CHANGES IN POPULATION STRUCTURE OF RARE SPECIES IN THE HIGH-MOUNTAIN ZONE OF THE UKRAINIAN CARPATHIANS AND PROBLEMS OF THEIR CONSERVATION

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The article presents results of studies on changes in population structure of rare and endemic plant and animal (amphibian and lower crustacean) species in the high-mountain zone of the Ukrainian Carpathians under current conditions of transformation in their environment. Structural shifts in the populations on the systemic level were established and the role of their components in functioning and maintaining viability under natural and anthropogenic factors, particularly climatic change, secondary restoration successions and recreation was determined. Factors of threat were revealed and problems and ways of conservation of rare population, specific and coenotic diversity in the high-mountain zone were defined.

Key words: population structure, rare species, high-mountain zone, Ukrainian Carpathians, conservation.

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INTRODUCTION

Natural ecosystems of the Ukrainian Carpathians have been significantly transformed for the last decades by land-use changes and human impact of different intensity (Holubets & Tsaryk 2001). The nature reserves were organized on the large areas in the 70-80s of the XX century. Since that time restoration successions have been developing under the conditions of protective regime. They resulted in considerable transformations in the population structure of many rare and endemic species (Tsaryk 2009). Meanwhile, the number of cattle and sheep decreased significantly in the 1990s causing drastic decline in pastoral and

mowing pressure on the mountain grasslands. However, the recreation impact on mountain ecosystems increased dramatically at that time. The most significant natural factor which causes transformation of biota is the climate change.

MATERIALS AND METHODS

The objects of our research are populations of rare plant species occurring in the high-mountain zone of the Ukrainian Carpathians and included in the Red Data Book of Ukraine (Didukh 2009a): *Callianthemum coriandrifolium* Reichenb., *Cerastium cerastoides* (L.) Britton, *Erigeron atticus* Vill., *Festuca porcii* Hackel, *Gentiana punctata* L., *Leontopodium alpinum* Cass., *Lilium martagon* L., *Loiseleuria procumbens* (L.) Desv., *Oreochloa disticha* (Wulfen) Link, *Ranunculus thora* L., *Rhododendron myrtifolium* Schott et Kotschy, *Saussurea alpina* (L.) DC. *Saxifraga carpatica* Sternb., *Senecio abrotanifolius* L. subsp. *carpathicus* (Herbich) Nyman and others.

Populations of such endemic species as *Centaurea mollis* Waldst. et Kit., *C. marmarosiensis* (Jáv.) Czerep., *Dactylis slovenica* (Domin) Domin, *Festuca carpatica* F.G.Dietr., *Heracleum carpaticum* Porc., *Poa deylii* Chrtek et Jirásek, *Pulmonaria filarszkyana* Jáv., *Symphytum cordatum* Waldst. et Kit. ex Willd. were studied.

The following heterosexual species were studied as well: *Antennaria dioica* (L.) Gaertner, *A. carpatica* (Wahlenb.) Bluff. et Fingerh., *Dianthus carpaticus* Wołoszczak, *Rhodiola rosea* L., *Rumex carpaticus* (Zapał.) Zapał., *Melandrium dioicum* (L.) Cosson et Germ., *Valeriana simplicifolia* (Reichenb.) Kabath, *V. transsilvanica* Schur, *V. tripteris* L.

Populations of rare and endemic *Galium* L. species were also investigated, in particular *Galium pawlowskii* I. Kucowa, *G. anysophyllum* Vill. (= *Galium bellatulum Klok.*), *G. album* Miller subsp. *suberectum* (Klok.) E. Michalková. The comparative research involved mainly rare and endemic species. However, some trivial plant species that are convenient as the model objects representing different life forms were studied as well and used in active experiments. These trivial species are: *Homogyne alpina* (L.) Cass., *Carex curvula* All., *Pedicularis verticillata* L., *Hypochoeris uniflora* Vill., *Senecio papposus* (Reichenb.) Less., and *Vaccinium* L. species.

Populations of rare plankton crustaceans in the high-mountain zone of the Ukrainian Carpathians are also the objects of our research, namely *Daphnia obtusa* (Kurz, 1874) – an arctic-montane species with Holarctic distribution (in Ukraine reported from the Carpathians only), *Streblocerus serricaudatus* (Fischer, 1849) – stenoecic species restricted to narrow pH range (occurs only on several swampy areas in the Carpathians and Polissya in Ukraine), *Mixodiaptomus tatricus* (Wierzejski, 1883), a European montane species (in Ukraine occurs only in the high-mountain zone of the Carpathians), and *Acanthodiaptomus denticornis* (Wierzejski, 1887) – a rare species presented by isolated populations in the Carpathians, Galicia and Polissya in Ukraine.

