

## Red list of ferns and flowering plants of Slovakia, 5<sup>th</sup> edition (October 2014)\*

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**Abstract:** The last version of Red List was published already more than 10 years ago but the knowledge of the flora of Slovakia has substantially improved due to large-scale mapping projects and taxonomical research. Therefore an updated fifth edition of the Red List is presented in this paper. For evaluation, we accepted IUCN categories (ER, CR, EN, VU, NT, LC, DD, NA, NE) and criteria (A–D), which were used first time in the history of Slovak Red Lists of ferns and flowering plants. In total 1 218 taxa are listed (the complete list of taxa is given in Electronic Appendix 1), which is nearly 34 % of the total number of 3 619 native taxa and archaeophytes of the flora of Slovakia. More than 80 taxa (7 %) were not confirmed in the flora (66 Regionally Extinct, 17 Probably Regionally Extinct), 155 taxa are evaluated as Critically Endangered (13 %), 171 Endangered (14 %) and 201 taxa are regarded Vulnerable (17 %). The largest group represent 347 taxa evaluated as Near Threatened (29 %), 162 taxa are assessed as Least Concern (13 %), 91 taxa are in category Data Deficient (7 %), and 8 taxa belong to categories of Not Evaluated and Not Applicable (1 %). In this Red List, 27 taxa are included as new for the flora of Slovakia and 14 taxa were rediscovered. Short history of Slovak Red lists of rare and threatened plants is also briefly mentioned.

**Key words:** IUCN categories and criteria; rare and threatened taxa; Red List; Slovakia

### Introduction

The history of systematic evaluation of rarity and endangerment of plants extends more than fifty years into the past at the international level. The very first attempts, relating only to animals, began before World War II and shortly thereafter. An irreplaceable role in this area has been played by one of the most well-reputed conservation organizations – the International Union for Conservation of Nature and Natural Resources (IUCN, today the World Conservation Union), which was founded in 1948. Former Czechoslovakia became its member in 1958 (Jedlička et al. 2007).

The first red lists of rare plant species appeared in the late seventies in former Czechoslovakia, in particular the first official full version of Red List of Plants of the Czech Socialistic Republic was published in the *Preslia* journal in 1979 (Holub et al. 1979). In Slovakia, Šomšák (1979) published a paper “List of endangered and disappearing plants of the Slovak flora of lowlands and highlands and the role of botanical gardens” in the same year. But the first complete Red List of endangered taxa was prepared with the cooperation of editor Štefan Maglocký along with a team of other

botanists in 1978–1980 (Maglocký 1981). A modified version incorporating the comments of the botanical community was published in 1983 (Maglocký 1983). A second, updated edition prepared in accordance with IUCN methodology, released ten years later (Maglocký & Feráková 1993) has been twice updated (Jedlička et al. 2007). The third version of Red List was not published separately, but as part of the Checklist of non-vascular and vascular plants of Slovakia (Marhold & Hindák 1998). The most recent, fourth version of the Red List was published in 2001 and includes 1,270 vascular plant taxa (Feráková et al. 2001). For completeness, we should add that more than 30 regional red lists on flora largely of mountain regions and large-scale protected areas, respectively have been published. These lists, usually based on the above-mentioned national lists, do not always use the same approach for the assessment of threat and vulnerability, although they remain a valuable source of knowledge (Eliáš sen. 2011; Eliáš jun. & Dítě 2011). Examples include the most recent Red List of rare and endangered plants of the Veľká Fatra Mts (Kliment et al. 2008) and Red List of vascular plants of the Carpathian part of Slovakia (Turis et al. 2014). The history is described in detail in Jedlička

\* Dedicated to memory of Štefan Maglocký (1937–2008) – the editor of the first Red List of higher plants of Slovakia

et al. (2007) and Turis et al. (2014), respectively.

As originally proposed, a 10 year span for Red List updating is recommended (IUCN 2012a) but this period is usually substantially longer (Grulich 2012). Nevertheless, new Red Lists of plants have recently been published in neighbouring countries (Király 2007; Hohla et al. 2009; Grulich 2012) and also at the European level (Bilz 2011).

Assessment of rarity and endangerment was for a long period very subjective and often country-specific and therefore difficult to compare. The first uniform international criteria were created more than 30 years ago. The development of quantitative criteria started in 1989 and the first results of the IUCN Council were adopted in 1994. System categories are based mainly on experience with the evaluation of large vertebrates, a fact which has shown the need to establish quantitative criteria suitable for all organisms and to include as a category the category of non-endangered. Such a system of categories and criteria adopted in version 3.1 in 2000, with minor modifications and explanatory additions is used to this day in version 4.0 (IUCN 2012a, b).

Based on IUCN criteria and for the above reasons, we have undertaken to draw up a fifth edition of the Red List of Slovakia, which we are presenting in this paper.

