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THE EARLY SPRING SYNUSIAS IN THE FORESTS OF FAGETO-CARPINETO-QUERCETA ROBORIS SUBFORMATION ON THE TERRITORY OF PRECARPATHIAN REGION (UKRAINE)

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Abstract

In the article were presented the results of studying the early spring synusias in the forests of *Fageto-Carpineto-Querceta roboris* subformation on the Pricarpathian territory. In the studied subformation were separated five associations: *Fageto-Carpineto-Quercetum roboris galiosum odorati*, *Fageto-Carpineto-Quercetum roboris caricetum pilosae*, *Fageto-Carpineto-Quercetum roboris vincosum*, *Fageto-Carpineto-Quercetum roboris galeobdolosum*, *Fageto-Carpineto-Quercetum roboris hederosum*. The revealed early spring synusias are formed by the following herbal species: *Leucojum vernum* L. *(Amaryllidacea)*, *Galanthus nivalis* L. *(Amaryllidacea)*, *Dentaria glandulosa* Waldst. et Kit. *(Brassicaceae)*, *Anemone nemorosa* L.*(Ranunculaceae)*, *Scilla bifolia* L. *(Liliaceae), Isopyrum thalictroides* L. (*Ranunculaceae*), *Corydalis cava* (L.) Schweigg. Koerte (*Papaveraceae*) та *Gagea lutea* (L.) Ker.-Gawl. (*Liliaceae*). It appears before the leaves blooming and forms the specific white-lilac-blue aspect. *Galanthus nivalis* L. synusias develops the first and then in the third decade of March develops the group with *Anemone nemorosa* L. domination. Last years as the result of the negative anthropogenic influence the number of *Leucojum vernum* L. and *Galanthus nivalis* L. groups – the rare ephemeroids put to the Ukrainian Red book was abruptly shortened.

Keywords: flora, association, synusia, phytocenosis, ontogenesis, ephemeroids.

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1. Introduction

The important precondition for formation of the *Fageto-Carpineto-Querceta roboris* forest groups is the presence of hilly relief and carbonate soils of alluvial origin [1]. The vegetal cover is closely connected with natural environment that predetermines its coenotic structure and is characterized with multilevel construction. The first tier is formed by *Quercus robur* L., *Fagus sylvatica* L. and rarely *Picea abies* Karst. *Fraxinus excelsior* L., *Acer platanoides* L., *Tilia cordata* Mill are mixed to it. The second tier is formed by *Carpinus betulus* L. and *Fagus sylvatica* L. In some places there is the third tier with *Carpinus betulus* L., *Acer campestre* L., *Malus sylvestris* (L.) Mill. and *Cerasus avium* (L.) Moench. In undergrowth tier grow *Corylus avellana* L., *Euonymus europaea* L., *Swida sanguinea* L., *Frangula alnus* Mill., *Crataegus monogyna* Jacq., *C. oxyacantha* L., *C sanguinea* Pall. and *C. ucrainica* Pojark. At spring before the leaves blooming synsias of the early spring ephemeroids prevail.

2. Literature survey

Among the modern works on the study of vegetation of the Ukrainian west regions are the works of geobotanical direction written by Gerushinsky Z. Y. (1996), Nesteruk Y. (2000), Buniak V. I. (2001), Parpan V. I. and the others [2–6]. In these works the important place takes the characteristics and description of the Carpathian and Precarpathian beech forests.

Mixed phytocenoses prevail in the group of formation of beech-hornbeam-oaken forests. Monograph by Lavrinenko D. D. (1965) is rather important for explanation of the complicated interplays between edificators, assectators of the oaken forests. The regional peculiarities of economy in the Carpathian mountain forests are noted in the work by Gensiruk S. A. (2002). In Zacarpathian foothills on the outcrops of volcanic rocks are spread the insular localizations of anhedral oaken forests and bush formations. Biotopes of the foliage forests were studied by Kish R., Andrik E., Mirutenko V. [7].

The interesting forest studies concerning Precarpathian beech-hornbeam-oaken forests, its natural renewal and reproduction were described by Katsuliak Y. D. [8]. The recreational value of plain and mountain forests was elucidated by Bondarenko V. D. and Furdychko O. I. (1994).

In Ivano-frankivsk region are known the groves of *Quercus robur* L. and *Quercus petraea* Liebl. The groves of *Quercus robur* L. are particularly spread in the plain localities with admixture of *Carpinus betulus* L., *Fraxinus excelsior* L., *Populus tremula* L., *Betula pendula* Roth. On the plain part and on the foothills of region the several localities are occupied by such mixed large-leaved forests as hornbeam-beech and oak-beech. Its floristic and syntaxonomic structure was described in the works of Tkachik V. (2000) and Stojko S. M. [9–11]. In particular Stojko S. M. elaborated classification of beech-hornbeam-oaken forests of Ukrainian Carpathians [11].