All the amphibian species of the investigated high-mountain region, such as *Lissotriton montandoni* (Boulenger, 1880), *Ichthyosaura alpestris* (Laurenti, 1768), *Bombina variegata* (Linnaeus, 1758), *Bufo bufo* (Linnaeus, 1758) and *Rana temporaria* (Linnaeus, 1758) were studied too. Three of them are included in the Red Data Book of Ukraine (Akimov 2009b).

The selected research objects represent various bio-morphological types and differ in their ecological needs (swamp, grassland, petrophytous species etc.), conservation status (rare, endangered, vulnerable), coenotic role (dominants, subdominants, companions), undergoing both natural and anthropogenic changes, and are representative for the high-mountain communities of the Ukrainian Carpathians.

Stationary research on the changes in the population structure *in situ* was carried out both on long-term monitoring transects established 5-40 years ago, and on the new sites. The transects are located in the alpine, subalpine and upper forest belts of the Ukrainian Carpathians within 1200–2000 m a.s.l. altitudinal range. The study sites involve the most common alpine phytocoenoses, chionophilous communities, selected forest and subalpine phytocoenoses, habitats of rare and endemic plant species populations, amphibian communities, habitats of the populations of plankton crustaceans. The research covered mountain territories of the Chornohora, Chyvchyny, Marmarosh, Svydovets and Beskydy ranges within different habitat types, which differ in their eco-coenotic characteristics and the level of anthropogenic transformation caused by various factors (trampling, grazing, reservation etc.). Most of the transects are located in the central part of the Chornohora range in the vicinity of the Kostyantyn Malynovsky High-mountain Biological Station of the Institute of Ecology of the Carpathians, NAS of Ukraine.

The methods of research are described thoroughly in our previous publications (Holubets & Malynovskyy 2004, Tsaryk 2009, Tsaryk 2014).

RESULTS AND DISCUSSION

Rare biota of the high-mountain zone of the Ukrainian Carpathians is exposed to significant threats from the impact of natural and anthropogenic factors, mainly due to climate change, restoration successions and intensive recreation. These processes cause rapid transformation of the high-mountain coenoses and ecosystems which results in degradation and extinction of numerous populations and communities of the rare species.

The main consequence of climate change is warming. The effective growth and development begins 2-3 weeks earlier at present compared to the 80-90s, and even 4-6 weeks earlier in chionophilous communities because of the faster snow melt. Other phenological stages, in particular flowering and fruiting have accelerated as well. Effective temperature difference exceeds 200°C by the end of the vegetative season which corresponds to about 1,3°C increase in the mean daily air temperature during the growth season. If the current climate change trend remains, it will lead to upward shifts of the timberline and subalpine zone for 200 m vertically and total disappearance of the alpine zone in the Ukrainian Carpathians.

As a result of significant changes in thermal and snow regimes in the high-mountain zone of the Carpathians a rapid structural transformation in the communities takes place which causes degradation and poses a threat of extinction to a series of rare and unique for Ukraine populations, species, and phytocoenoses. The prolongation of vegetative period, increase in the sum of effective temperatures, quicker snow melt as well as the decrease in precipitation in winter result in transformation of habitats and biotopes.

Because of warming, a lot of species undergo shifts of their eco-phytocoenotic optima, narrowing of the ecological niches, intensification of interspecific competition, invasion of the shrub species and competitive trivial herbaceous plants. Consequently, poorly competitive, heliophitic, and chionophilous rare species of stress-tolerant and ruderal strategies get displaced.

Negative climate-induced dynamics is peculiar to the populations of many petrophytous and chionophilous species of the Red Data Book of Ukraine: *Leontopodium alpinum*, *Erigeron atticus*, *E. alpinus, Saussurea alpina, Achillea oxyloba* subsp. *schurii, Saxifraga androsacea, Minuartia zarecznyi, Astragalus australis* subsp. *krajinae, Aconitum anthora* subsp. *jacquinii, Primula halleri, Ranunculus thora, Cerastium cerastoides, Saxifraga carpatica*, etc. Populations of rare alpine and arctic-alpine species of the rocky and summit communities – *Rhodiola rosea*, *Antennaria carpatica*, *Dianthus*

carpaticus, *D. speciosus*, *Rumex scutatus*, etc. – are threatened. The decline in numbers of individuals and population vitality is typical for them.

