

Flora and vegetation of the Ukrainian Upper Tisa Basin: Aspects of biodiversity conservation

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Abstract

Results of the flora and vegetation studies in the Upper Tisa basin within Ukraine are presented. The bicentennial history of the vegetation cover studies of Transcarpathia and the Maramarosh region in particular is considered.

Special attention is focused on the problem of biodiversity conservation in the Upper Tisa Region. Lists of the threatened vascular plants (366 taxa) of the region are presented, which were developed on the basis of the surveyed studies. The peculiarities of the distribution of rare and endemic species are stated.

Keywords: flora, vegetation, biodiversity, conservation, Upper Tisa

Introduction

The studies dealing with the vegetation cover of Transcarpathia (Ukraine) whose historical name is known as Ruthenia or Subcarpathia Rus, cover more than 200 years, which can be divided into three periods: Austro-Hungarian (1796-1918), Czecho-Slovakian (1918-1945) and Soviet-Ukrainian (from 1945).

The beginning of vegetation cover studies in Transcarpathia is connected with the names of P. Kitaibel and F. Waldstein who from 1796 undertook a series of expeditions in different parts of the region. They studied most extensively the flora of Maramarosh county where exactly the upper part of the basin of River Tisa is located. During these expeditions over 1000 plant species were collected; as a result of these studies dozens of taxa new for science were described (Kitabel 1863).

A substantial contribution to the vegetation cover studies of Transcarpathia was made by local botanist L. Vágner (L. Wagner) who studied mainly the flora of Maramarosh. His studies done for many years are generalised in a separate work (Vágner, 1876) which has not lost its importance even by present time.

Among the researchers of that period, the names of those who actively studied the flora of Maramarosh should be mentioned. They are: B. Müller (1863), V. Borbás (1877, 1878), K. Siegmeth (1881–1884 a, b; etc.), L. Biró (1885), F. Pax (1898–1908;

etc.), H. Zapalowicz (1889; etc.), J. Bezdék (1905), J. Tuzson (1919), A. Boros (1938, 1944; etc.), A. Péntes (1939), G. Andreánsky (1940; etc.), B. Zólyomi, J. Ujhelyi (1942), R. Soó (1933, 1944; etc.). Rich information about the vegetation cover of Transcarpathia can be also found in works by L. Fekete, Gy. Gáyer, F. Haszlinsky, V. Janka, S. Mágocsy-Dietz, L. Szücs, L. Thaisz, G. Ubrizsy, Z. Zisák and a number of other researches. The greatest achievement of this period was the publication of the plant identification handbook of Hungary (Jávorka, 1925), which contained lasting conclusions concerning the Hungarian - and particularly the Transcarpathian - flora studies.

Special attention is deserved by local botanist A. Margittai (A. Margittaj), whose activity dates back to the end of the first period and the second period of studies. A series of his works is devoted to the flora studies of Maramarosh (Margittai 1930, 1933, 1935; etc.) and Transcarpathia (Margittai 1911, 1923, 1927, 1936; etc.).

In the following period the vegetation cover of Transcarpathia was studied by Czechoslovakian botanists. There is valuable information about the flora of Maramarosh in the works by I. Nevole (1925), K. Domin (1929 a, 1930 a; etc.), Fr. Maloch (1932, 1933), M. Deyl (1935 a, b; 1936, 1940; etc.), J. Klášterský (1935, 1936), V. Krist (1935), A. Zlatník (1934-1935; etc.), M. Pulchart (1937, etc.). A great contribution to the studies of flora and vegetation in Transcarpathia is associated with the names of J. Buček, V. Drahný, A. Hilitzer, K. Hroch, J. Hruby, R. Jirasek, A. Láska, M. Maloch, J. Nádvorník, A. Pilat, K. Šiman, J. Suza and some other botanists. This period is characterized by the development of works of the general kind such as the plant identification handbook of Czechoslovakia (Polivka et al., 1928) which included also the flora of Transcarpathia, as well as the cycles of floristic works by K. Domin (1929 b, 1929–1931) and J. Klášterský (1929–1931), which were essential contributions to the information about the flora of the region.

When Transcarpathia joined Ukraine, intensive studies on vegetation cover developed in the region. They were crowned by the publication of the large general works in which Transcarpathian flora studies were included: Flora SSSR (1934-1964), Flora URSS (1936-1965), Flora Evropejskoj chasti SSSR (1974-1995), Vyznachnyk roslyn Ukrainy (1950, 1964, 1987), Vyznachnyk roslyn Ukrainykh Karpat (1977), etc. Some major works on systematics, geography, plant ecology of different systematic groups were devoted to the vegetation cover analysis in the region (Popov 1949; Roslynnist 1954; Makarevych 1963; Fodor 1974; Zerov, Partyka 1975; Chopyk 1976; Malynovsky 1980; Malinovsky et al. 1991; etc.).

In this period some works appeared that were devoted to the studies of flora and vegetation of the natural reserve objects of the Ukrainian Carpathians and Transcarpathia, the major part of which is concentrated in the Upper Tisa basin (Stojko 1977; Stojko et al. 1991; Okhorona pryrody ..., 1980; Flora i roslynnist ..., 1982; Bioriznomanittja ..., 1997; etc.). In many works data are given on the flora of the south-eastern part of Transcarpathia, which is within the former Maramarosh county (Fodor 1956, 1960, 1984; Kotov, Chopik 1960; etc.).

For the last decades dozens of other works have been published, which substantially supplemented the information on the vegetation of the region and made it more accurate, but, for shortage of place, we cannot dwell upon them. Thus, today the flora and vegetation of Transcarpathia have been studied comparatively well. The

annotated list of vascular plants and plant communities is given in the Upper Tisa Ramsar Sheet (Kricsfalusy et al. 1998b) which is dealt with in the present monograph.

Thanks to the efforts of several generations of botanists it has been stated that the region is a prominent depository of the gene pool of the flora, since in its area which is only 2% of Ukraine's territory, almost 50% of the vascular plants and communities are concentrated. In this context the extended studies of the vegetation biodiversity of Transcarpathia and its effective conservation acquire prior importance.

