Original article

An evaluation of the conservation status of the forest vegetation of the Volyn Upland, Ukraine

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ABSTRACT

The current conservation status of the rare vascular plant species and rare forest communities of the Volyn Upland (Ukraine) was characterized and analyzed. We found 14 rare plant species belonging to the Red Data Book of Ukraine in this territory (*Lycopodium annotinum* L., *Allium ursinum* L., *Cephalanthera longifolia* (L.) Fritsch, *Cephalanthera rubra* (L.) Rich., *Cypripedium calceolus* L., *Epipactis atrorubens* (Hoffm.) Schult., *E. helleborine* (L.) Crantz, *Lilium martagon* L., *Listera ovata* (L.) R. Br., *Neottia nidus-avis* (L.) Rich., *Platanthera bifolia* (L.) Rich., *P. chlorantha* (Cust.) Reichenb., *Galanthus nivalis* L., *Carex umbrosa* Host) and 28 locally rare species preserved within the Volyn, Rivne and Lviv regions. The major threats for these species were indicated. Four rare associations, according to the Green Data Book of Ukraine, were studied in the Volyn Upland (*Carpineto (betuli)–Quercetum (roboris) hederosum (helicis)*, *Carpineto (betuli)–Fraxineto (excelsioris)–Quercetum (roboris) alliosum (ursini)*, *Tilieto (cordatae)–Carpineto (betuli)–Quercetum (roboris) alliosum (ursini)* and *Pinetum (sylvestris) caricosum (humilis)*) and their structure, main features and status were characterized in detail. The importance of further research, and the development of recommendations for the conservation and continued preservation of these forest ecosystems of the Volyn Upland was highlighted.

KEY WORDS: forest vegetation, rare species and communities, Volyn Upland, Ukraine

ARTICLE HISTORY: received 27 November 2020; received in revised form 11 February 2021; accepted 17 February 2021

1. Introduction

Forest plant communities are one of the most widely distributed and valuable vegetation types in the territory of Western Ukraine. Currently degradation of the environment and all the components of ecosystems, especially forests as wood sources, are common in this region. This process is caused by the fragmentation of the forest vegetation, which occurs due to its being depleted mostly by felling and recreation.

The problem of biodiversity conservation in Ukraine is recognized as a priority at the state level. Therefore, the main tasks in this area are the preservation and restoration of natural and disturbed forests as habitats for individual species, plant communities and landscape components;

a transition to the balanced use of forest resources; and the minimization of direct and indirect impacts on forest ecosystems and their components. This problem can be solved not only by the protection of several plant species but by the conservation of whole natural forest communities. It will help to solve the threefold ecological problem – conservation of forests, rare species and these ecosystems in general (SHELYAG-SOSONKO, 2003).

By the systemic conservation concept forest communities in the territory of the Volyn Upland should be saved as the most vulnerable and damaged by human activity component of the vegetation. The location of the region on the edge of two geobotanical provinces – the Central European province of deciduous forests and the Eastern European province of coniferous-deciduous and

deciduous forests (DIDUKH & SHELYAG-SOSONKO, 2003) has contributed to the common distribution of hornbeam-oak forests and their derivative communities. The conditions of the studied region has led to the presence of several unique complexes of rare species and communities, especially pine forests with a domination of *Carex humilis* Leyss in the herb layer, steppes with *Stipa capillata* L. and carbonate fens with *Schoenus ferrugineus* L., *Cladium mariscus* (L.) Pohl and *Carex davalliana* Sm.

