



ORIGINAL RESEARCH PAPER

ABOUT THE CONSERVATION OF THE BIODIVERSITY IN THE HIGH-MOUNTAIN FLORA OF THE UKRAINIAN CARPATHIANS AND PROTECTION OF THE “HOT SPOTS”

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SYNOPSIS

Key words:

Ukrainian Carpathians, High-Mountain Flora and Vegetation, endangered and threatened species of the Vascular Plants.

As a result of the long-standing study of the endangered and threatened species of the Vascular Plants in the High-Mountain Flora of the Ukrainian Carpathians, we discussed their modern state, ecological and phytocoenotic peculiarities. The participation of the rare species of the Vascular Plants in the High-Mountain Floras of the Ukrainian Carpathians and Balkan was briefly compared. Besides, we implemented the comparative study of the above mentioned rare species at the nature biotopes and the experimental plot (NPP Synevir), mainly for their future reintroduction into the natural communities.

INTRODUCTION

The Conventions of Biological Diversity, signed in Rio Summit in 1992, in Valencia in 1994, and Pan-European Strategy of Biological and Landscape Diversity accepted in Sofia at the International Meeting “Environment for Europe” in 1995, aimed to protect the rare species and landscapes. Afterwards the above mentioned proposals were summarised in Strasbourg by the Council of Europe as “Convention on the conservation of European Wildlife and natural habitats” (Synge, 2000). Therefore, we regard the problem of the conservation of the endangered and threatened Vascular Plants, especially in the Carpathians and Balkan, as the very actual, and we try to do our best to promote their protection and conservation.

SUBJECTS AND METHODS OF RESEARCH

Our treatment is based on the results of the field research, but also on the herbarium and literature data on more than 50 rare species of the Vascular Plants,

mainly endangered and threatened, within the High-Mountain Flora of the Ukrainian Carpathians. We studied these species of plants within the High-Mountain communities mainly in the Ukraine, but also in the other countries of Europe (e.g., in the Southern Carpathians in Romania and in the Balkan in Serbia and Montenegro). As a result, we were able to discuss the geographic-ecological, coenotic and biomorphological peculiarities of ca. 50 very rare species. Besides, we discussed the results of the population study of 20 rare species in limits of the Project from the "International Global Ecologic Fund" (Ziman, 1997) and the treatments on 25 rare species published in the "Red Book of Ukraine. Plant World" (Didukh, 2009). Moreover, quite recently, we prepared the treatments on 13 critically endangered species for the publication in the next "Red Book of Ukraine" and we continue our work on the next 12 species. At present time, we began to discuss the results of the introduction of the rare Vascular Plants from the High-Mountain Flora of the Ukrainian Carpathians at the experimental plot in the National Nature Park Synevir situated in Ukraine, Transcarpathian Region (Ziman et al., 2011; Ziman, Derbak, 2012). We used in this manuscript the generally accepted methods of the biomorphological, population and phytocoenotic study.

RESULTS AND DISCUSSION

Our list of the studied in details model taxa includes 25 species belonging to the highest categories of rareness (CR - critically endangered and EN - endangered): *Achillea schurii* Sch.Bip., *Aconitum hosteanum* Schur, *A. jacquinii* Rchb., *A. nanum* Baumg., *Anemone narcissiflora* L., *Anthemis carpatica* Waldst. et Kit. ex Willd., *Aquilegia nigricans* Baumg., *Aster alpinus* L., *Astragalus krajinae* Domin, *Biscutella laevigata* L., *Coeloglossum alpinum* Schur, *Draba aizoides* (L.) Britt., *Gentiana acaulis* L., *G. laciniata* Kit. ex Kanitz, *G. verna* L., *Primula halleri* J.F.Gmel., *P. minima* L., *P. verna* L., *Ranunculus thora* L., *Rhodiola rosea* L., *Salix alpina* Scop., *S. retusa* L., *Saxifraga androsacea* L., *Veronica aphylla* L. A part of the above mentioned results of our study was already published (Ziman et al., 2009), and here we discussed the outlook of the conservation of the endangered High-Mountain Vascular Plants from the other points of view including the "Habitat concept of the biodiversity protection" (Kagalo, Prots, 2012).