A considerable contribution to the cause of the conservation of vegetation cover in Transcarpathia was made by A. Zlatnik, S.M. Stojko, V.I. Chopyk, K.A. Malynovsky, V.I. Komendar, S.S. Fodor and some other researchers. They initiated the compilation of the Red Data List of vascular plant species and plant communities, and, on the basis of their studies, targets of nature conservation, existing in various statuses, were set. A series of monographs, devoted to rare and disappearing species of the flora, including those of Transcarpathia, was published (Chopyk 1970; Kricsfalusy, Komendar 1990; etc.).

Today 145 species of the flora of Transcarpathia (7.3%) have entered the Red Data Book of Ukraine (Chervona Knyha ..., 1996), while the Green Data Book of Ukraine (Zelenaja Kniga ..., 1986) includes 56 plant communities. However, as the studies have shown, 485 plant species (24,4 %) need protection on the regional level in Transcarpathia (Kricsfalusy et al. 1998).

Materials and Methods

The whole river system of Transcarpathia belongs to the basin of River Tisa. Its upper part extends from the headwaters to the town of Hust where River Tisa, breaking through the volcanic ridge, enters the Transcarpathian Plain.

Accordingly, when giving the characteristics of flora and vegetation of the Upper Tisa basin, we mean the territory located east of River Rika (Figure 1.).

It is interesting to note that its outlines in the phytogeographic terms distinctly coincide with the boundaries of six floristic districts of the Ukrainian Carpathians: Svydovets, Chornohora, Maramarosh Alps, Horhans, Maramarosh depression, the area between the rivers Rika and Teresva.

The list of threatened plant species of the region is compiled on the basis of earlier works (Kricsfalusy et al. 1998 a). All taxa names have been collated with those given in S. K. Cherepanov's (1995) check list, with the supplements used in works on the flora of the adjacent regions and the Carpathian mountain system (Flora Polska 1919-1968; Flora României 1952-1976; Flora Slovenska 1966-1998; Soó 1964-1980).

We accepted and applied the categories of rarity (I-V) used in most recent publications on these problems (IUCN Red List categories, 1994). The following abbreviations were used: E - endemic (EC - East Carpathian, SEC - South - East Carpathian, PE - Pan Carpathian), RRL - Regional Red List, RBU - Red Book of Ukraine, ERL - European Red List.



Figure1. Map of studied area

Results and Discussion

On the basis of the general information on flora and vegetation of the Upper Tisa as well as based on our zoological analysis it was stated that 366 vascular plant species and 35 plant communities of the region needed protection.

All plant species in the highest conservation status entered the suggested list. In particular, they are included in the European Red List (1991) and the Red Data Book of Ukraine (Chervona Knyha ..., 1996), some are endemic, represents of specific gene pools. However, it should be noted that some of these species grow in comparatively

large areas, have rather stable population structures and there is actually no danger to their existence today.

We found that the European Red List and the Red Data Book of Ukraine, respectively, included 9 and 118 plant species of the studied region. For some reason, 6 species appearing in the European Red List, which grow in this territory, are not included in the Red Data Book of Ukraine.

Of great interest are the categories of rarity. According to their zoological status, the endangered plants are divided as follows: I (extinct) - 8 species, II (endangered) - 83, III (vulnerable) - 131, IV (rare) - 102, V (lower risk) - 42.

The highest indices of the flora's richness in endangered species, including the Red Data Book ones, are noted for the Svydovets and Chornohora. As regards the presence of different categories of rarity, it is the Maramarosh Alps that occupy an intermediate position between the aforementioned two massifs and the Horhans. The number of endangered species is the lowest in the anthropogenically most affected floristic districts i.e. the area between the rivers Rika and Teresva and the Maramarosh depression, despite that these areas are not the smallest ones in size (Figure 2.).

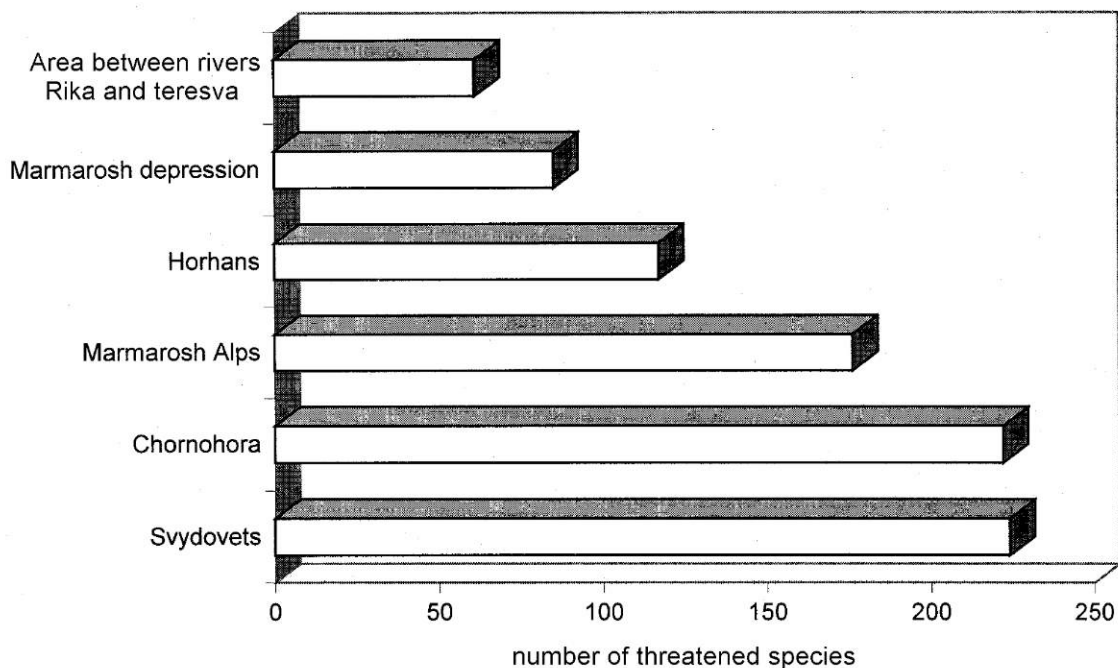


Figure 2. Distribution spectrum of threatened vascular plants in different floristic areas

A remarkable part of the flora composition of the studied region is made up by endemic plants. They number 94 species, of which 37 are East Carpathian, 26 are South-East Carpathian and 34 are Pancarpathian endemisms. Their densest concentration can be observed in the Chornohora, Svydovets and the Maramarosh

Alps. This index is twice as low for the Horhans, while in the other districts the number of endemic species drops markedly (Figure 3.).