In the work of Chopyk V. I. and Fedoronchuk M. M. [12] was elucidated an ecology, spreading, taxonomic and resource specificity of the specific composition of vascular plants of Ukrainian Carpathians.

The aforesaid botanical and forest publications deal with the results of research of the oaken phytocenoses in separate regions.

In the book by Panova L. S., Protopopova V. V., Morozuk S. S. [13] there were presented the plants of Ukrainian flora that blossom in spring. There were also described biological and ecological peculiarities and spreading of these species. The special attention was paid to the important problem of its protection.

3. Aim and tasks of research

Aim – the study of ontogenesis of ephemeroids that form the early spring synusias in the forests of *Fageto-Carpineto-Querceta roboris* subformation in Pricarpathian region.

For attaining the set aim the following tasks must be carried out:

– to reveal population of the spread species-ephemeroids that form the early spring synusias;

– to study ontogenesis of revealed species;

– to study the modern state of population.

4. Methods and materials of research

The study of the early spring synusias in the forests of *Fageto-Carpineto-Querceta roboris* subformation was carried out during vegetative period 2000–2003 years and 2014–2016 years by the route method as pave of the profile lines along which were made the temporary test plots for species accounting, was formed the synopsis of flora, was fixed the tiers of phytocenosis, its aspects, the cover density, the species vitality, were studied the conditions of plants growth.

The determination of plants was carried out according to "Determinant of Ukrainian Carpathian plants" (1977), systematic taxons were taken according to Takhtadjan A. L. (1987), the structure of populations was described according to Grigoroy I. M. and Solomakha V. A. [14], and the Ramensky's L. G. net was used for determination of species project cover [14].

5. Results of research

In the studied subformation prevailed five associations: *Fageto-Carpineto-Quercetum roboris galiosum odorati*, *Fageto-Carpineto-Quercetum roboris caricetum pilosae*, *Fageto-Carpineto-Quercetum roboris vincosum*, *Fageto-Carpineto-Quercetum roboris galeobdolosum*, *Fageto-Carpineto-Quercetum roboris hederosum*.

The main dominant in *Fageto-Carpineto-Quercetum roboris galiosum odorati* association is *Galium odoratum* (L.) Scop. (40–50 %) with admixture of *Sanicula europaea* L. (10–15 %), *Galeobdolon luteum* Huds. (5–10 %), *Luzula pilosa* (L.) Willd. (8–10 %) and others [15].

In *Fageto-Carpineto-Quercetum roboris caricetum pilosae* association the herbal tier with dominating *Carex pilosa* Scop. is well developed (40–50 %). Among the other species the most typical are: *Aegopodium podagraria* L. (10–15 %), *Viola sylvestris Lam.* (5–6 %), *Galium odoratum* (L.) Scop. (10–15 %), *Glechoma hederacea* L. (5–6 %), *Lysimachia nummularia* L. (1–2 %), *Pulmonaria obscura* Dumort. (4–5 %), *Sanicula europaea* L. (10–15 %).

The main background of the herbal tier of *Fageto-Carpineto-Quercetum roboris vincosum* association with the project cover 70–80 % forms *Vinca minor* L., the rarely found are *Galium odoratum* (L.) Scop. (+), *Dryopteris filix-mas* (L.) Schott (+), *Athyrium filix-femina* (L.) Roth (+), *Impatiens noli-tangere* L. (+), *Sanicula europaea* L. (+), *Carex pilosa* Scop. (+), *Paris quadrifolia* L. (+), *Aegopodium podagraria* L. (+), *Galeobdolon luteum* Huds. (+).

In the dense herbage of *Fageto-Carpineto-Quercetum roboris galeobdolosum* association during the all vegetative period dominates *Galeobdolon luteum* Huds. (25–30 %), in the group are present *Galium odoratum* (L.) Scop. (8–10 %), *Asarum europaeum* L. (8–10 %), *Dryopteris filix-mas* (L.) Schott (2–5 %), *Athyrium filix-femina* (L.) Roth (2–5 %), *Salvia glutinosa* L. (2–5 %), the rarely found are *Euphorbia amygdaloides* L. (+), *Viola odorata* L. (+), *Ajuga reptans* L. (+), *Majanthemum bifolium* (L.) F. W. Schmidt (+), *Carex pilosa* Scop. (+).

Fageto-Carpineto-Quercetum roboris hederosum association is found very rarely and fragmentary in the studied forests. In liana-bush-herbal cover prevails *Hedera helix* L. (60–70 %), the rarely admixed are the following species: *Luzula pilosa* (L.) Willd. (+), *Galeobdolon luteum* Huds. (+), *Vincetoxicum hirundinaria* Medik. (+), *Melittis carpatica* Klok. (+), *Pyrethrum corymbosum* (L.) Scop. (+), *Sedum hispanicum* L. (+), *Campanula persicifolia* L. (+). It must be noted in this only population we registered three rare species from the *Orchidaceae* family: *Cephalanthera damasonium* (Mill.) Druce, *C. longifolia* (L.) Fritsch (L.) Fritsch., *Cypripedium calceolus* L., that grow as the small inclusions in 3–4 individuals.

