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URBAN FLORA OF BILA TSERKVA TOWN OF KYIV REGION (SYSTEMATIC AND MORPHOLOGICAL ANALYSES)

The results of systematic and biomorphological analyses of urban flora of Bila Tserkva town of Kyiv region are presented. 930 species of vascular plants, which belong to 108 families, 54 orders, 6 classes and 4 divisions, were identified in the town and its suburbs. 22 families are characterized by a higher level of species diversity and include 664 species of plants (71.4%). The families of *Asteraceae, Poaceae, Brassicaceae, Fabaceae*, *Rosaceae* etc. dominate, i.e. their plant species are the most numerous. 29 species display high level of genus diversity (more than 2 genera and 7 species in each genus), 56 families have a lower level of genus diversity, 23 families are represented by one genus with one species only.

Urban flora of Bila Tserkva town and its suburbs include 308 genera represented by one species and 193 polytypic genera. The study shows that 52 dominant polytypic genera constitute 31.2% of the whole flora (290 species). *Carex, Trifolium, Allium, Poa, Ranunculus, Populus, Spiraea, Campanula, Rumex, Vicia* etc. are dominant genera with the greatest number of plant species.

According to biomorphological study most species are hemicryptophytes (455 species, 48.9%) and herbaceous polycarpics (465 species, 50%). The majority of species don't have a rhizome (560 species, 60%) and a rosette (480 species, 52%), they are summer-green (674 species, 72.5%) and perennial (663 species, 71%) and have a taproot system (534 species, 57%). Overall biomorphological structure of studied flora is characteristic of Forest-Steppe flora of Ukraine and can be considered typical of floras of transformed anthropic areas.

The results of the study indicate that the urban flora is boreal in character and has features characteristic of Forest-Steppe zone.

Keywords: town, urban flora, Bila Tserkva, hemicryptophyte, polycarpic

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LIFE CYCLE OF *GALANTHUS NIVALIS* L.

Abstract: Morphogenesis (or minor life cycle) and ontogenesis (or major life cycle) of *Galanthus nivalis* L. are given in this article. The length of minor and major life cycles is established. Phases of monocarpic shoot development within the bud and its further development are described. The seasonal development of *G. nivalis* is described too. On the basis of the analysis of *G. nivalis* ontogenesis four periods of age stages and seven age groups are distinguished. Multivariate ways of development of individuals are described.

Keywords: Galanthus nivalis L., *morphogenesis, renewal bud, monocarpic shoot, seasonal rhythm of development, ontogenesis, age stages, age groups*

Introduction. Among the important studies devoted the structure of the underground organs of bulb plants, works of Irmisch [21, 22] are distinguished, which contain detailed morphological description of bulbous representatives of the *Liliaceae* and *Amaryllidaceae* families, as well as bulb-tuberous representatives of the *Iridaceae* family. In works of Velenovský [31] and Kirchner, Loew & Schröter

[23] we find important information on the morphology of bulbs. Work of Troll [30]), dedicated to the comparative morphology of bulbous plants is deserved attention too. Problems of development of plants have an important place in this work. For the first time author gave an analysis and schematically depicted three-year period of development of generative bulbs *G. nivalis*. But the concepts of the annual cycle of development, morphogenesis of monocarpic shoot and complete ontogenesis are not clearly delimited and defined. Only fragmentary information on all these issues is contained in the work that is interwoven with problems of vegetative reproduction, comparative characteristic and so on. Some characteristics of *G. nivalis* bulbs structure on the basis of the analysis of 25 specimens compared with once of *Leucojum aestivum* L. and *L. vernum* L. are described in the work of Voss [32]. The above authors examined morphology of bulbs regardless of stages of development and environmental conditions.

Complex monographic study (including cycle of development) of *Galanthus* species in nature and in culture in Ukraine was carried out by Melnyk et Didenko [6].

A series of observations on the life cycle, phenology, and germination capacity of *G. nivalis* and some other early spring-flowering plants were made by Abrami [20]. It is showed, the various stages of life cycle of studied plants require different optimal thermoperiods.

Seed development and maturation of *G. nivalis* and *Narcissus pseudonarcissus* were studied by Newton et al. [26] to better understand the progression from developmental to germinable mode in order to improve seed collection and germination practices in these and similar species.

The relationship between phonological data and concurrent large scale meteorological data was examined by Maak et Storch [24].