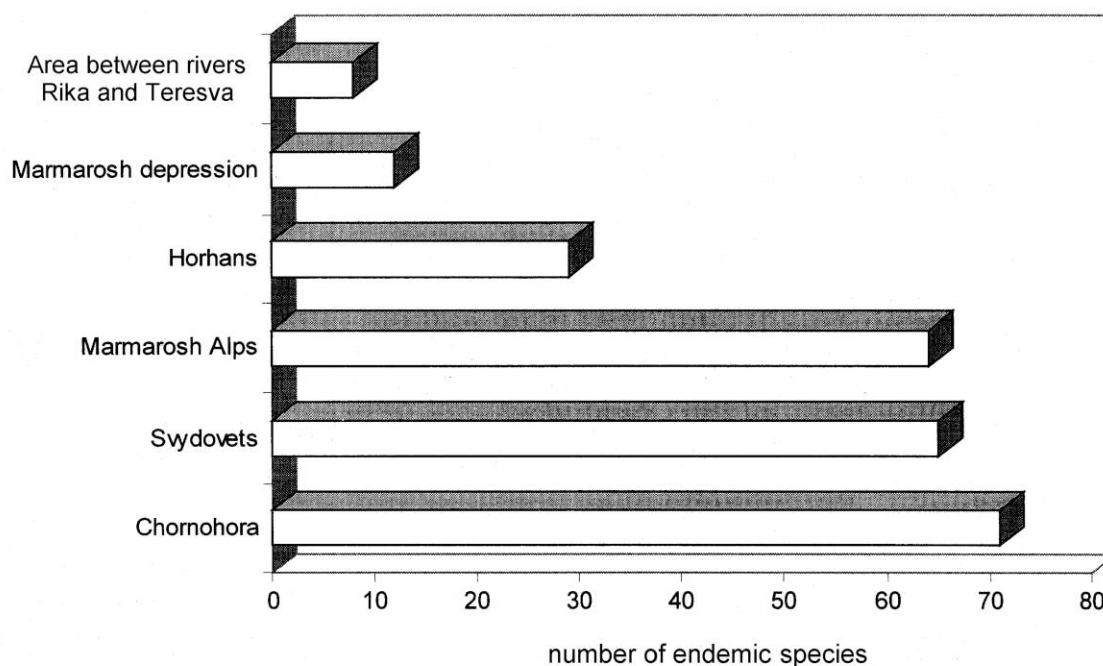


Figure 3. Distribution spectrum of endemic vascular plants in different floristic areas

The majority of endemic species occur in various highland areas. They grow mostly in woodlands, on the upper edge of forests and in tall-grass lands. At the same time there are a number of endemic plants attached only to a single district. There are 9 species that grow solely in the Chornohora, 6 in the Marmarosh Alps, 5 in the Sydovets, 1 in the Horhans and 1 in the area between the rivers Rika and Teresva. As a rule, these species, too, occur on the exposed rocky sites, and to a less extent in the tall-grass cenoses and forests.

It should be specially noted that a substantial proportion of species included in the regional Red List belong to the groups of valuable medicinal, decorative, or food plants which are laid in and used by pharmaceutics and food industry and in greenbelt setting.

Consequently, it is necessary to achieve the control of their populations and the regulation of economic load on them.

Threatened vascular plants of the area

Achillea carpatica - E (EC), RRL (IV)

Acinos baumgartenii (*A. alpinus* subsp. *baumgartenii*, *A. alpinus*, *Melissa baumgartenii*) - RRL (III)

Aconitum bucoviense (*R. callibotryon* subsp. *bucoviense*, *A. firmum* subsp. *bucoviense*) - E (EC), RRL (IV)
A. degenii (*A. paniculatum* subsp. *degenii*) - E (EC), RRL (II)
A. firmum (*A. firmum* subsp. *firmum*, *A. napellus* subsp. *firmum*) - RRL (IV)
A. gracile (*R. variegatum* subsp. *gracile*) - RRL (IV)
A. hosteanum (*A. moldavicum* subsp. *hosteanum*) - E (SEC), RRL (III)
A. jacquinii (*A. anthora* subsp. *jacquinii*) - E (SEC), RRL (II), RBU
A. nanum (*A. tauricum* subsp. *nanum*) - E (SEC), RRL (III)
A. paniculatum - RRL (IV)
A. variegatum (*A. rostratum*) - RRL (IV)
Agrostis rupestris subsp. *rupestris* - RRL (III)
Alchemilla babiogorensis - E (EC), RRL (II)
A. cymatophylla (*A. strigosula*) - III
A. deylii - E (EC), RRL (II)
A. firma (*A. glaberrima* subsp. *firma*, *A. pyrenaica*) - RRL (II)
A. flabellata (*A. truncata*, *A. pubescens*) - RRL (IV)
A. hoverlensis - E (EC), RRL (II)
A. incisa (*A. gracilis*, *A. vallesiaca*) - RRL (II)
A. obtusa (*A. obsoleta*) - RRL (II)
A. pseudoincisa - E (EC), RRL (III)
A. reniformis (*A. sudetica*) - RRL (II)
A. szaferi - E (EC), RRL (IV)
A. turkulensis - E (EC), RRL (IV)
Allium angulosum - RRL (III)
A. ursinum (*A. ucrainicum*) - RRL (IV), RBU
Alopecurus laguriformis (*A. pratensis* subsp. *laguriformis*) - E (SEC), RRL (III)
Andromeda polifolia - RRL (II)
Anemonastrum narcissiflorum (*Anemone narcissiflora*) - RRL (IV)
Antennaria carpatica - E (PC), RRL (III), RBU
Anthemis carpatica (*A. cretica* subsp. *carpatica*) - RRL (III)
Anthyllis alpestris (*A. vulneraria* subsp. *alpestris*) - RRL (IV)
Aquilegia nigricans - RRL (II), RBU
Arnica montana - RRL (IV), RBU
Arum alpinum (*A. maculatum*) - RRL (III)
Asplenium adiantum-nigrum (*A. adiantum-nigrum* subsp. *nigrum*) - RRL (II), RBU
Aster alpinus subsp. *subvillosus* - RRL (II), RBU
Astragalus krajinae (*A. australis* subsp. *krajinae*) - E (EC), RRL (II), RBU, ERL
Astrantia major subsp. *major* - RRL (V), RBU
Atropa bella-donna - RRL (IV), RBU
Bartsia alpina L. - RRL (III)
Bellardiochloa violacea (*Poa violacea*) - RRL (IV)
Biscutella austriaca subsp. *hungarica* (*B. alpestris* subsp. *austriaca*) - RRL (II)
Bistorta vivipara (*Polygonum viviparum*) - RRL (IV)
Blechnum spicant subsp. *spicant* - RRL (IV)
Botrychium lunaria - RRL (IV), RBU
B. matricariifolium (*B. ramosum*) - RRL (III)
B. multifidum (*Sceptridium multifidum*) - RRL (II)