## Material and methods

The evaluation process of fifth version of the Red List of ferns and vascular plants of Slovakia was characterized by four individual steps:

1) To update and supplement information in the latest (fourth) version of the Red List (Feráková et al. 2001), because this version was compiled according to the IUCN criteria and it presents the most appropriate basis for a new version of the Red List. We added to the list other species newly identified in Slovakia (e.g., *Carex vaginata*, *Festuca alpina*) as well as those which have only recently become threatened (e.g., *Geranium lucidum*, *Helianthemum nummularium*, *Scleranthus verticillatus*). However, taxa of the genera *Alchemilla* and *Rubus* as well as most of the apomictic taxa of the genus *Hieracium*, *Pilosella*, *Rosa* and *Taraxacum* are not listed in the fifth version due to the deficiency of data necessary for the assessment. In the case of taxa of the genus *Taraxacum* it is necessary to mention that taxa from sect. *Palustria* require the special attention of specialists in the future because their decline trend is exceptionally alarming and cannot be compared with any larger group of apomictic taxa (V. Grulich 2014 in verb.). In the case of genus *Sorbus*, only taxa forming stabilized populations are evaluated according to recent demographic and distribution data (Májovský et al. 1998; Mikoláš 1996, 2003; Bernátová & Májovský 2003; Bernátová 2012 in verb.).

2) The second step was focused on the gathering of maximum information for the evaluation of the selected taxa including especially the current and historical distribution and quantitative data on the respective populations. In particular, we used the most recently published data (after 2001, thus after the publication of the third version of Red List); if this was not available, older sources were taken into consideration. In many cases, unpublished field data ob-

tained during our research and research of other botanists were applied as well.

3) Evaluation of selected taxa. The IUCN Red List Categories were used in the present Red List following the above-mentioned guidelines of version 4.0 (IUCN 2012a, b): i) RE = Regionally Extinct – the category is used instead of EX (Extinct), because there are no endemics among the extinct taxa in Slovak flora; we use this category for taxa not confirmed for more than 50 years in Slovakia, ii) CR = Critically Endangered – here we use the unofficial subcategory CR(PE) = Critically Endangered (Probably Regionally Extinct) for taxa not confirmed for more than 21 but less than 50 years in Slovak territory, iii) EN = Endangered, iv) VU = Vulnerable, v) NT = Near Threatened, vi) DD = Data Deficient – for taxa with lack of distributional as well as demographical data, vii) LC = Least Concern – for the evaluated taxa included in older versions of Red Lists (in order to maintain continuity) that are not classified in any of the preceding categories and regarded as not threatened at present, viii) NA = Not Applicable – for taxa of controversial taxonomic status and finally ix) NE = Not Evaluated – for taxa of doubtful historical occurrence in our country.

As we have accepted IUCN categories, we evaluated the taxa using IUCN criteria, which were used for the first time in the history of Slovak Red Lists of vascular plants. The application of individual criteria A – E followed this scheme:

Criterion A = reduction in population size in the past or the probability of a reduction in the future – based on the data we had available, this criterion was reasonably applied e.g. in the case of vanishing weedy archaeophytes (*Agrostemma githago*, *Lolium temulentum*, *Silene gallica*) or for species habitats of which have been changed or destroyed on a large scale (*Andromeda polifolia* – habitat destruction, *Carthamus lanatus* – absence of pasture etc.).

Criterion B = small geographic range and estimates of at least two of the following: a) 1(CR), < 5(EN), < 10(VU) localities or severe fragmentation, b) continuing decline or c) extreme fluctuations in populations/localities. This criterion was applied in most cases, because it was the least problematic one particularly with respect to the data about geographic range, number of localities and the continuing decline inferred from the area, extent and/or quality of the habitat. Localities were considered recent if the record was no more than 20 years old and no information about the present destruction of the site was found. Data for Extent of Occurrence (EOO) and the Area of Occupancy (AOO) were calculated as a sum of a grid of squares (one square is 5 × 3 geographic minutes = ca 6 × 5 km = ca 33 km<sup>2</sup>) of the Floristic Mapping Project of Central Europe (Niklfeld 1971; Jasičová & Zahradníková 1976). To describe sub-criteria “B1a” and “B2a” more precisely in comparison with the IUCN Guidelines, we decided to distinguish whether there is only the fragmentation of extension [B1a(i) or/and B2a(i)] or there is the exact number of sites mentioned above [B1a(ii) or/and B2a(ii)] or both cases are found for the respective taxon [B1a(i,ii) or/and B2a(i,ii)].

Criterion C = small populations together with a continuing decline observed or inferred in individual numbers, unfavourable population structure or extreme fluctuations. This criterion was used in many cases, especially in rare taxa (e.g. *Carex magellanica* subsp. *irrigua*, *Serratula lycopifolia*), where quantitative data were sufficient in general, but insufficient to apply the criterion E.

Criterion D = very small population size or very restricted area of occupancy. This criterion has been suc-

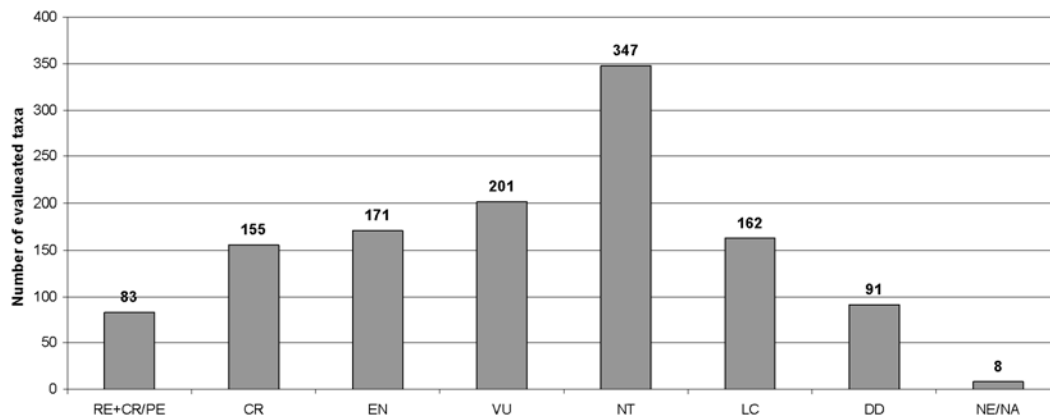


Fig. 1. Number of taxa classified in particular categories in current Slovak Red List. For explanation of abbreviations of the categories see the Material and method chapter.

