Ecological-coenotic features of rare flora species of pine-oak stands of Volyn Polissya

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Anthropogenic influence on the natural vegetation of Volyn Polissya threatens the existence of habitats of rare and endangered species of flora. Therefore, the region, unique in botanical and geographical terms, is gradually losing its specific vegetation characteristics. Having analyzed the literature data, herbarium data and materials of our own field studies in 2016-2019, we have compiled a list of rare and endangered species of pine-oak stands. In the habitat of pine-oak stands 89 rare species were found, 29 of which are listed in the Red Data Book of Ukraine, while Silene lithuanica is included in the European Red List. 3 species (Cypripedium calceolus, Trapa natans та Caldesia parnassifolia) are included into appendices of "The Convention on International Trade in Endangered Species of Wild Fauna and Flora". 10 species are subject to protection according to the appendix of "Convention on the Conservation of European Wildlife and Natural Habitats" 56 species are regionally rare species for the flora of the Volyn region, 4 species are rare species of pine-oak stands. In our research we have analyzed the age range, density and recovery index for the species studied. The study found that for 63 rare species the dynamics of species abundance and distribution are satisfactory. The area of distribution and the number of 7 species is increasing: Allium ursinum, Galanthus nivalis, Platanthera chlorantha, Anemone sylvestris, Campanula persicifolia, Corydalis cava, Isopyrum thalictroides. In the study area 14 species grow sporadically: Juniperus communis, Potentilla alba, Digitalis grandiflora, Gymnocarpium dryopteris, Daphne mezereum, Neottia nidus-avis, Epipactis helleborine, Scorzonera purpurea, Asparagus officinalis, Iris sibirica, Adonis vernalis, Cephalanthera damasonium, Gentiana cruciate, Gentiana pneumonanthe. Dissemination information for Caldesia parnassifolia, Succisella inflexa, Genistella sagittalis, Salix myrtilloides, Ophioglossum vulgatum is insufficient for establishing species dynamics and needs further investigation. The conservation of pine-oak stands in Volyn Polissya will help to create the conditions for the growth of rare and endangered species of flora.

Keywords: Rare species; Population; Age spectrum of the population

Introduction

Anthropogenic influence on the natural vegetation of Volyn Polissya threatens the existence of habitats of rare and endangered species of flora. Therefore, the region, unique in botanical and geographical terms, is gradually losing its specific vegetation characteristics. Information about the rare species of the flora of Volyn Polissya is given in the works of researchers, which mainly covered information about their geographical distribution (Vandas, 1986; Pachoski, 1900; Macko, 1937; Andrienko, et al., 2004, 2009). The current status of rare flora species of pine-oak stands of Volyn Polissya has not been sufficiently investigated, there are no satisfactory data on the geographical location of the localities and the state of the populations of the species, there is no general analysis of the horological patterns. The purpose of the research is to establish ecological-coenotic features of rare flora species of pine-oak stands of Volyn Polissya.

To achieve this goal, the following objectives were set:
- To compile a list of rare and endangered species of flora;
- To conduct a zoological analysis of rare species;
- To establish dynamic trends in the geographical distribution of rare flora species.

Therefore, studying the features of the current distribution of rare flora species, monitoring their status and population structure is an urgent and important task, without which there are risks of the extinction of some rare species from the natural flora of the region.

Objectives and Research Methods

Field studies of rare and endangered species were conducted from 2016 to 2019. During this time, locations known for literary and herbarium data were checked and new rare species were found. Field surveys were carried out annually using forwarding methods in the territory of the Lopatyn, Ozersk, and Zviriv Nature Conservation Departments of Kivertsi National Natural Park “Tsumanska Pushcha”.

For each botanical permanent sampling area (BA) a passport was established, a geobotanical description was made, and the age spectrum of the population was analyzed. Phytocoenotic descriptions were performed by the method (Rabotnov, 1978). Population age structure and their types by age composition have been studied by methods (Uranov, 1975; Rabotnov, 1978). The analysis of
the coenopopulations of rare species of flora was carried out on the basis of the quantitative ratio of plants of different ontogenetic states in permanent sampling areas. The study identified four age groups: juvenile (j), immature (im), virginal (v) and generative (g). For the analysis of the dynamics of self-sustaining population, the RI - renewal index was used as the ratio of the number of preregenerative specimens to the number of generative plants.