Many researchers have studied different types of vegetation within the Volyn Upland, but a comprehensive analysis of the current state of the rare component of these forest ecosystems is still missing. Some data about rare vascular plant species of the flora of the Volyn Upland can be found in articles by different scientists (PANEK, 1930; DIDUKH, 1993; MELNYK, 2000; ANDRIENKO & PRYADKO, 2001; KUZMISHINA, 2008ab; DATSYUK & LOGVINENKO, 2013; LOGVINENKO, 2014ab; VOLODYMYRETS, 2016). LOGVINENKO (2014ab) provided a study of the rare flora in the Volyn Upland and published a list of rare species of this region, made a brief analysis and recommended some measures for their protection, at the population level, of several of the most vulnerable representatives of such plants. Studies of rare plant communities of the Volyn Upland have been carried out by the author and presented in two articles (DATSYUK, 2011, 2012ab) and include a list of rare plant communities and their geobotanical characteristics, features of their distribution in this region, their current status and representation in the modern nature reserve network. However, the rare phytodiversity of forests as separate ecosystems has not been studied before.

The aims of this article were to evaluate the forest vegetation in the territory of the Volyn Upland by analysis of rare vascular plant species preserved in the national "Red Data Book of Ukraine" (DIDUKH, 2009a) and at regional levels, and of rare plant communities from "The Green Data Book of Ukraine" (DIDUKH, 2009b) which are characterized for the forests of this region. To achieve these aims the following tasks were realized: analysis of herbarium data and literatural sources, organization of field expeditions and the analysis of their results.

2. Materials and methods

2.1. Study area

The Volyn Upland is a flat undulating plain in North West Ukraine within the Volyn, Rivne and the most northern parts of the Lviv and Khmelnytskyi

regions. It stretches from the River Western Bug in the west to the River Korchyk (a tributary of River Sluch) in the east for almost 200 km; the width from north to south is 45–50 km. Total area is about 10,000 km². The average altitude is 220–250 m, the maximum – is 345 m (Mizotsky ridge). This region borders the Prypiyat-Slutsk lowland in the north, the Małopolska plain and the Dniπρο Upland in the south and the Lublin Upland in the west (the latter is a natural continuation of the research territory). The total slope of its surface is oriented from south to north. Geomorphologically it is distributed on the western slope of the Ukrainian Shield and the Volyno-Podilsky monocline. It consists of limestone and marls, and is mostly covered by forests. The relief of the Volyn Upland was formed as a result of neotectonic uplifts, accompanied by the active development of river-valley and ravine-beam forms. The depth of dismemberment of the region by river valleys of the Western Bug, Styr, Ikva and Goryn and their tributaries is 35–50 m, ravine-beam grid – 25–30 m. They are represented by the Koretska, Povchanska uplands and Mizotsky ridge. Linear and planar erosions are developed from modern geomorphological processes. Karst landforms are common, so there are many small karst features within the Volyn Upland.

According to the physical-geographical zoning of Ukraine the studied territory belongs to the Novovolynsk-Sokal, Lokachiv-Torchyn, Olytsia-Rivne, Ostroh-Goshchansky, Gorokhiv-Berestechkivsky, Povchansko-Mizotsky physical-geographical regions (MARYNYCH ET AL., 2003).

The Volyn Upland is the one of the most controversial regions in terms of zonal and provincial geobotanic affiliations. LAVRENKO (1947) attributed it to the Polissya sub-province of the Deciduous Forest zone. Later BILYK & BRADIS (1962) identified it as a Forest-Steppe zone. SHELYAG-SOSONKO (1974) believed that the plaque vegetation of the Volyn Upland is similar to the analogous vegetation type of the Western Pokut Upland and differs from the Polissya sub-province. Territorially the Volyn Upland of Ukraine is separated from the Western Pokut Upland by a narrow strip of the Małopolska Lowland genetically dividing the single upland into two parts: Volyn and Podillia Uplands. Based on features of relief, soil types and vegetation both these parts are unique so SHELYAG-SOSONKO (1974) considered that attribution of the Volyn Upland to the Polissya subprovince was inexpedient. SZAFER (1923) attributed this territory to the southern Pontic province but in the "Geobotanical Zoning of Ukrainian RSR" (BARBARYCH, 1977) it was considered as "Volyn Island" in the northern Polissya sub-