Accelerating degradation of many rare petrophytous communities during the last years has been caused by their overgrowth with shrubs (*Juniperus communis* subsp. *alpina, Alnus viridis, Pinus mugo*) and some trees (*Picea abies*, *Salix* spp., *Sorbus* spp.). The overgrowth with the forest and shrubby vegetation leads to simplification of the spatial structure, fragmentation and decrease in density of the rare species populations, their elimination from the community structure and, consequently, general depletion of floristic composition of phytocoenoses.

Climate change causes gradual extinction of some relic species, whose populations have survived in particular habitats where present conditions do not meet their ecological optimum. These are mainly cold-resistant representatives of arctic-alpine and Central-European high-mountain species, such as *Pedicularis oederi, Saxifraga aizoides, S. bryoides, Veronica bellidioides.* Regressive processes in their populations have accelerated in the last decades when the climate change became evident.

Among the natural factors affecting plankton crustaceans, the change in the air temperature is the most significant, because it directly influences the formation and time span of shallow high-mountain waterbodies, their depth, size, chemism, thermal and hydrological regimes. The decrease in numbers of habitats of the daughter populations, subpopulations and population loci is the most dangerous phenomenon which leads to fragmentation of population structures and reduces the genetic exchange between them.

Another natural factor of threat to the rare species populations is the impact of restoration succesions on their habitats. These changes are usually accompanied by increased shading and crowding of vegetation due to the spread of highly competitive species. Consequently, low-statured rare species disappear from the communities. In the high-mountain zone of the Ukrainian Carpathians, it refers mostly to grassland species that need open sites for the effective population recruitment, such as *Aquilegia nigricans, Botrychium lunaria*, *Genista tinctoria* subsp. *oligosperma, Koeleria macrantha* subsp. *transsilvanica, Thlaspi dacicum, T. kovatsii.* The negative dynamics of their populations is significantly contributed by the decrease or abandonment of grazing in the habitats.

The populations and communities on protected territories are most prone to changes. Restoration successions there are amplified by climate-induced changes which have been accelerating for the last 10-15 years. Particularly rapid regressive changes in the rare species populations and phytocoenoses take place due to colonization of their habitats by shrubs. This process is typical for the upper-forest, subalpine and lower part of the alpine belt. The shrinkage of population ranges and decrease in numbers is peculiar to *Pulsatilla alba, Gentiana acaulis, G. punctata, Heracleum carpaticum, Anemone narcissifolia*, *Erigeron alpinus*, etc. Some population loci or local populations of these species have already become extinct.

Populations of heterosexual plant species in the high-mountain zone of the Ukrainian Carpathians have been undergoing considerable transformations lately due to natural and anthropogenic factors of impact. The main changes in population structure organization concern the intensification of the restoration succession accompanied by the active invasion of shrub and tree species, as well as the representatives of the tall forbs. It refers primarily to the habitats of hygrophilous species of the upper forest and subalpine belts (*Valeriana transsilvanica*, *V. tripteris*, *V. simplicifolia*, *Doronicum carpaticum* etc.). Hence, populations of these species gradually degrade due to the negative trend in the numbers, shrinkage of their areas, and decrease of the recruitment ability. Intensification of reproduction and expansion

of population ranges of these species occur only fragmentarily and merely in the sites with sufficient insolation.

Restoration succession which takes place in the high-mountain zone of the Carpathians alters the amphibian habitats considerably. It affects primarily the reproductive ponds, especially under the conditions of protective regime. Natural restoration of the timberline, overgrowth of the high-mountain grasslands and lakesides cause gradual shading, mudding and shoaling of the ponds, especially small ones. The dynamics of the mentioned processes proves the negative tendency and the necessity of active protection management for the high-mountain amphibian populations of the Carpathians, particularly the Red Data Book species.

The increasing recreation intensity is the most dangerous anthropogenic factor for population existence. Numerous localities of the rare grassland plant species as well as high-mountain lakes and small waterbodies undergo negative transformations due to pedestrian and automobile tourism in the Chornohora and Svydovets.