**Results of the research**

Information on the distribution of rare species of flora is given in the works of researchers of Volyn Polissya. For the outskirts of the Tsuman village four rare species are listed as habitats: Betula humilis Schrank., *Anemone sylvestris* L., *Cimicifuga europaea* Schipcz., *Clematis recta* L. (Vandas, 1886). By studying the flora of Polissya, the author points at seven habitats of rare species of the studied area: *Cypripedium calceolus* L., *Platanthera bifolia* (L.) Rich., *Betula humilis*, *Anemone sylvestris*, *Melittis sarmatica* L., *Cimicifuga europaea*, *Clematis recta* (Paczoski, 1900). In describing the vegetation cover of the projected reserve “Yulana Area” in the vicinity of Lutsk are given Gladiolus imbricatus L., Lilium martagon L., *Anemone sylvestris*, *Campanula cervicaria* L., *Clematis recta* (Macko, 1937). 21 species of vascular plants from the Red Data Book of Ukraine were found within the Kivertsi National Nature Park “Tsumanska Pushcha” (*Caldesia parnassifolia* (L.) Parl., *Allium ursinum* L., *Galanthus nivalis* L., *Gladiolus imbricatus*, *Carex umbrosa* Host., *Lilium martagon*, *Cephalanthera longifolia* (L.) Frisch., *Cypripedium calceolus*, *Dactylorhiza incarnata* (L.) Soo., *Dactylorhiza fuchsii* (Druce) Soo., *Epipactis helleborine* (L.) Crantz., *Epipactis atrorubens* (Hoffm. ex Bernh.) Besser., *Neottia nidus-avis* (L.) Rich., *Platanthera bifolia*, *Platanthera chlorantha* (Cust.) Rchb., *Betula humilis* Schrank., *Genistella sagittalis* (L.) Gams., *Salix myrtilloides* L., *Iris sibirica* L., *Succisa inflexa* (Klok) G. Beck., *Silene lithuanica* Zapal.); 9 regionally rare species (Astrantia major L., *Polyodium vulgare* L., *Ophioglossum vulgatum* L., *Gymnocarpium dryopteris* (L.) Newm., *Cimicifuga europaea*, *Nimphaea candida* C. Presl., *Campanula persicifolia* L., *Melittis sarmatica*, *Trollius europaeus* L.); 3 rare species (*Aquilegia vulgaris* L., *Nimphaea alba* L., *Lonicera xylosteum* L.) (Andrienko, et al., 2004). During the study of flora of the Volyn region, the habitat of rare species for Kivertsi National Nature Park “Tsumanska Pushcha” is given for: *Lycopodium annotinum* L., *Allium ursinum*, *Galanthus nivalis*, *Carex umbrosa*, *Lilium martagon*, *Cephalanthera longifolia*, *Cypripedium calceolus*, *Dactylorhiza incarnata* (L.) Soo., *Dactylorhiza fuchsii*, *Epipactis helleborine*, *Epipactis atrorubens*, *Neottia nidus-avis*, *Platanthera bifolia*, *Platanthera chlorantha*, *Betula humilis*, *Genistella sagittalis*, *Salix myrtilloides*, Astrantia major (Andrienko, et al., 2009). The Red Data Book of Ukraine provides information on the protection of the following species in the study area: *Caldesia parnassifolia* (the reserve of the national value "Kormin" and the general zoological reserve of the local value "Devil's Swamp"); *Succisa inflexa* (landscape reserve "Kormin"); *Genistella sagittalis* (local reserve "Lopatynska Dibrova").

Having analyzed the literature, herbarium data and materials of our own field studies (Glinska et al. 2017, 2018; Shtokalo et al. 2017, 2018), we have compiled a list of rare and endangered species of pine-oak stands. The list was based on the species listed in the "Red Data Book of Ukraine" and the dominant species of the "Green Data Book of Ukraine", in the Appendices of "The Convention on International Trade in Endangered Species of Wild Fauna and Flora", "Convention on the Conservation of European Wildlife and Natural Habitats" and other international rare plant lists, at "List of rare and endangered plant species in the Volyn region" (Table 1).

