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The occurrence of critically endangered *Trifolium strictum* in Slovakia confirmed

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Abstract: A new locality of critically endangered *Trifolium strictum* was found in saline grasslands near Jatov settlement in 2013 one year after their ploughing. The species has rarely grown in a species-rich ruderal stage of former halophytic vegetation of the *Festucion pseudovinae* alliance. Next year, *T. strictum* occupied larger areas in mesic stands within the *Alopecurion pratensis* alliance. Since we did not confirm the occurrence of the species on the historical site at Kamenný Most village, the site near Jatov is the only locality of the species in Slovakia. According to IUCN categories and criteria (IUCN 2012), we suggest to classify *T. strictum* as critically endangered species [CR B2a(ii)b(iii,iv,v)c(iv)].

Keywords: clover, distribution range, halophytes, rare species

Introduction

The genus *Trifolium* includes about 240 annual, biennial or perennial species with a cosmopolitan distribution. The highest diversity is found in the temperate Northern Hemisphere, but many taxa also occur in South America and Africa, including at high altitudes on mountains in the tropics (ZOHARY & HELLER 1984; LAMONT et al. 2001). Some *Trifolium* taxa are salt-tolerant (e.g. *Trifolium angulatum*, *T. fragiferum*, *T. retusum*) and occupy various types of saline grassland habitats. *Trifolium strictum* L. (syn. *T. laevigatum* Poir., Fig. 1) requires also similar ecological conditions (KRIST 1940).

According to GAMS (1975) and FERÁKOVÁ & KUBÁT (1999), *T. strictum* is Atlantic-Mediterranean species native to the north-western Africa (Morocco,

Algeria, Tunisia), Western (British Islands, France), south-western (Portugal, Spain, Italy) and Central Europe (Hungary, Slovakia), Balkan Peninsula (Romania, Bulgaria, former Yugoslavia, Greece) and Turkey. The species is considered as an alien in Germany and Belgium (VERLOOVE & HEYNEMAN 2012). In Slovakia, *T. strictum* has been found only at a single location near Kamenný Most village (KRIST 1937; JASIČOVÁ 1988). It is included in the Slovak Red list of rare and threatened plant species in category critically endangered (FERÁKOVÁ et al. 2001).

The paper is aimed to bring information about *Trifolium strictum* at the new locality in Slovakia.

Fig. 1. Habit of *Trifolium strictum* (A) and *T. retusum* (B) sampled near the Jatov settlement in 2013.

Material and Methods

The study was carried out during the year 2013–2014. The data concerning the historical distribution of the species were obtained from herbaria BP, BRA, BRNU, BRNM, NI, OL, OLM, PR, PRC, SAV and SLO. Herbarium abbreviations are according to VOZÁROVÁ & SUTORÝ (2001). Results of this study are presented on the dot map. The map was designed by program ArcGis, version 9.2. The grid on the map follows one that was described by NIKLFELD (1971). A list of localities was compiled according to the directives of Flóra Slovenska VI/1 (cf. GOLIAŠOVÁ & MICHALKOVÁ 2012).

The phytosociological relevés were sampled according to the Zürich-Montpellier approach using the adapted nine-grade Braun-Blanquet's scale (BARKMAN et al. 1964). Nomenclature of flowering plants follows MARHOLD & HINDÁK (1998). Names of syntaxa are according to JAROLÍMEK et al. (2008). The Phytogeographical division of Slovakia are in accordance with FUTÁK (1980). Categories and criteria of threat were applied according to the methodology of IUCN (2012).

Results and Discussion

We found a new site of *T. strictum* south from Jatov village near the Jatovský kanál channel in 2013. The species occurred sporadically on a large abandoned saline grassland which was ploughed in 2012. We indicate the vegetation composition by the following phytosociological relevé:

Relevé no. 1. Nitrianska pahorkatina hills, Jatov, ca 2 km south from the village, shallow inundation in abandoned saline pastures,113 m, N 48°07´04.8˝, E 18°01´39.6˝, exposition -, elevation 0°, relevé plot 16 m^2, E_1 : 60%, 3. 6. 2013, P. Eliáš jun., D. Dítě & Z. Melečková.