province. According to the current geobotanical zoning (DIDUKH & SHELYAG-SOSONKO, 2003) these different points of view are explained by the fact that this territory is considered within the zoning of each state in isolation without a sufficiently critical assessment of neighboring territories. It cannot be attributed to the Pontic province as this is a steppe zone. It is also impossible to join it to the Forest-Steppe zone and to the Ukrainian Polissya since high relief with loess deposits with grey and podzolic chernozems and chalk outcrops has been characterized for this area. The presence of steppes and hornbeam-oak forests and the absence of pine forests are not typical for Polissya. The vegetation of the Volyn Upland is similar to the Western Podillya region, but beech forests are not found on this upland. At the same time the studied territory is a geomorphological continuation of the Lublin Upland combined with the Kielce-Sandomierz Upland and the Kraków-Czestochowa Upland and is a part of the Western Podillya-South Poland geobotanical sub-province (DIDUKH & SHELYAG-SOSONKO, 2003). That is why, the better solution would be to include the Volyn Upland in the European Deciduous Forest region of the Central European Deciduous Forest province of the South Poland-Western Podillya subcontinent of the Liublin-Volyn geobotanical district (DIDUKH, SHELYAG-SOSONKO, 2003) (Fig. 1).

Intensive human activity in the past has negatively affected the preservation of forest plant communities. Now the average forest cover of the Volyn Upland is about 10% (Fig. 2). The largest areas of forests are distributed in the western and southern part of this territory, the eastern part is characterized by an almost complete absence of

forests, the northern part by the presence of several local forest boundaries.

Fig. 1. The research territory (marked by an orange line) on the fragment from the map of the geobotanical zoning of Ukraine

I – Pannonian province of heliophyllous and nemoral forests, steppe meadows and meadow steppes: 1 – Transcarpathian district; II – Carpathian-Alps mountain province of forests and high mountain vegetation: 2 – Verkhovyna-Beskydy district, 3 – Marmarosy-Chornohora-Sydyovets district; III – Central-European province of broadleaved forests: 4 – Sandomyr-Verkhnyodniprovskiy district, 5 – Opillia-Kremenets district, 6 – Pokuttia-Medobory district, 7 – Roztochchia district, 8 – Malopoliskiy district, 9 – Liublinsko-Volynskiy district; IV – East-European province of conifer-broadleaved and broadleaved forests: 10 – Zakhidnopoliskiy district, 11 – Verkhnioprypiatskiy district, 12 – Tsentralnopoliskiy district; V – East-European Forest-Steppe province of oak forests, steppe meadows and meadow steppes: 13 – Pivnichnopoliskiy district, 14 – Tsentralnopoliskiy district, 15 – Bessarabian district

Fig. 2. Satellite map of the forests of the studied region (green colour – forests, red line – borders of the research territory)

2.2. Data collection and methods

This work is based on our own geobotanical research conducted between 2009–2020. We performed a critical analysis of herbarium collections (about 1 000 specimens), from National Herbarium

of Ukraine (Kyiv) (KW), M.M. Grishko National Botanical Garden of the National Academy of Sciences of Ukraine (KWA), Volyn Local Museum (Lutsk), Rivne Local Museum (Rivne), and also of data from different literature sources.

Traditional field methods of geobotanical research were used for the study of forest vegetation. Field research methods included a detailed route method, laying of temporary test areas and geobotanical relevés of the vegetation. The optimal routes for research and forest areas were selected using forest taxation maps (M 1: 25000). Geobotanical relevés were carried out on areas of 25 × 25 m (625 m²), provided in homogeneous conditions by means of an approximate assessment with an indication of all vascular plant species and their projective cover abundance. Geographical coordinates and altitude of the studied plots were recorded using GPS.

3. Results

According to our data the forest vegetation of the Volyn Upland belongs syntaxonically to three classes: *Quercus-Fagetum* Braun-Blanquet et Vlioger in Vlioger 1937 s.l. (oak and hornbeam forests), *Alnetum glutinosae* Braun-Blanquet et Tüxen ex Westhoff et al. 1946 (alder forests) and *Salicetum purpureae* Moor 1958 (willow and poplar forests).