Within the above mentioned group of the rare taxa, the relicts predominate (14), and they are characterized by the disjunctive, mainly European, Eurasian or sometimes Circumpolar areas. The Carpathian endemics are 7 (*Achillea schurii*, *A. hosteanum*, *A. jacquinii*, *A. nanum*, *Astragalus krajinae*, *Campanula carpatica*, *Coeloglossum alpinum*), and most of them are the narrow geographic races growing in few localities.

By the biomorphological peculiarities, the perennial herbs (polycarpics) predominate (19 species) and 6 species are the semishrubs (with lignified basal parts of the above-ground shoots - *Draba aizoides*, *Gentiana laciniata*, *Primula minima*, *Salix alpina*, *Saxifraga androsacea*, *Veronica aphylla*). The above mentioned polycarpics are semirosetteous plants and the semishrubs are non-rosetteous plants. The plants of most species (20) have the sympodial renewal of shoots and only 5 of them (*Anemone narcissiflora*, *Draba aizoides*, *Primula halleri*, *P. minima*, *P. verna*) are characterized by the monopodial main axis and correspondently monopodial renewal. All perennial herbs are characterized by the adventitious roots and within them plants of 9 species have short rhizomes plus 6 taxa with long rhizomes (*Achillea schurii*, *Astragalus krajinae*, *Gentiana acaulis*, *G. laciniata*, *G. verna*, *Rhodiola rosea*), meanwhile, plants of 4 taxa (*Aconitum hosteanum*, *Aquilegia nigricans*, *Biscutella laevigata*, *Draba aizoides*) have the caudices and tap-roots.

It is expedient to note that almost all the endangered high-mountain species are heliophytes and oreophytes that grow in the alpine or subalpine belts, mainly at the stone or rocky localities, frequently calcareous. For most of them, we noted a small size of populations, mainly isolated, therefore, a part of these populations look like the separate fragments. Moreover, almost all of them are characterized by the low ability of the reproductive propagation, not complete age spectra, low indexes of renewal and replacing.

The analysis of ca. 100 floristic lists of the high-mountain communities including the rare species in the Ukrainian Carpathians has shown the presence of the rather limited number of the constant species (about 50 species) which form the base of the peculiar high-mountain floristic complexes. On our opinion, the historical development of most high-mountain species took place exactly in their limits (Ziman, Hamor, 2009).

As a result of the long-standing monitoring on the high-mountain plants in the Ukrainian Carpathians, we follow F. Medail and P. Quesel (1997) who regarded the high-mountain communities including 5 to 10 (sometimes more) rare species as the "hot spots" being the important sectors of the endangered species diversity and integrity.

According to our data (Ziman et al., 2006), there are more than 20 "hot spots" close to summits of the Svidovets, Chernogora, Marmarosh, Chyvchyn and Gorgan Ranges, and most of them are rare, endemic or relict phytocoenoses.

The greatest communities are the alpine ones occurring at the upper part of the Svidovets Range (Dragobrat, Bliznitza, Herishaska and other summits). They are situated mainly on the calcareous uncoverings and they include totally ca. 40 rare species, within which 18 taxa [*Achillea schurii*, *Acinos alpinus* Schur, *Aconitum jacquinii*, *Antennaria carpatica* (Wahlenb.) Bluff et Fingerh, *Anthyllis alpestris* Rchb. *Aquilegia nigricans*, *Aster alpinus*, *Astragalus krajinae*, *Biscutella laevigata*, *Draba*

aizoides, *Dryas octopetala* L., *Hedysarum hedysaroides* (L.) Schintz et Thell., *Leontopodium alpinum* Cass., *Minuartia zarecznyi* (Zapal.) Klok., *Primula halleri*, *Saxifraga androsacea*, *Selaginella selaginoides* (L.) P.Beauv. ex Mart., *Veronica aphylla*] are CR.

