KÖLLNER 1983 sec. MUCINA 1993). Closed dense stands are developing on flat areas, which are situated in higher elevations. The terrain differences are not more than just some centimetres. According to certain authors (KÖLLNER 1983 sec. MUCINA 1993) this plant community occurs either in the margins of salt lakes on loamy solonchak soils on different parts of the Pannonian Plain. Due to short vernal floods these habitats are usually muddy.

In the past this community was relatively widespread in southern Slovakia and reached here its northernmost distribution borderline. It is reported from majority of Slovak saline habitats by KRIST (1940). With relevés it is documented from Kamenín, Kamenný Most, Palárikovo, Hájske, Tvrdošovce (VICHEREK 1973), Okoličná, Zlatná na Ostrove and vicinity of Komárno (KRIPPELOVÁ 1965). ŠMARDA (1935) also published relevés from Palárikovo, Šurany and Kamenín. Some data from the Východoslovenská nížina Lowland were published by VICHEREK (1973) including localities in the surrounding of Malčice and Veľké Raškovce. The most recent relevés of the association are originating from the Nature Reserves Mostové (ZLINSKÁ 2003) and Bokrošské slanisko (ZLINSKÁ 2005).

The aim of this paper is to actualise the occurrence and status of association *Artemisio santonici-Festucetum pseudovinae* – one of the most prevalent halophytic plant communities of the Pannonian Plain, which were acquired by field research in Slovak salt marshes and meadows since 2003.

Material and methods

The study was carried out during 2003–2009. Localities of *Artemisio santonici-Festucetum pseudovinae* were being found in the field with the help of data published in the past (see above). Coordinates of localities were obtained during field research using GPS equipment Garmin CS 60. The map was designed by program ArcGis, version 9.2. The phytosociological relevés were sampled according to the Zürich-Montpellier approach using the adapted nine-grade Braun-Blanquet's scale (BARKMANN et al. 1964). All relevés were stored in the TURBOVEG database (HENNEKENS 1996). The relevés were classified by divisive polythetic analysis using program TWINSPAN (HILL 1979).

Nomenclature of flowering plants follows MARHOLD & HINDÁK (1998) and the names of syntaxa are according to MOLNÁR & BORHIDI (2003).

Results and Discussion

During the field studies of Slovak saline habitats both dominant species were found in several remnants of halophytic localities (Fig. 1), they were abundant even in the strongly degraded plant communities. *Artemisia santonicum* subsp. *patens* is regarded as an obligate halophyte (KRIST 1940, KRIPPELOVÁ 1965), apart from occurrence in remains of primary habitats it can occupy ploughed up lands as well. These were places where the substratum has high concentration of salt, primary salt pans. After disturbance it was able to create vegetation with high coverage in a short term, which replacing the primary vegetation (e.g. assoc. *Camphorosmetum annuae*).

In those stands, a strong dominance of *Artemisia santonicum* (80 to 90%) was recorded (for example site near the Palárikovo village). In a course of time the stands keep on degrading and coverage of *Artemisia* is gradually descending. On the contrary, the number of meadow and ruderal species is ascending (ELIÁŠ jun., SÁDOVSKÝ, ŠUVADA, DÍTĚ ined.). The stands are characterized by low species-richness per relevé and occurrence of species with no demand on higher soil-salinity is typical as well.

The example of these stands represents the following relevé:

Palárikovo, remains of salt marshes along the railway line, E18°04'20.87", N48°04'06.06", altitude 110 m, relevé area 16 m^2, E_1: 85 %, E_0: 4 %, 15. 9. 2003, D. DÍTĚ, P. ELIÁŠ jun., M. SÁDOVSKÝ.
E_1: *Artemisia santonicum* subsp. *patens* 5, *Dichodon viscidum* 1, *Festuca rupicola* 1, *Puccinellia distans* agg. 1, *Podospermum canum* 1, *Bromus racemosus* +, *Poa pratensis* +.

The fescue *Festuca pseudovina* had a resembling tendency. This species is considered to be a facultative halophyte (KRIST 1940). Vegetation with the dominance of this species was created on several degraded saline habitats under influence of non-reversible gradual desalinization of the soil horizon with

the highest salt content. It reached high coverage, whereas the number of accompanying species was low.

