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ORIGINAL ARTICLE

Structure of some rare flora species populations in conditions of Volhynian Upland

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At the present stage, the study of rare and endangered plant species and the preservation of natural biodiversity is one of the most pressing problems. The purpose of this work was monitoring research of the spatial and ontogenetic structure of the populations of some rare flora species of the Volhynian Upland (*Adonis vernalis, Galanthus nivalis, Carlina onopordifolia, Cypripedium calceolus, Epipactis palustris, Cladium mariscus, Saxifraga granulata*) and the determination of causes that adversely affect the condition of their populations. The isolation of age spectra and the study of the spatial structure of populations of rare flora species were conducted taking into account the methods of V. Grant, K.A. Malynovskyi, T.O. Rabotnov, O.O. Uranov, O.V. Smyrnova and others. Categories of ontogenetic spectra were determined in accordance with the recommendations of Yu. A. Zlobin. In the conditions of the Volhynian Upland, the population of *A. vernalis* is comprehensive, normal, with a left-sided ontogenetic spectrum, however – regressive.The firmness and structure of species populations depend on the dynamics of the development of natural phytocoenoses. The parameters of the *G. nivalis* cenopopulation somewhat vary depending on the ecological-cenotic conditions of growth, as well as the location within the range and characterized by homeostaticity, centered age spectrum and average density. Populations of the species *C. onopordifolia* are isolated from each other, so they are very fragmented. By their structure, they are comprehensive, right-sided, but regressive. The structure of the populations of *C. calceolus* depends on the anthropic effect on the growth site. Homeostatic populations with full age age spectra are presented in antropically not disturbed places. Most species of the species have a right-side ontogenetic spectrum and show a complete and stable dynamics of the species. Monitoring research on the condition of *E. palustris* populations show stable positions of the species in phytocoenoses.The state of the populations of *E. palustris* depends mainly on the species biology and slightly less on the influence of meteorological conditions. Perennial observations of the species indicate a significant prevalence of generative individuals in populations. Studies of *C. mariscus* populations indicate their high density and number. It is the high density of underwater evergreen perennial stems *C. mariscus* and abundant fruiting, which ensure the stability of species populations, and also form a natural barrier against the penetration of other species.The populations of *S. granulata* are confined to the forest edge ecotones. Growing in the ecotone between forest or shrub and meadow vegetation in the valleys of the rivers, they form linear populations, which include a small number of individuals. Studies in the territory of Ukraine show that *S. granulata* as a species disappears. Consequently, most of the investigated populations of rare and endangered flora species are degraded.

Keywords: Rare plant species; population research; monitoring

Introduction

For a long time, the idea of conservation of the plants did not cause a sense of urgency. Funded were primarily the measures for animal conservation and reproduction, although, according to R.T Corlett, biodiversity of plants plays a much more important role in human life (Corlett, 2016).

At the present stage, the study of rare and endangered plant species and conservation of natural biodiversity is one of the most pressing problems.

The main causes of biodiversity decrease include: loss of habitat, fragmentation and degradation, excessive exploitation, the impact of invasive species, pollution and anthropogenic climate change.

Conservation of plant diversity is a huge global challenge; however, a combination of a well-designed and well managed worldwide system of protected areas and objects will ensure its implementation.

The most urgent problems of today on the way to the plant diversity conservation is the completion of a global botanical inventory and assessment of the conservation status of 94% of plant species that have not yet been evaluated (Corlett, 2016).

One of the goals of the Global Strategy for Plant Conservation (Heywood, 2009) is to monitor the state of plant diversity in the world, the trends in its changes and conservation, and the factors that threaten diversity. Maintaining such research is

especially needed to conserve the populations of rare, endangered and endemic species of plants, as well as species with very small populations (Falk et al., 1991; Brigham & Schwartz, 2003; Berg et al., 2014; Volis, 2016).
For a long time, the study of plants and vegetation cover traditionally included plant anatomy, plant morphology, plant taxonomy, phytocenology and phytogeography. Only in the second half of the twentieth century it became clear that populations are the real forms of plant species existence and that many processes that occur at the level of plant species, in plant communities and in the biosphere as a whole are initiated by the laws of life of plant populations (Zlobin et al., 2013).
Particularly informative are monitoring studies of some rare species populations that enable to estimate the state of populations over many years, compare populations of one species in different territories, and develop scientific basis of protection.
The modern research of individual rare and endangered plant species focuses on the works of many scholars (Szczecinska et al., 2016; Mykhailova, 2013; Melnyk et al., 2018, 75(1), 2018, 75(2), etc.). Studies of structural and spatial organization in particular were carried out by a number of scientists from all over the world (Torres et al., 2003; Watanabe et al., 2003; Luzuriaga et al., 2006; Turnbull et al., 2007; Quinones-Perez et al., 2014; Blinova, 2016 etc.).
The main objective of the National Strategy for the Conservation of Biodiversity in Ukraine is to stop the trend of degradation of the living component of the environment (Konischuk, 2016). In the list of measures envisaged by the Strategy, the "measures to conserve certain types of plants... or their groups, including those mentioned in the Red Data Book of Ukraine" take on a prominent place.
It is recommended to base development, planning and decision making concerning these measures on the results of monitoring studies. Therefore, the purpose of this publication was to monitor the study of the spatial and ontogenetic structure of the populations of some rare species of the flora of the Volhynian Upland and to identify the causes that negatively affect the condition of their populations.

Materials and methods of research

Volhynian Upland is confined to the Volhynian-Podolian Plateau within the East European Plain and occupies its southwestern part. In the west, the valley of the river the Western Bug is the border between Volhynian Upland and the Lublin Upland in Poland; in the south, the narrow strip of the Ostroh valley separates the Volhynian Upland from Podolian Upland; in the north and east the Volhynian Forest Plateau borders the Volhynian and Zhytomyr Polissia.
In administrative terms, the studied region covers the southern regions of Volyn and Rivne Oblasts and the north of Lviv Oblast. Volhynian Upland occupies an area of about 200 km long and 40-60 km wide. The total area is about 10 000 km^2. Significant vertical stratification is typical for the region (the watersheds are 80-120 m above the thalwegs of the valleys and balkas) and the almost continuous development of the forest cover, with a capacity up to 30 m (from which the Upland received the second name "Volhynian Forest Plateau").
Volhynian Upland, located on the border of two floristic provinces, is characterized by significant floristic diversity and is characterized by a peculiar history of the development of vegetation, the core of which has been preserved since the Tertiary period.
At the present stage, in research of populations of rare and endangered species of flora of the Volhynian Upland is engaged V.I. Melnyk (Melnyk & Parubok, 2004; Melnyk & Didenko, 2013; Melnyk et al., 2014; Melnyk et al., 2018), Ya.P. Didukh (Didukh, 2009), I.P. Lohvynenko (Lohvynenko, 2018) and others.
A population approach to the study of rare plants is one of the most important. It is impossible to develop effective and well-founded measures of protection of a certain species without examining the state of its populations, namely: the number of species, its density, age and spatial structure, reproductive characteristics. In addition, it is necessary to determine the factors of negative influence on the population of the species and the reaction of the latter to them.
For detailed monitoring studies, we selected 7 species belonging to the Red Data Book of Ukraine (Didukh, 2009). Three of them (Adonis vernalis L., Cypripedium calceolus L., Epipactis palustris (L.) Crantz.) are included in the Appendix to the CITES (Diekson, 2013), one (Carlina onopordifolia Bess. Ex Szaf., Kulcz. et Pawl.) – to the IUCN Red List (List of rare..., 1982). Species such as Carlina onopordifolia and Cladium mariscus (L.) Pohl. are relics. In addition, the selected species grow in different ecological conditions: Adonis vernalis, Carlina onopordifolia in steppe groups; Galanthus nivalis L., Cypripedium calceolus – in forest groups; Epipactis palustris and Cladium mariscus – in marsh groups; Saxifraga granulata L. – under ecotone conditions.
The isolation of age spectra and the study of the spatial structure of populations of rare species of flora were carried out taking into account the methods of K.A. Malynovskyj (Malynovskyj, 1986) and Yu.A. Zlobin with co-authors (Zlobin et al., 2013).
Within the cenopopulations, transepts were laid, from 5 to 10 meters long. Depending on the particular type of a transept, they were divided into square registers, ranging from 1 m2 to 0.25 m2. At each site, all specimen of the corresponding species were dug up and their age was determined. On the basis of measurements of 15-30 specimens of the biomorphological characteristics of plants of each age group was compiled.
The obtained data was processed by variational and statistical methods. Studying the cenopopulation of particular rare species, number of which was insignificant, the definition of age-old conditions was carried out without digging up of specimens. The categories of ontogenetic spectra were determined according to the recommendations of Yu.A. Zlobin with co-authors (Zlobin et al. 2013).
The names of the species are given by the collation of S.L. Mosyakin and M.M. Fedoronchuk (Mosyakin & Fedoronchuk, 1999).

