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УДК581.524

THE FEATURES OF *PINUS SYLVESTRIS* L. DEVELOPMENT ON THE INITIAL STAGES OF ONTOGENESIS AS WELL AS STRUCTURAL AND FUNCTIONAL PATTERNS OF ITS REGENERATION

Shevchuk S. Ye.

*Ivano-Frankivsk Vasyl Stefanyk Precarpathian National University
76018, Ukraine, Shevchenko Str., 57, Ivano-Frankivsk*

rezervportal@gmail.com

Secular variations of *Pinus sylvestris* L. in the process of its development on the fallows of Transdnistria Opillia were analyzed. Such age-related conditions were characterized as seedlings (p), juvenile (j), immature (im₁, im₂), virginal (v₁, v₂) and generative young (g₁) individuals. The age-space structure of the pine population formed in the process of growth was researched. Three functional zones were distinguished on the basis of density and spatial arrangement of *P. sylvestris*. The zone of mosaic structure and active growth with the individuals of all age-related conditions is the closest to the nursewood, the second zone is characterized by less density and equitable growth of individuals, the third zone is the place of sharp competitive struggle with herbaceous plants.

Key words: Pinus sylvestris, ontogenesis, Transdnistria Opillia, age-related conditions, fallows.

Шевчук С.Є. ОСОБЛИВОСТІ РОЗВИТКУ *PINUS SYLVESTRIS* L. НА ПОЧАТКОВИХ ЕТАПАХ ОНТОГЕНЕЗУ ТА СТРУКТУРНО-ФУНКЦІОНАЛЬНІ ЗАКОНОМІРНОСТІ ПРОЦЕСУ ЇЇ ВІДНОВЛЕННЯ / Прикарпатський національний університет ім. Василя Стефаника, 76018, Івано-Франківськ, вул. Шевченка, 57

Розглянуто вікові зміни *Pinus sylvestris* L. у процесі розвитку на перелогах Придністерського Опілля. Охарактеризовано такі вікові стани – проростки (p), ювенільні (j), іматурні (im₁, im₂), віргінільні (v₁, v₂) та молоді генеративні (g₁) особини. Досліджено просторово-вікову структуру популяції сосни, яка формується в процесі заростання. На основі щільності та просторового розміщення особин *P. sylvestris* в популяції вдалося виділити три функціональні зони. Найближчою до материнського насадження є зона мозаїчної структури та активного росту, де зустрічаються особини всіх виявлених вікових станів; друга зона характеризується меншою щільністю і рівномірним ростом особин, третя зона – місце загостреної конкурентної боротьби з трав'янистими рослинами.

Ключові слова: Pinus sylvestris, онтогенез, Придністерське Опілля, вікові стани, перелоги.

Шевчук С.Е. ОСОБЕННОСТИ РАЗВИТИЯ *PINUS SYLVESTRIS* L. НА НАЧАЛЬНОМ ЭТАПЕ ОНТОГЕНЕЗА И СТРУКТУРНО-ФУНКЦИОНАЛЬНЫЕ ЗАКОНОМЕРНОСТИ ПРОЦЕССА ЕЕ ВОССТАНОВЛЕНИЯ / Прикарпатский национальный университет им. Василия Стефаника, 76018, Ивано-Франковск, ул. Шевченко, 57

Рассмотрены возрастные изменения *Pinus sylvestris* L. в процессе развития на залежах Приднестровского Ополья. Дается характеристика таким возрастным состояниям – проростки (p), ювенильные (j), иматурные (im₁, im₂), виргинильные (v₁, v₂) и молодые генеративные (g₁) особи. Исследована пространственно-возрастная структура популяции сосны, которая формируется в процессе зарастания. На основе плотности и пространственного размещения особей *P. sylvestris* в популяции удалось выделить три функциональные зоны. Ближайшая к материнскому насаждению – зона мозаичной структуры и активного роста, где встречаются особи всех выявленных возрастных состояний; вторая зона характеризуется меньшей плотностью и равномерным ростом особей; третья зона – место обостренной конкурентной борьбы с травянистыми растениями.

Ключевые слова: Pinus sylvestris, онтогенез, Приднестровское Ополье, возрастные состояния, залежи.

INTRODUCTION

During the land reform in Ukraine there were works carried out not only on denationalization and privatization of lands, but also measures of removing from active agricultural use agricultural lands with degraded and unproductive soils. Much of these lands is transferred to the reserve lands and provision of rural councils [1]. At the same time, some agricultural lands appeared to be upturned by the owners, and have not been treated for a considerable time. The problem of the dynamics of fallows is extremely important, because starting from 1990, there has been removed from the cultivation in Ukraine of about 8.5 million hectares of plough lands, and this process still continues [2]. On these lands spontaneous overgrowth occurs, which goes through various stages of secondary succession towards the formation of meadow or forest vegetation, and on the final stages of formation approaches natural phytocoenosis [3].