We conducted an inventory and an analysis of the current state of rare species of flora and vegetation distributed in forest ecosystems of the Volyn Upland. According to KUZMISHINA (2008b) the flora of the Volyn Upland includes 71 species from the second edition of the Red Data Book of Ukraine (SHELYAG-SOSONKO, 1996). LOGVINENKO (2014ab) indicated 75 species from the third edition of the Red Data Book of Ukraine (DIDUKH, 2009a). According to the results of our research and analysis of herbarium and literature sources (DIDUKH, 1993; MELNYK, 2000; ANDRIENKO & PRYADKO, 2001; KUZMISHINA, 2008ab; DATSYUK & LOGVINENKO, 2013; DATSYUK & GOLOVKO, 2014; LOGVINENKO, 2014ab; VOLODYMYRETS, 2016) the studied forest flora includes 14 species from the Red Data Book of Ukraine: *Lycopodium annotinum* L., *Allium ursinum* L., *Cephalanthera longifolia* (L.) Fritsch, *Cephalanthera rubra* (L.) Rich., *Cypripedium calceolus* L., *Epipactis atrorubens* (Hoffm.) Schult., *E. helleborine* (L.) Crantz, *Lilium martagon* L., *Listera ovata* (L.) R. Br., *Neottia nidus-avis* (L.) Rich., *Platanthera bifolia* (L.) Rich., *P. chlorantha* (Cust.) Reichenb., *Galanthus nivalis* L. and *Carex umbrosa* Host.

Lycopodium annotinum (Lycopodiaceae) is a vulnerable species on the southern edge border of its range and distributed in coniferous and mixed forests, often spruce moist forests of the class *Vaccinio-Piceetum*. It is quite rare in the territory of the Volyn Upland. The main threats for this species are its collection as an ornamental and medicinal plant, deforestation, and increasing recreation.

Allium ursinum (Alliaceae) is a Central European mountain species distributed in shaded deciduous and mixed forests of the order *Fagetalia sylvaticae* Pawłowski 1928 (*Quercus-Fagetum*). Within the Volyn Upland it sporadically occurs in the northern and southern parts of this region. The main threats are related to the vulnerability of this species to anthropogenic factors (continuous deforestation, leaf cutting as a food plant and trampling of its leaves).

Cephalanthera longifolia (Orchidaceae) is a rare species found in light deciduous forests of the *Quercus-Fagetum* class. Within the Volyn Upland several populations of this species were found in the southern part. Its main threats are deforestation and removal as a decorative plant.

Cephalanthera rubra (Orchidaceae) is a rare species distributed in shady and sparse deciduous and coniferous forests, among shrubs and on the edges. Within the Volyn Uplands it occurs sporadically in small populations. Its main threats are removal as a decorative plant, destruction of habitats, deforestation, and replacement of forests by tree plantations.

Cypripedium calceolus (Orchidaceae) is a vulnerable mainly boreal Eurasian species distributed in deciduous and coniferous-deciduous forests, on edges, glades and meadows, among shrubs, and is found mainly on limestone soils. Within the Volyn Upland it was found in several localities in the western and eastern parts. Its main threats are deliberate removal and trampling, changes in its natural habitats, and deforestation.

Epipactis atrorubens (Orchidaceae) is a vulnerable Eurasian species that grows in deciduous, coniferous and mixed forests, and sometimes grows among shrubs. Within the Volyn Upland it is quite rare. The main threats are anthropogenic disturbance of its natural habitats, especially deforestation.

Epipactis helleborine (Orchidaceae) is a polymorphic species, which is typical of different types of forest communities on poor and rich soils with different soil humidity and pH, mainly on limestone soils. It has a sporadic distribution in all territories of the Volyn Upland. The main threats are the violation of ecotopes, continuous felling and excessive recreation.