Results

The structure of populations of *Adonis vernalis L.* (*A. vernalis*) – the Euro-Siberian steppe species, commonly spread from the Iberian Peninsula to the basin of the river Lena (Yakutia), from north to south from the coast of the Baltic Sea to the Ciscaucasus. Outside of the continuous spread in Europe and Siberia, insulated areas exist.

In Ukraine, it's rising to south of Polissia (rarely), in the forest steppe, steppe and Crimea. On the territory of the Volhynian Upland, species are confined to the central and eastern regions. As noted by V.I. Melnyk and M.I. Parubok (Melnyk & Parubok, 2004) in the Volhynia forest steppe A. vernalis is distributed to the north of the city of Dubno. Most of the localities are concentrated in the Dubno, Mlyniv and Rivne raions of the Rivne oblast (on the carbonaceous free-standing mountains Lysa, Kvitucha, Vyshneva, Smordva, stow Pechenyj Vil, stow Hraboveschyna).

According to the classification of K.A. Malynovskyj, populations of *A. vernalis* are referred to as the continuous (Malynovskyj, 1986). Such populations occupy similar locations within their range and are divided by large geographic disjunctions (Melnyk & Parubok, 2004).

Spatial placement of specimens in isolated populations *A. vernalis* is different in different parts of the range. In most of the habitats listed in the region, species of the population are local and only in the stow Pechenyj Vil the population is linear.

The spatial structure of the populations of *A. vernalis* on the mountains Lysa and Kvitucha is similar. The density of the populations on average is 1-5 specimens per 100 m^2.

On Vyshneva Mountain, the *A. vernalis* population is also regressive and the number of its specimens decreases year by year. There is an intense overgrowth of the steppe slopes of the mountain with aggressive species of flora, especially *Prunus spinosa*.

The population of the species in the stow Pechenyj Vil in spatial structure is linear and grows on the steppe slopes of the southern exposition, stretching along with Korablyshhe village (about 1 km). Of all the populations of *A. vernalis* in the territory of the Volhynian Upland studied by us, this one is the most numerous-155 specimens per 100 m^2.

On the stows of Smordva and Hraboveschyna, the population density of *A. vernalis* does not exceed 6-8 specimens per 100 m^2. Specimens of species grow in groups.

For the analysis of the cenopopulations of *A. vernalis* at the Volhynian Upland, the following age groups were taken into account: juvenile (j), virginile (v), immature (i) and generative (g). Senile (s) specimens were not detected during our field trials. As noted above, the population size is not high, the spectra of ontogenetic stages are presented in Table 1 and on Figure 1.

Table 1. Spectra of ontogenetic stages of Adonus vernalis in Volhynian Upland (Rivne oblast).

Location	**Number of specimens per 100 m^2**	**Spectra of ontogenetic stages**							
		g		**v**		**i**		**j**	
		specimens	**%**	**specimens**	**%**	**specimens**	**%**	**specimens**	**%**
Dubno raion, near Mylcha village, Mtn. Kvitucha	7	3	43	2	29	1	14	1	14
Dubno raion, near Mylcha village, Mtn. Lysa	9	4	45	3	33	2	22	_	_
Rivne raion, near Gorodok village, Vyshneva Mountain Reserve	15	7	46	4	26	2	14	2	14
Mlyniv raion, near Korablyshhe village, stow Pechenyj Vil	155	55	35	73	47	17	11	10	7
Mlyniv raion, near Smordva village, Mtn. Smordva	8	2	25	3	38	2	25	1	12
Mlyniv raion, near Vladyslavivka, Hraboveschyna Reserve	5	2	40	1	20	1	20	1	20

According to our data, the species of the population, although small, are represented by all ontogenetic stages, meaning, they are full-fledged. Four of the six studied populations are characterized by a centered ontogenetic spectrum, and two others are left-sided. Thus, most of the investigated populations of *A. vernalis* are normal but regressive. Monitoring surveys on the status of populations of the species show a tendency to reduce the population size and degradation of the species.

Within the Volhynian Uplands are concentrated fertile chernozem soils, during plowing of which the number of the localities of *A. vernalis* was significantly reduced. In addition, there was an insularization of populations and the transformation of continuum populations of the species into the local ones. Negative influence to the state of populations of the species were also intensive grazing of cattle, reforestation of steppe slopes, large volumes of harvesting of the species as a medicinal raw

material.

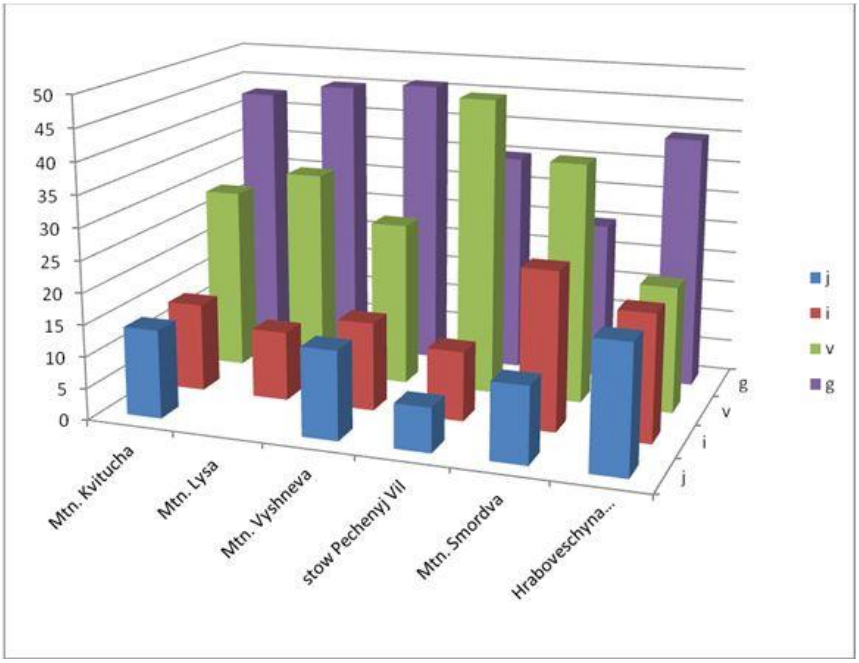

Figure 1. Spectra of ontogenetic stages of Adonus vernalis in the Volhynian Upland.

The structure of *Galanthus nivalis* L.: *Galanthus nivalis* is a European-Mediterranean species on the eastern boundary of the range. Distributed in Central Europe, the Mediterranean, Ciscaucasus. In the territory of Ukraine, the species is predominantly distributed at the Right-bank forest steppe, the Carpathians, the Carpathian region, Western Podolia, Roztocze, occasionally at the Right-Bank Polissia, and rarely at the Left-bank forest steppe (Didukh, 2009).

On the territory of the Volhynian Forest Plateau *G. nivalis* is distributed throughout the territory and yet most of the settlements are located in the eastern areas of the region.

Monitoring studies on the condition of populations of *G. nivalis* were conducted on four sites: 1) Rivne oblast, Zdolbuniv raion outskirts of Novomilsk village, near a chalk career; 2) Rivne oblast, Ostroh raion, outskirts of Verkhiv village; 3) Rivne oblast, Zdolbuniv raion, near the Novosilky village; 4) Rivne oblast, Zdolbuniv raion, south of the Naraiv village. Species populations are confined to hornbeam and oak-hornbeam forests.