**Table 1.** Rare and endangered species of flora in the lists of species in need of protection.
Dactylorhiza majalis (Rich.) P.F. Hunt et Summerhayes + +
Epipactis palustris (L.) Crantz + +
Epipactis helleborine (L.) Crantz + +
Epipactis atrorubens (Hoffm. ex Bernh.) Besser + +
Neottia nidus-avis (L.) Rich. + +
Platanthera bifolia (L.) Rich. + +
Platanthera chlorantha (Cust.) Rchb. + +
Betula humilis Schrank +
Silene lithuanica Zapal. +
Succisella inflexa (Kluk) G. Beck +
Genista sagittalis (L.) Gams +
Salix myrtilloides L. +
Trapa natans L. + +
Aconitum variegatum L. +
Astrantia major L. +
Anemone sylvestris L. +
Polypodium vulgare L. +
Vinca minor L. +
Lerchenfeldia flexuosa (L.) Schur +
Daphne mezereum L. +
Wolffia arrhiza (L.) Horkel ex Wimmer +
Ophioglossum vulgatum L. +
Actaea spicata L. +
Gymnocarpium dryopteris (L.) Newm. +
Ceratophyllum submersum L. +
Digitalis grandiflora Mill. +
Aquilegia vulgaris L. +
Potentilla alba L. +
Hepatica nobilis Mill. +
Hedera helix L. +
Primula elatior (L.) Hill. +
Dentaria bulbifera L. +
Nimphaea alba L. +
Nimphaea candida C. Presl. +
Gypsophila paniculata L. +
Clematis recta L. +
Thesium linifolium L. +
Pyrethrum corymbosum (L.) Scop. +
Eryngium planum L. +
Sempervivum ruthenicum Schnittsp. et C.B. Lehm. +
Inula helenium L. +
Melanthium arvense L. +
Campanula persicifolia L. +
Lonicera xylosteiua L. +
Isopyrum thalictroides L. +
Corydalis cava (L.) Schweigg et Koerte +
Spergula morisonii Boreau +
Scorzonera humilis L. +
Scorzonera purpurea L. +
Prunella grandiflora Scholl. +
Gentiana cruciata L. +
Gentiana pneumonanthe L. +
Asparagus officinalis L. +
Allium vineale L. +
Circaea intermedia Ehrh. +
Stachys recta L. +
Dryopteris austriaca (Jacq.)Woynar ex Schinz et Thell. +
Andromeda polifolia L. +

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As shown in Table 1, 89 rare species habitats have been found in pine-oak stands, 29 of them are in the Red Data Book of Ukraine. Among the species, 4 species (Cypripedium calceolus, Trapa natans, Caldesia parnassifolia) are subject to protection according to the Appendix of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. 10 species are included into Appendix of the Convention on the Conservation of European Wildlife and Natural Habitats. 56 species are regionally rare species for the flora of the Volyn region, and Silene lithuanica is listed in the European Red List. 3 species (Cypripedium calceolus, Trapa natans, Caldesia parnassifolia) are subject to protection according to the Appendix of "The Convention on International Trade in Endangered Species of Wild Fauna and Flora". 10 species are included into Appendix of "The Convention on the Conservation of European Wildlife and Natural Habitats". 56 species are regionally rare species for the flora of the Volyn region, and Silene lithuanica is listed in the European Red List.

Table 2. Age range of populations of rare flora species in permanent sampling areas.

| Permanent test area | Year of examination | Age groups | Density, specimens/100 m² | Renewal index, % |
|---------------------|---------------------|------------|---------------------------|------------------|
|                      |                     | J oc. %    | Im oc. %                  | V oc. %          |
|                      |                     |            |                           | G oc. %          |
| **Galanthus nivalis L.** |                    |            |                           |                  |
| BA-1                | 2016                | 27 3,5     | 87 11,3                   | 153 19,8         |
|                     | 2017                | 48 4,4     | 143 13,3                  | 231 21,4         |
|                     | 2018                | 41 3,8     | 137 12,6                  | 267 24,5         |
|                     | 2019                | 44 4,7     | 123 13,0                  | 169 17,9         |
|                     | 2016                | 37 4,4     | 73 8,8                    | 232 27,9         |
| BA-2                | 2017                | 59 5,9     | 114 11,3                  | 270 26,8         |
|                     | 2018                | 41 4,1     | 98 9,8                    | 283 28,2         |
|                     | 2019                | 48 5,0     | 107 11,1                  | 275 28,6         |
| **Allium ursinum L.** |                    |            |                           |                  |
| BA-3                | 2016                | 7 10,8     | 11 16,9                   | 17 26,2          |
|                     | 2017                | 10 11,4    | 21 23,9                   | 23 26,1          |
|                     | 2018                | 12 15,0    | 15 18,8                   | 16 20,0          |
|                     | 2019                | 12 15,0    | 17 21,3                   | 21 26,3          |
|                     | 2016                | 277 10,3   | 812 30,1                  | 786 29,1         |
| BA-4                | 2017                | 249 9,3    | 783 29,2                  | 814 30,4         |
|                     | 2018                | 283 10,4   | 796 29,3                  | 795 29,3         |
| Year | BA-5 | BA-4 | BA-3 | BA-2 |
|------|------|------|------|------|
| 2019 | 261  | 9,9  | 754  | 28,5 | 801  | 30,3 | 831  | 31,4 | 2647 | 2,19 |
| 2016 | 373  | 9,4  | 2536 | 63,7 | 719  | 18,0 | 356  | 8,9  | 3984 | 10,19|
| 2017 | 389  | 9,6  | 2448 | 60,4 | 746  | 18,4 | 469  | 11,6 | 4052 | 7,64 |
| 2018 | 253  | 6,5  | 2359 | 60,9 | 783  | 20,2 | 476  | 12,3 | 3871 | 7,13 |
| 2019 | 271  | 7,1  | 2275 | 59,7 | 802  | 21,0 | 465  | 12,2 | 3813 | 7,20 |