In February-April the spring aspect is clearly expressed in studied phytocenoses. The herbal early spring synusias of ephemeroid species: *Leucojum vernum* L., *Galanthus nivalis* L., *Dentaria glandulosa* Waldst. et Kit., *Anemone nemorosa* L., *Scilla bifolia* L., *Isopyrum thalictroides* L., *Corydalis cava* (L.) Schweigg. Koerte та *Gagea lutea* (L.) Ker.-Gawl astonish by its botanical value and unique beauty [16]. Before the leaves blooming there is observed the early blossom of these species that create the specific white-lilac-blue aspect.

Our observations show that in the first turn develop the synusias of the rare Red book specie *Galanthus nivalis* L. from the *Amaryllidacea* family [17]. It is spread on the more or less parched rises of soil as the small flowerbeds with size 2–3 m^2 and project cover 30–35 %. In the small flowerbeds grow 8–10 *Galanthus nivalis* L. individuals 4–6 of it are generative and the other ones – immature and virgin. In the middle size flowerbeds – 17–20 individuals among which the 13–15 ones are generative. In several more or less big flowerbeds grow 38–40 individuals of the different age (17–19 generative, the other ones immature, virgin and juvenile). As to ontogenesis of *Galanthus nivalis* L. its development depends on the weather-climatic conditions. For example in 2015 year the first shoots appeared in January, 28–30 (generative individuals), bud formation begun only in February, 10–15, blossom – February, 23–24 and the mass blossom was observed in March, 03–05 and it continued till the 20 of March. At that time the shoots appeared and the virgin, immature and juvenile individuals developed. In 2016 year we observed shoots in February, 3, bud formation – February, 9–10 and at once already in 2–3 days – blossom that continued till the 10 of March. According to our observations the blossoming aspect of *Galanthus nivalis* L. synusias continues almost month from the first or second decade of February to the second or third decade of March. In *Galanthus nivalis* L. synusias the *Hepatica nobilis* Mill. are rarely found (1–2 %).

Synusias of the Central European mountain specie *Leucojum vernum* L. (*Amaryllidaceae*) put to the Ukrainian Red book are spread on all forest territory. The flowerbeds of cenopopulations with size 8–10 m^2, with general project cover 45–50 %, in 40–60 individuals of the different age in every flowerbed. Our observations on the ontogenesis of *Leucojum vernum* L. proved that for example in 2015 years shoots appeared in February, 20–22, the bud formation and start of blossom – in March, 1–5, mass blossom- in March, 20–22 and continued till the April, 10. In 2016 year the first shoots appeared earlier – already in February 10-13, bud formation – in February 19–20, the first blossom was fixed in February 22–23 and the mass one – in the first decade of March. In *Leucojum vernum* L. synusas are found also the *Dentaria glandulosa* Waldst. et Kit. (10–20 %), *Anemone nemorosa* L. (2–3 %), *Pulmonaria obscura* Dumort. (1 %), *Scilla bifolia* L. (1–2 %), *Dentaria bulbifera* L. (+), *Hepatica nobilis* Mill. (+), *Gagea lutea* (L.) Ker-Gawl. (+).

As to fruitfulness we did not observe in *Galanthus nivalis* L. any individual with fruits, despite the abundant blossom it is possible that there are no pollination. And in the *Leucojum vernum* L. all blossoming shoots bear fruits. It testifies that it is reproduced with onions as well as with seeds.

Scilla bifolia L. cenopopulations from the *Liliaceae* family is rarely found in forests. It is spread as the small inclusions in 5–6 individuals in every one. The blossom was observed from the second decade of March to the first decade of April.

In the second and third decades of March dominates the early spring ephemeroid from the *Brassicaceae – Dentaria glandulosa* Waldst. et Kit. family. Projective cover of the group is 40–45 %. In the composition of cenopopulation co-dominate *Leucojum vernum* L. (15–20 %), *Dentaria bulbifera* L. (5–6 %), *Scilla bifolia* L. (1–2 %), *Hepatica nobilis* Mill. (+). The early spring synusia *Dentaria glandulosa* Waldst. et Kit. is spread on the all territory of the forest phytocenoses and in the period of blossom form the very good-looking lilac aspect.