Localities *G. nivalis* near Novomilsk village and near Naraiv village are quite numerous and the species serves as an edifier in the spring synizoses. The density of specimens per 1 m2 in these places reaches 85-90. Less numerous are the populations of the species near Novosilky village and near Verkhiv village – 20-30 specimens per 1 m^2.

Age conditions of *G. nivalis* were chosen on the basis of the periodization of its ontogenesis, proposed by V. I. Melnik and S. Ya. Didenko (Melnyk & Didenko, 2013). In the course of field studies, three age classes were taken into account: juvenile (j), virginile (v), and generative (g). The results of the census are presented in Table 2 and on Figure 2.

Table 2. Spectra of Galanthus nivalis ontogenetic stages at Volhynian Upland (Rivne oblast).

Location	**Number of specimens per 1 m^2**	**Spectra of ontogenetic stages**					
		g		**v**		**j**	
		specimens	**%**	**specimens**	**%**	**specimens**	**%**
Zdolbuniv raion, outskirts of Novomilsk village	87	47	54	25	29	15	17
Ostrog raion, near Verkhiv village	23	9	38	11	47	4	15
Zdolbuniv raion, near Novosilky village	27	13	48	8	30	6	22
Zdolbuniv raion, near Naraiv village	85	45	53	25	29	15	18

In the studied populations, there are both individual specimens and clones of vegetative origin. This indicates the effectiveness of both seed and vegetative reproduction. The studied populations are homeostatic, since they represent all age groups. Most of them are characterized by a centered ontogenetic spectrum.

Taking into account the current state of species populations in the investigated localities-it has stable positions in phytocoenoses. However, in recent years, populations, located near settlements and in recreation areas, become regressive, therefore monitoring of the condition of populations of *G. nivalis* should be carried out continuously.

Consequently, the main causes of the degradation of *G. nivalis* populations are picking the plants for bouquets, digging up bulbs and recreational loads. The latter is manifested in deforestation, which leads to an overgrowing the area with shrubs. Under these conditions, seed restoration of *G. nivalis* populations is discontinued. As a result, the number of specimens and

the population density drastically decreases. Specimens, which have survived, pass from generative to senile stage. Accordingly, cenopopulations of a regressive type with a right-sided spectrum of ontogenetic stages that are doomed to complete degradation are formed.

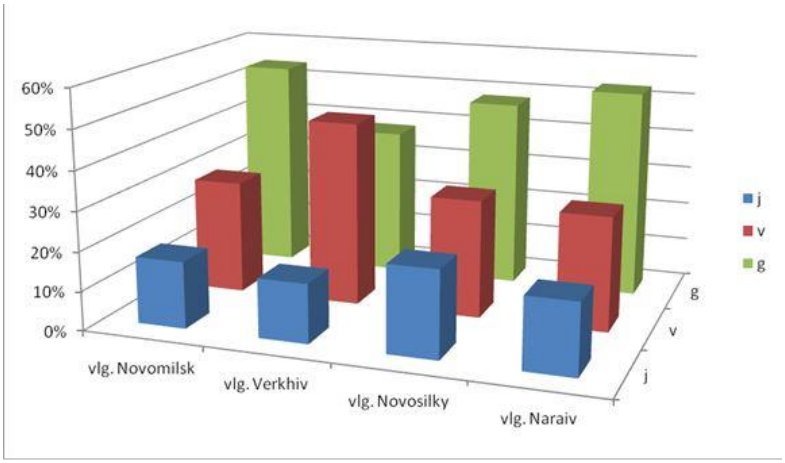

Figure 2. Spectra of ontogenetic stages of Galanthus nivalis in the Volhynian Upland.

The structure of the populations of Carlina onopordifolia Bess. ex Szaf. Carlina onopordifolia Besser ex Szafer, Kulcz. et Pawl. (Asteraceae) is a rare species of flora in Ukraine, which is included in the Red Book of Ukraine (Didukh, 2009) and to Annex I of the Berne Convention (Bowman et al., 2010).

In Ukraine, the geographical distribution of *C. onopordifolia* is limited to the Volhynian-Podolian Upland, which was not covered by glaciation; therefore, this species can be considered a Tertiary relic of Volhynian-Podillia. On the territory of Volhynian Upland *C. onopordifolia* was first recorded in the outskirts of Zvyniache village in Horokhiv raion of the Volyn oblast. Unfortunately, until now, this place has not survived, and the species was considered to have disappeared from the flora of the Volhynian Upland. However, in 2002 and 2007, *C. onopordifolia* was detected on the territory of the Mlyniv raion of Rivne oblast (Melnyk et al., 2005).

C. onopordifolia has a disjunctive area and in the territory of the Volhynian Upland the localities of the species are located at 50 km from each other.

Census monitoring sites are located in the stow Hraboveschyna and on the Smordva mountain (Mlyniv raion). In some years of monitoring studies on the state of the species, the number of its populations was quite significant. In such a way, in the Hraboveschyna stow in the area of 2 hectares 393 specimens were recorded; at mountain Smordva on the area of 5 hectares-123 specimens. However, in the following years, such amount of specimens was no longer recorded. *C. onopordifolia* is a monocarpic plant and reproduces only by seed method (only in rainy years, and only individual plants form lateral branches from which daughter plants develop). The seeds don't have a stage of organic rest, it does not require stratification, but it never sprouts in the late autumn. Seeds sprout in spring, but rather late, when the soil warms above 10 °C. The energy of germination is the highest at a temperature of 25-30 °C, which means, that *C. onopordifolia* belongs to megaterm plants. Therefore, the decrease in the number of specimens in the populations under study is probably due to insufficient soil temperature during seed germination. In addition, in snowless winters heads of *C. onopordifolia* are completely destroyed by birds eating the seeds, causing great damage to already impoverished populations of the species.

For the analysis of the cenopopulations of *C. onopordifolia* on the Volhynian Upland, we took into account the following age groups: juvenile (j), virginile (v), immature (i) and generative (g). The results of our studies are presented in Table 3 and on Figure 3.

Table 3. Spectrum of ontogenetic stages C. onopordifolia on the Volhynian Upland.

Location	**area**	**Number of specimens**	**Spectra of ontogenetic stages**							
			j		**i**		**v**		**g**	
			specimens	**%**	**specimens**	**%**	**specimens**	**%**	**specimens**	**%**
Mlyniv raion, near Smordva Mountain Smordva	5 ha	175	11	6. 3	59	33. 7	104	59. 4	1	0. 6
Mlyniv raion, near Vladyslavivka stow Hraboveschyna	2 ha	331	20	6	150	45. 3	157	47. 5	4	1. 2

Populations of the species are full-fledged, right-sided (with a predominance of the proportion of virginile specimens), however, regressive. Worth mentioning is a significant decrease in the number of generative specimens in populations over

the years.

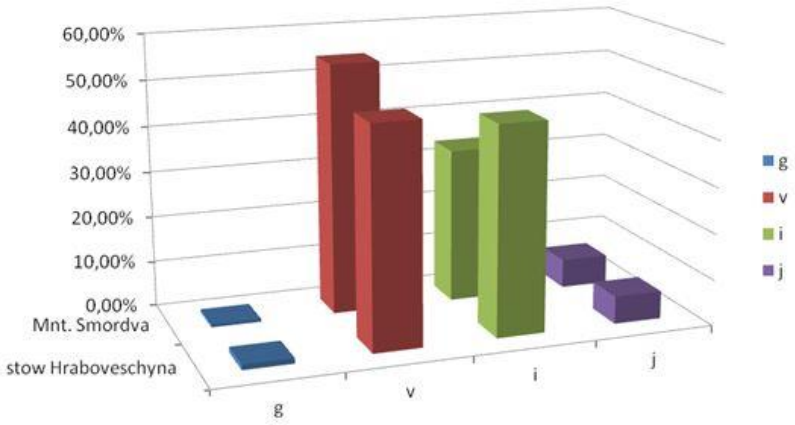

Figure 3. Age stages of C. onopordifolia on the Volhynian Upland.