**Dentaria glandulosa** Waldst. et Kt.

| Year | BA-5 | BA-4 |
|------|------|------|
| 2016 | 17   | 2,9  |
| 2017 | 21   | 3,5  |
| 2018 | 12   | 2,0  |
| 2019 | 16   | 2,7  |

**Dentaria bulbifera** L.

| Year | BA-3 | BA-4 |
|------|------|------|
| 2016 | 16   | 1,3  |
| 2017 | 21   | 1,6  |
| 2018 | 11   | 0,9  |
| 2019 | 7    | 0,6  |
| 2016 | 5    | 2,3  |
| 2017 | 4    | 1,8  |
| 2018 | 9    | 4,1  |
| 2019 | 15   | 6,1  |

**Isopyrum thalicroides** L.

| Year | BA-3 | BA-4 |
|------|------|------|
| 2016 | 2    | 1,3  |
| 2017 | 3    | 1,8  |
| 2018 | 6    | 3,4  |
| 2019 | 7    | 4,0  |
| 2016 | 8    | 3,4  |
| 2017 | 3    | 1,3  |
| 2018 | 1    | 0,4  |
| 2019 | 5    | 2,3  |
| 2016 | 8    | 3,3  |
| 2017 | 5    | 1,9  |
| 2018 | 3    | 1,1  |
| 2019 | 4    | 1,5  |

**Anemone sylvestris** L.

| Year | BA-5 | BA-6 |
|------|------|------|
| 2017 | 0,0  | 217  |
| 2018 | 0,9  | 243  |
| 2019 | 1,4  | 267  |

**Cephalanthera damasonium** (Mill.) Druce

| Year | BA-7 |
|------|------|
| 2017 | 0,0  |
| 2018 | 0,0  |
| 2019 | 0,0  |

**Epipactis helleborine** (L.) Crantz.

| Year | BA-7 |
|------|------|
| 2017 | 0,0  |
| 2018 | 0,0  |
| 2019 | 0,0  |

"At Panas's"

| Year | BA-7 |
|------|------|
| 2017 | 0,0  |
| 2018 | 0,0  |
| 2019 | 0,0  |
Ecological-coenotic features of rare flora species of pine-oak stands of Volyn Polissya

Studies have found that the highest population density recorded was the following: *Allium ursinum* – 4052 specimens/100 m²; *Anemone sylvestris* – 1606 specimens/100 m²; *Dentaria bulbifera* – 1289 specimens/100 m²; *Galanthus nivalis* – 1088 specimens/100 m²; *Dentaria glandulosa* – 606 specimens/100 m². Populations of Orchidaceae have low quantity and density, right-sided spectra of ontogenetic states dominated by generative individuals: *Cephalanthera damasonium* – 18-42 specimens/100 m²; *Epipactis hellearone* – 7-32 specimens/100 m²; *Dactylorhiza majalis* – 10-45 specimens/100 m²; *Dactylorhiza incarnata* – 6-8 specimens/100 m²; *Platanthera bifolia* – 26-35 specimens/100 m². Population *Betula obscura* consist of 1 tree about 80 years old, seed reproduction is not observed. In January 2019, three trees were killed as a result of the storm.

**Conclusion**

Having analyzed the literary information, herbarium data and materials of our own field research, we have compiled a list of rare and endangered species of pine-oak tree stands of 89 species. The study found that for 63 rare species population dynamics and distribution of species is satisfactory. The area of distribution and the quantity of 7 species is increasing: *Allium ursinum, Galanthus nivalis, Platanthera bifolia, Anemone sylvestris, Campanula persicifolia, Corydalis cava, Isopyrum thalictroides*.

Distribution information on Caledisia parnassifolia, Succisella inflexa, Genistella sagittalis, Salix myrtillioides, Ophioglossum vulgatum is insufficient to establish the species dynamics and needs further investigation. The importance of preserving the species in this area is difficult to quantify. It is extremely important to preserve species that are confined to meadows and wetlands specific to the study area: *Gladilios imbricatus, Iris sibirica, Dactylorhiza incarnata, Dactylorhiza fuchsii, Dactylorhiza majalis, Epipactis palustris, Betula humilis, Succisella inflexa, Genistella sagittalis, Salix myrtillioides, Trapa natans*. Preservation of pine-oak stands of Volyn Polissya will help to create conditions for growth: *Dipsisiastrum camplanatum, Cephalanthera damasonium, Cephalanthera longifolia, Cephalanthera rubra, Epipactis...*
helleborine, Epipactis atrorubens, Neottia nidus-avis, Platanthera bifolia, Platanthera chlorantha, Silene lithuanica, Dianthus pseudosquarrosus, Cimicifuga europaea, Primula elatior

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