there are populations of Asarum europaeum of all three types (depressed, balanced and prosperous) in the forests of this region. First of them are the most common. It is proved, that the biggest impact on the vitality structure of the populations of this plant has the factor of illumination under the forest canopy and the level of carbonate in soil also. For a complex of abiotic environmental factors on the formation of populations of Asarum europaeum the most favorable conditions were grouping Tilieto (cordatae)–Quercetum (roboris) stellariosum (holosteae), the worst – Pinetum (sylvestris) franguloso (alni)–vacciniosum (myrtilli) and Quercetum (roboris) coryloso (avellanae)–convallariosum (majalis).

Key words: forest phytocenoses, morphometric analysis, morphometric analysis, vitality structure of populations, Asarum europaeum L., Ukrainian Left-Bank Polissia.

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THE STRUCTURE OF CLONES OF FOREST SUBSHRUBS *CALLUNA VULGARIS* (L.) HULL. IN ECOSYSTEMS OF NORTH-EASTERN UKRAINE

I. M. Kovalenko, associate professor, Sumy National Agrarian University

Forests of the North-East of Ukraine have long been subjected to various anthropogenic impacts: industrial timber harvesting, amelioration, berry picking, mushroom gathering, recreation. In 1999, Desnyansko-Starogutsky National Nature Park with an area of 16 hectares was created in the North-East of Ukraine. Cenosis forming plants of the lower forest layers carry these loads. One of these plants, common in the forests of the North-East of Ukraine, is Calluna vulgaris (L.) Hull. The clonal structure of Calluna vulgaris (L.) Hull. has been examined using the total mapping method. The regularities of changes within the radii of clones, density of partial bushes and their age have been found out. The author has suggested an original statistical and graphical method which allows to estimate age state of each clone and make its land zoning.

Keywords: subshrubs, clones, partial bush, populations, age state.

Formulation of the problem. The important structural and functional component of forest ecosystems is a live ground cover. Therefore, the condition of species and plant populations of the grass and shrub layer is a sustainability index of forest ecosystems. There is a need for permanent monitoring of plant populations that are a part of forest ecosystems. The goal of this study is to analyze phyto-population monitoring of forest herbs that form a live ground cover of forest ecosystems in North-Eastern Ukraine.

The stability of clones is largely determined by the fact that in the early stages of the ramet formation they receive the necessary organic matters from genet and therefore are much more stable than regular shoots and sprouts. Thus, the structure of clones, the rate of their formation and stability are not the same [1] in clone plants with different ways of vegetative reproduction (rhizomes, mustache, stolons, root sprouts, etc.).

Wide-spread occurrence of vegetative mobile plants which form clones in forest ecosystems suggests that live ground cover of the forests is mosaic, spotted, uneven. Clones are an important structural component of the herbaceous and subshrub layer of forest phytocenoses.

Objects and methods of the study. The study of the clones of plant populations of forest subshrubs in North-Eastern Ukraine was conducted by total mapping of the area occupied by a clone. The entire area occupied by a clone was broken into squares (50x50 cm). For each square horizontal projection was made, on which the location of partial bushes of the investigated species, their number and age state of each were indicated. After that, the litter and surface soil were removed, and the position of rhizomes was marked in the scheme, being made.

A detailed analysis of the clonal formation and structure was made for a model group of subshrubs, such as ***Calluna vulgaris (L.) Hull*.** It is dwarf subshrub which is characterized by vegetative reproduction, and forms clones. Morphostructural unit of clone formation is a partial bush. The list and main features of phytocenoses, in which the study of clones of model plants of herbaceous and subshrub layer has been conducted, are given in table 1.

Table 1

Brief geobotanical characteristics of forest associations with participation of herbaceous and subshrub layer dominants

Number and name of association	Stand density	Average stand age, year	Average stand height, m	Average projective cover of dominant, %
I. Betuleto-Pinetum callunoso-myrtillosum	0.5	48	20	30
II. Pinetum callunoso-hylocomiosum	0.5	50	21	25
III. Querceto-Pinetum callunoso-hylocomiosum	0.4	45	18	35

Clones are significantly different from each other by the ratio of partial bushes of different age, and the location of bushes of different age is not accidental within each clone. To estimate the total

age state of clones we have developed the three new indexes: the index of recovery (I_{recov}), the index of aging ($I_{ag.}$) and the index of generativity ($I_{generat.}$), based on the approaches of M. V. Glotova [2]. They were calculated according to the following formulas.