An interesting situation is observed in the Monastyrskiyi district, of Ternopil region, where on the fallows the mutation processes of varying degrees of intensity are taking place. The salient is undulating plain with the height 240-380 m. above sea level. The annual precipitation – 610 mm. The soil is light-grey ashed, limestone comes to the surface. On the areas, where more than 20 years there were no agricultural actions, the process of intensive reforestation with *Pinus sylvestris* L. is observed.

The national plan action of environment protection of Ukraine foresees decrease of areas of plough lands by removing from intensive cultivation, conservation of degrading and unproductive agricultural lands aiming to expand the elements of natural frame and structure rationalization of agrolandscapes [4]. The criteria of quality assessment of conservation can be stability of forest phytocoenosis that develops on these areas. The condition of the above-mentioned phytocoenosis according to Part 4 Art. 20 of the Land Code of Ukraine is also the basis for the change of the intended purpose of the conserved lands.

During the critical phase of the development of forest formation species young individuals come into the phase of small growth. This issue is rather urgent for the pine since for the appearance of seedlings some requirements are necessary: large percentage of soil mineralization, absence or low density of grass and bush floor, increased requirement for lighting starting from the third year of life. This explains outburst of the pine regeneration after ground fires as the ground litter, grass and bush floor are destroyed by fire. The vacant ecological niche is occupied by the pine and its seeds extensively sprout in the period between one and two years. But soon due to regeneration of the live topsoil and other reasons the pine sprouts massively cease growing.

Thus the aim of our research was to research the development process of population *P. sylvestris* on the initial stages of its ontogenesis, as well as structural and functional mechanisms of its restoration process. On the basis of received results a conclusion can be made about the state of the analyzed areas and the perspectives of their further usage.

METHODS OF RESEARCHES

The peculiarities of natural restoration *P. sylvestris* on the fallows of Transdnistria Opillia were the subject of the research conducted between 2011 and 2015. The researched sites were divided into two groups according to the land type where the overgrowing took place. To the first group belong former pastures – hills with limestone outlet, unsuitable for farming. To the second group belong flat sites which during the soviet times were used for planting grain crops but at present time it became not profitable.

Researched areas differ between each other also by the exposure of slope and distance from the wall of the forest, by the predominant wind direction and nature of the litter. In spite of the

mentioned differences the process of *P. sylvestris* regeneration took place through the equal structural and functional mechanism on all the sites.

The research was made by route method by laying transects and on the fixed accounting platforms. (20*40 m).

As a part of populations the plants were identified in accordance with the general approaches of ontogenesis tree species periodization [5]. The vital status of the plants was determined by a scale of categories condition, received in the forest pathology. Index of the plantations state was calculated as a weighted average by the data of the state assessment of the individual trees. The state of plantations was assessed according to the received average indexes.

Also the value of morphological parameters of virginal species *P. sylvestris* was determined to assess the level of variability in the population of the younger generation.

The plants were evaluated by such morphological parameters: number of whorls, height of species, stem diameter, crown diameter, length of needles, order of branching [6]. The results were presented as arithmetic mean \pm mean accuracy ($M \pm m$).

RESULTS OF THE RESEARCH

During the research of ontogenesis such age-related conditions of *P. sylvestris* were distinguished: seedlings (p), juvenile (j), immature (im_1 , im_2), virginal (v_1 , v_2) and generative young (g_1) individuals.

Seedlings (p) are represented by individuals with a height of up to 0,05 m, which come across in the form of between four and eight seed lobes on the hypocotyl. Some develop a virgin offset with a length of up to 7 cm where individual needles of juvenile type are spirally located.

Juvenile plants (j) have one oblong shoot with a height of up to 0,17 m, where needles of mature type are located on the short shoots – brachyblasts.

Immature plants are divided into two subgroups. The plants of the first subgroup (im_1) start developing a crown, in other words side shoots develop round a central shoot forming a second generation axis. The total height of the individuals is not more than 0,5 m. The age is between 3 and 7 years.

Immature plants of the second subgroup (im_2) have the shoots of the third and sometimes the fourth generation. The crown is cone-shaped. The total height of the individuals is between 0,50 and 1,10. The age is between 4 and 8 years.

To virginal individuals of the first subgroup (v_1) belong the plants with an age of between 5 and 10 years and a height of up to 3 meters. These individuals have a monopodially growing crown with a pointed top and shoots of the fourth generation. Lower branches are characterized by slow growth though they may touch the ground.

Virginal individuals of the second subgroup (v_2) are characterized by a considerable annual growth which allows them to extend upwards and reach the size of up to 8 meters. The branching of the fifth generation prevails. They start the process of losing branches in the lower part of the stem. The age is between 9 and 17 years [7].

