

REGULARITIES OF NEEDLE DISTRIBUTION ALONG FIR-TREE RAMULE

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Needle length along ramule of fir-trees growing in pollution conditions, allows to compare various ecological conditions of habitat of these ramules on the same fir-tree. And the distribution character of needles along ramules varies depending on a pollutant level of a section near tree.

The differences on cardinal directions in needle quantity on numbers on one ramule are hardly appreciable, and depending on a pollutant level determine a characteristic figure of distribution of needle sizes on ramule length from its the basis. The analysis method of needle length distributions along one fir-tree ramule allows to determine general tendencies of needle distribution and gives fundamental biotechnical regularity.

Key words: accountable fir-tree, ramules placed on verticils, needle disposition, length parameter, needle distribution along ramules

The fir-trees are capable to register in difference age annual changes of an environment [2].

The changes of fir-tree needle properties are considered as adaptive behaviour directed on survivability and supporting of persistent growth and development in conditions of environmental pollution [3]. These changes allow defining ecological relations on territory, on which investigated accountable trees grow [2]. Therefore fir-trees can be used for realizations of ecological monitoring by a discrete evaluation of effects on fir environment, in other words its habitat.

However in the known publications attention is insufficiently directed to geometric parameters of needles, which should be of different length on ramules, situated in a small zone of pollution.

The purpose of the article - to prove biotechnical regularities of distribution of needle length along ramule stem taken in a specific geodesic direction on accountable fir-tree verticil limb tip.

For consummation of the purpose in view the following problems were decided:

- 1) Parameter of distribution along ramule as fir-tree needle length was determined;
- 2) Model of needle distribution by identification of the stable laws was obtained;
- 3) The possibility of accountable fir-tree needle length application for realization of an ecological evaluation of fir-tree habitat was justified.

For study of a fir-tree needle length change on ramule length on Yoshkar-Ola centre territory one accountable fir-tree *Picea abies* [1] at the age of 25-30 years was selected. The tree is situated near building of theatre named after Shketan on square named after Lenin. Auto-road and parking lot are situated from east direction of a tree, and from western direction fir-tree is bedimmed by adjoining building of theatre. Other fir-trees are disposed between accountable tree and auto-road, and also between accountable tree and parking lot.

In a fig. 1 disposition scheme of accountable fir-tree, from which ramule sampling for experiment realization was conducted, is represented.

Before sampling cardinal directions were defined by a compass, paper packets with the indication of the cardinal direction and number of sample were prepared. Fir-tree ramules were snipped by knife. Linear needle parameters were measured by ruler and caliper. Needles were dried on a paper square with meshes for preservation them before measurements after drying-up. About each mesh number cardinal direction and distance up to the basis of each fir-tree needle beginning from ramule stem were denoted.

Ramules were snipped from limb stem extremity approximately at height 1,3 m from tree trunk root collar level.