In series of recent works we can find results of research of various physiologic aspects of *G. nivalis*. Thus, seed dormancy induction and alleviation in the moist temperate woodland species, which are *G. nivalis* and *Narcissus pseudonarcissus* were examined by Newton et al. [27]. In particular, temperature, light and desiccation were investigated to elucidate their role in the germination ecophysiology of the above mentioned species. Flowering biology as well as the topography, anatomical, and ultrastructural features of the floral nectary of *G. nivalis* are shown in the work of Weryszko-Chmielewska & Chwil [33]. The flower lifespan, the breeding system, and the mass of pollen and nectar produced by the flowers were determined and these results were elucidated in the article. The nectary structure was examined under electron microscopy too. Results of study of photosynthetic competence in vegetative and reproductive structures of *G. nivalis* by the use of chlorophyll (Chl) fluorescence techniques as well as of oxygen exchange measurements are shown in work of Aschan & Pfanz [19].

Morphogenesis of monocarpic shoot of bulbous and bulb-tuberous geophytes in relation to the seasons is elucidated in works of Skripchinskij jun. [12, 14], Skripchinskij sen., Dudar, Skripchinskij jun. & Shevchenko [10] and others. Quite complete information about bulb morphology as well as a brief outline of *G. nivalis* development in cultivation are presented in the monograph of Artjushenko "*Amaryllidaceae* of the USSR" [1].

Thus, there is lack of works in literature, in which morphogenesis of *G. nivalis* is described in detail.

Best of all methodological problems of ontogenesis and morphogenesis are elucidated in works of the above authors (Skripchinskij sen., Dudar, Skripchinskij jun. & Shevchenko [10] and Skripchinskij jun. [13]). Ontogenesis of many ephemeroid geophytes of Russia is studied in details by the same authors [9, 11, 15]. General principles and problems of study of major life cycle can be found also in the work of Berko [2]. Author presented a detailed scheme of periodization of major life cycle of vegetatively mobile plants and for the first time he identified aclonal and clonal subcycle of ontogeny.

Shorina & Prosvirnina [18] studied peculiarities of major life cycle of *Galanthus woronowii* Los. in Western Transcaucasia. General questions of development of bulbous plants are elucidated in the work of Troll [30]. Some features of the ontogeny of *G. nivalis* from seed germination to flowering are described by Artjushenko [1]. Detailed morphological description of generative plants is carried out by Irmisch [21, 22], Velenovský [31], Troll [30], Speta [29].

Thus, there are no information in the literature on the life cycle of *G. nivalis* from seed germination to the natural death of the plant.

G. nivalis is a perennial plant with a distinctive specialized organ of vegetative reproduction – bulb (Fig. 1). According to the Raunkiaer [28] classification of life forms of plants, in which location and method of protecting of renewal buds during unfavorable season (cold and dry) is taken as a basis, *G. nivalis* belongs to geophytes, i.e. plants, renewal buds of which during unfavorable seasons are hidden in the soil at a shallow depth (a few centimeters). According to the phylogenetic scheme of basic types of life forms of angiosperms and conifers developed by Serebrjakov [8] the object belongs to a division of ground herbs of type of polycarpic herbs.

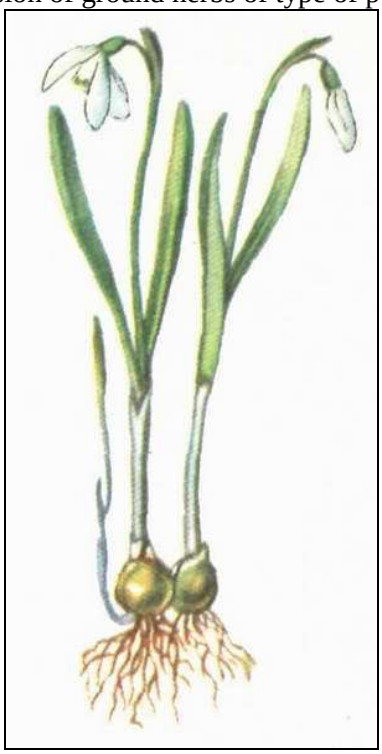

Fig. 1. *Galanthus nivalis* L.