B. virginianum (*B. virginianum* subsp. *europaeum*, *Botrypus virginianus* subsp. *europaeus*) - RRL (II)
B. longifolium subsp. *vapincense* - RRL (III)
Bupleurum ranunculoides subsp. *orbiculatum* - RRL (II)
B. tenuissimum - RRL (III)
Calla palustris - RRL (II)
Callianthemum coriandrifolium (*Ranunculus rutifolius*) - RRL (II)
Callitriche stagnalis - RRL (IV)
Calluna vulgaris - RRL (II)
Campanula carpatica - E (PC), RRL (III), RBU
C. polymorpha (*C. kladniana*, *C. kladniana* subsp. *polymorpha*, *C. rotundifolia* subsp. *polymorpha*, *C. tatrae*) - E (PC), RRL (IV)
C. serrata (*C. napuligera*, *C. pseudolanceolata*, *Thesium serratum*) - E (PC)
C. subcapitata (*C. glomerata* subsp. *elliptica* f. *subcapitata*) - E (EC), RRL (II)
Cardaminopsis ovirensis (*C. halleri* subsp. *ovirensis*, *Arabis ovirensis*) - RRL (III)
C. neglecta (*A. neglecta*) - E (PC), (III)
Carduus bicolorifolius (*C. personata*, *C. personata* subsp. *albidus*) - E (EC), RRL (IV)
C. kernerii (*C. transsilvanicus*) - RRL (V)
Carex bicolor - RRL (I)
C. buxbaumii - RRL (II), RBU
C. davalliana (*C. scabra*) - RRL (II), RBU
C. disticha (*C. disticha* subsp. *grossheimii*, *C. grossheimii*, *C. intermedia*) - RRL (II)
C. fuliginosa subsp. *fuliginosa* - RRL (II)
C. hartmanii (*C. buxbaumii* subsp. *hartmanii*) - RRL (II)
C. humilis (*C. buschiorum*) - RRL (III)
C. limosa - RRL (III)
C. pauciflora - RRL (IV), RBU
C. rupestris - RRL (II), RBU
C. umbrosa subsp. *umbrosa* - RRL (V), RBU
Centaurea carpatica (*C. phrygia* subsp. *carpatica*, *Jacea carpatica*, *J. phrygia* subsp. *carpatica*) - E (SEC), RRL (V), RBU
C. Maramaroshiensis (*C. mollis* subsp. *Maramaroshiensis*, *Cyanus Maramaroshiensis*, *C. montanus* subsp. *Maramaroshiensis*) - E (EC), RRL (IV)
C. melanocalathia (*C. nigriceps*, *C. phrygia* subsp. *melanocalathia*, *C. phrygia* subsp. *nigriceps*, *J. phrygia* subsp. *nigriceps*) - E (EC), RRL (V)
Centaureum pulchellum - RRL (III)
Cephalanthera damasonium (*C. grandiflora*, *C. alba*) - RRL (III), RBU
C. longifolia (*C. ensifolia*) - RRL (V), RBU
C. rubra - RRL (IV), RBU
Cerastium lanatum (*C. alpinum* subsp. *lanatum*) - RRL (IV)
Chamaecytisus elongatus (*Ch. ratisbonensis* subsp. *elongatus*) - RRL (II)
Chimaphila umbellata - RRL (III)
Chrysaspis badia (*Trifolium badium*) - RRL (IV)
Chrysosplenium alpinum - E (SEC), RRL (IV)
Cimicifuga foetida - RRL (IV)
Coeloglossum viride (*C. bracteatum*) - RRL (IV), RBU
Colchicum autumnale - RRL (IV), RBU
Comarum palustre - RRL (II)

Conioselinum tataricum (*C. boreale*, *C. vaginatum*) - RRL (IV)
Corallorhiza trifida (*C. innata*) - RRL (III), RBU
Cortusa matthioli - RRL (III)
Cotoneaster integerrimus - RRL (IV)
Crataegus lipskyi - RRL (IV)
Crocus banaticus - RRL (IV), RBU
C. heuffelianus (*C. vernus* subsp. *vernus*) - RRL (V), RBU
Cynoglottis barrelieri (*Anchusa barrelieri*) - RRL (IV)
Cypripedium calceolus - RRL (I), RBU, ERL
Cystopteris regia (*C. alpina*) - RRL (I)
Dactylis slovenica (*D. glomerata* subsp. *slovenica*) - E (EC), RRL (IV)
Dactylorhiza cordigera (*Orchis cordigera*) - RRL (IV), RBU
D. fuchsii (*D. longibracteata* subsp. *longibracteata*, *O. fuchsii*) - RRL (V), RBU
D. incarnata subsp. *incarnata* (*O. incarnata*, *O. strictifolia*) - RRL (V), RBU
D. longibracteata subsp. *soóiana* - E (P), RRL (III)
D. maculata subsp. *maculata* - RRL (IV), RBU
D. majalis (*O. latifolia*, *O. majalis*) - RRL (V), RBU
D. sambucina (*O. sambucina*) - RRL (V), RBU
D. transsilvanica (*D. maculata* subsp. *O. transsilvanica*) - E (PC), RRL (IV)
Daphne mezereum - RRL (V)
Delphinium elatum subsp. *elatum* (*D. atropurpureum*, *D. intermedium*) - RRL (II), RBU
Dianthus carpaticus (*D. carthusianorum* subsp. *saxigenus*) - E (SEC), RRL (IV)
Dichodon cerastoides (*Cerastium cerastoides*) - RRL (III)
Diphasiastrum alpinum (*Diphasium alpinum*, *Lycopodium alpinum*) - RRL (III)
Doronicum carpaticum (*D. columnae*) - RRL (IV)
D. clusii (*D. styriacum*, *Arnica styriaca*, *A. glacialis*, *Aronicum clusii*) - RRL (III), RBU
D. hungaricum (*D. longifolium*) - RRL (II), RBU
Draba aizoides subsp. *aizoides* - RRL (III)
D. carinthiaca - RRL (IV)
Drosera rotundifolia - RRL (IV)
Dryas octopetala subsp. *subinciza* (*D. octopetala*) - RRL (II), RBU
Echinops exaltatus (*E. commutatus*) - RRL (III)
Elatine alsinastrum - RRL (V), ERL
E. hungarica (*E. schkuhriana*) - RRL (III)
Eleocharis austriaca (*E. leptostylopodiata*, *E. mamillata* subsp. *austriaca*) - RRL (III)
E. carniolica - RRL (IV), ERL
Epipactis atrorubens (*E. atropurpurea*, *E. rubiginosa*) - RRL (IV), RBU
E. helleborine subsp. *helleborine* (*E. latifolia*) - RRL (V), RBU
E. palustris (*E. longifolia*) - RRL (IV), RBU
Epipogium aphyllum - RRL (II), RBU
Equisetum hyemale (*Hippochaete hyemalis*) - RRL (III)
E. telmateia (*E. majus*, *E. maximum*) - RRL (IV)
Erigeron alpinus - RRL (III)
Erythronium dens-canis subsp. *dens-canis* - RRL (III), RBU
E. dens-canis subsp. *albiflorum* - RRL (III)
Euphorbia carpatica (*Tithymalus carpaticus*) - E (EC), RRL (V)
E. salisburgensis (*E. carpatica*) - RRL (II)
Festuca carpatica (*F. dimorpha*) - E (PC), RRL (IV)