The recreation factor has caused total degradation of the only *Oreochloa disticha* population in Ukraine on the summit of Mt. Turkul in the Chornohora. The vegetation on the summit of Mt. Hoverla has been devastated because of the excessive tourist pressure. The most destructive effect on the soil layer and vegetation is caused by large groups of hikers.

Various types of recreation pose a threat to high-mountain ecosystems of the Svydovets. Vehicle excursions along the Svydovets ridge, particularly to Lake Gereshaska are regularly performed in the vicinity of the recreation complex on Mt. Drahobrat. Anthropogenic degradation of the lake ecosystem, its surroundings including unique petrophytous communities of Mt. Gereshaska is in progress while the rare plant species are destroyed by tourists.

Considerable changes in the crustacean plankton communities of the Chornohora range have been noticed in one of the model waterbodies named Bolotne Oko (Swamp Eye). The path to that lake was made in 2009 by the Carpathian Biosphere Reserve staff as the territory of Ozirne was included in the list of wetlands protected by the Ramsar Convention. The waterbody is inhabited by the maternal for the Chornohora population of a cladocerous species *Streblocerus serricaudatus.* The site is the only known habitat for this species in the Ukrainian Carpathians. Because of the path, the cattle have got regular access to the waterbody and it has been subjected to significant negative impact during the last years. Consequently, the fraction of *S. serricaudatus* in the crustacean plankton community has dropped and *Ceriodaphnia quadrangula* became equally eudominant here. In 2015, *Daphnia obtusa* was found in this waterbody for the first time as well. The similarity (Sorensen-Czekanowski index) of crustacean communities in Lake Bolotne Oko between 2007 and 2016 reached 0,50. It shows the most drastic change in the composition of crustacean communities among the Chornohora waterbodies for the last decades.

Contamination of water by tourists and decrease in its transparency due to shore line erosion cause chemical changes in waterbodies. Rare high-mountain species are very sensitive to the acid-base balance of their aquatic environment. For example, the increase in the pH value results in the shifts in the sex ratio of *Mixodiaptomus tatricus* population in favor of the males and, consequently, decrease in fertility, which disturbs the population dynamics significantly.

Intensive grazing close to the waterbodies is one of the main threats to the amphibian populations. It can alter water chemistry due to allochthonous organics input, change in vegetation composition, etc. Occasionally, it can cause injuries to amphibians or destruction of their spawn. On the other hand, permanent trampling and keeping vegetation low facilitates the spread and migration of the amphibians on land, particularly the metamorphs. In addition,

the newt populations can exist for a long period of time under the grazing impact without any evident decrease in their viability.

Dirt roads and tourist paths as a fragmentation factor of amphibian habitats can be considered as positive, because under moderate pressure they contribute to the increase in the number of small breeding ponds and amphibian dispersal to new territories. However, the intensive use of roads creates preconditions for penetration of the atypical amphibian species and, consequently, accelerates the colonization of high-mountain waterbodies by euryoecic species, e.g. *Rana temporaria*. These species change the unique structure of the high-mountain amphibian communities which undermines their stability.

The significant negative factor of impact on the amphibian populations in the region of investigations is the automobile transport, i.e. increase in car concentration in the vicinity of the recreation regions in the high-mountain zone. The unorganized parking process results in permanent transformation and destruction of small breeding ponds. High intensity of the mentioned factor has caused considerable degradation of habitats of several Red Data Book amphibian species and disappearance of many breeding ponds during the last decade.

The main mitigation measure to ensure stable existence of present hydrocole populations in the high-mountain zone of the Ukrainian Carpathians is the relocation of tourist routs from their habitats. Small and shallow waterbodies are exposed to intensive tourist impact in the Chornohora and Svydovets at present. The lakesides of high-mountain lakes are very attractive for tourists to stay overnight.

They destroy the vegetation cover by trampling and cutting, pollute the water area and territory around. It is important to forbid putting up tents in the water basins and to control it strictly in order to restore the populations of many hydrocole species.

The intensive movement of tourists across the amphibian habitats slows down the restoration successional changes but it does not compensate the ongoing negative habitat transformations there. In order to protect these habitats we suggest to apply the active protection approach for conservation of the Red Data Book species (*Lissotriton montandoni*, *Ichthyosaura alpestris*, *Bombina variegata*). It includes cutting down the shrubs and underwood around the ponds, elimination of herbaceous and other vegetation from the ponds, removing the mud and partial deepening of the ponds, etc. It is also advisable to apply moderate local grazing that will facilitate not only the sustainment and conservation of populations of rare and endemic amphibian species, but also populations of many other plant and animal high-mountain species thus shaping high diversity of that unique landscape.