Material and methods

Specimens from natural population of Transcarpathian Lowland, located near the village Vorochevo, Perechynsky district, Transcarpathian region, Ukraine (130 m above see level) were used to study life cycle of *G. nivalis*. Observations on the seasonal development of plants were carried on by the method of periodic registration of their phenological state. The morphological changes were noted. Successive changes of the plant appearance were fixed. In some cases phenological observations were provided by phonometric measurements. Minor life cycle was studied by preparing bulbs. During the vegetation season each decade five generative plants were dug up from the soil and a detailed morphological analysis was carried out. Major life cycle study has been carried out on transects, laid by randomization method. Transects were divided into square plots of 1 m^2. All individuals of this species on the plot have been dug up and their age stages were determined. Biomorphological characteristics of plants in each age group and the subgroup have been estimated using the data of measurement of 15 specimens. Age stages have been determined according to Rabotnov scheme [7] completed by Smirnova et al. [17].

Results

Bulb of *G. nivalis* is perennial, tunicate, with monopodial type of branching (Fig. 2). Müller-Doblies [25] points out sympodial branching of *G. nivalis*, with which we can not agree. The bulb is consisting of scales of two types: scales, formed by basal leaves and scales, formed by the bases of the assimilating leaves. Three scales develop yearly, one of which is formed by the basal leaf and two others are formed by the bases of the assimilating leaves. Two scales are concentric, and the third one,

formed by the base of the leaf, preceding the flower, is not closed. The scales and leaves are attached to the bottom of the bulb, i.e. to the shortened stem with very closely approximated internodes.

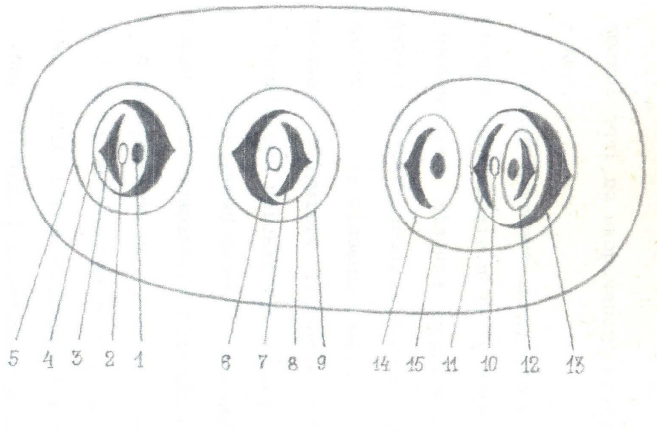

Fig. 2. Horizontal section of the bulb of *Galanthus nivalis* L.: 1 – growing point; 2, 6, 10 – flowers of shoots of different ages; 3, 4 assimilating leaves of the renewal shoot of the current year; 5 basal leaf of the renewal shoot of the current year; 7, 8 assimilating leaves of the renewal shoot of the last year; 9 basal leaf of the renewal shoot of the last year; 11, 13 assimilating leaves of the renewal shoot of the year before last; 12, 14 lateral vegetative shoots; 15 basal leaf of the renewal shoot of the year before last.

Minor life cycle is a characteristic of shoots life duration from developing of bud on the shoot of previous order to the death of all its parts. Phases of morphogenesis are the main stages of life form forming and its degradation during ontogeny. Minor life cycle or morphogenesis of monocarpic shoot includes the period from the beginning of its founding as undifferentiated area of meristem, then includes within the bud phase of development of shoot, its further development and then the death of all aboveground and underground structures. Annual cycle of development of plant means the development of all ages shoots, composing this plant during the year [5].

Let us analyze the minor life cycle of *G. nivalis*. Every year a new renewal shoot develops from a bud that is laid in the bulb before two years of realization of this shoot. At the beginning of the season of development (late February) well-formed vegetative and generative structures that will develop in the current year are in the bulb as well as the rudiments of vegetative structures in the renewal bud of next year.

After the blossom has fallen the processes of differentiation take place in the renewal bud of next year. Scales and leaves laid down during the previous season increase in size as well as flower shoot begin to form. Soon knob of new renewal bud is formed. Thus, there are two renewal buds in the bulb which are at different stages of development. At the same time, lateral renewal buds which are the organs of vegetative reproduction start to develop in the axils of the assimilating leaves.

Intensive processes of differentiation take place in both renewal buds during the summer. Successive formation of parts of the flower takes place in the renewal bud, laid down during the previous season: at first three segments of outer perigonium are formed, then three segments of inner perigonium are formed, after them outer and inner circles of stamens are formed. After the anthers lay down the nests of ovary are formed. Then the formation of pollen and seed buds takes place.