F. drymeja (*F. montana*) - RRL (IV)
F. filiformis (*F. capillata*, *F. ovina* subsp. *tenuifolia*, *F. tenuifolia*) - RRL (III)
F. inarmata (*F. amethystina* subsp. *inarmata*, *F. amethystina* subsp. *orientalis*) - RRL (IV)
F. porcii - E (SEC), RRL (II), RBU
F. pseudodalmatica (*F. dalmatica* subsp. *pseudodalmatica*, *F. valesiaca* subsp. *pseudodalmatica*) - RRL (III)
F. saxatilis (*F. rupicola* subsp. *saxatilis*, *F. sulcata* subsp. *saxatilis*, *F. valesiaca* subsp. *saxatilis*) - RRL (II)
Filago minima (*Logfia minima*) - RRL (IV)
F. oxycarpa (*F. angustifolia* subsp. *oxycarpa*, *F. excelsior* subsp. *oxycarpa*) - RRL (IV)
Gagea minima - RRL (IV)
Galanthus nivalis - RRL (V), RBU
Galium bellatulum (*G. anisophyllum*, *G. anisophyllum* subsp. *bellatulum*, *G. pawlowskii*) - E (EC), RRL (III)
G. carpaticum (*G. polonicum*) - E (EC), RRL (V)
G. x polonicum (*G. abaujense* subsp. *polonicum*) - E (EC), RRL (III)
G. suberectum - E (EC), RRL (V)
G. transcarpaticum - E (EC), RRL (IV)
Genista rupestris (*G. alpicola*, *G. oligosperma*, *G. tinctoria* subsp. *hungarica*, *G. tinctoria* subsp. *oligosperma*) - E (SEC), RRL (II)
Gentiana acaulis (*G. excisa*, *G. kochiana*, *Ciminalis acaulis*) - RRL (IV), RBU
G. laciniata - E (EC), RRL (IV), RBU
G. lutea - RRL (II), RBU
G. nivalis - RRL (II)
G. punctata - RRL (III), RBU
G. verna subsp. *verna* (*G. arctica*, *Calathiana verna*) - RRL (III), RBU
Gladiolus imbricatus (*G. apterus*) - RRL (IV)
G. palustris - RRL (I), RBU
Glyceria nemoralis - RRL (III)
Goodyera repens - RRL (III), RBU
Gymnadenia conopsea subsp. *conopsea* - RRL (V), RBU
Hammarbya paludosa (*Malaxis paludosa*) - RRL (II), RBU
Hedysarum hedysaroides subsp. *hedysaroides* (*H. obscurum*) - RRL (III), RBU
Helianthemum grandiflorum subsp. *grandiflorum* - RRL (IV)
H. nitidum (*H. grandiflorum* subsp. *glabrum*, *H. nummularium* subsp. *glabrum*) - RRL (II)
Helleborus purpurascens - RRL (V)
Heracleum carpaticum (*H. sphondylium* subsp. *carpaticum*) - E (SEC), RRL (III), ERL
H. palmatum (*H. palmatum* subsp. *transsilvanicum*, *H. sphondylium* subsp. *transsilvanicum*, *H. transsilvanicum*) - E (SEC), RRL (III)
Herminium monorchis - RRL (II), RBU
Hesperis candida (*H. albiflora*, *H. matronalis* subsp. *candida*, *H. nivea*) - E (PC), RRL (IV)
Hieracium atrellum (*H. atratum*) - E (PC), RRL (III)
H. caesiogenum - E (SEC), RRL (III)
H. kotschyianum - E (SEC), RRL (III)
H. krasanii - E (SEC), RRL (III)
H. lomnicense - E (SEC), RRL (III)
H. mukaczewense - E (EC), RRL (III)
H. rapunculoidiforme - E (EC), RRL (III)