The recent status of these stands is represented by the following relevé:

Šurany – Okomáň farmstead, E18°07'12.5", N48°05'35.8", alt. 114 m, relevé area 16 m^2, E_1 90 %, E_0 0 %, 13. 6. 2008, D. DÍTĚ, P. ELIÁŠ jun., R. ŠUVADA.
E_1: *Festuca pseudovina* 5, *Podospermum canum* +, *Galium verum* r, *Plantago maritima* r.

In still existing stands which can be classified as association *Artemisio santonici-Festucetum pseudovinae,* coverage of *Artemisia santonicum* subsp. *patens* reached high values (min. 15%, on average 50%, max. more than 75%). Similar coverage values were sampled for *Festuca pseudovina*, too (on average about 50%).

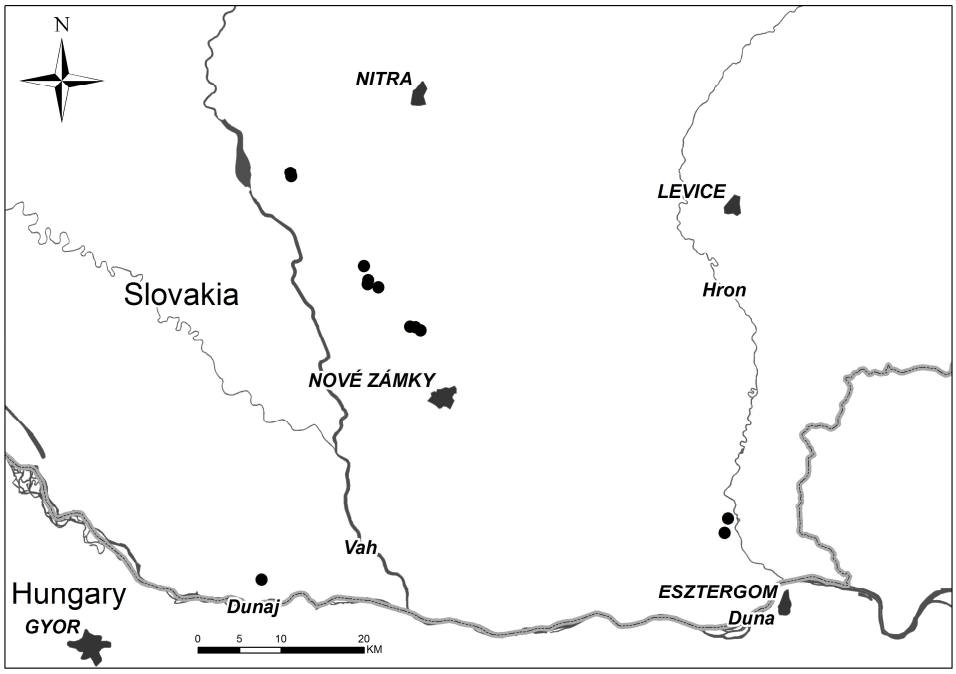

Fig. 1: Map of sampled localities of association *Artemisio santonici-Festucetum pseudovinae* in the Podunajská nížina Lowland, Slovakia (R. Šuvada, orig.).

The community was represented by more or less closed vegetation. The coverage of vascular plants was high, usually from 75% to 90% or more. Bryophytes were also frequent. Their coverage was various, but the average reached about 50%. Sometimes they were totally absenting or conversely they covered 90% of the relevé area.

Obviously in our relevés (Tab. 1) the association was formed by these name giving taxa: *Artemisia santonicum* subsp. *patens* (syn. *Artemisia monogyna*) and *Festuca pseudovina* with sporadic occurrence of other obligate and facultative halophytes. In many cases, there were also species which require not

high soil salinity like *Festuca rupicola, Poa pratensis* or *Cruciata pedemontana*. Their higher coverage together with the occurrence of ruderal species has indicated habitat destruction regarding advanced desalination.

Mosses in the existing vegetation are considered as pioneer species of dry and warm slopes with bare soils. Majority of these species are indifferent to the type of the substratum (e.g. *Amblystegium serpens, Brachythecium campestre, Hypnum cupressiforme*), a few of them requires basic (e.g. *Barbula unguiculata, Didymodon fallax*) or acidic ground (e.g. *Sanionia uncinata*). Taking their area into account they were rather circumpolar species or seldom cosmopolites (cf. PILOUS & DUDA 1960, BOROS 1968, SMITH 2004). Owing to these facts, in this case bryophytes can neither be considered as characteristic nor as diagnostic species of the association.