Meanwhile, the rather high concentration of the rare species is characteristic for communities close to the summit of Petros (Chernogora) which include ca. 30 rare species, within which 13 species (*Acinos baumgartenii* (Simk.) Klok., *Carduus kernerii* Simonk., *Bupleurum ranunculoides* L., *Carex bicolor* All., *Coeloglossum alpinum* Schur, *Erigeron alpinus* L., *Minuartia zarecznyi*, *Primula halleri*, *Ranunculus thora*, *Salix alpina*, *S. retusa*, *Saxifraga bryoides* L., *Selaginella selaginoides*) are CR and ca. 15 species (*Carex rupestris* All., *Galium bellatulum* Klok., *Rhodiola rosea* L., *Veronica fruticans* Jacq. and others) are EN.

The high-mountain communities at the upper part of the Pop Ivan Marmarosh are also valuable because we noted there ca. 20 rare species including three unique CR species (*Anthemis carpathica*, *Jovibarba hirta* (L.) Opiz, *Sempervivum marmoreum* Griseb.).

As a whole, we regard the high-mountain communities close to the summits of Bliznitsa (massif Svidovets, three "trumpets" of Dragobrat, ca. 1800 m above sea level) and the north-eastern slopes below the summit of Petros (massif Chernogora (ca. 1800 m above sea level) as the most valuable. Within their localities, but also at the mountain massives Marmarosh, Gorgan and Chyvchyn, there are ca. 20 associations including 5 to 20 (sometimes more) critically endangered, endangered or vulnerable species.

Within them, six associations [*Festucetum amethystinae* (Domin) Coldea 1984, *Festucetum pictae* Krajina 1933, *Festucetum saxatilis* Domin 1933, *Cystopteridetum fragilis* Oberd. 1938, *Primulo (minima) – Caricetum curvulae* Br.-Bl. 1926 em. Oberd. 1957 and *Salicetum kitaibeliana* Coldea 1985] are regarded as the rare, and in these communities 10 to 20 rare species of the Vascular Plants are observed. Besides, two associations [*Achilleo (schurii) – Dryadetum* (Beldie) Coldea 1984 and *Rhododendro (myrtifolii) – Vaccinietum carpaticae* Puskaru & al. 1956] are regarded as the endemic. At last, we noted three associations [*Saxifrago (paniculatae) – Festucetum versicoloris* Wal. 1933, *Salicetum retuso-reticulatae* Br.-Bl. 1926 and *Salicetum herbaceae* Coldea 1985] as the relict ones. Within all of the above mentioned associations the number of the rare species varies from 10 to 20 species and most of them are habituated to the subalpine or alpine limestones.

The subalpine endemic association *Festucetum amethystinae* is the richest because of including more than 80 taxa of the Vascular Plants, and ca. 20 of them are endangered (viz., *Aconitum jacquinii*, *Aster alpinus*, *Leontopodium alpinum*, *Rhodiola rosea*, etc.). We noted this association at the massives Svidovets (summits Dragobrat and Bliznitsa) and Chernogora (close to summits of Turkul and Rebra)

The very valuable association is the subalpine relict *Saxifraga (paniculatae)*–*Festucetum versicoloris* Wal. 1933 which also includes ca. 80 species with ca. 20 rare ones (viz., *Aster alpinus*, *Draba aizoides*, *Hedysarum hedysaroides*, *Rhodiola rosea*, etc.). Its localities are situated at Svidovets (Dragobrat, Bliznitsa, Heryshaska) and Chernogora (Turkul and Shpytsky).

About 50 species were noted within the endemic association *Achilleo (schurii)* – *Dryadetum* (Beldie) Coldea 1984. This association is rather valuable too because it includes more than 20 rare species including dominant critically endangered *Achillea schurii* but also the endangered species *Antennaria carpatica*, *Aster alpinus*, *Primula halleri*. Its localities are situated at Svidovets (Dragobrat, Herishaska) only.

