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TREE-RING CHRONOLOGIES OF *PINUS SYLVESTIS* L.: TERRITORIAL DIFFERENTIATION

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In the presented work, we have tried to estimate the usage potential of tree-ring information combined with the methods of multivariate statistical analysis to identify the regional belonging of pine tree material.

Keywords: dendrochronological analysis, Scots pine, cluster analysis, tree-ring chronologies.

Illegal forest management is rightly one of the most difficult for investigation encroachments on the natural environment.

The subject of the research is mossy (Pinetum pleuroziosum), bristle-cone (Pinetum pleuroziosum) and myrtillus pine (Pinetum myrtillosum).

In this work, the tree-ring material sampled from the temporary testing squares landed in 2015–2017 over the whole territory of the republic is used.

Parameters calculation of radial growth was conducted with the help of automatic operating place «Dendro-Exp» [1]. As the result of the conducted research, 85 generalized and standardized tree-ring chronologies (hereinafter referred to as TRC) were constructed. The standardization was conducted separately for each tree with further indexes averaging of the far-reaching growth for the object using the method of a simple 5-year moving average. In the received chronologies the timespan of 60 years was studied. The calculated statistical parameters, such as synchronicity, sensitivity indexes etc. have confirmed the fact that all the analyzed TRCs are representative, and thus can be used in dendroecological researches. To answer the question whether the certain groups/regions, which are similar under the dynamics of far-reaching growth, exist in the Republic of Belarus the cluster analysis in terms of the program Statistica 10.0 (StatSoft, USA) was conducted. As long as we did not possess the information that a certain parameter could be more important for classification than others, we tended to consider the differences taking into account all the parameters in equal measure, thus we used Pearson's 1-r as a mean of metrics and as an algorithm of clustering we used Ward's method. As the result of the conducted hierarchical classification, the vertical dendrogram was received. Further on, choosing the liminal distance for a certain step of clustering we studied possible options of TRC differentiation. To fulfill this task, the perpendicular line was drawn from the dot corresponding to the chosen distance and the quantity of its crosses with the branches of dendrogram was calculated. The quantity of crosses identified the number of clusters, and the objects that were on the cut off branch identified its structure. The final quantity of clusters was identified using the graphic of combination process and the table of object combination. As the result, 8 clusters of homogeneous tree-ring chronologies of *Pinus sylvestis* L. similar by the dynamic to the far-reaching growth were identified:

– cluster 1 (stTRC_1-stTRC_10), region: Vitebsk; districts: Rossony, Verkhnedvinsk, Gorodok;

– cluster 2 (stTRC_11-stTRC_23), region: Minsk; districts: Miadel, Vileyka, Molodechno, Borisov;

– cluster 3 (stTRC_35-stTRC_45), region: Grodno; districts: Shchuchin, Lida, Diatlovo, Grodno;

– cluster 4 (stTRC_24-stTRC_34), region: Brest; districts: Kamenets, Zhabinka;

– cluster 5 (stTRC_46-stTRC_55), region: Mogiliov; districts: Khotimsk, Klimovichi, Krasnopolye, Cherikov;

– cluster 6 (stTRC_56-stTRC_64), region: Brest; districts: Pinsk, Luninets, Stolin;

– cluster 7 (stTRC_65-stTRC_73), region: Gomel; districts: Khoyniki, Bragin, Kalinkovichi, Rechitsa;

– cluster 8 (stTRC_74-stTRC_85), region: Brest; districts: Brest, Malorita.

Thus, using the algorithm of the offered cluster analysis makes it possible to analyze great volume of quantitative dendrochronological data that combined with other TRC characteristics (general tendencies of graphics, visible periods of oppression, correlation and synchronicity coefficients and etc.) will allow to solve the tasks connected with the growth place identification of the cut pine tree and the affirmation of the declared place of its preparation with great probability.

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CONIFEROUS SPECIES IDENTIFICATION ON THE BASIS OF THE SPECTROMETRIC INFORMATION

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The paper discusses the possibility and describes some approaches to application of spectroscopic methods for species affiliation of felled wood.

Keywords: wood identification, infrared spectroscopy, statistical methods, principal component analysis, softwood.

Currently, the wood species identification is carried out using microscopic analysis methods mainly that is a sufficiently long and time-taking process. At the same time, such tasks can be successfully solved using data from spectroscopic methods based on differences in the chemical composition (in particular, the ratio of the components number), thereby identification wood samples of different species [1].

In this study, infrared spectroscopy methods were used [2].

The object of the study were test samples of Scots pine (*Pinus sylvestris* L.), fir spruce (*Picea abies* L.), common silver fir (*Abies alba* L.), European larch (*Larix decidua* L.) and blue spruce (*Picea pungens* Glauca) from the Ksiloteka-collection of academic chair and forest protection of the Belarusian State Technological University. The choice of species used in study is determined to the fact that soft timber is widely used in the vast majority of industries where wood materials can be applied.

Infra-red spectra were recorded on the "Thermo Fisher Scientific" Nicolet iS10 FT-IR spectrometer, USA, equipped with a ZnSe beam divider. The spectra were recorded in the 4000 – 650 cm^{-1} range with a resolution of 4 cm^{-1} after averaging the accumulated spectrograms. Each spectrum was constructed by averaging of 128 measurements, at three different points on each sample. To reduce the level of experimental noise and errors in the analysis, a second-order derivative was calculated using the Savitsky – Golay method (a polynomial of order 2, 19 smoothing points).

Research indicated the IR spectra of the five coniferous species to be similar. However, the use of statistical analysis methods allows to differentiate samples according to species identification on the basis of differences in spectra. The further spectra processing was carried out using statistical methods for analyzing multifactorial dependencies aimed at solving discriminatory tasks.

The Principal Component Analysis, used in the modeling of spectrometric information obtained by infrared spectroscopy method, has showed that the samples can be divided into five clusters and these clusters coincide with their botanical affiliation.

Botanical species of common silver fir and European larch are localized in the negative values scope for factor 1 (clusters 1 and 2), while samples from three other clusters (clusters 3-5) – Scots pine, fir and blue spruce have positive values of the factor 1 axis. In this case, the samples of Scots pine have positive values of the factor 2 axis, while the value of factor 2 is characterized by a negative value for spruce samples. Particularly worth mentioning is the applicability of this model for the different spruce species identification based on factor 3 (clusters 3 and 4). Thus, basing on spectral data obtained by infrared spectrometry, in combination with multivariate data analysis, it is possible to conduct the coniferous species discriminatory analysis without a detailed chemical