C. onopordifolia is a heliophyte and therefore quickly disappears from slopes that become overgrown with herbs and shrubs. Insufficient knowledge of the geographical distribution of the species, ecological and cenotative conditions of the places of birth is an obstacle to the scientifically based protection of *C. onopordifolia*. Negative influences to the state of populations of the species are: intensive grazing of cattle and frequent spring burning of plant formation. It is necessary to constantly monitor the state of populations of the species.

The population structure of *Cypripedium calceolus* L.: *Cypripedium calceolus* is a paleoboreal species that covers almost the whole of Europe, with the exception of the Netherlands, Ireland, Iceland, Portugal, Andorra, Cyprus, Turkey, Albania, Bosnia and Herzegovina, Macedonia, Siberia, Northern Kazakhstan, Central Asia (Northern Mongolia, Northeast China) and North-East Asia (Russian Far East, Korea, Japan).

In Ukraine, *C. calceolus* grows in the Carpathians, Polissia, Volhynian-Podillia, the Middle Dnieper region and the mountains of the Crimea (Zagulskyj, 1993). On the Volhynian Upland, *C. calceolus* was found in the Lviv region in the Sokal raion near the Skomorokhy village and Hromosh stow near Peretoky village (Vavrysh & Sobko, 1984), in Uliana stow near Lutsk (Macau, 1938, LUM, Panek, 1938, LUM), in Lutsk raion near Vorotniv village (Melnyk et al., 2018, 75(1), 75(2)); in the outskirts of Zoria village (Melnyk et al., 2018, 75(1), 75(2), in Dubno raion in the outskirts of Bilohorodka village (Melnyk et al., 2018, 75 (1), 75 (2)), in Radyvyliv raion in the Baranie stow near the Krupets and Mykhailivka villages (Melnyk et al., 2018, 75(1), 75(2)), in Mlyniv raion at Turetska mountain, near Vyrky village (Melnyk et al., 2018, 75(1), 75(2)).

The new location of *C. calceolus* in Uzhynets stow near Ulianivka village and near Vladyslavivka and Smordva villages in the Mlyniv raion of Rivne oblast (Melnyk et al., 2018, 75(1), 75(2)) are discovered. In general, 14 locations of C. calceolus were detected within the Volhynian Upland, 5 of which are probably lost, since they were not confirmed after 1950.

On the territory of the Volhynian Upland, the *C. calceolus* cenopopulations are found as small in area populations, with a mosaic location and occupying relatively elevated elements of relief. The ontogenetic spectrum of species populations largely depends on ecological and cenotic conditions of growth. It grows in mixed and deciduous forests, and, as a rule, is confined to the forest glades and meadows, with the close occurrence of carbonates.

The populations of *C. calceolus* were investigated in Hromosh stow, near the village Peretoky, Sambir raion, Lviv oblast. (2 specimens); in Uzhynets stow, near Ulianivka village, Mlyniv raion, Rivne oblast; in the outskirts of Vladyslavivka, Mlyniv raion.

The population of *C. calceolus* in Hromosh stow is full-fledged. The spectrum of ontogenetic stages is dominated by virginile specimens. The population is somewhat lower than that of previous researchers (Vavrysh & Sobko, 1984). This is obviously due to the increase in shading at the habitat due to the high tightness of crowns nowadays.

The population of *C. calceolus* in the Uzhynets stow near Ulianivka village of the Mlyniv raion of the Rivne raion is confined to the hornbeam-oak forest on the slope of the south-western exposition. The population is full-fledged and occupies an area of about 25 m2. The population of the species has changed somewhat over the last five years. The total number and density of specimens in the population has become much smaller. The spectrum of ontogenetic stages indicates the degradation of the population.

The population of *C. calceolus*, which is located in the outskirts of Vladyslavivka of the Mlyniv raion of the Rivne oblast, is confined to the hornbeam forest. The C. colocolus cenopopulation is not large and covers an area of about 5 m^2. In the age spectrum virginile specimens dominate. However, in the last 2-3 years, the proportion of generative specimens and the overall population has slightly increased. We associate such a progressive tendency with partial deforestation, which was carried out in this habitat.

Ontogenetic conditions of *C. calceolus* were determined according to the recommendations of M. G. Vahrameeva (Vahrameeva et al., 1987). For *C. calceolus* it is longer than other orchids growing on the territory of Ukraine, the period from germination of seeds and until flowering takes 15-17 years. However, in favorable conditions, this period can be reduced to 8 years.

In the cycle of development of *C. calceolus* distinguished are the following periods: 1) latent; 2) virginile (seedlings, juvenile,

immature); 3) generative; 4) senile.

The following age groups were taken into account for the analysis of *C. calceolus* cenopopulations in the Volhynian Uplands: juvenile (j), immature (im), virginile (v) and generative (g).

The results of the study of three cenopopulations of species we studied are presented in Table 4.

Table 4. Number and spectra of ontogenetic stages of populations *Cypripedium calceolus* L. in the territory of the Volhynian Upland.

Population habitat	**Age stages**				**Number of specimens**
	j	**im**	**v**	**g**	
Uzhynets stow, near Ulianivka village, Mlyniv raion, Rivne oblast.	5	10	30	15	60
	8.3	16.6	50	25	100
Outskirts of Vladyslavivka village, Mlyniv raion, Rivne oblast.	2	4	3	7	16
	12.5	25	18. 8	43.8	100
Gromosh stow, near Peretoky village, Sokalsky raion, Lviv oblast.	7	13	53	25	98
	7.1	13.3	54.1	25.5	100

Note. The numerator shows absolute values, the denominator-their percentage ratio.

Most investigated cenopopulations of *C. calceolus* are full-fledged, normal, and characterized by right-sided age spectrum with a maximum of virginile specimens (Figure 4).

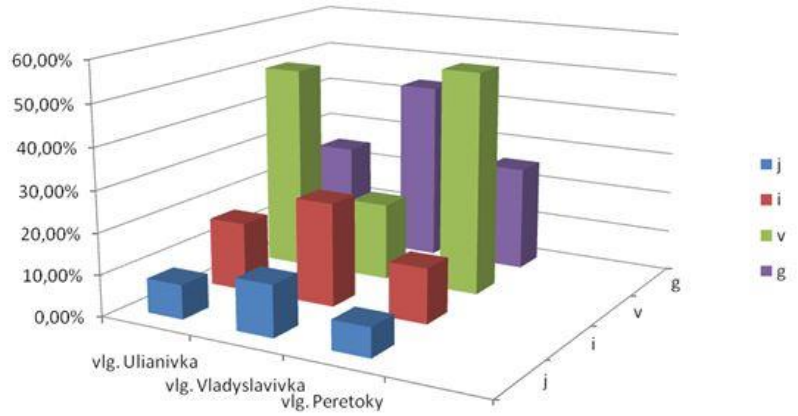

Figure 4. Spectrum of ontogenetic stages of Cypripedium calceolus on the territory of the Volhynian Upland.

The most numerous among them is the *C. calceolus* population in the Hromosh stow, where *C. calceolus* plants are located individually. The two other populations we examined are smaller in number, but full-fledged. Spatial placement of populations of the species is the same as in the Hromosh stow.

In the absence of significant shading, as well as a powerful anthropogenic pressure, the risk of the species falling out of from the studied phytocoenoses is not manifested.

The reasons for the decrease in the number of *C. calceolus* populations are picking the plants for bouquets, digging up plants, trampling, habitat change, deforestation, melioration, reduction of insect-pollinating populations and symbionic fungi. Restoration of natural populations of the species is difficult due to the long development cycle and high specificity towards mycorrhiza-forming symbionts.