cessfully used for rare taxa with no obvious decline and/or threat to their habitat e.g. for very rare mountain species as *Arctous alpina*, *Belardiochloa variegata*, *Kobresia simpliciuscula* etc. Here, we have used the description more precisely than it is defined in IUCN Guidelines, but only for the category VU (vulnerable). The “D2(i)” specification was used if the AOO of the vulnerable taxon (VU) was smaller than 20 km<sup>2</sup> and “D2(ii)” specification was used if the number of locations of the vulnerable taxon equalled at most 5. Finally, the specification “D2(i,ii)” was used if both above possibilities were simultaneously valid.

Criterion E = quantitative analysis showing the probability of extinction in the wild. It has not been used due to the lack of such data for taxa of the Slovak flora.

4) Additional information on taxa. For most of the evaluated taxa, some additional data were included, namely (i) status in international lists (the Bern Convention etc.) and in the List of protected vascular plants of Slovakia (Order of the Ministry of Environment of the Slovak Republic Nr. 24/2003), (ii) endemism (Kliment 1999) and residence status (archaeophytes / neophytes) sensu Medvecká et al. (2012) and (iii) review of references used for the evaluation, especially after 2001 (thus, after the publication of the third version of Red List). If not available, older sources were used and listed. Citations of basic sources such as the Red Data Book of higher plants of the Czech Republic and Slovakia (Čeřovský et al. 1999) and Flóra Slovenska series are used in shortened form in the list e.g. Holub 1999 (RB) and Králik 1992 (FS IV/1).

Nomenclature of taxa is according to the Karyological database of ferns and flowering plants of Slovakia (<http://www.chromosomes.sav.sk>) but we also accept the changes published in the latest (VI/3) volume of the series of Flóra Slovenska (Goliašová & Michalková 2012) and current literature (e. g. Mitka et al. 2007). The nomenclature of the genus *Scilla* follows the work of Trávníček et al. (2009) and the genus *Galatella* follows the work of Marhold & Hindák (1998). When another source of nomenclature was used for particular taxa, we refer to it in the list and it is marked with an asterisk (“\*”), for example for *Cyclamen purpurascens* subsp. *immaculatum*. In many cases, the most common synonyms are included.

## Results and discussion

In total 1218 taxa are listed in this Red List (the complete list of taxa is given in Electronic Appendix 1),

which is nearly 34% of the total number of 3619 native taxa and archaeophytes of the flora of Slovakia (species, subspecies, including hybrids and microspecies) (see Medvecká et al. 2012). From this group (Fig. 1), 83 taxa (7%) were not confirmed in the flora (66 Regionally Extinct, 17 Probably Regionally Extinct); 527 taxa (30%) are evaluated as threatened: 155 Critically Endangered (13%), 171 Endangered (14%) and 201 Vulnerable (17%). From the other categories, the largest group represent 347 taxa evaluated as Near Threatened (29%), 162 taxa are assessed as Least Concern (13%), 91 taxa are in category Data Deficient (7%), and 8 taxa belong to categories of Not Evaluated and Not Applicable (1%).

*New taxa to flora of Slovakia included in the Red List*  
Although the territory of Slovakia is floristically relatively well researched, several discoveries of new species of flora have recently been reported in the region. In this Red List, 27 taxa are included as new to Slovak flora. Those newly reported taxa can be divided into two groups: a) new taxa found during investigations in field or herbaria (14 taxa) and b) taxa newly described for science (13 taxa) and also two new nomenclatorial combinations (*Aconitum firmum* subsp. *maninense* and *Aconitum lasiocarpum* subsp. *kotulae*).

Newly described taxa represent especially the *Sorbus* microspecies stabilized by means of apomixis. Two of them, *Sorbus dolomiticola* and *S. amici-petri* (Mikoláš 1996, 2003), are stenoendemic species growing in xerothermophilous vegetation of forest-steppe and hornbeam forests near the town of Košice in eastern Slovakia. The next seven species (*Sorbus atrimontis*, *S. caeruleomontana*, *S. diversicolor*, *S. haljamovae*, *S. montisalpae*, *S. salatini*, and *S. zuzanae*) are regarded as narrow endemics of the Western Carpathian high mountains or an even smaller region (Bernátová & Májovský 2003).

Other taxa new to science belong to the genus *Minuartia*. Letz (2012) described *Minuartia glomerata* subsp. *pannonica* as a Pannonian cytotype ( $2n = 30$ ) which is morphologically different from the nominate subsp. *glomerata* ( $2n = 28$ ) and partially isolated in

the northwestern part of the species distribution range. The taxon is reliably documented from sandy and rocky areas in Slovakia and Hungary, and its occurrence in Romania and the Balkan Peninsula is likely. The second newly recognized member of the genus *Minuartia*, *Minuartia pauciflora*, is known as an endemic mountain species from the Western (Slovakia, Poland) and a small part of the Eastern Carpathians (Ukraine) occupying rocky ledges, crevices of rock walls and steep gorges (Dvořáková 2003; Letz 2012).