Lilium martagon (Liliaceae) is a rare species with a disjointed range. It grows in deciduous and coniferous-deciduous forests in mesotrophic conditions, on meadows, and forest edges. Within the Volyn Upland it is not quite rare. The main threats are significant human impact, felling for bouquets, digging of bulbs for cultivation, and deforestation.

Listera ovata (Orchidaceae) is a rare orchid species with a disjointed range. It is characterized

for broadleaved and mixed forests in mesotrophic conditions, meadows and forest edges. Within the Volyn Upland it has a sporadic distribution. The reasons for changes in its populations are human pressure, deforestation, harvesting for bouquets, digging of bulbs for transplanting.

Neottia nidus-avis (Orchidaceae) is a rare Western Palearctic orchid species with a saprophytic (symbiomycotrophic) type of nutrition. It is characterized for shady deciduous, coniferous-deciduous forests, and is mainly from areas with a sparse cover of the herb layer. It has a sporadic distribution in the territory of the Volyn Upland. Its main threats are destruction of habitats, and the negative impacts of recreation and forest management.

Platanthera bifolia (Orchidaceae) is a rare Euro-Mediterranean species, distributed in broadleaved and oak-pine shrubs and on forest edges. It is rather common in the territory of the Volyn Upland. Its main threats are deforestation, recreation, and the picking of its flowers.

Platanthera chlorantha (Orchidaceae) is a rare Euro-Mediterranean species that grows in deciduous and mixed forests, mainly on limestone soils. It is quite rare in the territory of the Volyn Upland. Its main threats are deforestation, destruction of natural forest habitats and other types of anthropogenic activity.

Galanthus nivalis (Amaryllidaceae) is a rare Euro-Mediterranean ephemeroïd plant on the eastern edge of its range. The habitat of this species is confined mainly to oak and hornbeam-oak forests on rich, sufficiently moist soils. It occurs sporadically in the territory of the Volyn Upland. Its main threats are picking of its flowers for sale, digging up its bulbs, and recreational activity.

Carex umbrosa (Cyperaceae) is a rare species on the eastern edge of its range, growing in sparse forests, in bushes, meadows and the edges of carbonate fens. It is quite rare in the territory of the Volyn Upland. Its main threats are excessive recreation, deforestation, and the destruction of ecotypes. The data about rare species conserved in Ukraine on a national level are summarized in Table 1.

In addition, we have established a list of regionally rare species for three administrative regions of the territory of the Volyn Upland (Table 2). Most of them were found in the Volyn region (22 species, including 2 trees, 3 shrubs and 17 herbaceous plants).

Rare communities included in the Green Data Book of Ukraine (DIDUKH, 2009b) in the territory of the Volyn Upland are represented by four associations with a dominant classification:

Table 1. Number of locations of rare species found in the Volyn Upland by the author

Plant species	Number of found locations
<i>Lycopodium annotinum</i>	1
<i>Allium ursinum</i>	5
<i>Cephalanthera longifolia</i>	0
<i>Cephalanthera rubra</i>	0
<i>Cypripedium calceolus</i>	0
<i>Epipactis atrorubens</i>	1
<i>Epipactis helleborine</i>	6
<i>Lilium martagon</i>	15
<i>Listera ovata</i>	0
<i>Neottia nidus-avis</i>	20
<i>Platanthera bifolia</i>	7
<i>Platanthera chlorantha</i>	0
<i>Galanthus nivalis</i>	5
<i>Carex umbrosa</i>	0
Total	61

1. *Carpinetum (betuli)–Quercetum (roboris) hederosum (helicis)* – Corresponding syntaxa from the class *Querco-Fagetea*: 1) *Aceri platanoidis-Fraxinetum excelsioris* Onyshchenko 1998 from the alliance *Tilio platyphylli-Acerion* Klika 1955 and the order *Aceretalia pseudoplatani* Moor 1976; 2) *Isopyro thalictroidis-Carpinetum* Onyshchenko 1998 from the alliance *Carpinion betuli* Issler 1931 and the order *Carpinetalia betuli* P. Fukarek 1968; 3) *Tilio cordatae-Carpinetum* Traczyk 1962 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*).