The index of recovery as the ratio of pre-generative partial bushes to their total number:

$$I_{re\ cov\ .} = \frac{\sum_{i=1}^{p-v} n_i}{\sum_{i=1}^{p-s} n_i} \cdot 100$$

where *p... s* – age state of partial bushes in standard designations.

The index of aging as the ratio of partial bushes of age status *g3, ss* and *s* to their total number:

$$I_{ag.} = \frac{\sum_{i=1}^{g_3-s} n_i}{\sum_{i=1}^{p-s} n_i} \cdot 100$$

The index of generativity as the ratio of number of generative partial bushes to their total number:

$$I_{generat\ .} = \frac{\sum_{i=1}^{g_1-g_3} n_i}{\sum_{i=1}^{p-s} n_i} \cdot 100$$

Results of the study and its discussion.

Calluna vulgaris. The study of *C. vulgaris* clones was made in the three associations: I. Betuleto-Pinetum callunoso-myrtillosum, II. Pinetum callunoso-hylocomiosum, III. Querceto-Pinetum callunoso-hylocomiosum.

Specific procumbent axial formation (procumbent stem) plays the leading role in making subshrub form of *C. vulgaris* growth in the forest ecosystems. They are usually formed by the development of lateral branches. Under the conditions of forest ecosystems in North-Eastern Ukraine, *C. vulgaris* bushes form on average 3-5 procumbent stems that grow from a small stem up to 6 cm in length under the soil.

M. T. Mazurenko and O. P. Khokhryakov [3] defined the following phases in the ontogeny of heather: 1) primary branch with short off-shoots (first 3-5 years); 2) development of elongated off-shoots (the lower of which can be growth, long, plagiotropic; 3) lodging and rooting of the main branches, sympodial branching; 4) the formation of a clone.

Under our conditions *C. vulgaris* is typically vegetative half-creeping, half-sprawl subshrub, the main structural and biological elements of bushes of which are plagiotropic stems. Adventitious roots are formed on the nodes of these stems, and axillary buds of vertical stems form a new partial bush. Stems with orthotropic shoots form *C. vulgaris* clones.

We have managed to distinguish the five clones of heather of different ages in various associations. Under the conditions of the National Nature Park, heather clones have a diameter of 7 to 10 m, rarely up to 15-18 m. Partial bushes are sparsely arranged in them. Their average density does not exceed 15-20 partial bushes per 1m^2. They are usually only 8-12 pieces/ m^2.

Within a radius of a clone, partial density of heather bushes is reduced on average from 4.0 - 4.5 to 0.5 pieces on the investigated plot. The regression equation for reduction in the density of partial bushes within a radius of a clone is as follows: $y = 4.4 – 0.3\ x$.

Depending on the age of a heather clone, the ratio of partial bushes of different age is not the same within each clone. Young clones (No. 3 and No. 4) are characterized by high value of the index of recovery and the reduced index of aging (tab. 2). Their index of recovery is 56% and 68%, index of aging is 0% and 9% respectively. In the middle-aged clones (clone No. 5), the index of recovery is reduced by 37%, and the index of aging increases by 17%. The index of generativity at least equals to 50%. In older clones (No.1 and No. 2) the index of aging reaches 50% at an even greater decrease in the index of recovery. We have not identified very old clone of heather in the investigated associations.

Table 2

Age state of *C. vulgaris* clones in forest associations of North-Eastern Ukraine

Clones	$I_{rec.}$	$I_{ag.}$	$I_{generat.}$
1	28.3	50.0	52.5
2	17.8	48.6	61.9
3	68.1	9.7	26.4
4	56.3	0.0	43.8
5	37.8	16.9	56.3

Heather clones of different ages are characterized by placement of the regression lines for the index of recovery and the index of aging. In young clones the regression line for the first of these indexes is higher than the second one. In the middle-aged clones, they cut one another, and in the old clones the regression line of the index of recovery is below than the regression line of the index of aging.