Structure of populations of *Epipactis palustris* (L.) Crantz. Epipactis palustris is a Eurasian species, the habitat area of which covers the Scandinavian Peninsula, Denmark, England, France, Spain, Italy, the northern part of the Balkan Peninsula, Germany, the middle and southern strip of the European part of the former USSR, the Caucasus, Northern Iran, Asia Minor, Syria, Lebanon, North Asia from the Urals to the Sayans, Central Asia, the Himalayas, North Africa. In Ukraine, this species is usually common on Polissia, quite rare in the northern part of the forest steppe, and even less often in the south of the forest steppe. In the zone of the steppe it can be found near the Dnieper and the Donets rivers, in Kherson region on Tendra Spit and on the island of Dzharylgach. In the Carpathians it occasionally occurs in the Chornohora, in the Gorgany, the Eastern Beskydy and in the Precarpathians. Very rarely it can be found on the Southern coast of the Crimea (Didukh, 2009).

On the territory of the Volhynian Upland *E. palustris* is distributed throughout the territory. Mainly the species is confined to the eutrophic herbage and peat bogs of the Scheuchzerio-Caricetea nigrae class. It also can be found as a part of cereal and grass swamp meadows. Quite often there are other rare species of carbonate bogs-*Cladium mariscus* (L.) Pohl, *Carex davalliana* Smith., *Dactylorhiza incarnata* (L.) Soo, *D. Majalis* (Reichenb) P.F. Hunt et Summerhayes, Schoenus ferrugineus L.

To study the current state of populations of *E. palustris*, the following registry areas were selected: 1) the outskirts of the

village of Kopytkiv, Zdolbuniv raion, Rivne oblast; 2) the outskirts of the village of Miatyn, Mlyniv raion, Rivne oblast; 3) the outskirts of the city of Dubno, Rivne oblast.
On the outskirts of the village of Kopytkiv *E. palustris* was discovered by us for the first time. The population of the species was quite numerous and occupied a large area, while localities of the species were concentrated by several clumps on 1 m^2. In the spatial structure the population was placed in spots throughout phytocoenosis. Near the village of Miatyn, Mlyniv raion, the *E. palustris* population is slightly smaller, denser, located in a phytocoenic spot. On the outskirts of the city of Dubno the population of *E. palustris* is the smallest of the studied ones and is located in a phytocoenosis group of several clumps.
The ontogeny spectrum of the studied populations of *E. palustris* was determined on the basis of methodology of M.H. Vahrameeva (Vahrameeva et al., 1987). As a phytocenotic quantitative unit, an overhead sprout was used, as it is impossible to identify the integrity of specimens without digging them out. Given that it is extremely difficult to elicit juvenile and immature specimens in the natural environment, we took into account only the virginile (v) and generative (g) age of the E. palustris. The results are presented in Table 5 and on Figure 5.

Table 5. Spectra of ontogenetic stages of populations *Epipactis palustris* in the territory of the Volhynian Upland.

Location	**Area**	**Age stages**	
		v	**g**
the outskirts of the village of Kopytkiv, Zdolbuniv raion, Rivne oblast.	5 ha	127	378
		25.1	74.85
the outskirts of the village of Miatyn, Mlyniv raion, Rivne oblast.	625 m^2	58	112
		34.1	65.88
the outskirts of the city of Dubno, Rivne oblast	10 m^2	35	65
		35	65

Note. The numerator shows absolute values, the denominator – their percentage ratio.

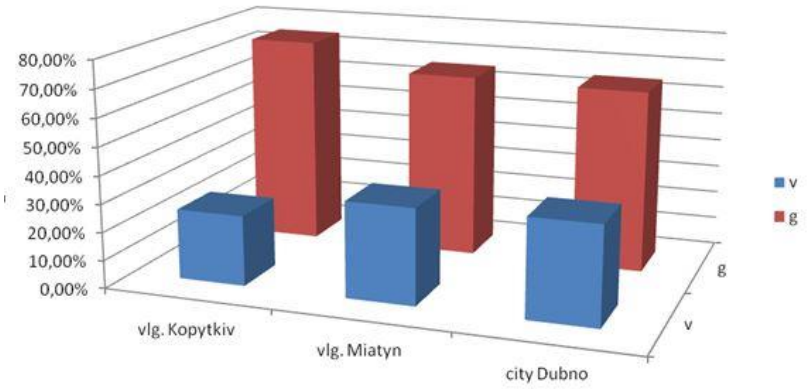

Figure 5. Age spectrum of the populations of *Epipactis palustris* in the territory of the Volhynian Upland.

E. palustris reproduces well in a vegetative way, thus forming dense patterns in phytocoenoses where it grows. The plants are not prone to soil and air humidity, but are sensitive to disturbance of the hydrological regime. The *E. palustris* populations studied by us are in a progressive state, are well reproduced and occupy stable positions in the investigated phytocoenoses.
The structure of the populations of *Cladium mariscus* (L.) Pohl. Cladium mariscus is a polyzonal European-subatlantic species, which is located on the eastern border of Eastern Europe. In Ukraine there are two subspecies of C. mariscus: subsp. martii, which is common in the coastal strips of the Black Sea Region and in the Crimea and subsp. mariscus, which is common in the continental part of the Volhynian Upland and Lower Polissia.
There were mentioned 11 places of *C. mariscus* areas of habitat (Melnyk & Baranskij, 2006) for the west of Ukraine. Most of them are confined to the Volhynian Upland and, in particular, Rivne Oblast: in the flood plain of the Ustia river near the village of Derman, Zdolbuniv raion; between villages Ivachkove and Novomylsk, Zdolbuniv raion; in the flood plain of the Horyn River between the villages of Posiahva, Hoshcha raion and Taikury, Zdolbuniv raion; in the outskirts of Pereverediv village of Mlyniv raion.
The results of modern research have shown that of the known locations of *C. mariscus* area on the territory of Volhynian forest steppe were preserved the following:
- *C. mariscus* population near Derman village, Zdolbuniv raion, although its state is worrisome (the population is not numerous and is represented by several clumps);
- in the flood plain of the Horyn River between the villages of Posiahva and Taikury, the population is not numerous or dense, and is represented by separate specimens.
In addition, we have discovered new habitats of the species at Volhynian Uplands:
- the outskirts of city of Dubno, Rivne oblast (the largest of the identified *C. mariscus* populations in the territory of the Volhynian Upland);
- the outskirts of Kopytkiv village, Zdolbuniv raion of Rivne oblast, where the species is represented by several hundred

specimens;

- the outskirts of Markovychi, Lokachi raion, Volyn oblast. The population of the species is numerous.

In addition to the above-mentioned locations of *C. mariscus*, we have confirmed the presence of localities of the species in the Mlyniv raion, near the village of Viinytsia, at Zahaine swamp. Growth of the species in this territory is recorded in the diary of the expedition T.L. Andrienko and G.M. Antonova in 1987. This location of the species is also given in the work and V.I. Melnik (Melnik & Baranovsky, 2006). The latter work refers to the group of C. mariscus in the valley of the Ikva River at the wetland Miatyn, near the village of Miatyn. *C. mariscus* forms a monodominant group on a small lake shore. Interestingly, on this wetland, the *C. mariscus* groups have spread to areas that are free from vegetation after the peat extraction.

In general, the location of *C. mariscus* in the Volhynian Upland is concentrated in the central and eastern regions. Most of *C. mariscus* populations are confined to transformed phytocoenoses, where typical bog species are gradually replaced by the meadows ones.

For a detailed study of the present stage of *C. mariscus* populations, we selected the following locations: 1) near the village of Derman Druha, Zdolbuniv raion, Rivne region; 2) in the outskirts of Kopytkiv village, Zdolbuniv raion, Rivne region; 3) near city of Dubno, Rivne oblast.

Near Derman Druha village state of species populations is extremely unsatisfactory – regressive. Only individual localities of species recorded. Apparently this is due to a change in the hydrological regime of habitat area. Despite the conservation status on the territory of the array the harvesting of peat is carried out.

In the wetland near the village of Kopytkiv, Zdolbunivsky raion of Rivne oblast, the *C. mariscus* population is confined to the wetland with an area of 50 ha. The *C. mariscus* population is located within a wetland ranging up to 500 m in width and 1.5 km in length. It can be found in the form of large spots that clearly stand out against the background of the bog grassland with a light blue tint of its color. The population density and number are quite high. In this location there is a regular massive flowering and fruiting, and the high potential of vegetative reproduction indicates the high activity of the *C. mariscus* population.