2. *Carpinetum (betuli)–Fraxinetum (excelsioris)–Quercetum (roboris) alliosum (ursini)* – Corresponding associations from the class *Querco-Fagetea*: 1) *Aceri platanoidis-Fraxinetum excelsioris* Onyshchenko 1998 from the alliance *Tilio platyphylli-Acerion* Moor 1976 and the order *Aceretalia pseudoplatani*; 2) *Circae-Carpinetum* Borhidi 2003 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*; 3) *Isopyro thalictroidis-Carpinetum* Onyshchenko 1998 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*; 4) *Tilio cordatae-Carpinetum* Traczyk 1962 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*.

3. *Tilieta (cordatae)–Carpinetum (betuli)–Quercetum (roboris) alliosum (ursini)* – Corresponding associations from the class *Querco-Fagetea*: 1) *Aceri platanoidis-Fraxinetum excelsioris* Onyshchenko 1998 from the alliance *Tilio platyphylli-Acerion* and the order *Aceretalia pseudoplatani*; 2) *Circae-Carpinetum* Borhidi 2003 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*; 3) *Isopyro*

thalictroidis-Carpinetum Onyshchenko 1998 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*; 4) *Tilio cordatae-Carpinetum* Traczyk 1962 from the alliance *Carpinion betuli* and the order *Carpinetalia betuli*.

4. *Pinetum (sylvestris) caricosum (humilis)* – Syntaxonomy of these communities from the Western Ukraine remains unclear with a lack of phytosociological data and needs further research.

Table 2. Representation of regionally rare forest plant species of the Volyn Upland with an indication of administrative oblasts (regions)

Plant species	Volyn region	Rivne region	Lviv region
<i>Anemone sylvestris</i> L.	+	+	+
<i>Asparagus officinalis</i> L.	+	–	–
<i>Astrantia major</i> L.	+	+	–
<i>Alnus incana</i> (L.) Willd.	+	+	+
<i>Aquilegia vulgaris</i> L.	+	+	+
<i>Asplenium trichomanes</i> L.	–	+	–
<i>Chimaphila umbellata</i> (L.) W. P. C. Barton	+	+	+
<i>Cerasus fruticosa</i> Pall.	–	+	+
<i>Corydalis cava</i> (L.) Schweigg. et Koerte	+	–	–
<i>Clematis recta</i> L.	+	–	–
<i>Cimicifuga europaea</i> Schipcz.	–	+	–
<i>Campanula persicifolia</i> L.	+	+	–
<i>Dianthus carthusianorum</i> L.	+	+	–
<i>Daphne mezereum</i> L.	+	+	–
<i>Geranium phaeum</i> L.	–	+	–
<i>Hepatica nobilis</i> Mill.	+	+	–
<i>Lycopodium clavatum</i> L.	+	+	–
<i>Melittis melissophyllum</i> L.	+	+	+
<i>Moneses uniflora</i> (L.) A. Gray	+	+	+
<i>Polypodium vulgare</i> L.	+	+	+
<i>Polystrihum aculeatum</i> (L.) Roth	+	+	–
<i>Pyrethrum corymbosum</i> (L.) Scop.	+	–	–
<i>Potentilla alba</i> L.	+	–	+
<i>Pyrola rotundifolia</i> L.	–	+	–
<i>Rubus hirtus</i> Waldst. et Kit.	+	–	–
<i>Quercus petraea</i> Liebl.	+	+	+
<i>Calla palustris</i> L.	–	–	+
<i>Vinca minor</i> L.	+	–	–
Total	22	19	11

