

ANNOTATION

**For a dissertation for the degree of Doctor of Philosophy (PhD)
in the specialty «6D060700 – Biology»**

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on the topic «Dendrochronological studies of the hanging birch (*Betula pendula* Roth.) in the conditions of the forest-steppe of Eastern Kazakhstan».

General description of the study: The main purpose of this doctoral dissertation is to evaluate and study the annual growth of the hanging birch (*Betula pendula* Roth.) in the conditions of the forest-steppe of Eastern Kazakhstan, to study the influence of climatic factors on the annual growth of the hanging birch, core selection, calculation of annual growth by cores that reflect the influence of external and internal factors.

Relevance of the study: The hanging birch (*Betula pendula* Roth.) belongs to the main forest-forming species of the territory of the forest-steppe zone of Eastern Kazakhstan and has great ecological and economic importance. Studies of the variability of radial growth of hanging birch wood (*Betula pendula* Roth.) in connection with climatic parameters in the territory of the forest-steppe zone of Eastern Kazakhstan have not been conducted, which underlines the relevance of studying hanging birch (*Betula pendula* Roth.) by dendrochronological method.

Dendrochronological studies of the seasonal formation of annual tree rings provide an opportunity to establish how environmental factors affect the annual growth of wood and how the processes of xylem formation determine the subsequent anatomical and hydraulic structure of annual rings.

Currently, dendrochronological studies of the degree of adaptation of the hanging birch (*Betula pendula* Roth.) to changes in the natural environment are valuable for environmental monitoring, early diagnosis of forest damage, when developing measures for forest biogeocenoses and when managing in forest ecosystems. The research initiated by us will fill one of the most important problems of preserving forest ecosystems, as well as adapting forestry to changes in natural and climatic conditions aimed at overcoming the negative consequences of anthropogenic factors.

Consequently, the study of the dynamics of the growth of the hanging birch (*Betula pendula* Roth.) in Eastern Kazakhstan is currently relevant and will help solve one of the most important problems of preserving forest ecosystems, as well as adapting forestry to changes in natural and climatic conditions.

The purpose of the study: to study the features of the growth of the hanging birch (*Betula pendula* Roth.) under the influence of climatic factors in the conditions of the forest-steppe of Eastern Kazakhstan by dendrochronological method.

The main objectives of the study:

1. To investigate the dynamics of the influence of climatic factors on the radial growth of wood in the conditions of the forest-steppe of Eastern Kazakhstan;
2. To analyze the tree-ring chronologies of the hanging birch (*Betula pendula* Roth.) in the Katon-Karagai National Nature Park;

3. Determine the age structure of the hanging birch (*Betula pendula* Roth.) in the Katon-Karagai National Nature Park;

4. To conduct a comparative anatomical and hydraulic study of tree species in the conditions of the forest-steppe of East Kazakhstan;

5. To conduct a cluster analysis of the tree-ring chronologies of the hanging birch (*Betula pendula* Roth.) in the Katon-Karagai National Nature Park.

Objects and materials of the study: the main object of the study is a hanging birch (*Betula pendula* Roth.), obtained cores, anatomical sections, tree branches.

Research methods: dendrochronological methods, anatomical and hydraulic methods of dissection, cluster methods, correlation method.

Scientific novelty of the study: New dendrochronological studies on the growth of the hanging birch (*Betula pendula* Roth.) in the conditions of the forest-steppe of Eastern Kazakhstan are presented for the first time. The chronologies of stands reflecting the general regional climatic signal are shown, opening up prospects for the construction of a generalized regional chronology for the Altai region. It has been revealed that old-age trees (birch, larch and fir) dating back to the XVIII century grow on the territory of the Katon-Karagai National Natural Park. It was found that in the age structure of birch plantations, young trees and old-age trees are in a noticeable deficit. At the same time, medium-aged trees from 30 to 70 years old predominate, which indicates the relative youth of birch plantations. Anatomical and hydraulic indicators of stands revealed features in the structure of annual rings in hardwoods and are characterized as "healthy".

It is shown that precipitation has a significant impact on the formation of annual growth of the hanging birch (*Betula pendula* Roth.), where a positive correlation of annual growth with precipitation is observed. The precipitation of June and August has a positive effect on the variability of the increase. The air temperature has a negligible effect on the formation of the annual growth of the hanging birch, a negative correlation with the annual growth and air temperature has been revealed. The relationship of tree growth with cyclical fluctuations in solar activity is analyzed, a positive correlation of annual growth with solar activity is observed.

Theoretical and practical significance of the study: The results of the study make a significant contribution to the development of dendrochronological and dendroclimatological science in Kazakhstan and may have applied significance.

The validity and reliability of the research results is confirmed by a large volume of experimental material with the use of scientifically-based methods of collecting and processing initial data by statistical methods using modern computer programs that ensure consistency of the results. 10 trial areas were laid. More than 1600 wood cores were selected for dendrochronological studies and 220 twigs for anatomical and hydraulic studies. The collected field material was processed using standard dendrochronological methods using statistical analysis.