The second group represents new taxa found during floristic and vegetation investigations or revisions of herbarium material. Particularly important is the discovery of small population of *Asplenium platyneuron* in disturbed serpentine woodland in south-central Slovakia. This find represents a new addition to the fern flora of Europe, and probably results from long-distance spore dispersal, because the nearest known sites for this species are those in eastern North America, about 6 500 km away (Ekrt & Hrivnák 2012).

*Carex vaginata* is a typical glacial relict species in Central Europe (Holub 1999). In Slovakia, a single unreliable report of its occurrence in one location near the Dobšiná settlement had traditionally been accepted. However, Mráz (2002a) proved the falsity of those data on the basis of revision of herbarium specimens. Surprisingly, the species was actually discovered in 2009 at a single site in the Orava region, where there is a small population growing on an abandoned mountain pasture (Bernátová 2012).

Kaplan (2010) found three species of aquatic plants as new for Slovakia in revised herbarium material. *Potamogeton compressus* was collected only once in central Slovakia (Rakúsy) in 1860 and it is extinct now. *Potamogeton obtusifolius* is known from three sites in the Východoslovenská Nížina Lowland and Kaplan (l. c.) mentioned it as extinct for Slovakia because it was last collected in 1975. However, Kochjarová et al. (2010), found the species in two locations in Orava water reservoirs (Slanická Osada, Bobrov) and the authors proposed to evaluate it as critically endangered. Similarly, *Callitriche hamulata* has up to now been known from only two collections (Kaplan 2010), but several new locations have been found (Kochjarová et al. 2010; Rydlo & Smatanová 2011; Prančl in litt.).

*Festuca alpina* subsp. *alpina*, a member of the *Festuca halleri* group, occurs mainly in the Alps and Pyrenees, where it usually grows in the fissures of exposed calcareous rocks in the subalpine and alpine zones. It was found on the main ridge of the Velká Fatra Mts in 2004 (Šmarda & Kočí 2005). The locality has relict character and it represents the north-western outpost of the species range, situated 280 km away from the nearest localities in the NE Alps. The species was found at other nearby locations shortly thereafter (Kliment et al. 2008).

Most recently, *Gagea bohemica* subsp. *saxatilis* was recognized during the study of herbarium material. The single location is situated in the Malé Karpaty Mts following the subspecies distribution range in the Czech

Republic and Hungary. However, the description of the site is unclear and a recent occurrence of the taxon in this area was not confirmed (Košťál et al. 2013).

The taxon *Aconitum firmum* subsp. *moravicum* var. *maninense* was described by Skalický in the middle of the 1980s in the Manínska Tiesňava Valley near the town of Považská Bystrica in western Slovakia. Later Starmühler & Mitka (2001) evaluated it at the subspecies level on the basis of the presence of the glandular hairs in inflorescence comparing to hairy (subsp. *moravicum*) and glabrous (subsp. *firmum*) taxa; the legitimacy of this assessment was confirmed by molecular methods (Mitka et al. 2007). This endemic taxon is distributed in the Strážovské Vrchy Mts and the Vysoké Tatry Mts (Starmühler & Mitka 2001; Meredá & Hodálová 2011).

*A. degenii* subsp. *degenii* is a Carpathian subspecies endemic to W Carpathians, E Carpathians, S Carpathians, and the Apuseni Mts. The name "*A. paniculatum* Lam." for this taxon was not valid (cf. Ilnicki & Mitka 2011; Novikov 2013). Its occurrence in Slovakia was confirmed by A. Novikov (2013) during his study of herbarium material. A total of four locations were known in Strážovské Vrchy Mts, Malá Fatra Mts and Bukovské Vrchy Mts, but its current existence is uncertain and new field research is needed for exact evaluation.

Exact evaluation is also needed for *Aconitum lasiocarpum* subsp. *kotulae*, which is subendemic of Western and Eastern Carpathians. In Slovakia, only old distribution data which are available include a single location in the Vysoké Tatry Mts and a few sites in the Bukovské Vrchy Mts. The taxon is clearly different from nominate subspecies in glabrous or less pubescent pedicels and helmets (Mitka & Starmühler 2000).

Mráz (2002) confirmed occurrence of *Hieracium glanduliferum* in Slovakia during revision of Haussknecht's herbarium collection deposited in Jena. This single herbarium voucher collected in 1863 below Mt. Kriváň is the only known collection of the species in Slovakia (and the whole of the Carpathians) and it was not confirmed later. Therefore, the species is evaluated as RE (Regionally Extinct) in this Red List.

*Hieracium vierhapperi* has been found by Z. Szelag during a revision of herbarium material of the genus *Hieracium* L. in the Natural History Museum in Brno (BRNM). In the Western Carpathians *Hieracium vierhapperi* is known so far only from the massif of Prašivá on siliceous rocky-grassy habitats in open places in *Pinus mugo* communities at an altitude of 1300–1600 m. *H. vierhapperi* grows in sub-alpine communities of the alliances *Calamagrostion villosae* and *Vaccinion* (Szelag 2006).

*Hieracium austrotatricum* was described by Z. Szelag in 2008 on the basis of distinct morphological and genetic differentiation of a population in the Nízke Tatry Mts hitherto treated as *H. silesiacum*. It is known only from some localities there, where it grows in sub-alpine grasslands of the alliance *Calamagrostion villosae* on quartzite and gneiss. It is probable that *H.*

*austrotaticum* also occurs in the neighbouring range of the Tatry mountains (Ronikier & Szelağ 2008).