The rarest communities within the Volyn Upland are the association *Pinetum (sylvestris) caricosum (humilis)*. These phytocoenoses are derivatives of relic pine forests. Their dominant of herb layer is a relic steppe species *Carex humilis*. These communities have a localised distribution, and their status is “in danger of extinction”. In the territory of the Volyn Upland they are known from the Rivne region. Fragments of the association were found in “Vyshneva Hora” national botanical reserve. We discovered a new location of these communities in “Dermansko-Ostrozkyi” National Nature Park near the village of Bushcha in Zdolbuniv district of the Rivne region. These coenoses are formed on slopes of the southern exposure in poor dry areas, where the underlying rocks are marl, limestone or Torton sandstones. The stands are single-tiered with *Pinus sylvestris* L., with a

crown closure of 40–50% and 12–15 m tall. Undergrowth is absent, but *Corylus avellana* L. occurs alone. Dense herb cover of 70–80% formed by *Carex humilis* (40–60%), sometimes the co-dominant is *Brachypodium pinnatum* (L.) P. Beauv (8–10%). The floristic composition is represented by different forest and steppe plant species (*Daphne mezereum* L., *Cerasus fruticosa* Pall., *Salvia nutans* L., *Betonica officinalis* L. etc.) (DATSIUK, 2012a).

Phytocoenoses of *Carpinetum (betuli)–Quercetum (roboris) hederosum (helicis)* associations are common in the central and southern part of the Volyn Upland. They are characterized by a rare type of association of the dominant species of the main layer with the dominant herbaceous-shrub layer with the relic species *Hedera helix* L. They are located on the north eastern edge of their distribution and have “endangered” status. In Ukraine, they occur

in the western part of the Podillya and Volyn Uplands, the Transcarpathian lowlands and in the Precarpathians. The tree layer consists of two sublayers, its cover is 70–80%. The first sublayer (30–40%) is dominated by *Quercus robur* (60–90 years old and 20–25 m tall) with a single participation of *Acer platanoides* L. and *Fraxinus excelsior* L. The second sublayer (0.5–0.6) is dominated by *Carpinus betulus* L., which reaches a height of 16–18 m at the age of 40–60 years. Undergrowth has not been detected. Separate plants of spindles (*Euonymus europaea* L., *E. verrucosa* Scop.) and an undergrowth of *Carpinus betulus* occur here. Dense (70–75%) ground cover is formed by *Hedera helix* (45–65%). The floristic structure is represented by typical nemoral species (*Galium odoratum* (L.) Scop., *Aegopodium podagraria* L., *Stellaria holostea* L., *Mercurialis perennis* L. and others).

For the first time in the study area we found rare plant communities of the association *Tilieto (cordatae)–Carpineto (betuli)–Quercetum (roboris) alliosum (ursini)*. They were described near the Smordva village in the Mlyniv district of the Rivne region. Its location is characterized by a flattened surface with a small hilly terrain. Phytocoenoses are characterized by the usual type of association of dominant species from different layers. These communities are distributed on the northern edge of the range and have an “endangered” status. They have two-layer stands formed by *Quercus robur* L. (first tree layer) with *Carpinus betulus* L. and *Tilia cordata* Mill. (in the second tree layer). The age of the stands are about 80–90 years old. Closure of the crowns is 80–90%. The total cover of the dominant herb layer – *Allium ursinum* is 25–30%. The floristic composition is represented by typical nemoral species (*Galeobdolon luteum* Huds., *Stellaria holostea*, and other species with a projected cover abundance of 1–5%). The locality described by us on the Volyn Upland is a new one and it is not indicated in the Green Data Book of Ukraine (DIDUKH, 2009b).

The plant communities of the association *Carpineto (betuli)–Fraxineto (excelsior)–Quercetum (roboris) alliosum (ursini)* are described in the territory of the protected tract of “Ash forest area” (Mlynivsky forestry, sq. 35, department 10, within Demydiv district of the Rivne region). These communities are characterized by the usual type of association of dominants from different layers. They are distributed on the northern edge of the range and have an “endangered” status according to the Green Data Book of Ukraine (DIDUKH, 2009b). The forest habitats are characterized by low humidity and dominated by species of nemoral flora. A two-layer stand with a total crown closure

of 70–80% is represented by *Fraxinus excelsior* L., *Quercus robur* L., *Carpinus betulus* L., *Tilia cordata* Mill., *Betula pendula* Roth. The shrub layer is poorly developed, with only a few individuals of *Corylus avellana* L. The herb layer of these communities is similar to *Tilieto (cordatae) – Carpineto (betuli)–Quercetum (roboris)–alliosum (ursini)* which have been described before.