All sampled relevés of the association (Tab. 1) come from more or less disturbed salt marshes of the Podunajská nížina Lowland. Relatively most preserved sites were found in the Mostové Natural Reserve (rels. 1, 2), Jatov (rels. 4, 7, 15) and from some localities between villages of Kamenín and Kamenný Most (rels. 16–18). Nevertheless, our data showed that vegetation of the community, regardless of their various origin (close to primary vs. secondary), did not differ essentially from each other. Their species diversity was mainly related to species composition of the adjacent vegetation.

Vegetation of some micro-localities between Kamenín and Kamenný Most (Tab. 1, rels. 16–18) included plant species which have occurred exclusively in this part of Slovakia – *Limonium gmelinii* and *Ranunculus pedatus*. These sites were characterized by high number of species in relevés; many of them do not belong to typical halophytic taxa (e.g. *Vicia tetrasperma, Trifolium campestre, Allium vineale*). We believe this is due to damaged water regime and permanent desalinization. The salt meadows of this region were successively transforming into sub-halophile meadows and the above mentioned species are extending from the surrounding stands.

The vegetation of *Artemisio santonici-Festucetum pseudovinae* was developed in Slovakia from bare sites (salt pans) through initial phase until closed, tussock grasslands. The next stage of the succession cannot be studied, because grazing was keeping the stands on the same level (cf. KRIPPELOVÁ 1965). Recently, the situation is different.

According to the relief of halophytic habitats remnants we can conclude that now the vegetation of *Artemisio santonici-Festucetum pseudovinae* occupies places, which had the highest salt concentration in the past (former salt pans). On these sites (at least partly), *Camphorosmetum annuae* or *Puccinellietum limosae* communities were originally developed (compare e.g. KLIKA & VLACH 1937). Since the salt could not have been removed completely from the soil, these soils are still saline and not suitable for agricultural use, yet the adjacent fields in close vicinity are cultivated annually. Proximity of these cultivated sites to saline habitat is indicated by the presence of numerous ruderal species. The above mentioned bryophytes and grassland mesophytes as well are alerting to the vegetation changes.

Tab. 1. A table of relevés of the *Artemisio santonici-Festucetum pseudovinae* recorded in Slovakia.

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Area of relevé m^2	12	16	16	16	16	16	16	16	16	16	16	8	16	16	16	16	16	16	16
cover E_1 %	75	80	80	65	85	90	80	70	70	80	90	70	85	70	80	75	70	75	85
cover E_0 %	80	60	10	60	2	15	5	60	5	10	35	0	10	0	20	60	80	10	70
*Artemisia *patens*	3	3	3	3	3	5	3	4	3	4	3	3	3	b	3	3	b	3	3
Festuca pseudovina	3	4	4	3	4	3	4	3	4	a	3	3	4	a	4	4	b	3	4
Plantago maritima	1	a	.	1	+	+	1	.	1	.	a	.	r	.	1	1	a	+	1
Podospermum canum	+	1	.	1	r	+	+	+	.	.	a	1	r	.	1	.	+	.	1
Dichodon viscidum	1	+	.	.	.	.	+	.	+	1	1	a	1	1	1	a	.	3	a
Sanionia uncinata	4	3	a	4	1	.	1	.	a	a	3	.	.	.	.	.	.	.	.
Phascum cuspidatum	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus japonicus	.	.	.	+	.	1	+	.	.	1	1	.	+	.	.	+	.	1	r
Veronica arvensis	.	.	.	.	r	+	+	+	+	.	1	.	+	.	+	1	1	+	1
Puccinellia distans	.	.	.	.	.	+	+	.	a	3	.	.	.	3	.	.	.	.	.
Erophila verna	.	.	.	.	.	+	+	.	.	.	1	1	+	.	.	.	.	.	+
Amblystegium serpens	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.
Bryum caespiticium	.	.	.	.	.	a	.	3	.	.	.	.	+	.	1	.	.	.	.
Elytrigia repens	.	.	.	.	.	.	.	+	.	.	+	.	.	+	+	.	.	.	+
Matricaria discoidea	.	.	+	.	.	.	.	.	1	.	+	a	+	r	.	.	r	+	.
Tripolium pannonicum	.	.	.	.	.	.	.	.	+	+	+	r	r	1	.	.	.	.	.
Brachythecium campestre	.	.	.	.	.	.	1	.	.	.	.	.	.	.	b	4	4	.	4
Lamium purpureum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.
Bromus hordeaceus	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.
Alopecurus pratensis	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	1	.	.
Myosotis arvensis	.	.	.	.	r	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Myosotis stricta	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.
Vicia tetrasperma	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	+	+
Allium vineale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	1	r
Cruciata pedemontana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	1
Limonium gmelinii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	b	a	.
Ranunculus pedatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	1	.
Trifolium campestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	a	.
Ceratodon purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	b