In late summer the flower stalk with a completely formed flower can be seen in the bud, laid down during the previous season, and the new renewal bud with two leaves is by the flower stalk base. During this period, the most intensive formation of new roots takes place (there are much less new roots in spring). During the cold period growth processes are very slow.

Intensive growth of all organs begins in spring. The above-ground part of shoot grows intensively and at the end of the period of above-ground vegetation the renewal bud, laid down during the previous season begins to grow and differentiate again. Later a knob of new renewal bud is laid by the flower stalk base and the cycle repeats.

Thus, minor life cycle is completed within three years (36-38 months). In the first year rudiments of assimilating leaves and scales are formed in renewal bud, in the second year reproductive structures are formed, and in the third season (second calendar year of development) the plant comes into flower. The bulb scales in this development cycle retain their vitality for one year more, and then die away.

Seasonal development of *G. nivalis* is divided into two main periods: above-ground, connected with the appearance of leaves and flowers and underground, connected with the processes taking place in the bulb.

Terms of the beginning and the end of the season of development mainly depends on the altitude and weather conditions this year. When winter is long and cold, and spring is late the vegetation season can start later.

During the seasonal development following phenological phases are clearly observed: the beginning of development, flowering, seed ripening, dying out of the above-ground part of plants and semination. In the Transcarpathian Lowland development of *G. nivalis* usually starts in late February. Leaves and flower stalks appear at the same time. Flowering starts when the leaves have reached more than half of the maximum size and goes on up to three weeks. In the middle of May leaves and flower stalks turn yellow and than die away. Fruits ripen on the ground and burst open later – in early June. Thus, the average duration of vegetation is 4 - 4.5 months. After dying away leaves and flower stalks, a period of rest comes. At higher altitudes, the terms of development shift and shorten to some extent.

According to phenological rhythmical type the studied object belongs to plants with early spring flowering and summer-winter rest.

An important biomorphological feature of *G. nivalis* is that its bulbs are characterized by self-regulation of depth. When planting depth, secondary meristem on some level of underground part of flower stalk occurs, the result of which thickening is formed. In the lower part roots are formed, and above the thickening sheath and leaves are formed that turn than to storing scales. During the developmental season, a new bulb with storing scales and renewal bud is formed.

According to Kuperman [5], ontogeny is a living of organism from the moment of zygote or vegetative bud to natural death.

On the basis of the analysis of *G. nivalis* ontogeny four age stages and seven age groups are distinguished.

I. Latent stage

Sm (seeds). The seeds are round, yellowish-white, with well-developed endosperm, containing much starch in the early stage of development. Elaioplasts develop from the chalazal area, which consist mostly of thin-walled cells, rich in fats [4]. Weight of 1000 seeds is 10,554 - 12,067 g.

II. Pregenerative stage

P (seedlings). Fresh seeds, having poured out of the boll in June, germinate on the forest floor after four months, in late September. The seed coat bursts next to the mikropyle, than the primary root and the cotyledon sheath appear. During some days they grow intensively down into the soil, then the first green leaf breaks through the cotyledon sheath, comes out of the forest floor to a few centimeters. Then their growth slows down, leaf blade dies, and in this condition the sprout hibernates. Some seeds germinate in spring.

J (juvenile plants). In spring the green leaf comes out of the soil, developing its green blade. The blade is narrow, linear, without a central vein. The primary root comes downward out of the forest floor layer and enters the soil. By that time the endosperm is already exhausted, connection with the seed is lost and the plant begins to independent autotrophic nutrition. At the end of the aboveground development the closed sheath of the green leaf enlarges, forming the only storing scale of the monopodial bulb. The bulb is covered outside with glumiferous scales, formed by the cotyledon sheath. By late May, the leaf blade dies away, and the stage of summer rest begins.

In the second year some adventitious roots develop. They start growing since autumn. In spring two leaves appear: one is a basal sheath leaf, the other is a middle assimilating leaf. At the end of the developmental season the sheaths of both leaves enlarge and turn into storing scales.

Im (immature plants). During the next 1-2 years two leaves form yearly, a basal leaf and a middle one. Leaf blade is wider than the juvenile plants and a central vein appears. The number of fleshy scales grows to 3-4, that of dry glumiferous ones – to 2-3.