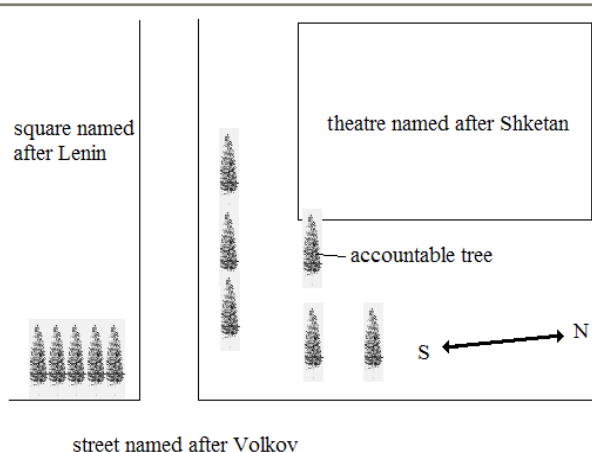


Fig. 1. The accountable fir-tree disposition scheme

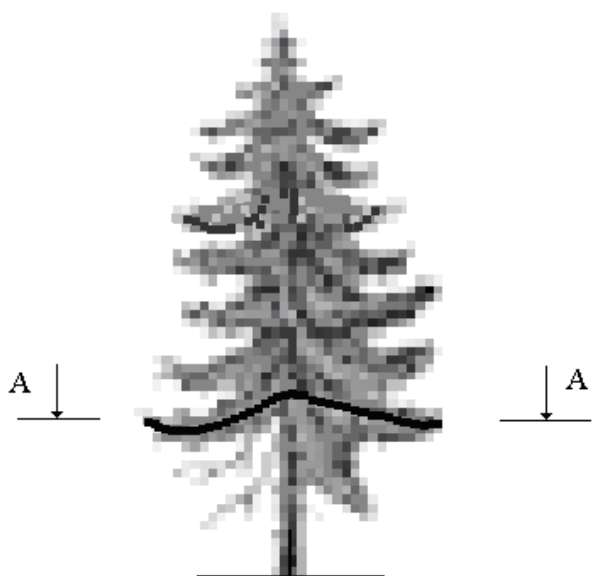


Fig. 2. An accountable fir-tree

Sampling for measurements of needle sizes on ramule length was conducted once in March, while vegetation period of fir-trees was not yet begun. On accountable fir-tree verticil was selected, then on it limb with a measurement of a geodesic direction of its stem was selected. After from an extremity of limb sample as ramule was snipped.

On accountable fir-tree (fig. 2) limbs inside one verticil were selected in four cardinal directions.

Before snipping of each ramule mark was made about what party of needles on it grows upward. Fir-tree ramule samples were

combined in paper packets, on which snipping time and geodesic direction from four cardinal directions (north, east, south and west) were noted, and then the samples were delivered in laboratory for consequent linear measurements.

In a fig. 3 verticil of a fir-tree V-01 (top view) from which samples were collected (cut A - A in a fig. 2) is represented.

Further in room conditions measurements of needle length l_i by caliper to within 0,01 mm, where i - needle number from ramule stem were conducted. The distances x_i from the basis cut ramule up to i -ой иголки were measured by scale to within $\pm 0,5$ mm.

In a fig. 4 the tentative schemes of a needle disposition on fir-tree ramule are shown. The needle serial numbers are represented on a frontal projection.

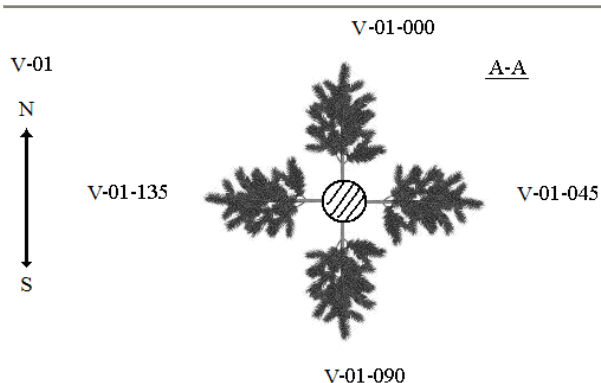


Fig. 3. Verticil V-01 of accountable fir-tree

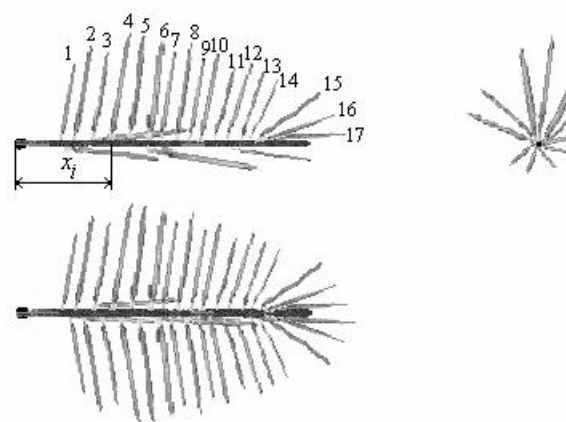


Fig. 4. The fir-tree ramule scheme (elevational drawing and top view)

Needles on ramule are placed by numbers on conditional four sectors - upper, under, right and left sectors in relation to ramule if to look on it from apex to the stem basis.

The measurement results of needles, situated in the upper ramule sector from

northern limb direction, are represented in table 1.

Greatest ramule needle quantity is observed from the southern cardinal direction, and also in upper sector. In bedimning conditions fir-tree needles is short.