H. x roxolanicum (*H. guthnickianum*, *H. rehmannii*) - E (EC), RRL (III)
H. wimmeri - E (PC), RRL (III)
Huperzia selago subsp. *selago* (*Lycopodium selago*) - RRL (IV), RBU
I. helenium - RRL (III)
I. graminea subsp. *graminea* - RRL (III)
I. pseudocyperus (*I. graminea* subsp. *pseudocyperus*) - RRL (II), RBU
I. sibirica - RRL (III)
Jovibarba preissiana (*J. hirta*, *J. hirta* subsp. *glabrescens*, *Sempervivum hirtum*, *S. hirtum* subsp. *glabrescens*, *S. hirtum* subsp. *preissianum*, *S. preissianum*, *S. soboliferum* subsp. *glabrescens*) - E (PC), RRL (III)
J. sobolifera (*J. hirta* subsp. *borealis*, *S. soboliferum*) - RRL (III)
Juncus bulbosus subsp. *bulbosus* (*J. supinus*) - RRL (III), RBU
J. triglumis - RRL (IV)
Juniperus sabina - RRL (II)
Knautia kitaibelii (*K. kitaibelii* subsp. *alpigena*, *Scabiosa kitaibelii*) - E (PC), RRL (III)
Larix x polonica (*L. decidua* subsp. *polonica*) - RRL (II), RBU
Leersia orysoides - RRL (IV)
Leontodon kulczynskii (*L. repens*) - E (SEC), RRL (IV)
L. pseudotaraxaci (*L. montanus* subsp. *pseudotaraxaci*, *Scorzoneroides pseudotaraxaci*) - E (PC), RRL (III)
Leontopodium alpinum - RRL (II), RBU
Leopoldia comosa (*M. comosum*) - RRL (IV)
Leucanthemum subalpinum raciborskii, *L. vulgare* subsp. *subalpinum*, *Chrysanthemum montanum*) - E (SEC), RRL (IV)
L. waldsteinii (*L. rotundifolium*, *Ch. rotundifolium*, *Tanacetum waldsteinii*) - E (PC), RRL (V)
L. vernum - RRL (V), RBU
Leucorchis albida (*Pseudorchis albida*) - RRL (IV), RBU
Lilium bulbiferum subsp. *bulbiferum* - RRL (II)
L. martagon subsp. *martagon* - RRL (IV), RBU
Linum extraaxillare (*L. perenne* subsp. *extraaxillare*) - RRL (III)
Liparis loeselii - RRL (II), RBU
Listera cordata - RRL (III), RBU
L. ovata - RRL (V), RBU
Lloydia serotina - RRL (III)
Loiseleuria procumbens - RRL (III)
Lonicera caerulea subsp. *caerulea* - RRL (I)
Lotus tenuis (*L. tenuifolius*) - RRL (III)
Lunaria rediviva - RRL (V), RBU
Lycopodiella inundata (*Lycopodium inundatum*, *L. palustre*) - RRL (II), RBU
Lycopodium annotinum (*L. juniperifolium*, *Lepidotis annotine*) - RRL (V), RBU
Malaxis monophyllos (*Microstylis monophyllos*) - RRL (IV), RBU
Matteuccia struthiopteris (*Struthiopteris germanica*, *S. filicastrum*) - RRL (IV)
Melampyrum saxosum - E (SEC), RRL (V)
Melica ciliata (*M. nebrodensis*, *M. simulans*) - RRL (III)
M. transsilvanica (*M. ciliata* subsp. *transsilvanica*) - RRL (IV)
Menyanthes trifoliata - RRL (IV)
Minuartia zarecznyi (*Alsine zarecznyi*) - E (PC), RRL (III)
Muscari botryoides subsp. *transsilvanicum* (*M. transsilvanicum*) - E (EC), RRL (II)

Myricaria germanica (*Tamarix germanica*) - RRL (III)
Narcissus poeticus subsp. *angustifolius* (*N. angustifolius*, *N. radiiflorus*) - RRL (IV), RBU
N. poeticus subsp. *stellaris* (*N. stellaris*, *N. seriorflorens*) - RRL (II)
Neottia nidus-avis - RRL (IV), RBU
Nepeta cataria - RRL (III)
Noccaea dacica (*Thlaspi dacicum*) - E (SEC), RRL (II)
Nuphar lutea - RRL (II)
Oberna carpatica (*Silene carpatica*) - E (PC), RRL (V)
Ophioglossum vulgatum - RRL (III)
Orchis coriophora - RRL (IV), RBU
O. laxiflora (*O. ensifolius*) - RRL (III), RBU
O. mascula subsp. *mascula* - RRL (V), RBU
O. mascula subsp. *signifera* (*O. signifera*, *O. speciosa*) - RRL (III), RBU
O. militaris - RRL (III), RBU
O. morio - RRL (V), RBU
O. pallens - RRL (II), RBU
O. palustris (*O. elegans*, *O. laxiflora* subsp. *elegans*, *O. laxiflora* subsp. *palustris*) - RRL (V), RBU
O. ustulata - RRL (IV), RBU
Oreochloa disticha (*Poa disticha*, *Sesleria disticha*) - RRL (II), RBU
Orlaya grandiflora - RRL (III)
Orobanche caryophyllacea (*O. vulgaris*) - RRL (IV)
O. reticulata (*O. scabiosa*) - RRL (IV)
Oxycoccus microcarpus (*Vaccinium microcarpus*) - RRL (II), RBU
Oxyria digyna - RRL (IV)
Oxytropis carpathica - E (PC), RRL (II), RBU
Padus avium subsp. *petraea* (*Prunus padus*, *P. petraea*) - RRL (III)
Pedicularis oederi - RRL (III), RBU
P. palustris subsp. *palustris* - RRL (III)
P. sylvatica subsp. *sylvatica* - RRL (III)
Phyllitis scolopendrium (*Asplenium scolopendrium*, *Scolopendrium officinale*) - RRL (IV)
Physalis alkekengi - RRL (III)
Phyteuma tetramerum (*Ph. spicatum*) - E (SEC), RRL (V)
Ph. vagneri - E (SEC), RRL (V)
Pinguicula alpina - RRL (III), RBU
Pinus cembra - RRL (II), RBU
P. sylvestris - RRL (II)
Plantago altissima - RRL (IV)
P. atrata subsp. *carpathica* (*P. montana* var. *carpathica*) - E (PC), RRL (III)
Platanthera bifolia subsp. *laxiflora* - RRL (V)
P. chlorantha - RRL (III), RBU
Poa deylii (*P. granitica* subsp. *disparilis*) - E (SEC), RRL (III), RBU
P. media (*P. laxa*, *P. ursina*) - RRL (II)
P. nemoralis subsp. *carpathica* (*P. balfourii*, *P. carpathica*) - E (PC), RRL (III)
P. remota - RRL (III)
Polygala amarella subsp. *amarella* (*P. amara*) - RRL (III)
P. subamara (*P. amara* subsp. *brachyptera*) - RRL (III)
Potamogeton alpinus - RRL (II)