The protection and conservation of most “hot spots” within the High-Mountain Flora has to be the urgent task of the preservation of the plant diversity of the Ukrainian Carpathians.

The next important question is the discussion of the ecological-geographical patterns of the rare species in the Ukrainian Carpathians, other Regions of Europe and the whole world.

The high-mountain flora of the Ukrainian Carpathians includes ca. 200 rare taxa, and we were able to analyze the geographical and ecological peculiarities of ca. 70 of them. As a result of the appropriate analysis, we have to note that about 45 studied rare species in the High-Mountain Flora of the Ukrainian Carpathians are the alpine-subalpine plants and the rest ca. 25 species are the arctic-alpine plants. The valuable peculiarities of most studied rare species (ca. 60 taxa) are their disjunctive areas, which include the Alps and partly the Balkan Mountain Ranges. Besides, within them there are ca. 20 relict species that are characterized by the wide disjunctions.

We should like to note that many of the high-mountain taxa are the endangered in Ukraine and less rare in the other parts of the Carpathians (Ziman et al., 1998). For instance, within 80 rare species in common to the High-Mountain Floras of Ukraine and Romania about 20 species (*Aster alpinus*, *Biscutella laevigata*, *Campanula carpatica* Jacq., *Veronica alpina* L. and others) are endangered in Ukraine but only vulnerable in Romania. Meanwhile, in the High-Mountain Flora of Romania the species more rare than in such Flora of Ukraine are few (*Aconitum jacquinii*, *Gentiana acaulis*, *G. lutea* L., *Rhodiola rosea* and some others).

Within the rare species in common to the High-Mountain Floras of the Ukrainian Carpathians and Balkan, there are ca. 100 taxa of the Vascular Plants (Beck–Mannagetta et al., 1967; Gajic, 1984; Hayek, 1927; Nikolic and Topic, 2005; Peev et al., 2011, etc.).

Nevertheless, within the above mentioned species, only two rare taxa (*Anemone narcissiflora* and *Aster alpinus*) are distributed in the all countries of Balkan (Albania, Bosnia and Hercegovina, Bulgaria, Croatia, Macedonia,

Montenegro, Serbia, Croatia, Kosovo and Slovenia including more than 10 National Parks). Meanwhile, most of the above mentioned common rare species [*Draba aizoides*, *Gentiana acaulis*, *G. verna* L., *Pedicularis oederi* Vahl, *Phyteuma vagneri* A.Kerner, *Primula farinosa*, *Pulsatilla scherfelii* (Ullep.) Skalicky, *Rhododendron myrtifolium* Schott et Kotschy, *Saxifraga androsacea* and some others not included into our discussion] grow only in Bulgaria (Kozuharov et al., 1980; Peev et al., 2011).

Several species of the rare plants in common with the Flora of the Ukrainian Carpathians (e.g., *Biscutella laevigata*, *Dryas octopetala*, *Gentiana laciniata*, *Primula minima*, *Rhodiola rosea*) grow in the High Mountains of Montenegro (Lakusic et al., 2004), and some of them (e.g., *Gentiana laciniata*, *Leontopodium alpinum*, *Primula halleri*, *P. minima*, *Rhodiola rosea*) are noted in the High-Mountain Floras of Serbia (Gajic, 1984; Stevanovic, 1999; Tomovic et al., 2007). Several rare species in common with the Flora of the Ukrainian Carpathians (*Biscutella laevigata* and *Gentiana laciniata*) grow also in Croatia (Nikolic, Topic, 2005; Sugar, 1994). We have to note the presence of rather many common endangered taxa in the High-Mountain Floras of the Ukrainian Carpathians and Albania (*Dryas octopetala*, *Gentiana verna*, *Potentilla crantzii* G.Beck ex Fritsch, *Ranunculus thora*, *Salix retusa* L., *Veronica aphylla* – Ball, 2005; Rakai, 2009), and also in Macedonia (*Leontopodium alpinum*, *Biscutella laevigata* - Micevski, 1985). The next valuable phenomenon is the rariness of several the High-Mountain Vascular Plants [e.g., *Aconitum firmum* Rchb., *Atragene alpina* L., *Bartsia alpina* L., *Linum extraaxillare* Kit., *Trollius europaeus* L., *Valeriana simplicifolia* (Rchb.) Kabath and others] in the Balkan despite they are not rare in the High-Mountain Flora of the Ukrainian Carpathians.