E_1: *Matricaria recutita* 2b, *Carduus acanthoides* 2a, *Chenopodium album* 2a, *Artemisia santonicum* 1, *Atriplex littoralis* 1, *Cirsium arvense* 1, *Chenopodium urbicum* 1, *Inula britannica* 1, *Myosurus minimus* 1, *Polygonum aviculare* agg. 1, *Rumex crispus* 1, *Trifolium angulatum* 1, *T. campestre* 1, *T. retusum* 1, *T. striatum* 1, *Achillea pannonica* +, *Alopecurus pratensis* +, *Bromus commutatus* +, *B. hordeaceus* +, *Capsella bursa-pastoris* +, *Crepis biennis* +, *Daucus carota* +, *Dichodon viscidum* +, *Elytrigia repens* +, *Epilobium tetragonum* +, *Galium verum* +, *Linaria vulgaris* +, *Myosotis arvensis* +, *M. ramosissima* +, *Poa angustifolia* +, *Podospermum canum* +, *Potentilla argentea* +, *Puccinellia distans* agg. +, *Solanum nigrum* +, *Sonchus asper* +, *Thlaspi arvense* +, ***T. strictum*** +, *Veronica arvensis* +,*Vicia hirsuta* +, *Arabidopsis thaliana* r

The relatively species-rich stands are regarded as a ruderal stage of former halophytic vegetation of the *Festucion pseudovinae* alliance. High number of mesic species points out a low salt content in soil, therefore the stands could be considered as the *Achilleo-Festucetum pseudovinae* association in the past. *T. strictum* is a characteristic species of this association in Hungary, Romania and Serbia (SOÓ 1980; FERÁKOVÁ & KUBÁT 1999; BLAŽENIĆ et al. 2005; SANDA et al. 2008). On the site near Jatov, ploughing has destroyed the close hemicryptophytic grassland vegetation and on the other hand it has created a niche for annual, mostly weedy species (e.g. *Matricaria recutita*, *Carduus acanthoides*, *Chenopodium album*) and species requiring intensive disturbance (e.g. *Polygonum aviculare*). Thanks to this activity, several sub-halophytic clover species, including *T. strictum* have emerged. The species was present scattered and formed small groups on about 50 m^2 area. In the following year after the intervention, the grassland was mowed and in the next year in 2014 more closed, dense vegetation cover has developed. *T. strictum* has spread significantly as

well. The species formed relatively large and dense stands on about 0.25 ha area. It is demonstrated by the following relevé:

Relevé no. 2. Nitrianska pahorkatina hills, Jatov, ca 2 km south from the village, abandoned saline pastures, 113 m, N 48°07'4.9", E 18°01'39.1", exposition -, elevation 0°, relevé plot 16 m^2, E_1: 100%, 14. 5. 2014, P. Eliáš jun., D. Dítě & Z. Melečková.

E_1: *Trifolium angulatum* 3, ***Trifolium strictum* 3**, *Alopecurus pratensis* 2a*, Poa angustifolia* 2a, *Arrhenatherum elatius* 1, *Cerastium subtetrandum* 1, *Galium verum* 1, *Matricaria recutita* 1, *Potentilla argentea* 1, *Trifolium campestre* 1, *Achillea milefolium* agg. +, *Allium vineale* +, *Artemisia vulgaris* +, *Capsella bursa-pastoris* +, *Carduus acanthoides* +, *Cirsium arvense* +, *Inula britannica* +, *Lathyrus tuberosus* +, *Linaria vulgaris* +, *Myosotis arvensis* +, *Pastinaca sativa* +, *Plantago lanceolata* +, *Podospermum canum* +, *Rumex crispus* +, *Stenactis annua* +, *Trifolium retusum* +, *T. striatum* +, *Veronica arvensis* +, *Vicia sativa* +.

The stand is considered as a mesic vegetation of the *Alopecurion pratensis* alliance. Presence of some sub-halophytic species (*Cerastium subtetrandrum*, *Trifolium angulatum*, *T. retusum*, *T. strictum*) indicates higher salt content in the soil. Those *Alopecurion* stands created a mosaic together with the halophytic vegetation of *Festucion pseudovinae*, however, on places dominated by clover species the mesic vegetation prevailed.

The above mentioned site of *T. strictum* is only the second known locality in Slovakia (Fig. 2). The first one was found by V. KRIST in 1937 (KRIST 1937; DOMIN 1939) in saline pastures named Irtoványi rétek (now the Čistiny Nature Reserve) north from the Kamenný Most settlement. On this site, the species for certainly survived until the mid-50-ies of the 20th century, although F. ČERNOCH pointed out the threat of extinction due to the meliorations. FERÁKOVÁ & KUBÁT (1999) mentioned that *T. strictum* was confirmed here last time in 1985, but Svobodová & Řehořek (1985) have not recorded it in the same year. Later, in 1988, 1992, 1996 and 1997, the occurrence of *T. strictum* on the location was not verified (SVOBODOVÁ & ŘEHOŘEK 1988, 1992, FERÁKOVÁ & KUBÁT 1999) and ELIÁŠ et al. (2011) regarded it as regionally extinct. It was not found neither during the last detailed research in this area in 2012 (MELEČKOVÁ et al. 2013). According to the above mentioned information, we believe that *T. strictum* vanished from the Irtoványi rétek already in the 50s, since no evidence was given to its occurrence in the 80s (herbarium sheet, published data), and it was not even recorded in the area during the detailed research of salt habitats by Vicherek (1973) and Svobodová & Řehořek (1985). Our finding of *T. strictum* near Jatov is therefore the first mentioned record after 60 years period. The mentioned site is the single present location of the species in Slovakia, since even in 2014 we did not confirm it on the other historical site north from Kamenný Most.