Potentilla crantzii - RRL (II)
Primula elatior subsp. *leucophylla* (*P. leucophylla*) - E (EC), RRL(II)
P. farinosa subsp. *farinosa* - RRL (I), RBU
P. halleri subsp. *platyphylla* (*P. longiflora*) - RRL (III)
P. minima - RRL (III), RBU
P. poloninensis (*P. elatior* subsp. *poloninensis*) - E (SEC), RRL(IV)
Ptarmica lingulata (*Achillea lingulata*) - RRL (III), RBU
P. tenuifolia (*A. oxyloba* subsp. *schurii*, *A. schurii*) - E (SEC), RRL(III), RBU
P. vulgaris (*A. ptarmica*) - RRL (IV)
Pulmonaria filarszkyana - E (EC), RRL(V), ERL
Pulsatilla alba (*P. scherfelii* subsp. *alba*) - RRL (V), RBU
Pyrola carpatica - E (PC), RRL (III)
Ranunculus carpaticus (*R. dentatus*) - E (SEC), RRL (IV)
R. hornschuchii (*R. oreophilus*) - RRL (II)
R. malinovskii (*R. kladnii*) - E (EC), RRL (III), ERL
R. montanus (*R. geraniifolius*) - RRL (III)
R. thora (*R. tatrae*) - RRL (IV), RBU
Rhamnus cathartica - RRL (II)
Rhizomatopteris montana (*Cystopteris montana*) - RRL (III)
Rhodiola rosea (*Sedum rhodiola*) - RRL (III), RBU
Rhododendron myrtifolium (*R. kotschyi*) - RRL (IV), RBU
Rhynchospora alba - RRL (II)
Rumex rugosus (*R. carpaticus*, *Acetosa alpestris* subsp. *carpatica*) - E (EC), RRL (V)
R. scutatus - RRL (III)
Salix alpina (*S. jacquinii*) - RRL (II)
S. herbacea - RRL (III), RBU
S. phyllicifolia - RRL (IV)
S. retusa subsp. *retusa* - RRL (III), RBU
S. retusa subsp. *kitaibeliana* (*S. kitaibeliana*) - E (PC), RRL (IV)
S. rosmarinifolia (*S. repens* subsp. *rosmarinifolia*) - RRL (IV)
Saussurea alpina subsp. *alpina* - RRL (III), RBU
S. porcii - E (EC), RRL (II), RBU, ERL
Saxifraga adscendens subsp. *adscendens* - RRL (IV)
S. aizoides - RRL (II), RBU
S. androsacea - RRL (III), RBU
S. bryoides - RRL (III)
S. oppositifolia subsp. *oppositifolia* - RRL (II), RBU
Scabiosa barbata (*S. lucida* subsp. *barbata*) - E (SEC), RRL (IV)
S. opaca (*S. lucida*) - E (EC), RRL (IV)
Scheuchzeria palustris - RRL (III), RBU
Schoenus ferrugineus - RRL (II), RBU
Scilla bifolia subsp. *subtriphyllo* (*S. kladnii*, *S. subtriphyllo*) - E (PC), RRL (V)
Scopolia carniolica - RRL (V), RBU
Scorzonera humilis - RRL (IV)
Securigera elegans (*Coronilla elegans*, *C. latifolia*) - RRL (III), RBU
S. alpestre - RRL (III)
S. annuum - RRL (III)
S. atratum - RRL (III)

S. hispanicum (*S. glaucum*) - RRL (II)
S. selaginoides (*Lycopodium selaginoides*) - RRL (II), RBU
Sempervivum montanum subsp. *carpathicum* - E (PC), RRL (II), RBU
Senecio carniolicus - RRL (IV)
S. carpathicus (*S. abrotanifolius* subsp. *carpathicus*) - E (PC), RRL (IV)
Sesleria heufleriana subsp. *heufleriana* - RRL (IV)
Sideritis comosa (*S. montana* subsp. *comosa*) - RRL (III)
Silene dubia (*S. nutans* subsp. *dubia*) - E (EC), RRL (IV), ERL
S. jundzillii - RRL (III)
Soldanella hungarica (*S. Maramaroshsiensis*, *S. montana* subsp. *hungarica*) - E (EC), RRL (IV)
Sparganium angustifolium (*S. affine*, *S. natans*) - RRL (II)
Staphylea pinnata - RRL (II), RBU
Swertia alpestris (*S. perennis* subsp. *alpestris*) - E (PC), RRL (III), RBU
S. perennis subsp. *perennis* - RRL (II), RBU
S. punctata - RRL (II)
Syringa josikaea - RRL (III), RBU
Taxus baccata - RRL (III), RBU
Thelypteris palustris (*Th. thelypteroides* subsp. *glabra*) - RRL (IV)
Thymus alpestris (*Th. subalpestris*) - E (EC), RRL (V)
Th. clandestinus (*Th. enervius*, *Th. montanus*) - E (EC), RRL (IV)
Th. pulcherrimus (*Th. circumcinctus*, *Th. sudeticus*) - E (PC), RRL (V)
Th. roegneri (*Th. alternans*) - E (EC), RRL (V)
Tozzia carpathica (*T. alpina* subsp. *carpathica*) - E (PC), RRL (IV)
Traunsteinera globosa (*Orchis globosa*) - RRL (V), RBU
Trifolium pratense subsp. *frigidum* (*N. frigidum*, *T. pratense* subsp. *nivale*) - RRL (III)
Trisetum alpestre - RRL (III)
T. ciliare (*T. carpathicum*, *T. fuscum*) - E (PC), RRL (IV) *N. macrotrichum* - E (EC), RRL (II)
Valeriana dioica - RRL (II)
V. simplicifolia (*V. dioica* subsp. *simplicifolia*) - RRL (V)
Verbascum densiflorum (*V. thapsiforme*) - RRL (III)
V. lanatum subsp. *lanatum* (*V. alpinum*) - RRL (III)
V. lanatum subsp. *hinkei* - RRL (III)
Veronica alpina subsp. *pumila* (*V. alpina* subsp. *australis*, *V. pumila*) - RRL (IV)
V. aphylla - RRL (IV)
V. baumgartenii - RRL (IV)
V. bellidioides subsp. *bellidioides* - RRL (I)
V. fruticans - RRL (III)
V. spicata (*Pseudolysimachion spicatum*) - RRL (III)
Viola dacica - RRL (III)
V. declinata - E (SEC), RRL (IV)
V. saxatilis subsp. *saxatilis* - RRL (III)
V. uliginosa - RRL (III)
Vitis sylvestris (*V. vinifera* subsp. *sylvestris*) - RRL (II)
Woodsia alpina (*W. ilvensis* subsp. *alpina*) - RRL (I), RBU

