

**SPATIAL STRUCTURE OF PINUS SYLVESTRIS (PINACEAE)  
COENOPOPULATIONS IN THE NORTHERN TAIGA SCOTS  
PINE FORESTS OF KOLA PENINSULA**

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SUMMARY

The aim of the study was to assess the diversity of spatial distribution of *Pinus sylvestris* L. coenopopulations and their main components (stand, large and small regrowth) in middle-aged Scots pine forests and woodlands within the subzone of northern taiga. The studies were performed in the Kola Peninsula in 2010–2014. Data collection was carried out on 11 permanent sample plots (PSP) of the size 0.10–0.15 ha. Four types of Scots pine communities were analyzed: Scots pine lichen woodlands (Subpinetum cladinosum) (3 PSP), Scots pine forests of lichen site type (Pinetum cladinosum) (3 PSP), Scots pine forests of lichen-green moss site type (Pinetum cladinoso-hylocomiosum) (3 PSP) and Scots pine forests of green moss site type (Pinetum hylocomiosum) (2 PSP). In lichen Scots pine forests and woodlands the share of lichen in ground cover was over 70 %, in lichen-green moss Scots pine forests — from 30 to 70 %, in green moss Scots pine forests — less than 30 %. We identified individuals 4 cm at breast height as stand trees, specimens with diameter at breast height of less than 4 cm as large regrowth, specimens of height < 1.3 m and > 0.1 m as small regrowth.

Permanent sample plots were divided into squares measuring 5 x 5 m. Within each square all living individuals of Scots pine taller than 0.1 m were recorded.

Type of spatial structure of coenopopulations and their major components (stand, large and small undergrowth) was determined by the value of the p coefficient of the negative binomial distribution, which was used to approximate Scots pine individual distribution over squares. Six types of spatial structure have been allocated (Stavrova, 2012): random ( $P \geq 0.70$ ), slightly contagious ( $P = 0.50–0.69$ ), moderately contagious ( $P = 0.35–0.49$ ), markedly contagious ( $P = 0.20–0.34$ ), sharply contagious ( $P = 0.10–0.19$ ), very sharply contagious ( $P < 0.10$ ).

Three groups of Scots pine communities were reliably distinguished on the basis of sum of basal area: Scots pine woodlands of lichen site type ( $7.8 \pm 0.8 \text{ m}^2/\text{ha}$ ), Scots pine forests of lichen and lichen-green moss site type ( $14.2 \pm 0.7 \text{ m}^2/\text{ha}$ ) and Scots pine forests of green moss site type ( $27 \pm 2 \text{ m}^2/\text{ha}$ ). Only Scots pine forests of green moss site type were found to be significantly different from other types of communities by the number of pine trees per unit area (respectively  $6 \pm 2 \text{ ind./25 m}^2$  and  $2.2 \pm 0.3 \text{ ind./25 m}^2$ ).

All investigated types of drained middle-aged northern Scots pine forests and woodlands (having a range of basal area from 6 to 29  $\text{m}^2/\text{ha}$  and the density from 300 to 3000  $\text{ind./ha}$ ) were characterized by two types of spatial distribution of pine trees: random and poorly contagious. A higher degree of pine tree clustering (moderately contagious distribution) was only found in lichen woodlands.

Extremely low average density (less than 0.6  $\text{ind./25 m}^2$ ) and mostly random type of distribution (70 % of the communities) were the characteristic features of the spatial structure of Scots pine large regrowth in

northern middle-aged forests. Slightly and moderately contagious distribution of Scots pine large regrowth was observed only in some lichen communities.

The density of the small regrowth differed significantly between the two groups of communities — lichen Scots pine forests and woodlands ( $4.9 \pm 1.6$  ind./25 m<sup>2</sup>) and lichen-green moss and green moss Scots pine forests ( $0.9 \pm 0.6$  ind./25 m<sup>2</sup>). The space distribution of small regrowth compared to other components of Scots pine coenopopulations showed the greatest variety (from random to sharply contagious) and the highest degree of clustering: in half the time it was markedly or sharply contagious.

No relationship was found between spatial structure of Scots pine stands, large and small regrowth and type of forest communities, the density and total basal area of stands. In particular, weakly contagious distribution of Scots pine trees was observed in all the studied types of middle-aged pine forests in the range of total basal area from 12 to 29 m<sup>2</sup>/ha and tree density from 700 to 3000 ind./ha.

The relationship between spatial structure and Scotch pine forest type in the conditions of northern taiga was revealed only at the coenopopulation level. Lichen Scots pine forests and woodlands were more highly contagious spatial distribution of pine coenopopulation (predominantly markedly and moderately contagious types) compared to pine forests of lichen-green moss and green moss site type (predominantly weakly contagious type). The high degree of territory occupation by Scots pine individuals was characteristic to all types of communities, without exception: the share of free space was on average 4 %.

Key words: *Pinus sylvestris*, Scots pine, coenopopulations, spatial structure, the northern part of Europe.