Young generative individuals (g_1) develop microstrobila and macrostrobila (cones). The number of female cones in one tree is not large which is connected with a relatively young age of the plants of this ontogenetic type – between 17 and 25 years (Table 1). Many individuals forward transition from v_2 into g_1 , in this way they react to a plant's top damage through branch cutting or breaking it off.

Table 1 – Specific values of biomorphological characteristic of *P. sylvestris* on different stages of its ontogenetic development ($M \pm m$)

Age-related condition	Length of age-related condition, years	Hight of a plant, m	Stem diameter at the hight of 1,3 m, cm	Top diameter, m	Order of branching	Length of needles, mm
p	2±0,1	0,05	-	-	-	23±1,5
j	3±0,2	0,2±0,03	-	-	1	47±2,3
im ₁	4±0,3	0,3±0,1	-	0,1±0,01	2	51±1,5
im ₂	6±0,7	0,9±1,1	-	0,8±0,4	3-4	63±3,2
v ₁	7±0,7	2,1±0,2	3±0,2	1,5±0,4	4-5	73±2,3
v ₂	13±0,3	5,2±0,7	7±0,5	2,3±0,3	4-5	69±1,8
g ₁	21±3,5	13,1±1,7	12,5±5,3	5,7±0,52	5-6	67±1,6

For the studied areas the characteristic is the uneven structure of the undergrowth. On the basis of plants density and their placement the area of overgrowing can roughly be divided into 3 zones. The first - from the wall of the tree stand to the distance ≈ 70 meters, the average density of undergrowth in recalculation is $5438 \pm 0,57$ species / hectares. Contagiousness of distribution of self-seeding and undergrowth is evident. This is reflected in the uneven distribution of species *P. sylvestris* on the area, their aggregation into groups of 9-36 plants. The maximum age of species - 15-18 years, there are juvenile (j), immature (im₁, im₂) and virginal species (v₁, v₂). The percentage of seedlings (p) and generative young individuals (g₁) is relatively low, and the seedlings occur only outside the clusters mentioned above on the «sparse» areas. Index of the tree stand is 2.06.

The second zone - the band width ≈ 50 m, is below the ecotone limit of parent plants - pasture, so the impact of the marginal effect is minimal. An important place takes the mineralization of topsoil and some sod of soil. The average density in terms of undergrowth is $3188 \pm 0,93$ species / hectares. Significant clusters were not found - single plants or grouped by 6 - 9 species. Vital status of plants mainly refers to the first category, the projective cover of crowns and other morphometric parameters prevail similar to those species of the first zone.. Though a great number of cut down or damaged species were defined that during the indexation of the tree state an indicator 1,8 was given. The maximum age of the species - 9-10 years, seedlings (s), juvenile (j), immature (im₁, im₂) and virginal species (v₁) are present. Cones are present in the damaged plants, that suggests the presence of generative species (g₁).

In the third zone (≈ 120 m from the wall stand) we observe the solitary species of pines under 10 years old, mixed with *Alnus glutinosa* L. Gaertn., *Betula pendula* Roth, *Cerasus avium* L. Moench, *Crataegus monogyna* Jacq., *Sambucus nigra* L., *Rosa canina* L., *Corylus avellana* L., *Malus sylvestris* Mill., *Populus tremula* L., *Quercus robur* L., *Salix alba* L., *S. caprea* L. Further spread of pine trees on the abandoned agricultural land areas prevents dense herbage and much sod of soil.

On the fallows where the regeneration of the pine takes place there is an evident disparity in the distribution of individuals *P. sylvestris* on the researched area, aggregation in the groups and the presence of windows in the tent is consistent with the concept of circular mosaic-ecosystems that was suggested by S.M Sannykov and V.E. Parpan [8]. Placing of plant density decreases from

the center to the periphery where comes into effect interspecific competition with deciduous species and herbaceous plants.

We consider further research of ecological distribution of the *P. sylvestris* in Transdnistria Opillia to be challenging and relevant. This will give the opportunity to estimate the quality of degraded and unproductive soils conservation and predict the effectiveness of their agroecological condition improvement. Given the stable development of phytocoenosis we are going to achieve radical improvement of lands through exploiting their soil protective and other features of protective afforestation.

CONCLUSION

1. Stable groups of the pine were formed on the fallows of Transdnistria Opillia. They consist of individuals of various age-related conditions (p-j-im₁-im₂-v₁-v₂-g₁). These populations are young that is why their age range is centered to the left.
2. Natural regeneration of *P. sylvestris* on the researched area happens through formation of some space-age structure of the population. Zoning of the growth area is clearly observed. The individuals of all researched age-related conditions can be met closer to the nurse-wood. The plants grow densely, forming compact groups of virginal and generative plants and small gaps where younger individuals grow. In the second zone the strict mosaic structure has not been formed yet, single generative individuals can be met. The third zone is the place of competitive struggle with herbaceous plants.

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