Zázvorka (2010) found during a comparative study of a broomrape (*Orobanche* sp. div.), that plants parasitic on *Colymbada scabiosa* belong to two distinct and nonrelated species, correctly classified as *Orobanche kochii* F.W. Schultz and *O. elatior* Sutton. *O. kochii* is more common and widely distributed in Slovakia, while *O. elatior* is currently known only at a single location in the Slovenský kras Region, where the number of individuals is not greater than 50 (Šuvada 2013 in litt.).

A new species *Senecio ucrainicus* occurring in the eastern part of the West Carpathians, the East Carpathians and the eastern part of the South Carpathians, was described in 1999 in Ukraine (Hodálová 1999a, b). In Slovakia it occurs in the Vihorlat Mts and Bukovské Vrchy Mts. *S. ucrainicus* is mostly distributed in tall-herb and grass communities, in forest communities, forest glades and clearings, on sufficiently moist and humus-rich soils in montane and supramontane belts (cf. Hodálová 1999a).

Occurrence of *Silene cretica* is documented in Slovakia by two herbarium vouchers, which J. L. Holuby collected between 1865 and 1867. The species was transiently introduced with flax seed into the surroundings of the Zemianske Podhradie village in the Biele Karpaty Mts; its last occurrence here was published in 1891 (cf. Merea et al. 2012). It is uncertain whether the species can be considered as a neophyte or archaeophyte because it is not included in the list of alien species of Slovakia (Medvecká et al. 2012). We provisionally evaluated *S. cretica* in the category RE (Regionally Extinct), but its origin in Slovakia requires further study. The same situation also applies in the case of *Allium atropurpureum* and *Schoenoplectus pungens*, which we evaluated as DD (Data Deficient). *A. atropurpureum* is known from three recent locations in S Slovakia (Podunajská nížina Lowland and the Poiplie Region), all of these sites are of anthropogenic origin (road side, pasture) and no historical data have yet been found (Dítě & Eliáš jun. ined.). The second species, *S. pungens*, was found at a single location on the bank of a gravel pit in Bratislava – Jarovce in 2002 (Ondrášek 2006). The origin and the current situation of the population are not known.

Finally, it should be noted that the number of taxa in the recent Red List may also decline as a result of recent taxonomic studies. For example, three taxa of *Alyssum montanum* have been reported in Slovakia (*A. montanum* subsp. *montanum*, *A. montanum* subsp. *brymii* and *A. montanum* subsp. *gmelinii*). Španiel et al. (2012) demonstrated that the traditional delimitation of these three subspecies is not substantiated and should be considerably revised. Both genetic and morphometric analyses revealed that populations of those three taxa do not differ from each other and correspond to the taxon now evaluated as *Alyssum gmelinii* (Španiel 2014 in verb.).

*Rediscovered species evaluated as probably extinct (EX?) or extinct (EX) in the last version of the Red List*

Since the publication of the fourth version of the Red List (Feráková et al. 2001), 13 taxa were rediscovered in the flora of Slovakia. Six of them are annuals occurring mostly temporarily, depending especially on climatic factors and management of the habitat, but other species are perennials, which often require stable conditions and well-preserved natural habitats.

*Carex burxbaumii* is a species considered as a glacial relict in Central Europe. In Slovakia, a single location was known in the surroundings of Jablonica (SW Slovakia), but the species was not confirmed at this site for quite some time (Holub & Grulich 1999). After many decades it was found in a small population in the Turčianska Kotlina Basin, where it occurs in a complex of alternately wet and drying meadows (Bernátová 2008).

*Chenopodium chenopodioides* is a species of salt marshes, which was evaluated as probably extinct (Feráková et al. 2001) in spite of the assessment as category EN by Holub (1999) due to lack of actual data. Eliáš jun. et al. (2009, 2011) mentioned four locations in field inundations in the Podunajská Nížina Lowland (in the surroundings of Zlatná na Ostrove, Bajč and Iža and in a saline pool in Tvrdošovce). Later, a further two locations were found (Bodzianske Lúky, Čenkov). Most sites are only periodic and if the climatic conditions are not appropriate (low total precipitations), they are not developed for a significant period.

*Ceratocephala testiculata* previously occurred in several localities in south-western Slovakia (phytogeographical districts of Kováčovské kopce Hills, Devínska Kobyla Hills and Podunajská nížina Lowland); it was last recorded in 1969 (Bertová 1982). In April 2013, the species was rediscovered in Slovakia after more than 40 years at the Čierna nad Tisou railway station (eastern Slovakia). The location represents the most eastern, probably secondary, locality of its occurrence in Slovakia (Májeková et al. 2013).

*Elatine hungarica*, an inconspicuous wetland species reported from the Východoslovenská Nížina Lowland, was missing from Slovak flora for about 25 years. No data on this species had appeared since 1975, until at the turn of the millennium, Molnár et al. (1999) re-found it in the above-mentioned area near Streda nad Bodrogom and a first locality of *E. hungarica* was also found at the Podunajská Nížina Lowland in a temporary field inundation near the village of Okánikovo in 2010 (Király & Eliáš jun. 2012).