The intentional creating of new temporary waterbodies as breeding habitats would increase the number of local populations of amphibians, protect them from the negative effect of natural ecological factors and contribute to the effective functioning of their metapopulation structure, which is peculiar to some of the amphibian species in the high mountain zone of the Chornohora.

The tourist routes should not threaten the existence of populations of the rare species. Populations of a number of the rarest Carpathian plant species are located along the most popular tourist paths at present. For instance, the unique for Ukraine habitats of *Callianthemum coriandrifolium* and *Oreochloa disticha*, as well as isolated localities of *Dryas octopetala*, *Senecio abrotanifolius* subsp. *carpathicus*, *Pedicularis oederi*, *Doronicum clusii*, etc. are located on the Chornohora ridge where a huge amount of hikers passes every season. Therefore, attractive for tourists alternative routs should be developed, in particular along the lower ranges of the high-mountain massifs. For instance, in the Chornohora they may pass through Maryshevska, Kukul, Kozmeska, Ozirnyi, and Kostrych Mts. It would relieve the anthropogenically degrading territories.

The visiting regime for the most popular high-mountain tourist objects, particularly, Petros, Hoverla, Turkul, Pip-Ivan, Drahobrat Mts and Nesamovyte, Berbeneska, Gereshaska Lakes needs urgent regulations, whereas the mass hiking tours must be forbidden. The summit of Mt. Turkul should be closed for tourist visits in order to protect and restore the unique population of *Oreochloa disticha*.

Gathering medicinal and ornamental species – *Rhodiola rosea, Ranunculus thora, Gentiana lutea, G. punctata,* etc. poses a considerable threat. At present, in most of the high-mountain regions of the Carpathians these species are represented by small populations with the disturbed age, spatial and vital structures. All the populations of *Leontopodium alpinum*, a rare ornamental species, are subjected to total degradation resulting from plant-collecting.

Conservation and restoration of population structure is possible mostly under the condition of moderate or short-term grazing and mowing. Moderate pressure contributes to higher population viability in many rare species due to fragmentary thinning of grassland stands and reduction of competition. The conditions of absolute protection are favourable for the rare species only at the initial stages of the restoration succession.

The survival of small populations of a series of critically endangered narrow-range taxa declining in their solitary habitats in the Chyvchyny and Svydovets Mts, e.g. *Erysimum witmannii, Genista tinctoria* subsp. *oligosperma, Minuartia verna* subsp. *oxypetala*, *Nigritella carpatica*, *Thlaspi dacicum*, *T. kovatsii* depends on the maintenance or restoration of traditional anthropogenic pressure in their localities.

However, conservation of the most valuable high-mountain sites of biodiversity needs the expansion of protected territories. Numerous sites on the slopes of Petros, Petrosul, Shpytsi, Rebra, Gutyn-Tomnatyk, Berbeneska, Munchel, Dzembronia and Pip-Ivan Mts in the Chornohora need higher protection status. Remarkable for its unique population and coenotic diversity central part of the Svydovets massif which includes the summits of Gereshaska, Rebro, Vorozheska, and Velykyi Kotel Mts still does not have any protection status. As a result, a threat of its anthropogenic transformation has emerged, namely the planned development of the ski resort. In order to avoid the anthropogenic degradation, this massif should be included into the Carpathian Biosphere Reserve or a new landscape reserve should be established there.

In order to slow down the degradation of rare species populations caused by long-term restoration succession and climate change, active protection measures should be applied which also concerns the protected territories. Local application of traditional anthropogenic land-use activities (grazing and mowing) is needed, as well as shrub and tree cutting for the conservation of the rarest and unique communities and populations.

Reproductive microhabitats representing most favourable conditions are crucial for population viability and sustainability under adverse environmental changes. Such loci are characterized by the largest density of high-vitality flowering individuals and comprise the population core. Therefore, measures aimed at conservation of rare species should be focused primarily on protection of such reproductive microhabitats.

Reintroduction, repatriation and development of the ways of maintenance and restoration of the rare species population viability need to define favourable conditions separately for the seedlings and flowering individuals. Measures for viability maintenance and restoration of an existing population of any species should be focused on the maintenance or creation of the conditions favourable for the development of both seedlings and flowering individuals. On the other hand, reintroduction and repatriation measures should be differentiated. If oversowing or planting young individuals is applied, then conditions should be favourable for the mentioned group of individuals. And contrarily,

if the flowering individuals are to be planted, the conditions should be appropriate particularly for them rather than for the seedlings. In practice, the efficiency of the mentioned measures can be compromised without such differentiation.