In the outskirts of the city of Dubno, Rivne oblast, a unique wetland is explored, where in areas with transformed vegetation rare plant species were still preserved. The total area of the wetland reaches about 50 ha. The area occupied by the *Cladium mariscus* population is quite significant. The analysis of cenopopulations with the participation of *Cladium mariscus* shows that this population is the largest of the existing on the territory of the Volhynian Upland. Localities of the species are concentrated in large spots.

Given the long rhizome type of species growth, we took into account only two age states: virginile (v) and generative (g). The results are presented in the Table 6 and Figure 6.

The main causes of the degradation of *C. mariscus* populations are: the change in the hydrological regime of habitat areas and, as a consequence, the transformation of bog vegetation into the meadow one. Also, the burning of plant formation has a negative influence on the state of the populations of the species. In this case *C. mariscus* plants grow damaged, and some even do not bloom after burning.

Positive effect on the population of *C. mariscus* provides moderately grazing of cattle that does not eat the vegetative mass of the species, but prevents excessive growth of other species of bog and meadow species.

Table 6. Spectra of ontogenetic stages of populations *Cladium mariscus* in the territory of the Volhynian Upland.

Location	**Area**	**Age stages**	
		v	**g**
Near Derman Druha village, Zdolbunivskyi raion, Rivne oblast.	200 m^2	25	29
		46.29	53.7
Near Kopytkiv village, Zdolbuniv raion, Rivne oblast.	50 ha	257	378
		40.47	59.52
Near city of Dubno, Rivne oblast	50 ha	359	476
		42.99	57

Note. The numerator shows absolute values, the denominator-their percentage ratio.

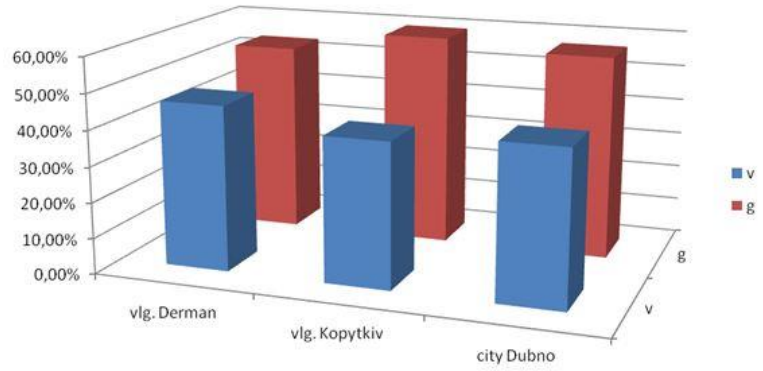

Figure 6. Age spectrum of *Cladium mariscus* populations in the territory of the Volhynian Upland.

The structure of the populations of *Saxifraga granulata* L. Saxifraga granulata is a Middle European and Mediterranean disappearing species on the eastern boundary of its habitat area. In Ukraine, it is known from a few localities on the south of Podillia (Holohory), Opillia, Central Podillia (Tovtry ridge), Volhynian Upland (Didukh, 2009).

In the territory of the Volhynian Uplands, the location of the species is known only from four localities, all of which are concentrated in the Rivne oblast. *S. granulata* grows on mesophytic swollen meadow, glades on the slopes, where the true meadows are formed, among the sparsified forests, is mainly confined to ecotones.

To study the current state of *S. granulata populations*, we selected the following species locations: 1) near the village of Verben, Demydivka raion (two localities); 2) 2.5 km from the village of Khorupan, Mlyniv raion.

Near Verben village, Demidov raion, there are two specimens of *S. granulata*. The first is confined to the ecotone group, stretching along the strip for 60 m. The species population is located on the slopes of the northwest exposition, which at the top goes into rarefied pine forests, and from the bottom-to floodplain meadows. The population of *S. granulata* in this area is the most numerous of the studied and consists of up to 370 specimens. By classification of Malynovskyj K.A. (Malynovskyj, 1986), the *S. granulata* population is linear, as it stretches along the first terrace above flood-plain of the Styr river.

The second locality of the species near the Verben village is located in a rarefied pine forest. The population of *S. granulata* is also linear, spread in a strip of up to 50 m in width, up to 7-8 m in width.

The habitat area of *S. granulata* is located at 2.5 km from the village Khorupan (Mlyniv raion) and is the least numerous. The species population is confined to the edge of mixed forest and is located on the slopes of the northern and northwest exposition.

Table 7. Number and spectra of ontogenetic states of populations *Saxifraga granulata* in the territory of the Volhynian Upland.

Population growth	**Age stages**				**Number of specimens**
	j	**im**	**v**	**g**	
near Verben village, Demidovsky raion	30	38	57	246	371
(locality I, near the Styr river)	8.08	10.24	15.36	66.3	
near Verben village, Demidovsky raion	15	25	39	56	135
(locality II, in the pine forest)	11.1	18.5	28.8	41.48	
2.5 km from the village Khorupan,	28	29	32	30	119
Mlyniv raion	23.5	24.36	26.89	25.2	

Note. The numerator shows absolute values, the denominator-their percentage ratio.

In the course of the research four age-old states of *S. granulata* were distinguished (Table 7). In all studied populations, the proportion of generative specimens predominates (Figure 7).

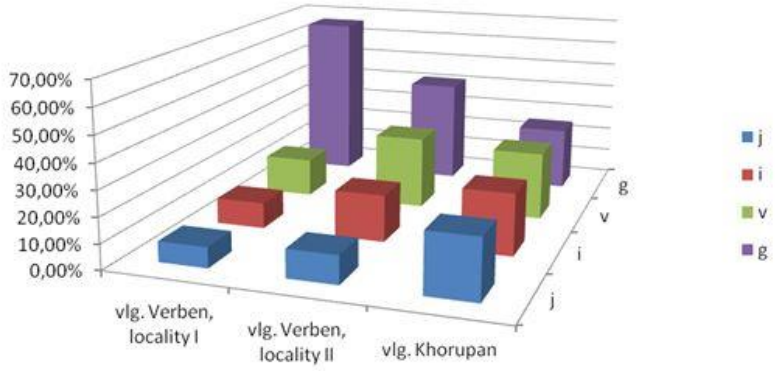

Figure 7. Age spectrum of *Saxifraga granulata* populations in the territory of the Volhynian Upland.

The populations of *S. granulata* in the territory of the Volhynian Upland are small but relatively stable. They are full-fledged, left-handed, centered and linear. The seed-type renewal of species is extremely unsatisfactory. The reasons for the decline in the size of the species include intensive agricultural use of the land: grazing, multiple re-plucking throughout the year, plowing the territories.

Discussion

Thus, in the conditions of the Volhynian Upland, *A. vernalis* populations are full-fringed, normal, with a left-sided ontogenetic spectrum, but-regressive. As pointed out by Polish scientists (Denisow et al., 2008; Denisow et al., 2014), the stability and structure of species populations depend on the dynamics of the development of natural phytocoenoses. The condition of particular populations, their resources, and the area of species growth vary depending on the degree of overgrowing of the meadows and, consequently, changes in lighting conditions. Analysis of the studied populations on the territory of the Volhynian Upland also points to the problem of overgrown with A. vernalis meadows as a priority.

On the territory of the Volhynian Upland, the population of *G. nivalis* is confined to broad-leaved forests on high hills. The parameters of the species's cenopopulations vary somewhat depending on the ecological-cenotic conditions of growth, as well as the location within the range. On the Volhynian Upland populations of G. nivalis are characterized by homeostasis, centred age spectrum and average density. The maximum density of species populations is typical especially for wet areas. According to the data (Doroshenko, 2006), the populations of *G. nivalis* in the Lviv region in the conditions of dry sedge beech forests have a minimum density. The low population density of *G. nivalis* also determines the prevalence of seed reproduction and low intensity of vegetative reproduction. The density of species populations decreases in the eastern direction. Populations located near the western boundary of the range are characterized by full-fledged, right-sided ontogenetic spectrum, high performance of seed productivity and vegetative reproduction (Melnyk & Didenko, 2013). The main causes of regressive changes in the populations of *G. nivalis* are deforestation, cattle grazing, opening of recreation zones, flower picking during vegetation, bulb digging (Melnyk & Didenko, 2013; Crook & Davis, 2013).