Species recorded in two relevés only: *Achillea collina* b (1), a (17); *Barbula unguiculata* 1 (2), + (3); *Carex stenophylla* + (3), + (14); *Didymodon fallax* a (2), 1 (13); *Elytrigia intermedium* + (1), + (2); *Galatella punctata* 1 (17), + (18); *Galium aparine* + (5), r (13); *Homalothecium lutescens* a (1), a (18); *Hypnum cupressiforme* 4 (7), 3 (9); *Myosurus minimus* + (10), + (12); *Ornithogalum kochii* + (17), r (18); *Plantago tenuiflora* r (3), 1 (8); *Poa angustifolia* 1 (6), + (17).

Species recorded in one relevé only: *Arabidopsis thaliana* + (16); *Atriplex littoralis* 1 (14); *Brachythecium starkei* + (13); *Bryum capillare* + (13); *Cardaria draba* r (19); *Cynodon dactylon* 1 (12); *Epilobium tetragonum* r (2); *Eurhynchium schleicheri* a (13); *Festuca rupicola* r (19); *Galium verum* a (17); *Holcus lanatus* + (17); *Jacea pratensis* + (1); *Juncus compressus* + (14); *Medicago lupulina* a (1); *Potentilla argentea* + (18); *Potentilla heptaphylla* r (17); *Pottia truncata* 1 (2); *Ranunculus sardous* r (12); *Rumex crispus* r (18); *Solidago* sp. r (13); *Spergularia media* a (14); *Valerianella locusta* + (18); *Vicia lathyroides* + (1); *Vicia sativa* + (16);

Localities of relevés No:

1, 2. Veľké Kosihy, Mostové (Dérhídja) Natural Reserve, remains of vanishing salt pan, 17°54´26.63´´; 47°46´08.99´´, 106, 12. 6. 2008. **3, 5, 13.** Palárikovo, Malé Čiky gamekeeper house, remnant of a salt pan in old fallow, 18°07´38.39´´; 48° 03´14.15´´, 114 m, 11. 5. 2008. **4, 7, 15.** Jatov, south of the village, fragment of salt meadow in the middle of the field, 18°01´38.00´´; 48°07´01.20´´, 108 m, 9. 5. 2009. **6, 8.** Močenok, Siky farmstead, remnants of a salt pan in dried out and degraded salt meadow, 17°53´42.41´´; 48°12´40.30´´, 121 m, 10. 5. 2009, **9.** Palárikovo, Malé Čiky gamekeeper house, remnants of degraded salt pan, 18°07´06.90´´; 48°03´25.10´´, 116 m, 9. 5. 2009. **10.** Palárikovo, Malé Čiky gamekeeper house, remnants of a salt meadow, vanishing salt pan, 18°06´35.90´´; 48°03´25.10´´, 115 m, 9. 5. 2009. **11.** Tvrdošovce, border of the village, ploughed up and abandoned salt meadow, 18°02´08.30´´; 48°05´53.90´´, 114 m, 10. 5. 2008. **12.** Tvrdošovce, north of the village, shallowly ploughed up salt meadow, 18°02´09.09´´; 48°06´09.20´´, 109 m, 12. 5. 2005. **14.** Tvrdošovce, site near the Ráczovo jazierko pool, 18°03´11.52´´; 48°05´45.30´´, 108 m, 8. 5. 2004. **16, 18.** Kamenný Most, north of the village, degraded fragment of a salt pan, 18°38´40.60´´; 47°51´42.10´´, 109 m, 8. 5. 2009. **17.** Kamenín, the Kamenínske slanisko Natural Reserve, vanishing salt pan, 18°38´53.30´´; 47°52´38.90´´, 110 m, 8. 5. 2009. **19.** Močenok, Siky farmstead, remnant of a salt pan in a degraded and partially afforested salt marsh, 17°53´40.50´´; 48°12´39.10´´, 120 m, 10. 5. 2008.