We propose the following forest associations for regional protection: *Quercetum (roboris) hederosum (helicis)*, *Carpinetum (betuli) vincosum (minoris)*, *Carpineto (betuli)–Quercetum (roboris) vincosum (minoris)*. The need for their protection is explained by the low rate of occurrence in the territory, their good preservation in the Volyn Upland, dominance in the herb-shrub layer of relic species of *Hedera helix* and *Vinca minor* L., which have a tendency to reduce their area of distribution.

4. Discussion

The distribution of the rare species found from the Red Data Book of Ukraine throughout the region is heterogeneous. A significant part of them are found only in the southern part of the Volyn Upland, which is due to better preservation of forests which are less fragmented there.

In the future, we plan to conduct geobotanical research in the adjacent areas of the Volyn Upland in order to establish common or distinctive features of the composition of these communities and their floristic features.

In the multifaceted work of forest ecosystem protection, one of the important and difficult issues is the development of protection regimes for rare plant communities. The concept of protection regimes should be formed on the basis of the systemic nature of their forms, types and levels of ecosystem organization. To substantiate the system of nature protection regimes for rare forest communities within the region, it is necessary to take into account the reasons for the rarity of these phytocoenoses, such as the nature of their distribution, their dynamic state, the population strategy of their dominant species, threats from human impact, etc. On the basis of our research into the general condition of rare phytocoenoses we established that in the practical plan three variants are possible for their protection: 1) absolute protection in the conditions of a constant reserved regime; 2) regulated protection in the conditions of the moderate activity; 3) regulated protection by the application of special biotechnical measures. In general, these biotechnical measures can be divided into measures aimed at: a) eliminating

the undesirable components of rare communities; b) correcting the destructive processes in them; c) ensuring the maintenance of homeostatic capacity.

The ecological substantiation of practical methods of protection of these communities for the purpose of preservation should be based on the principles of application of the system of preventive and direct methods of protection depending on their homeostasis and botanical value. The specificity of preservation of rare communities depends on the number and area of localities, ecological features of edaphotopes, dynamic tendencies of phytocoenoses and the extent of their risk of extinction.

5. Conclusions

The Volyn Upland has centres of preserved natural forest vegetation with genetic links to the Eastern European flora, which is manifested in the affinity of its flora and vegetation of the studied region with analogous Western European communities. It is necessary to develop the recommendations for the processes of reducing the human impact on forest phytocoenoses under the influence of recreation, especially near towns and settlements. Ensuring the mapping of the least disturbed forest ecosystems will ensure control and monitoring of coenoses at all levels from the populations of separate species to plant communities. The evidence of current problems, primarily related to threats, on the one hand is natural basis of the studied forests, and on the other – a certain understanding of these threats and the need to take measures for their reproduction, conservation and protection, and especially their most sensitive components – rare species and communities, determine the importance of studying this complex phenomenon, developing ways to solve the problems of "biodiversity crisis". It has been established that the local protection of the gene and price fund, the system of bequests of territories of different categories, etc. are not able to solve the problem of the growing imbalance of biodiversity conservation. In this regard, the formation of a regional ecological network, which would provide a balance of economic, social and natural, ecosystem components, can be more effective. The creation of an ecological network will be a key point in the practical implementation of the ecological paradigm by nature management.

Acknowledgements

The author is grateful to anonymous reviewers for their valuable comments on the manuscript and to Dr. D. Davydov and Dr. T. Dvirna, for their assistance in improving the style and language of the manuscript.

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