As noted Mičieta (1993), *Juncus sphaerocarpus* was last recorded in Slovakia in 1966 near the Okánikovo settlement. The species was rediscovered during a floristic course in the surroundings of the town of Tornaľa at a single location (Boublík, Douda, Lepší & Petřík in Kochjarová 2010) and this find initiated an intense search for the occurrence of the species in Slovakia. Today, more than 15 locations are known in the Podunajská Nížina Low-

land and the Poiplie region (Dítě & Eliáš jun. 2013 ined.).

The taxon *Lathyrus nissolia* subsp. *futakii* was described as new to science in 1983. This Pannonian endemic has occurred in wetlands and swamps of the Východoslovenská Nížina Lowland near the village of Bořany and the last record was published in the mid 1970s (Chrtková 1988). The occurrence was not confirmed later because its habitat was destroyed due to hydromeliorations (Kliment 1999). However, it was observed after 2001, probably in the vicinity of the *locus classicus* by I. Hodálová (in litt.). A new location has been found by J. Bogoly and F. Bača in swamp meadows near the Strážne settlement in 2008 (Bača 2009), but no exact information about demographic characteristics of the population is known.

*Linnaea borealis* is in Slovakia a very rare mountain species. It was documented only at a few locations in the Nízke Tatry, Vysoké Tatry and Západné Tatry Mts, and in the Orava region near Podbiel. Most records come from the period before the World War II; the last herbarium voucher was sampled in the Bielovodská Dolina Valley (Vysoké Tatry Mts) in 1957 and the last literature reference was published in 1970 in the Nízke Tatry Mts (Bertová 1985). The species was not found despite an intensive search for many years, until the occurrence was confirmed in Bielovodská Dolina Valley in 2013 (Jasík et al. 2014).

Hlavaček et al. (1984) processed the occurrence of *Peucedanum officinale* in Slovakia. The authors stated that the species is found only very rarely in the Pannonian phytogeographical districts of Záhorská Nížina Lowland and Východoslovenská Nížina Lowland, but it had not confirmed there for many years. In August 2008, Eliáš jun. et al. (2010) found a single individual at a site located on the south-eastern edge of the Kamenínske slanisko National Nature Reserve. The origin of the species here is not clear; the authors suspect the transfer of diaspores from Hungary.

*Potamogeton alpinus* was reliably documented only in the surroundings of Štvrtok village in 1882; although there are also numerous newer data in the literature, they are considered doubtful (Kaplan & Čerovský 1999). Recently, the species was confirmed at a single location in Orava region, where around 30 individuals occupied a shallow inundation near Rabča village (Kochjarová et al. 2010).

*Ornithogalum pyrenaicum* subsp. *sphaerocarpum* was documented in approximately 15 historical locations concentrated in the Biele Karpaty Mts, Podunajská Nížina Lowland and Štiavnické Vrchy Mts and in the Red Data Book assessed as EX? (Holub & Hrouda 1999). Recently, five locations were confirmed, four in the Biele Karpaty Mts, the first one by Prach 2003 (in Mertanová & Smatanová 2006) and one in the Podunajská Nížina Lowland. Most of populations are very small including not more than 20 individuals, excepting the location in the Červenokamenské Lúky meadows near the village of Lednica, where hundreds of plants were confirmed (Jánsky 2013 in litt.).

Domin (1926, 1929) published the first data on the occurrence of *Sibbaldia procumbens* in Slovakia; he found it in the alpine grasslands on the top of the Temniak peak. Despite these data, the occurrence in Slovakia was questioned and all locations in the Červené Vrchy Mts (Western Tatra Mts) were situated on the Polish side of this mountain (Kmeťová 1992). In 2011, Duchoň & Dítě (2013) confirmed the presence of the species in the Slovak part of the Červené Vrchy Mts near the top of the Kresanica peak.

*Trifolium angulatum*, a species of saline pastures evaluated as probably extinct (EX?) in Slovakia, was confirmed in Kamenínske Slanisko Nature Reserve in 2010 (Eliáš jun. et al. 2011) near Jatov village in 2013 (Dítě, Melečková & Eliáš jun. ined.) and near Zemplínske Kopčany village in the Východoslovenská Nížina Lowland in 2014 (Dítě, Melečková, Šimková & Eliáš jun. ined.). While the stands of *T. angulatum* near Kamenín and Zemplínske Kopčany were developed in an area of approx. 25 m<sup>2</sup>, stands in the third locality occupied at least hundreds of square meters and the species occurred here from the seed bank after ploughing of salt meadows.

The occurrence of *Utricularia bremii* was reported in the Záhorská nížina Lowland several times, however, it was probably based on incorrect data published by Degen et al. (1923). Šípošová & Oľaheľová (1997) mentioned only a single reliably confirmed historical record of *U. bremii* in Slovakia – Senica, Pustý Mlyn site. Since 1948, *U. bremii* had not been found anywhere in Slovakia (Vydrová et al. 2009), however, it was re-discovered in the Borská Nížina Lowland, at the locality of Hanšpilje near Plavecký Peter village in 2006 (Dítě et al. 2013).