At last, we should like to pay attention to the modern habitat concept of the biodiversity protection as a basic document of the European Union (Kagalo, Prots, 2012) in which the conservation of the very rare plant species and their nature habitats are regarded as the extremely valuable. We regard our unsuccessful result to reintroduce species *Primula farinosa* L. disappeared from the unique nature habitat in the Ukrainian Carpathians (Ziman et al., 2001) from the other countries (Brezno in Slovakia and Tuzhnadj in Romania) as the first attempt to begin the comparative study of the rare species *in situ* and *ex situ*.

Meanwhile, we continue to realize our intentions of the above mentioned study of the rare species of the Vascular Plants *in situ* and *ex situ*, and in 2010 we created the experimental plot for the cultivation of the rare species in the National Nature Park Synevyr. In 2010-2013 about 50 rare species from the above mentioned "hot spots" Dragobrat (massif Svidovets), Petros (massif Chernogora), Pip Ivan (massif Marmarosh) and close to Synevyr Negrovets (massif Gorgan), also from some other high-mountain localities (Ziman et al., 2012) were introduced there. At present time our collection includes ca. 900 plants belonging to ca. 50 species. We have to note

that many of the introduced plants grow there successfully (including their blossoming, fruiting and propagation). At present time the best introducents seem to be *Aconitum nanum*, *Anthemis carpatica*, *Aquilegia nigricans*, *Arnica montana*, *Aster alpinus*, *Galium bellatulum*, *Gentiana acaulis*, *Jovibarba preissiana*, *Leontopodium alpinum*, *Narcissus angustifolius*, *Veronica aphylla*, almost all introduced taxa of *Orchidaceae* [(*Coeloglossum viride* (L.) Hartm., *Gymnadenia conopsea* (L.) R.Br., *Listera cordata* (L.) R. Br., *L. ovata* (L.) R.Br., *Orchis purpurea* Huds., *Traunsteinera globosa* (L.) Rchb.), also *Potentilla crantzii*, *Rhododendron myrtifolium*, *Rhodiola rosea*, *Scabiosa opaca* Klok., *Veronica aphylla*. Meanwhile, the results of the initial introduction of *Achillea schurii*, *Anemone narcissiflora*, *Aquilegia nigricans*, *Astragalus krajinae*, *Gentiana lutea* L., *G. laciniata*, *Minuartia oxypetala* (Woloszcz.) Kulcz. and some other species are debatable. Moreover, the plants of *Botrychium lunaria* (L.) Swartz, *Gentiana verna* and *Ranunculus thora* perished.

CONCLUSIONS

We presented the brief results of the discussion of the modern state of the rare (mainly endangered) species of the Vascular Plants in the High-Mountain Flora of the Ukrainian Carpathians (participants of the modern "Red Book of Ukraine" 2009 - under my authorship). We paid attention to the growing of these species mainly in the communities including 5 to more rare species (hot spots). Most of them are rare, endemic or relict ones, therefore, these communities are frequently considered as the important sectors of the preservation of the plant diversity and have to be revealed and conserved *in situ*. To specify the reasons of the depressed state and frequent disappearing of the plants of the threatened taxa, we moved from the long-standing monitoring and reporting to the real attempts to conserve these plants. Therefore, we began to realize the detail comparative study of the rare species at their natural habitats and simultaneously at the experimental plot (*ex situ*). Afterwards we intend to arrange the subsequent reintroduction of the extremely rare taxa (viz., *Leontopodium alpinum*, *Anthemis carpatica*, *Aster alpinus* and others) into their former natural biotopes.

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