After this synusia in the third decade of March develops the group with dominating *Anemone nemorosa* L. *(Ranunculaceae)*. Its cenopopulations are scattered over all territory with project cover 50–70 %. Among herbal cover of cenosis grow the *Anemone ranunculoides* L. (5–8 %), *Dentaria glandulosa* Waldst. et Kit. (10–15 %), *Corydalis cava* (L.) Schweigg. et Koerte (5–6 %), *Isopyrum thalictroides* L. (3–5 %), *Pulmonaria obscura* Dumort. (2–3 %), *Dentaria bulbifera* L. (1–3 %), *Hepatica nobilis* Mill. (+). The blossom of *Anemone nemorosa* L. begins in the third decade of March and continues depending on climatic conditions till the twentieth of April.

In the third decade of April in the forests of *Fageto-Carpineto-Quercetum roboris* subformation develops the early spring synusia with 2–3 species of dominating ephemeroids: *Isopyrum thalictroides* L. (*Ranunculaceae*) (15–20 %), *Corydalis cava* (L.) Schweigg. Koerte (*Papaveraceae*) (10–15 %) та *Gagea lutea* (L.) Ker.-Gawl. (*Liliaceae*) (10–15 %). The general project cover of cenosis– 50–60 %, in the composition of herbal tier: *Asarum europaeum* L. (2–5 %), *Dentaria glandulosa* Waldst. et Kit. (1–3 %), *D. bulbifera* L. (+), *Hepatica nobilis* Mill. (+), *Viola sylvestris* auct. non Lam. (+). *Isopyrum thalictroides* L. synusia is found fragmentary in 25–30 individuals in flowerbeds, *Corydalis cava* (L.) Schweigg. Koerte grows in groups in 5–6 individuals in the same flowerbed and the *Gagea lutea* (L.) Ker.-Gawl. – in 3–4 individuals. The blossom of these ephemeroids continues during two weeks (April-May) and can take place at the considerable temperature fluctuations. Flowers have a pleasant scent, produce a lot of nectar and are pollinated by insects so the most of generative individuals bear fruits. But to the high regret we did not observe the seeds ripening. Probably because of deficiency of sunshine that cannot penetrate through the developed leaves of trees. It must be noted that side by side with this synusia in several wet places are found the small but unbroken flowerbeds of perennial rhizome plant from the *Saxifragaceae* – *Chrysosplenium alternofolium* L. family that also blossoms in the second-third decade of April forming the original golden-yellow aspect. According to our observations cenopopulations of this species are related to the described association.

6. Approbation of the results of research

The results of research were discussed at annual scientific-practical conferences of the teachers of Institute of natural sciences of SHEI "Vasyl Stefanyk Precarpathian National University".

7. Conclusions

Our researches demonstrated that the *Fageto-Carpineto-Querceta roboris* forest associations have the rich and botanically significant specific composition especially the early spring synusias formed by the rare decorative ephemeroids species astonish by its beauty and originality. In the summer aspect of association were also revealed the species of plants put to the Ukrainian red book (*Cephalanthera damasonium* (Mill.) Druce, *C. longifolia* (L.) Fritsch., *Cypripedium calceolus* (L.) and elements of thermophilic forest-steppe flora (*Vincetocsicum hirundinaria* Medik., *Pyrethrum corymbosum* (L.) Scop., *Sedum hispanicum* L.) that are rarely found on Precarpathian territory.

The study of specific composition and spread of cenopopulations of early spring synusias demonstrated that its number significantly decreased in last decades and the group of such Red book species as *Leucojum vernum* L. and *Galanthus nivalis* L. absolutely disappeared in several Precarpathian forest tracts. There remains only the spring phytocenoses with dominating *Anemone nemorosa* L. and *Scilla bifolia* L.

For protection and reproduction of the early spring ephemeroids on the studied territory must be organized monitoring on ontogenesis and state of its populations, it is necessary to study the biological and ecological peculiarities, number of individuals and the frequency of occurrence in cenoses.

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IN SILICO MODELING OF THE REDOX METABOLISM IN HUMAN ERYTHROCYTES

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Abstract

There was elaborated the mathematical model of erythrocytes metabolism, including glycolysis (Embden-Meyerhof pathway), pentose phosphate pathway, metHb restoration pathway, H_2O_2 metabolism reaction. The final model includes 50 reactions and 60 metabolites. Within the model was studied the change of activity of some enzymes and concentrations of metabolites in stationary state, that take part in the processes of utilization of oxygen active forms and restoration of metgemoglobin, depending on amount of exogenous and endogenous H_2O_2. There was demonstrated the threshold character of changes of the many studied parameters, that testifies that the cells can be practically in physiological state at the change of external conditions for rather long time.

There was carried out an assessment of redox-state of erythrocytes at oxidizing load: was demonstrated the change of $E_{GSSG/2GSH}$ and from the concentration of endogenous H_2O_2. There was established that in the studied diapason of concentrations of endogenous H_2O_2 was observed the high slope of the change of $E_{GSSG/2GSH}$, that was not observed for and the other redox-pairs.