The results obtained can be used in carrying out forestry activities to preserve the biological diversity of forests. The revealed patterns of growth of various forms of hanging birch (*Betula pendula* Roth.) can be used in regional monitoring of forest ecosystems. The research results can be used in classes on the discipline of dendrochronology, in a practical course on forestry, in lectures of a special course on

dendrochronology and dendroclimatology and in research papers of students, undergraduates and PhD doctoral students.

Basic provisions of protection:

1. Long-term exposure to precipitation has a significant impact on the formation of annual growth of the hanging birch, where there is a moderate correlation of the correlation of growth with precipitation, precipitation in July and August have a positive effect on the variability of the growth of the hanging birch. The influence of the climatic factor, such as air temperature, caused a negative correlation relationship on the formation of the annual growth of the hanging birch in the study area, and the influence of solar activity on the radial growth of the hanging birch causes a significant and strong increase relationship.

2. The long-term dynamics of the growth of the hanging birch shows a synchronous correlation of radial growth in all the obtained chronologies in the studied areas.

3. The age structure of the distribution of birch stands in terms of core indicators indicates the relative youth of birch stands, since medium-aged trees from 30 to 70 years predominate.

4. Comparative analysis of anatomical and hydraulic studies indicates the stability and positive dynamics of the forest gene pool.

5. Cluster analysis has shown that when constructing dendrograms, the chronologies of the main sites form a separate cluster, which indicates that the radial growth of trees is significantly influenced by the peculiarities of their growing places (forest-steppe and mountainous areas), which determine the nature of the impact of external factors.

Main results of the study and conclusion:

The results of this study revealed the positive influence of precipitation and solar activity, revealed the negative influence of temperature on the formation of the annual growth of the hanging birch, which can serve as a basis for creating a forecast of the climatic situation in the studied region.

High correlation values were obtained between the generalized tree-ring chronologies of the six main sites, which indicates the presence of a common regional signal affecting the growth of trees within the entire study area. The generalized chronologies of the main sites of the hanging birch show a high reliable correlation, synchronicity and sensitivity among themselves, and are also well cross-dated.

It was revealed that in the age structure of birch plantations, young trees and old-age trees are in a noticeable deficit. At the same time, medium-aged trees predominate, which indicates the relative youth of birch plantations. It was found that old-age trees (birch and larch, fir) dating back to the XVIII century grow on the territory of the study, which made it possible to build chronologies lasting 305 years for Siberian fir, 268 years for Siberian larch and 137 years for hanging birch.

The results of cluster analysis showed the spatial variability of the climatic signal of tree-ring chronologies and the unification of the studied sites into clusters in the studied territory.

Levels of research organization: population-specific, biogeocenotic and biospheric.

Connection of the research with the scientific project: The dissertation work was carried out within the framework of the international research project "Forest regeneration and biodiversity at the forest-steppe border of the Altai and Khangay Mountains under contrasting developments of livestock numbers in Kazakhstan and Mongolia", carried out between Germany, Kazakhstan and Mongolia. Agreement No.31. 19.04. 2011 and Agreement No. 23 dated 24.01.2014 between S. Toraighyrov Pavlodar State University (Pavlodar, Kazakhstan), Botanical Institute named after Albert-von-Heller University of Göttingen. Georg-August (Göttingen, Germany) and the National University of Mongolia, Department of Biology (Ulaanbaatar, Mongolia).

The author's contribution to the results described in the dissertation: All the main results described in the work are performed and collected by the author. In addition, the author directly participated in the collection and analysis of initial data, scientific expeditions, approbation of research results, preparation of major publications on the work performed. All data and conclusions are based on the results obtained in the course of work and research for the degree of Doctor of Philosophy.

Approbation of the research: The main theoretical provisions and practical results of the dissertation were reported and discussed at:

International tree-ring conference "Rudenko-2014" (Bishkek – Cholpon-ATA, Kyrgyzstan 2014);

International tree-ring conference "Rudenko-2017". (Barnaul, Russian Federation, 2017);

- International scientific and practical conference "Satpayev readings-2013 (Pavlodar, Republic of Kazakhstan, 2013);

- International scientific and practical conference "Satpayev readings-2014 (Pavlodar, Republic of Kazakhstan, 2014);

- Seminar of the Department of Plant Ecology of the Albert von Heller Botanical Institute of the University of Göttingen. Georg-Augusta (Göttingen, Germany 2013);

- Seminar of the Department of Plant Ecology of the Albert von Heller Botanical Institute of the University of Göttingen. Georg-Augusta (Göttingen, Germany 2014).

Publications. 12 publications have been published on the topic of the dissertation, including:

1) 1 article in the SCOPUS database journal;

2) 1 article - in the indexed edition of the Web of Science Journal: Tree Physiology, Q1;

3) 1 monograph;

4) 4 articles in journals recommended by the KKSON of the Ministry of Education and Science of the Republic of Kazakhstan;

5) 5 articles in international scientific and practical conferences.

The structure and scope of the dissertation. The dissertation consists of an introduction, 4 sections, main conclusions, a list of references consisting of 257 sources, appendices. The dissertation includes 222 pages of text, including 53 figures and 17 tables.