Populations of the species *C. onopordifolia* can be found only in Ukraine and Poland. In Ukraine, this species grows in less than 20 places, in Poland – only in 4 places. The populations are isolated from each other, so they are very fragmented. In general, there is a tendency for populations to decrease. There is no concern about the population of *C. onopordifolia* in Poland, where they are all protected and stable (Melnyk, 2011). Within Ukraine, two locations of species habitat, studied on the Volhynian Upland, are full-fledged, right-sided, but regressive. On the territory of Podillia, ecological-coenotic conditions of the growth and density of populations of *C. onopordifolia* are similar to those in other locations in the Podolian, Volhynian, Lublin and Małopolska Uplands (Melnyk et al., 2014, 71(2), Melnyk et al., 2014, 71(3); Bzdon & Krechowski, 2012). The main factors of the regression of populations of *C. onopordifolia* are the change of steppe slopes, the transformation of steppe slopes into agricultural land, the planting of steppes by forest crops, and wildfires (Melnyk, 2011).

C. calceolus is a rare but also a widespread species in almost all of Europe (Melnyk et al., 2018, 75(1)). Species populations in Ukraine are small and comprise mostly from several numbers to several dozen specimens; rarely there is a smaller number of species of the population than a few hundred specimens. The structure of populations depends on the anthropic influence on the place of their growth. Homeostatic populations with full-age age spectra are presented in anthropically not disturbed places (Melnyk et al., 2018, 75(2)). Like the populations studied at the Volhynian Uplands, most *C. calceolus* populations in Ukraine have a right-side ontogenetic spectrum (Melnyk et al., 2018, 75(2)). Research by foreign scientists (Flolence et al., 2005) shows a slow and stable dynamics of the species. The key factors in the existence of *C. calceolus* populations, from their point of view, are the survival of adult specimens and the preservation of seeds. Populations with prevalence in the age range of young specimens are more sensitive to environmental changes and may soon disappear. At the same time, protected populations are more durable, since only minor environmental changes occur in protected areas (Flolence et al., 2005). Anthropic factors (destruction of the growth site, deforestation, intensification of agriculture, grazing, wildfires) lead to degradation and complete elimination of *C. calceolus* populations (Melnyk et al., 2018, 75(2); Rankon & Bilz, 2014). At the same time, the anthropic effects of violations of the soil surface are favorable for the formation of new populations of the species (Melnyk et al., 2018, 75(2)).

Monitoring studies on the condition of *E. palustris* populations show stable species positions in phytocoenoses. The state of the populations of *E. palustris* depends mainly on the species biology and slightly less – on the influence of meteorological

conditions (Kluza-Wieloch & Maciejewska-Rutkowska, 2015). Many years of observations indicate a significant prevalence of generative specimens in populations (Kluza-Wieloch & Wyrzykiewicz-Raszewska, 2016; Khapugin et al., 2016). The greatest threat to the existence of this heliophilic orchid is the overgrowth of species growth sites with tree-shrub vegetation and, as a consequence, shading of the species.

Long-term studies of *C. mariscus* populations indicate their high density and number. The difference in the number of sprouts between periods of growth is negligible (Conway, 2015). It is the high density of underwater evergreen perennial stems of *C. mariscus*, with a height of more than two meters and abundant fruiting, which provides stability of species populations, and also forms a natural barrier against the penetration of other species (Namura-Ochalska, 2005). However, despite the abundant formation of seeds, the species reproduces mainly vegetatively and only seeds that hibernate on the parent, able to sprout (Namura-Ochalska, 2005). Obviously, the negative effect on the condition of *C. mariscus* populations is due to the burning of the grass and the change in the hydrological regime.

According to the studies of *S. granulata* populations, not only on the territory of the Volhynian Upland, but also throughout Ukraine, the species is confined to the ecotones of the forest glades. Growing in the ecotone between forest or shrub and meadow vegetation in the valley of rivers, it forms linear populations, which include a small number of specimens. Studies in the territory of Ukraine show that *S. granulata* is disappearing as a species. The degradation is caused by the agricultural transformation of land in the river valleys, early haymaking, cattle grazing and excessive recreational pressure (Melnyk et al., 2014).

Conclusions

Consequently, most of the investigated populations of rare and endangered species of flora degrade. A comparative analysis of species populations from the territory of the Volhynian Uplands and populations from other areas of habitat indicates a regressive change in the state of populations caused by almost the same factors. The main reason for the regression of populations of rare species of flora is anthropogenic impact.

References

Berg, C., Abdank, A., Isermann, M., Jansen, F., Timmermann, T., & Dengler, J. (2014). Red List and conservatoin pripritization of plant communities - a methodological framework. Applied Vegetation Science, 17, 504-515. doi: 10.1111/avsc.12093

Blinova, I. V. (2016). Spatial population structure of rare orchid species in rich fens in the central part of Murmansk oblast. Russian Journal of Ecology, 47(3), 234-240. doi: 10.1134/s1067413616030036

Bowman, M., Davies, P. & Redgweii, C. (2010). The Convention on the Conservation of European Wildlife and Natural Habitats. Cambridge University Press, pp: 297-345. doi: 10.1017/CB09780511975301.012

Brigham, C. A., Schwartz, M. W. (2003). Population viability in plants: conservation, management, and modeling of rare plants. Springer-Verlag Berlin. Heidelberg New York. doi: 10.1007/978-3-662-09389-4

Bzdon, G. & Krechowski, J. (2012). Carlina onopordifolia Besser in protected areas of Western Podillya region (Ukraine). Annales UMCS, Biologia. The Journal of Maria Curie-Sklodowska University, 66 (2)., 7-14. doi: 10.2478/v10067-012-0001-4

Conway, V. M. (2015). Cladium mariscus. Journal of Ecology, 30 (1), 211-216. doi: 10.2307/2256697

Corlett, R. T. (2016). Plant diversity in a changing world: status, trends, and conservation needs. Plant Diversity, 38 (10-16), 10-15. doi: 10.1016/j.pjd.2016.01.001

Crook, V. & Davis, A. (2013). Galanthus nivalis. The IUCN Red List of Threatened Species 2013. doi: 10.2305/ICN.VK.2011. – 1.RLTS.T 162168A5551773.en

Denisow, B., Wrzesien, M. & Cwener, A. (2008). The estimation of Adonis vernalis populations in chosen patches of Lublin upland. Acta Agrobotanica, 61 (1)., 3-11. doi: 10.5586/ aa.2008.001

Denisow, B., Wrzesien, M. & Cwener, A. (2014). Pollination and floral biology of *Adonis vernalis* L. (Ranunculaceae) - a case study of threatened species. Acta Societatis Botanicorum Poloniae, 83 (1), 29-37. doi: 10.5586/asbp.2014.001

Diekson, B. (2013). Endangered Species Threatened Convention. The Past, Present and Future of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora. London. doi: 10.5962/bhl.title.45024

Doroshenko, K. V. (2006). Parameters changes in coenopopulations of Galanthus nivalis L. according to different ecological and coenotic conditions (Lviv Regoin, Ukraine). Chornomorsk Bot Z, 2(1), 36-49/ doi:10.14255/2308-9628/06.21/2

Falk, D. A. & Holsinger, K. E. (1991). Genetics and conservation of rare plants. Oxford university press, New York. doi: 10.2307/4117957

Flolence, N., Brzosko, I. & Till-Bottrau, D. (2005). Population viability analysis of Cypripedium calceolus in a protected area: longevity, stability and persistence. Journal of Ecology, 93 (4)., 716-726. doi: 10.11111/j.1365-2745.2005.0101.x

Heywood, V. H. (2009). A global strategy for the conservation of plant diversity. Grana, 34, 363-366. doi: 10.1080/00173139509429467