#### *Trends over the last 30 years*

Except for the second Slovak Red List (Maglocký & Feráková 1993), the number of evaluated taxa in the individual lists has decreased (Fig. 2). The reasons for this are probably a better knowledge of Slovak flora as a basis for the evaluation of particular taxa as well as the methodological approach (using strict IUCN criteria). The difference in the number of assessed taxa in the recent Red List in comparison with the previous three editions is even more conspicuous when only the categories VU and higher are taken into consideration. The number of the taxa listed in these categories comprises a little more than 50% of the recent Red List, while in the older lists this value oscillates within the interval 67–79%. When comparing four editions of the Slovak Red Lists, we observe an increase of evaluated taxa in the time sequence only as concerns the categories RE + CR/PE (Fig. 3). This trend suggests a gradual disappearance of certain taxa from the flora of Slovakia as a result of human activities connected with the ongoing devastation of habitats (e.g., *Asplenium ceterach* subsp. *ceterach*, *Cyperus pannonicus*, *Dactylorhiza cruenta*, *Spiraea crenata*), intensification of agriculture (e.g., *Brassica elongata* subsp. *elongata*, *Camelina sativa* subsp. *zingeri*, *Lathyrus aphaca*,

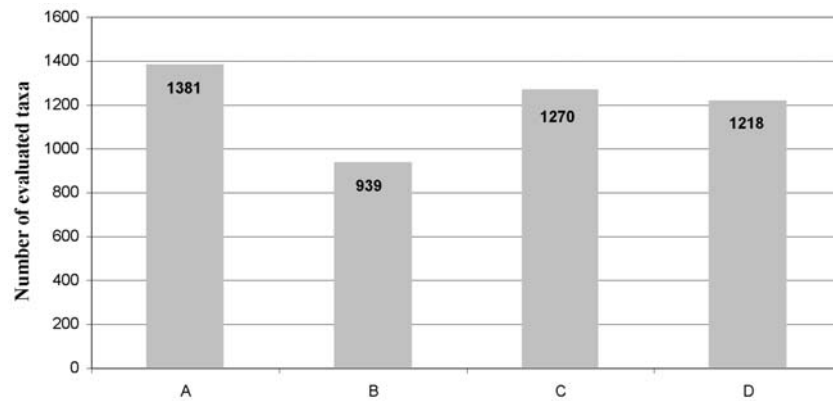


Fig. 2. Number of evaluated taxa in four editions of the Slovak Red Lists (A – Maglocký 1983, B – Maglocký & Feráková & 1993, C – Feráková et al. 2001, D – recent Red List).

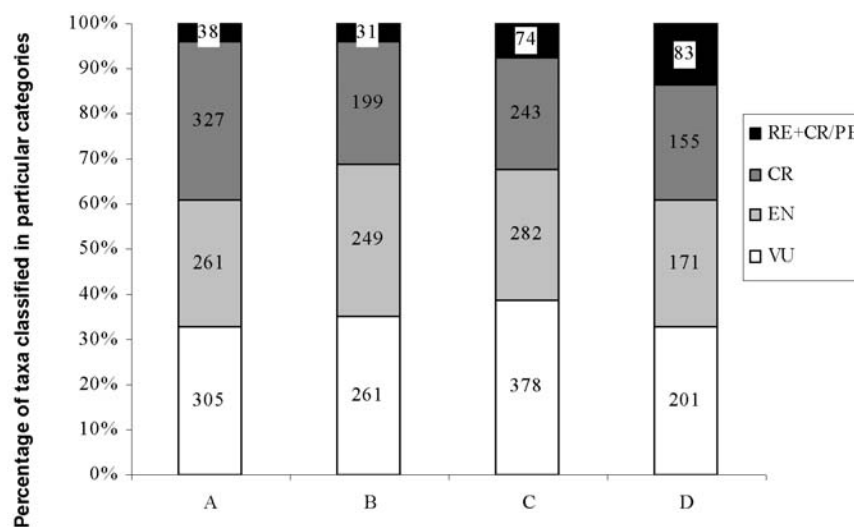


Fig. 3. Percentage of taxa classified in particular categories in four editions of the Slovak Red Lists (A – Maglocký 1983, B – Maglocký & Feráková & 1993, C – Feráková et al. 2001, D – recent Red List). For explanation of abbreviations of the categories see the Material and method chapter.

*Spergula maxima*, *Veronica opaca*), changes in land use and succession processes in habitats (e.g., *Amaranthus graecizans* subsp. *sylvestris*, *Minuartia viscosa*, *Polycnemum heuffelii*, *Stipa smirnovii*, *Trifolium romanicum*). Logically it follows that the remaining species in the recent Red List (less than 50%) are classed in the categories NT + LC + DD. The increase of the number of taxa evaluated in categories lower than VU represents a consequence of the strict assessment using the IUCN criteria. The majority of changes in the evaluation of taxa in the recent Red List as compared to the previous three editions represent a two category downgrading. The number of three step category downgrades varies along the time gradient, with the number of such changes decreasing from the oldest Red List to the last published one (Fig. 4). The reasons are similar to those for the total decrease of taxa assessed in the published lists. Upgradings and downgradings by more than 4 categories are minimal (Fig. 5). A downgrading by 4 steps was established in the case of taxa *Bupleurum affine*, *Scilla bifolia* subsp. *buekkensis* (versus the Red

List of Maglocký 1983) and *Poa granitica*, *Poa laxa*, *Ranunculus glacialis* (Maglocký & Feráková 1993). In each case it is connected to the more systematic study of these species during recent years, with better knowledge of their distribution and subsequently a more objective assessment (e.g., Kochjarová 2005). It is also interesting to follow the constancy of the taxa classed in particular categories through all lists published up to now (Fig. 3). Logically the largest number of taxa has been found in the category CR and the lowest in the category VU. The species considered as critically endangered, or at least some of them, are under the long-term supervision of the botanical community including the organizations securing their protection. Their distribution, biology and ecology are thoroughly known and adequate legislative and practical conservation follows. Therefore it is among these that the highest number of taxa whose assessment does not change over time is found (e.g., *Alkanna tinctoria*, *Artemisia austriaca*, *Colchicum arenarium*, *Ferula sadleriana*, *Pulsatilla zimmermannii*, *Scorzonera rosea*).