After KRIPPELOVÁ (1965), on the well preserved saline localities of the natural salt steppes there were two stages of the association *Artemisio santonici-Festucetum pseudovinae*. The first one, stage with *Camphorosma annua,* follows up the salt pans covered by *Camphorosmetum annuae*. By now, this vegetation was recorded only in minor fragments (a few m^2) in the Kamenínske slanisko Nature Reserve, and until recently even in the Mostová Nature Reserve (Eliáš jun., Sádovský, Dítě ined.). The second one was more abundant stage with *Plantago maritima*. This stage was quite common on bare solonetz soils and also there, where the humus horizon was removed by human activities. According to the author this stage indicates soils with lower salinity than the primary stage at the same time. *Plantago maritima* was found almost in each stand during our research (Tab. 1), in both remnants of primary and in secondary vegetation, too. The species usually occurred in low coverage (to 5%). This fact is reflecting a decrease of salinity level. KRIPPELOVÁ (l. c.) described variant with *Tripolium pannonicum* within this stage. In her opinion this variant occurred on soils with removed humus horizon and *Tripolium pannonicum* is considered as a pioneer species of moister places. Recently, accessory presence of *Tripolium pannonicum* was recorded only in secondary stands of degraded salt steppes (Tab. 1, rels. 9–14).

KRIPPELOVÁ (1965) also quoted, that *Festuca pseudovina* always grows together with *Puccinellia distans* agg. in *Artemisio santonici-Festucetum pseudovinae*. We found this common occurrence only in some stands (see Tab. 1). Every case has represented secondary stands in degraded salt steppes. VICHEREK (1973) published relevés of the community (under synonym *Statice gmelinni-Artemisia monogyna* subas. with *Festuca pseudovina*) with much more species than KRIPPELOVÁ (1965) (15 species in average, without bryophytes). In his review there were also a floristic differences between relevés sampled north of the Štúrovo town and other relevés, because in this area *Limonium gmelinii* and *Ranunculus pedatus* were present. Moreover, he considered *Limonium*

gmelinii as a diagnostic species of the association, while species like *Festuca pseudovina* and *Trifolium campestre* were evaluated as taxa of sub-associational rank. The author regarded both *Limonium gmelinni* and *Artemisia santonicum* as taxa characteristic to the association.

Similarly, WENDELBERGER (1950) considered these two species together with *Podospermum canum* and *Plantago schwarzenbergiana* as characteristic (identifying) to association *Artemisio santonici-Festucetum pseudovinae*. Later this opinion shares MUCINA (1993) as well in his vegetation survey of Austria (under synonym *Artemisietum monogynae* WENZL 1934). It might be interesting that *Limonium gmelinni* and *Plantago schwarzenbergiana* did not occur in Austria.

We believe in accordance of BORHIDI (1996, 2003) that association *Artemisio santonici-Festucetum pseudovinae* is characteristic by dominant presence of *Artemisia santonicum* subsp. *patens* a *Festuca pseudovina*. Moreover, BORHIDI (2003) directly stated that integration *Artemisio santonici-Festucetum pseudovinae* with *Limonio-Artemisietum santonici* (SOÓ 1927) ȚOPA 1939 is not correct. According to POP (2002) the association *Limonio-Artemisietum santonici* is developed on degraded stands of *Artemisio–Festucetum* as a result of intensive grazing. This association created two faithful taxa: *Artemisia santonicum* subsp. *patens* and *Limonium gmelinii*; accompanying species have been *Tripolium pannonicum*, *Petrosimonia triandra* and *Puccinellia limosa*. Coverage of *Festuca pseudovina* reaches not more than 25%. *Limonio-Artemisietum santonici* is known from Voyvodina, southeast Hungary and Romania (POP 2002, BORHIDI 2003).

ŠMARDA (1952) considered as association (under the name *Artemisieto-Festucetum pseudovinae* SOÓ) the vegetation with more than 50% coverage of *Festuca pseudovina* (in two cases over 25%), while *Artemisia santonicum* subsp. *patens* absented or reached only minimal abundance (+ to 25%). These records can be compared with degraded vegetation of recent salt meadows with a strong dominance of *Festuca pseudovina* (e.g. locality at Palárikovo – Malé Čiky).

Concerning the development of the vegetation in the mentioned localities (absence of any type of management, agricultural fields in close vicinity, application of fertilizers, expansion of ruderal species etc.) is evident that the occurrence of this plant community is only temporary and without appropriate intervention its existence might be non-sustainable. Consequently, we can assume that the association is critically endangered in Slovakia.

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