According to IUCN categories and criteria (IUCN 2012), we suppose to classify *T. strictum* as critically endangered species of Slovak flora [CR B2a(ii)b(iii,iv,v)c(iv)].

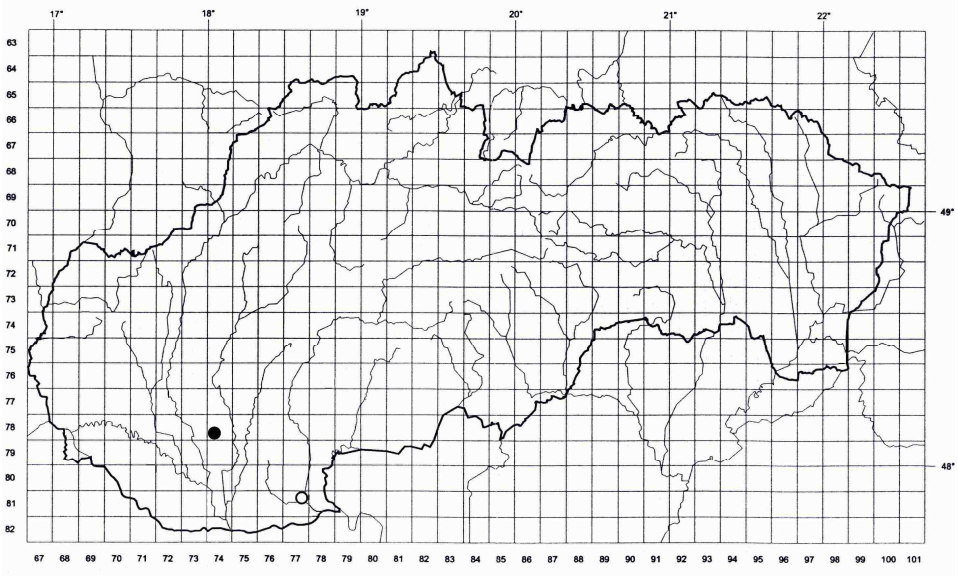

Fig. 2. Historical (○) and current (●) occurrence of *Trifolium strictum* in Slovakia.

Although the occurrence of *T. strictum* in Slovakia has been mentioned in several works (JASIČOVÁ 1988; DOSTÁL 1989; DOSTÁL & ČERVENKA 1991; FERÁKOVÁ & KUBÁT 1999), consistent excerption of literature and herbarium data is missing. Therefore, we do so within this work.

List of localities of *T. strictum*:

6. **Podunajská nížina lowland:** Kamenný Most [Kamenné Ďarmoty], saline pastures named Irtoványi rétek = Čistiny Nature Reserve (Krist 1937 and 1937, 1938 BRNU; Domin 1939; Valenta 1938 BRA; Černoch 1953 BRA, PR; Šourek 1954 PR; Dostál 1989; Dostál & Červenka 1991; Feráková & Kubát 1999). – Jatov, abandoned saline pastures ca 2 km south from the village (Eliáš jun., Dítě et Melečková 2013, 2014 NI).

The closest sites of *T. strictum* occur in Hungary to the southeast and north of Budapest (Szentendre, Rákos) (SOÓ 1966) at a distance of about 80 km from Jatov. However, the species was currently not confirmed here and it has always been rare in western Hungary (KIRÁLY 2014 in verb.). New location in Jatov shifts the northern limit of *T. strictum* distribution range of about 30 kilometers to the north. The fate of the discovered site is still uncertain. However it is included in the Natura 2000 as Special Protection Area SKCHVU005 Dolné Považie, but it does not provide sufficient protection. Therefore, the best option of *T. strictum* conservation seems to save its seeds in gene bank.

Finally, it should be noted that *T. strictum* is quite often confused with *T. retusum*. It was shown by our study of herbarium material and also by the fact,

that the image illustrating the species *T. strictum* in the Red Book of endangered and rare plants of the Slovak and Czech Republic (FERÁKOVÁ & KUBÁT 1999) is actually *T. retusum*. *T. strictum* differs from *T. retusum* by mostly erect, unbranched or slightly branched stem, linear-lanceolate leaflets up to 4 cm long and stipules longer than flower pedicels (Fig. 1).

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