Khapugin, A., Silaeva, T., Semchuk, A. & Kunaeva, E. (2016). Populations of Orchis militaris, Epipactis palustris and Malaxis monophyllos in the Republic of Mordovia (Central Russia). Biodiversity Research and Conservation, 42 (1), 33-40. doi: 10.1515/biorc-2016-0012

Kluza-Wieloch, M. & Maciejewska-Rutkowska, I. (2015). Population of *Epipactis palustris* (L.) Crantz (Orchidaceae) in South-Western part of Poznan. Steciana, 19(4). 231-238. doi: 10.12657/steciana.019.023

Kluza-Wieloch, M. & Wyrzykiewicz-Raszewska, M. (2016). Current status of the population of Epipactis palustris (L.) Crantz (Orchidaceae) in the Wielkopolska National park. Steciana, 20(4). 201-207. doi: 10.12657/steciana.020.021

Konischuk, V. V. (2016). Perspectives of researches of preserving biodiversity of agrosphere in Ukraine. Visnyk Agrarnoi Nauky. 94 (3), 53-57. doi: 10.31073/agrovisnyk201603-11

List of rare, threataned and endemic plants in Europe. By the IUCN Threataned plants comm. -Kew, United Kingdom. Strasbourg, Council of Europe, 1982. doi: 10.5962/bhl.title.44932

Lohvynenko, I. P. (2018). The prairie vegetation of the Volynski Highlands and the challenges of its protection. Lesia Ukrainka Eastern European National University Scientific Bulletin, Series: Biological Sciences, 4 (377), 37-43. doi: 10.29038/2617-4723-2018-377-37-43

Luzuriaga, A. L., Escudero, A., Albert, M. J. & Gimenez-Benavides, L. (2006). Population structure effect on reproduction of a rare plant: beyond population size effect. Canadian Journal of Botany, 84(9), 1371-1379. doi: 10.1139/b06-078

Malynovs'kyj, K. A.(1986). Populjacijna biologija roslyn: cili, zavdannja i metody. Ukrai'ns'kyj Botanichnyj Zhurnal. 43(4),5-12.

Melnyk, V. I. & Parubok, M. I. (2004). Gorycvit vesnjanyj (*Adonis vernalis* L.) v Ukrai'ni Kyi'v:Fitosociocentr.

Melnyk, V. I.,Volodymyrec, V. O. & Kuzmishyna, I. I. (2005). Geografichne poshyrennja ta umovy miscezrostan' Carlina onopordifolia Besser ex Szafer, Kulcz. et Pawl. (=*Carlina acanthifolia* All.) na Volyns'kij vysochyni. Visnyk nac. naukovo-pryrodnychogo muzeju. Serija botanichna. ch. 2. – Kyi'v, 2005, 489-495.

Melnik, V. I. & Baranskij, A. R. (2006). Dinamika areala *Cladium mariscus* (Cyperaceae) v Ukraine. Bot. Zhurn, 91(4), 565-571.

Melnyk, V. (2011). *Carlina onopordifolia*. The IVCN Red List of Threatened Species 2011. doi: 009/10. 2305/IUCN.UK.2011-1.RLrs. T161848A5503822.en

Melnyk, V. I. & Didenko, S. Ja. (2013). The species of the genus Galanthus L. (Amaryllidaceae) in Ukraine. NBS NAN UKrai'ny. Kyiv.

Melnik, V. I., Skoroplas, I. O. & Batochenko, V. M. (2014). Modern status of population of Carlina onopordifolia in western Volhynia-Podillya. Ukr Bot J, 71 (2), 196-202. doi: 10.15407/ukrbotj71.02.196

Melnik, V. I., Skoroplas, I. O. & Vakoluk, V. D. (2014). *Carlina onopordifolia* (Asteraceae) in eastern Podillya. Ukr Bot Zhurn, 71(3), 324-329. doi: 10.15407/ukrbotj71.03.324

Melnyk, V. I., Baransky, A. R., Volodymyrets, V. A., Lohvynenko, I. P. & Gutsman, S. V. (2014). *Saxifraga granulata* (Saxifragaceae) in Ukraine. Ukr. Bot. J, 71(4)., 517-521. doi: 10.15407/ukrbotj71.04.517

Melnyk, V. I., Shynder, O. I., & Nesyn, Yu. D. (2018). Distribution of *Cypripedium calceolus* (Orchidaceae) in Ukraine. Ukr.Bot. J, 75(1), 20-32. doi: 10.15407/ukrbotj75.01.020

Melnyk, V. I., Shynder, O. I., & Nesyn, Yu. D. (2018). Habitats and the current state of populatoins of Cypripedium calceolus (Orchidaceae) in Ukraine. Ukr.Bot. J, 75(2), 160-168. doi: 10.15407/ ukrbotj75.02.160

Mosyakin, S. & Fedoronchuk, M. (1999). Vascular plants of Ukraine. A nomenclatural. Kiev.

Mykhailova, O. (2013). Phytocenological description of population of rare species of genus Crambe L. in Crimea. Biologija, 59(3), 263-270. doi: 10.6001/biologija.v59i3.2788

Namura-Ochalska, A. (2005). Contribution to the characteristic of *Cladium mariscus* (L.) Pohl population in the initial zone of floating mat on an oligo-humotrophic lake in north-eastern Poland. Acta Societatis Botanicorum Poloniae, 74 (2), 167-173. doi: 10.5586/asbp.2005.022

Quinones-Perez, C. Z., Simental-Rodriguez, S. L., Saenz-Romero, C., Jaramillo-Correa, J. P. & Wehenkel, C. (2014). Stapial genetic structure in the very rare and species-rich Piceachihuahuana tree community (Mexico). Silvae Genetica, 63(4), 149-159. doi: 10.1515/sg-2014-0020

Rankon, H., Bilz, M. (2014). *Cypripedium calceolus*. The IVCN Red List of Threatened. Species 2014: e.T 162021A3316125. doi: 10.2305/IVCN.UK 2014-1RLrs, T162021A43316125.en

Red data book of Ukraine. Didukh, Y. P. (2009). Plant kindom. Kyyiv. Globalkonsalting.

Szcecinska, M., Sramko, G., Wolosz, K. & Sawicki, J. (2016). Genetic diversity and population structure of the rare and endangered plant species Pulsatilla patens (L.) Mill in East Central Europe. Plos. One a peer-reviewed, Open Aceess Journal, 11(3). doi: 10.1371/journal.pone.0151730

Torres, E., Iriondo, J. M., Escudero, A. & Perez, C. (2003). Anajysis of within-population spatial genetic structure in Antirrhinum microphyllum (Scrophulariaceae). American Journal of Botany, 90(12), 1688-1695. doi:10.3732/ajb.90.12.1688

Turnbull, L. A., Coomes, D. A., Purves, D. W. & Rees, M. (2007). How spatial structure alters population and community dynamics in a natural plant community. Joutnal of Ecology, 95, 79-89. doi: 10.1111/ j.1365-2745.2006.01184.x

Vahrameeva, M. G., Denisova, L. V., Nikitina, S. V. (1987). Osobennosti struktury cenopopuljacij vidov semejstva orhidnyh. Populjacionnaja biologija rastenij: Materialy konferencii. M.: Nauka. 1987, 147–150.

Vavrysh, P. O. & Sobko,V. G. (1984). Ridkisna populjacija Cypripedium calceolus L. na Volyns'kij vysochyni. Ukr. Botan. Zhurn, 41(2),86-88.

Volis, S (2016). How to conserve threatened Chinese plant species with extremely small populations? Plant Diversity, 38 (1), 45-52. doi: 10.1016/j.pld.2016.05.003

Watanabe, A., Kouichi, G. & Izumi, W. (2003). Effects of population spatial structure on the quantity and quality of seeds set by Primula sieboldii (Primulaceae). Plant Species Biology, 18 (2-3), 107-121. doi: 10.1111/j.1442-1984.2003.00091.x

Zlobin, Ju. A., Skljar, V. G., Klimenko, A. A. (2013) Populjacii redkih vidov rastenij: teoreticheskie osnovy i metodika izuchenija: monografija. Sumy: Universitetskaja Kniga.

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