V (virgin plants). Annual increment of the virgin specimen is three leaves: a basal leaf and two middle leaves. All vegetative organs of the virgin specimens are conspicuously larger, those of the plants of all the preceding age groups, and they enlarge annually. In the root system two types of roots can be found, i.e. feeding roots, which are thin, coiled, growing mainly horizontally, and anchoring (contractile), thicker roots, growing downward, having distinct folds in the basal part.

III. Generative stage

G (generative plants). *G. nivalis* is going to flower usually of age 4-5 years. In specimens of this age group, unlike the previous groups, the upper middle leaf sheath is not closed. From the axile bud of the upper middle leaf a flower stalk appears. Thus, even if the bulbs are going to flower, they retain monopodial growth. A lateral generative shoot bears one bractal membranous leaf and one flower. In the group of generative plants we found specimens among which there is a break in flowering. They have the rest of the flower stalk, which stops their growth at different stages of development.

IV. Postenerative stage

S (senile plants). These individuals occur within the populations very rarely. So this age group is singled out somewhat conventionally. This is a very weakened, dying plants. Senile individuals are characterized by losses in the ability of flowering, fruiting and vegetative reproduction. Stopping of growth of all organs can be observed too. The depth of the bulbs of the senile plants is less than that of the generative plants, sometimes rotting of bulbs can be observed.

Discussion

According to the classification worked out by Smirnova [16], on the life cycle duration *G. nivalis* should be qualified as a plant with long ontogeny (at least 12-15 years) and according to its development rate it should be characterized as a plant with the slow duration of pregenerative period (4-5) years. Generative reproduction cycle is not long (3-5 years), vegetative – short (2-3 years). Judging by the peculiarities of the major life cycle, *G. nivalis* can be classified as a type of monocentric biomorphs with complete early nonspecialized disintegration [17].

In course of ontomorphogenesis of *G. nivalis* the following stages take place: primary shoot (p-im), primary bush (v-g), bushy particle (g).

The studies of *G. nivalis* ontogeny have shown that it is characterized by multivariate ways of development of some morphogenetic phases; it can be confirmed in existence of clonal and unclonal subcycles of development (Fig. 3). According to the classification of age categories of herbaceous plants, worked out by Berko [2] *G. nivalis* should be qualified as a plant with unclonal and clonal subcycles of ontogeny with considerable prevalence in Transcarpathian populations the first subcycle. Virgin and generative specimens can reproduce by vegetative way. Daughter individuals belong to virgin and generative age groups. Among generative plants, as we noted above, there is a break in flowering.

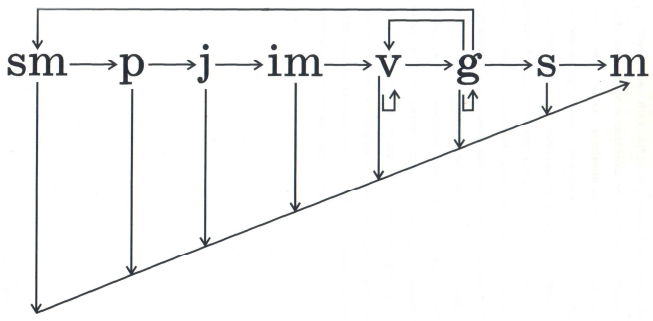

Fig. 3. Scheme of multivariate ways of ontogeny of *Galanthus nivalis* L.: sm-s – indices of age groups, m – dying out.

Conclusions

Minor life cycle of *G. nivalis* is completed within 36-38 months. In the first year rudiments of assimilating leaves and scales are formed in renewal bud, in the second year reproductive structures are formed, and in the third season (second calendar year of development) the plant comes into flower. The bulb scales in this development cycle retain their vitality for one year more, and then die away.

On the basis of the combination of qualitative and quantitative features, four age stages and seven age groups of *G. nivalis* are distinguished. Multivariate ways of development of individuals, which can be confirmed in existence of clonal and unclonal subcycles of ontogenesis are established. *G. nivalis* can be classified as a type of monocentric biomorphs with complete early nonspecialized disintegration. In course of ontomorphogenesis the following phases take place: primary shoot (p-im), primary bush (v-g), bushy particle (g).

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ЖИТТЄВИЙ ЦИКЛ *GALANTHUS NIVALIS* L.