Based on changes in the density of partial bushes and their age state, the clone area can be divided into the three zones: central, intermediate and peripheral. In the middle-aged clone, the central zone consists mainly of partial bushes of old generative and post-generative age state (a population of partial bushes of regressive type). The intermediate zone consists of partial bushes of generative and old vegetative age state (a population of partial bushes of normal type). And the peripheral zone is represented mainly by pre-generative partial bushes (a population of partial bushes of invasive type). The boundaries among them, of course, have a fuzzy nature, but the areas are significantly different from each other.

As in the other investigated clonal plants with

vegetative overgrowth, partial heather bushes of different age state are quite naturally placed in clones. This allowed us to offer the three graphical models of heather clones (fig. 1).

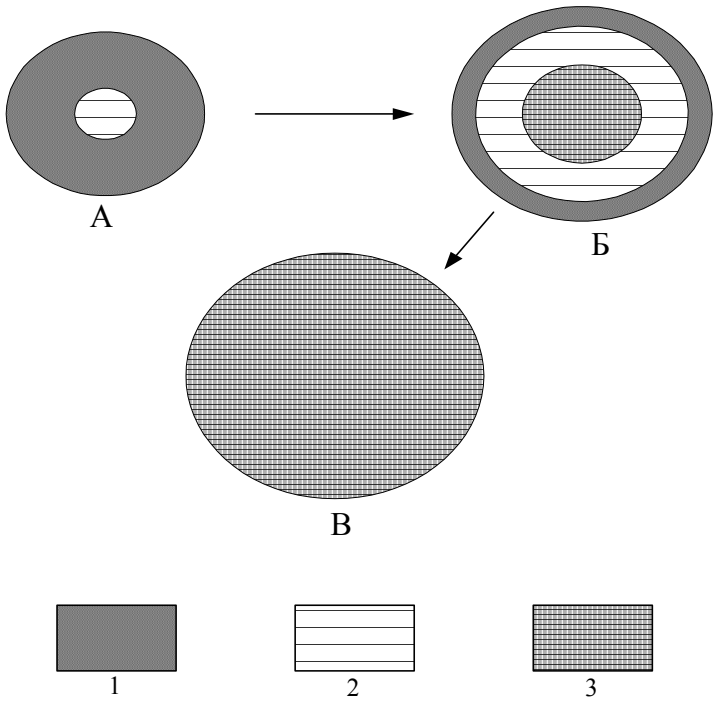

Figure 1. *C. vulgaris*: diagram of the clonal structural models at different stages of development:
A – clone, in the creation of which pre-generative, virginal and generative partial bushes are involved; B – clone, in the creation of which pre-generative, virginal, generative and post-generative partial bushes are involved; C – clone, in the creation of which post-generative partial bushes are involved. 1 – a population of partial bushes of invasive type; 2 – a population of partial bushes of normal type; 3 – a population of partial bushes of regressive type.

Conclusions. In the forests of North-Eastern Ukraine forest subshrubs of *Calluna vulgaris (L.) Hull,* act as key edificator species of live ground cover and largely determine the self-recovery of forest forming species and the stability of the forest ecosystems as a whole. It has been found that these types of subshrubs form clonal structures that correspond to one or another of the theoretical clonal models. This is an assessment of aging and clonal structural features of the investigated plant species.

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СТРУКТУРА КЛОНОВ ЛЕСНОГО ПОЛУКУСТАРНИЧКА CALLUNA VULGARIS (L.) HULL. В ЭКОСИСТЕМАХ СЕВЕРО-ВОСТОКА УКРАИНЫ

И. Н. Коваленко

В 1999 году в северо-восточной части Украины был создан Национальный природный парк «Деснянско-Старогутский» площадью 16 га. Леса Северо-Востока Украины уже давно подвергаются различным воздействиям: промышленной заготовки древесины, мелиорации, сбор ягод, грибов, рекреация. Основную часть нагрузки несли ценозы, которые образуют растения нижних ярусов. Один из этих растений, распространенный в лесах на северо-востоке Украины, является Calluna vulgaris (L.) Hull. Клоновая структура Calluna vulgaris (L.) Hull. была рассмотрена с использованием общих методов. Были обнаружены закономерности изменений радиуса клонов, плотность парциальных кустов и их возраст. Автор предложил оригинальный графический метод, который позволяет оценить возрастное состояние каждого клона и сделать их зонирование.

Ключевые слова: полукустарники, клоны, парциальные кусты, популяции, возрастное состояние.