Table 1. Results of measurements of length of needles, situated in the upper sector of ramule

Distance x_i , cm	Length l , cm	Distance x_i , cm	Length l , cm	Distance x_i , cm	Length l , cm	Distance x_i , cm	Length l , cm
0.15	2.11	4.80	2.48	2.40	2.40	7.80	2.14
0.25	2.14	5.15	2.47	2.60	2.53	8.10	2.09
0.50	2.16	5.40	2.44	2.80	2.68	8.15	2.08
0.70	2.06	5.70	2.43	2.90	2.57	8.60	1.95
0.80	2.16	5.75	2.38	3.10	2.60	8.65	1.95
1.05	2.18	6.00	2.38	3.20	2.48	8.95	1.89
1.20	2.34	6.15	2.42	3.45	2.51	9.20	1.86
1.30	2.26	6.50	2.30	3.60	2.58	9.30	1.89
1.50	2.48	6.70	2.37	3.75	2.47	9.60	1.85
1.60	2.45	6.85	2.29	4.00	2.61	9.75	1.74
1.80	2.50	7.00	2.26	4.10	2.53	9.76	1.68
1.90	2.43	7.30	2.22	4.30	2.44	9.90	1.66
2.10	2.48	7.60	2.23	4.55	2.55	9.95	1.63
2.30	2.44	7.75	2.21	4.70	2.40	10.00	1.42

From east accountable fir-tree direction, where the road is placed, needles are affected by contamination. Colour of some needles is chestnut brown, therefore they dry up.

In a software envelope Curve Expert-1.3 the graphs on the revealed needle length distribution regularities $l = f(x_i)$ depending on a distance along ramule were constructed. The mathematical equations of a kind $y = ax^b \exp(-cx^d)$ are obtained.

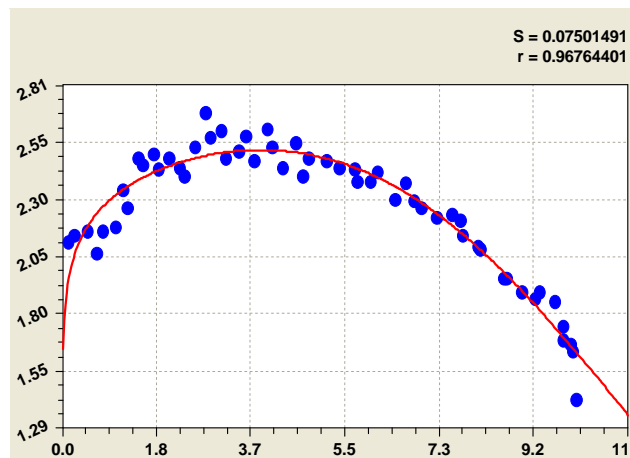


Fig. 5. Distribution of needle lengths on ramule from northern cardinal direction in upper sector

For example, in north from in upper sector of ramule length distribution (the fig. 5) has a kind:

$$l = 2.31476x^{0.081973} \exp(-0.00033881x^{3.20398}).$$

The needle distribution regularities from other cardinal directions and other sectors have a similar formula construction.

The graph of dependence of needle length on all four sectors together (the fig. 6), depending on ramule length, for example, from northern cardinal direction, has a formula kind:

$$l = 2.466396x^{0.096663} \exp(-0.00043716x^{3.151097}).$$

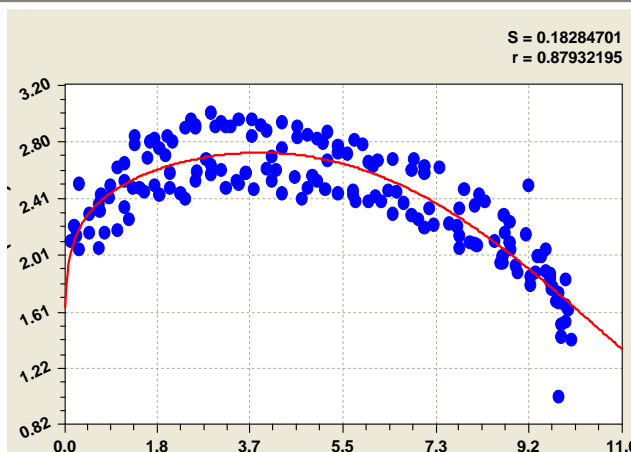


Fig. 6. The graph of dependence of needle length distribution on all four numbers

Greatest needle length is observed in upper sector on a comparison, for example, with the under sector, and also the characteristic figure of needle distribution is determined more precise in upper sector.

The analysis method of needle size change on fir-tree ramule length allows to define general biotechnical regularities of needle distribution.

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