Резюме: У статті розглядаються питання морфогенезу (або малого життєвого циклу) та онтогенезу (або великого життєвого циклу) підсніжника білосніжного. Визначена тривалість малого і великого життєвого циклів. Описані етапи розвитку монокарпічного пагона у бруньці поновлення. Описаний також сезонний ритм розвитку *G. nivalis*. На основі аналізу онтогенезу *G. nivalis* виділені чотири періоди та сім вікових груп особин. Встановлена поліваріантність розвитку особин.

Ключові слова: Galanthus nivalis L., морфогенез, брунька поновлення, монокарпічний пагін, сезонний ритм розвитку, онтогенез, вікові стадії, вікові групи

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ЖИЗНЕННЫЙ ЦИКЛ *GALANTHUS NIVALIS* L.

Резюме: В статье рассматриваются вопросы морфогенеза (или малого жизненного цикла) и онтогенеза (или большого жизненного цикла) подснежника белоснежного. Определена длительность малого и большого жизненного циклов. Описаны етапы развития монокарпического побега в почке возобновления. Описан также сезонный ритм развития

G. nivalis. На основе анализа онтогенеза *G. nivalis* виделены четыре периода и семь возрастных групп особей. Показана поливариантность развития особей.

Ключевые слова: Galanthus nivalis L., морфогенез, почка возобновления, монокарпический побега, сезонный ритм развития, онтогенез, возрастные стадии, возрастные группы

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ЕКОЛОГО-ЦЕНОТИЧНА ПРИУРОЧЕНІСТЬ *PRIMULA VERIS* L. У СНОВСЬКО-СЕМЕНІВСЬКОМУ ГЕОБОТАНІЧНОМУ РАЙОНІ ТА ЇЇ РОЗМНОЖЕННЯ EX SITU

В умовах Сновсько-Семенівського геоботанічного району всі місцезростання *P. veris* віднесено до асоціації Ulmenion minoris Oberd. 1953 (клас Querco-Fagetea Br.-Bl. et Vlieg. 1937; порядок Fagetalia sylvaticae Pawl. 1928; союз Alno-Ulmion Br.-Bl. Et R. Tx. 1943).

На досліджуваній території більшість місцезростань підлягають значному антропогенному впливу - вирубкам.

Встановлено особливості введення *P. veris* в культуру в умовах вирощування у дерново-підзолистих ґрунтах, зокрема: підвищенню біопродуктивності сприяє часткове затінення (до ¼ довжини світлового дня). Вегетативне розмноження в умовах соснового лісу (союзу Dicrano-Pinion Libb. 1933) відбувається, хоч і меншими темпами, ніж у звичайних для виду умовах.

Ключові слова: Primula veris L., Східне Полісся, популяція, поширення, ex situ

Primula veris L. зустрічається у помірному поясі по всій Європі від Ірландії і до Уралу, Криму, Кавказу та Ірану [6]. Приурочений до світлих широколистяних або рідше мішаних лісів, частіше зустрічається на узліссях або лісових галявинах [1, 2]. Більшою продуктивністю вирізняються популяції, що зростають на сірих лісових добре дренованих суглинистих ґрунтах [1, 6].

Питання поширення *P. veris* у Східному Поліссі і зокрема у Чернігівському й Новгород-Сіверському Поліссі наразі вивчено недостатньо. Згідно з опрацьованими матеріалами [1, 6] досліджені популяції розташовані на межі ареалу виду. Таке географічне розташування супроводжується заміною ґрунтового покриву на бідніші дерново-підзолисті ґрунти і широколистяних лісів на мішані й хвойні, що приводить до зменшення частки виду в екосистемах району досліджень. Іншим фактором, який значно впливає на чисельність виду є антропогенна зміненість ландшафтів [3, 6].

Матеріал і методи досліджень

При проведенні пошукових досліджень використовували маршрутні й напівстаціонарні методи. При встановленні географічних координат меж популяцій *P. veris* використано GPS-навігатор Garmin Dakota 10. Геоботанічні описи здійснювали під час вегетації та квітування рослин у квітні-травні 2012-2016 року на ділянках площею 50-100 м. Фіксувалося загальне проективне покриття кожного ярусу та окремих видів. Під час обробки отриманих даних використовували роботи з флористичної класифікації рослинності [5, 7]. Номенклатура синтаксонів наведена за W. Matuszkiewicz [7].