Threatened plant communities of the area

- Asplenietea trichomanis (Br.-Bl. in Meyer et Braun-Blanquet 1934) Oberd. 1977
- Potentilletalia caulescentis Br.-Bl. in Braun-Blanquet et Jenny 1926
Cystopteridion (Nordhagen 1936) Richard 1972
Aspleno-Cystopteridetum fragilis Oberd. (1936) 1949
Saxifrago luteoviridis-Trisetetum alpestris (Pawl. et Wal. 1949) Malinovsky et al. 1991
- Elyno-Seslerietea Br.-Bl. 1948
Seslerietalia caeruleae Br.-Bl. in Braun-Blanquet et Jenny 1926
Festuco saxatilis-Seslerion bielzii (Pawl. et Wal. 1949) Coldea 1984
Saxifrago-Festucetum versicoloris Wal. 1933
Thymo-Festucetum inarmatae Ishbirdin et al. 1991
Oxytropido-Elynetalia Oberd. 1957
Oxytropido-Elynion Br.-Bl. 1948
Dryas octopetala (community)
- Thlaspietea rotundifolii Br.-Bl. 1948
Galio-Parietarietalia officinalis Boşcaiu et al. 1966
Stipion calamagrostis Jenny-Lips ex Braun-Blanquet, Roussine et Nègre 1952
Rumicetum scutati Faber 1936
Rumici scutati-Rhodioletum rosei Malinovsky et al. 1991
- Juncetea trifidi Hadaè in Klika et Hadač 1944
Caricetalia curvulae Br.-Bl. in Braun-Blanquet et Jenny 1926
Juncion trifidi Krajina 1933
Primulo-Caricetum curvulae (Br.-Bl. 1926) Oberd. 1959
- Loiseleurio-Vaccinietea Eggler 1952
Rhododendro-Vaccinietalia Br.-Bl. in Braun-Blanquet et Jenny 1926
Rhododendro-Vaccinion J. Br.-Bl. ex G. and J. Braun-Blanquet 1931
Rhododendretum myrtifolii Puscaru et al. 1956
Cetrario-Loiseleurion Br.-Bl. et Sissing 1939
Loiseleurio-Cetrarietum Br.-Bl. et Sissing 1939
Cetrario-Vaccinietum Kricsfalusy et al. 1991
Juniperion nanae Br.-Bl. et al. 1939
Juniperetum nanae Br.-Bl. et Sissing 1939
- Salicetea herbaceae Br.-Bl. 1949
Salicetalia herbaceae Br.-Bl. in Braun-Blanquet et Jenny 1926
Salicion herbaceae Br.-Bl. in Braun-Blanquet et Jenny 1926
Salicetum herbaceae Br.-Bl. 1931
Polytricho-Poetum deyllii Malinovsky et al. 1991
Arabidetalia coeruleae Rübél 1933
Arabidion coeruleae Br.-Bl. 1926

Salicetum retuso-reticulatae Br.-Bl. 1926

Mulgedio-Aconitetea Hadaè in Klika et Hadaè 1944

Adenostyletalia Br.-Bl. 1930

Adenostylion Br.-Bl. 1926

Ranunculo platanifolii-Adenostyletum alliariae (Krajina 1933) Dubravcova in Mucina et Maglocky 1985

Pulmonario-Alnetum viridis Paw³. et Wal. 1949

Calamagrostietalia villosae Paw³. in Paw³owski, Soko³owski et Wallisch 1928

Calamagrostion villosae Paw³. in Paw³owski, Soko³owski et Wallisch 1928

Hyperico alpigeno-Calamagrostietum villosae Paw³. et Wal. 1949

Phragmito-Magnocaricetea Klika in Klika et Novák 1941

Magnocaricetalia Pignatti 1953

Magnocaricion elatae Koch 1926

Caricetum paniculatae Wangerin 1916

Caricion gracilis Neuhausl 1959 em. Balátová-Tuláèková 1963

Narcisso-Caricetum vesicariae Kricsfalusy 1987

Montio-Cardaminetea Br.-Bl. et Tüxen 1943

Montio-Cardaminetalia Paw³. in Paw³owski, Soko³owski et Wallisch 1928

Cratoneurion commutati Koch 1928

Brachytecio rivularis-Cardaminetum opizii (Krajina 1933) Hadaè 1983

Doronico-Cratoneuretum commutati Paw³. et Wal. 1949

Saxifragetum stellaris Deyl 1940

Saxifrago-Chrysosplenietum Paw³. et Wal. 1949

Calthetum laetae Krajina 1933

Scheuchzerio-Caricetea fuscae Tüxen 1937

Caricetalia fuscae Koch 1926

Caricion fuscae Koch 1926 em. Klika 1934

Caricetum goodenowii J. Braun 1915

Caricion lasiocarpae Van den Berghen in Lebrun et al. 1949 em. Rybnièek in Rybnièek et al. 1984

Caricetum chordorrhizae Paul et Lutz 1941

Scheuchzerietalia palustris Nordhagen 1937

Rhynchosporion albae Koch 1926

Caricetum limosae Br.-Bl. 1921

Carex dacica (community)

Molinio-Arrhenatheretea Tüxen 1937

Arrhenatheretalia Tüxen 1931

Arrhenatherion Koch 1926

Narcisso-Arrhenatheretum elatioris Kricsfalusy 1987

Cynosurion Tüxen 1947

Centaurio-Narcissetum angustifolii Kricsfalusy 1987

Molinetalia Koch 1926

Alopecurion pratensis Passarge 1964

Sanguisorbo-Narcissetum angustifolii Kricsfalusy

Nardo-Callunetea Preising 1949

Nardetalia Oberd. ex Preising 1949

Nardion Br.-Bl. 1926

Narcisso-Nardetum strictae Kricsfalusy 1987

Soldanello-Nardetum Kricsfalusy et al. 1991

Festuco-Brometea Br.-Bl. et Tüxen ex Braun-Blanquet 1949

Festucetalia valesiaca Br.-Bl. et Tüxen ex Braun-Blanquet 1949

Seslerio-Festucion pallentis Klika 1931 corr. Zólyomi 1966

Thymo-Festucetum saxatilis (Paw³. et Wal. 1943) Kricsfalusy et al. 1991

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