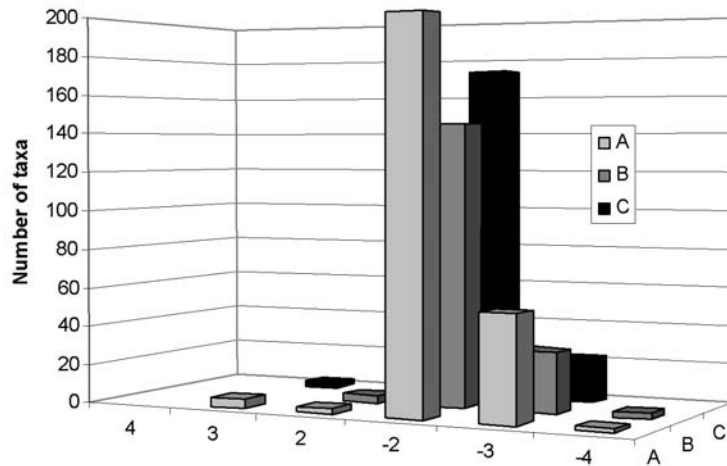


Fig. 4. Number of taxa with changes accross categories (increase and decrease across 2–4 categories) within four editions of the Slovak Red Lists (A – Maglocký 1983, B – Maglocký & Feráková & 1993, C – Feráková et al. 2001, D – recent Red List).

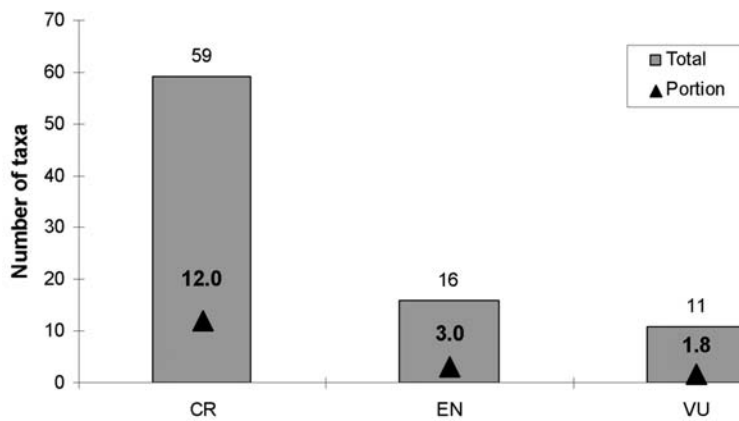


Fig. 5. Number of taxa classified in the same categories in four editions of the Slovak Red Lists (total number – upper bar, percentage of total number of taxa in individual categories in four editions of the Slovak Red Lists – upper triangle). For explanation of abbreviations of the categories see the Material and method chapter.

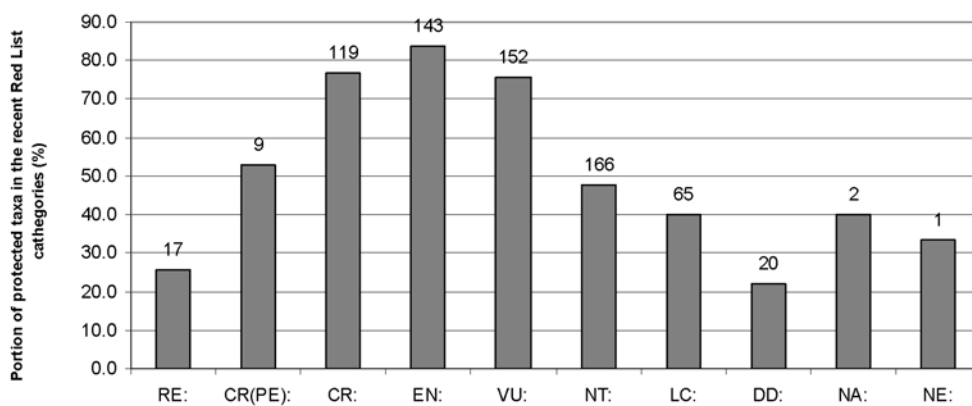


Fig. 6. Percentage and number of legislatively protected taxa in individual categories of the recent Red List. For explanation of abbreviations of the categories see the Material and method chapter.

*Comparison of legislative protection and the recent Red List*

Both documents have undoubtedly a strong mutual connection; logically the most threatened taxa should be also protected by law to prevent their further direct elimination, but as Fig. 6 shows, this is not always the

case. Taxa considered as regionally extinct should not be found in the document of protected species, especially those which have already been extinct from the territory of Slovakia for more than 50 years (category RE). On the other hand, the critically endangered and endangered taxa (CR and EN) should be protected by



law to the fullest possible extent. However, these prerequisites do not reflect the reality; 17 taxa in the category RE and only about 80% of the taxa in the categories CR and EN are protected. We see the main contribution of the recent Red List as the possibility of joining legislative protection with contemporary knowledge of the actual degree of threat to our flora. Naturally, the legislative protection should be followed by particular, practical care of the most endangered taxa of the flora of Slovakia. In this way the trend of an increase in the number of species assessed as RE and CR/PE could be, if not stopped, at least slowed down.

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