It was found out that metapopulations have the highest long-term dynamic persistence and functional stability among population systems under different natural and anthropogenic conditions in the transformed environment. Metapopulation type of existence is typical for a series of rare plant and animal species, particularly for petrophytous, hygrophilous and hydrocole species. Structure of metapopulations with the highest vitality is characterized by the presence of a large mainland partial population which is usually confined to more favourable ecological conditions, and smaller labile, more dynamic peripheral island partial populations.

CONCLUSIONS

Evaluation of the population status should be done by means of vitality estimation as an integrative index which characterizes the most important individual and group parameters of structure, growth, development and reproduction. Population analysis must include the vitality analysis.

Thus, our research revealed that not only anthropogenic, but also natural factors can cause degradation of the population structure posing a threat to viability of numerous populations of rare and endemic plant and animal species. Climate change has led to drastic negative changes in viability and sometimes even to extinction of populations of rare species during the last decade. However, restoration successional processes resulting from passive protection do not ensure sustainability of populations in primary communities, and sometimes they can even pose a significant threat.

Taking into account the current recreation boom in the high-mountain zone it is necessary to elaborate and implement a set of mitigation measures for sustainable use and conservation of population resources, primarily in the Chornohora and Svydovets massifs. It is also essential to follow the nature-conservation legislation, especially on the territory of nature reserves.

Special attention should be paid to prevention of destruction of rare ornamental and medicinal plant species from the Red Data Book of Ukraine. Eco-educational activities are also crucial, particularly those concerning high vulnerability of the high-mountain ecosystems, their slow restoration after disturbance, harmful impact of different types of recreation on the environment (contamination, making bonfires and stone-piles, etc.).

In order to define ways to prevent extinction of rare populations and communities, profound research into ontogenetic and ecological characteristics of rare species at the limits of their ecological tolerance is needed, as well as comparative studies of populations on different stages of their life cycles, revealing their persistence, plasticity, and adaptive possibilities under the unfavourable environment change.

It is important to investigate characteristics of the individual ontogeny, as well as population structure, dynamics and functioning under optimal, pessimal and critical conditions. It will allow to elaborate practical measures and new approaches to protection, conservation and restoration of populations and communities of rare species which undergo negative dynamics, degradation, and are exposed to extinction risk.

Current rapid environmental changes cause the necessity to create systemic programs for monitoring populations and communities of rare and endemic species of plants and animals in the high-mountain zone to evaluate their status and dynamics in order to develop species-specific methods for their conservation. There is an urgent need for implementation of new biodiversity protection and conservation approaches, particularly for regulation of visiting the areas of intensive recreation, application of different

forms of active protection of rare biodiversity, revision of the absolute conservation regime within nature-protective territories, however, nature-conservative legislation of Ukraine should be strictly followed.

The elaboration of the scientific program for comprehensive research of rare plant and animal species populations is topical now in order to provide conservation and avoid biodiversity loss in the high-mountain zone of the Ukrainian Carpathians.

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REFERENCES

Akimov A.I. (Ed.). 2009b. Red Data Book of Ukraine. Animals. Globalconsulting, Kyiv: pp. 600 (In Ukrainian).

Didukh Y.P. (Ed.). 2009a. Red Data Book of Ukraine. Plants. Globalconsulting, Kyiv: pp. 900 (In Ukrainian).

Holubets M., Malynovskyy K. (Eds.). 2004. Intrapopulation diversity of rare, endemic and relic plant species of the Ukrainian Carpathians. Polly, Lviv: 198 p. (In Ukrainian; abstract in English).

Holubets M., Tsaryk Y. (Eds.). 2001. Strategy of plants populations in natural and anthropogenic change ecosystems of the Carpathians. Eurosvit, Lviv: pp. 160 (In Ukrainian; abstract in English).

Tsaryk Y. (Ed.). 2014. The mechanisms of self-renewal of populations. SPOLOM, Lviv: pp. 216 (In Ukrainian; abstract in English).

Tsaryk Y. (Ed.). 2009. Viability of plant populations of high-mountain zone of the Ukrainian Carpathians. Mercator, Lviv: pp. 172 (In Ukrainian; abstract in English).