

Annotation

on the dissertation for scientific degree of Doctor of Philosophy (Ph.D.) in specialty «6D061300 – Geobotany»

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“Study of new *Malus sieversii* (Ledeb.) M. Roem variety-clones of the Dzhungar population in in-situ and ex-situ conditions”

General characteristics of the work.

The dissertation is devoted to a comparative study of the current state of *Malus sieversii* Ledeb. M. Roem of the Zhetysu Alatau (Dzungar) population in natural conditions and in the conditions of the Botanical Garden.

Relevance of the research topic.

According to the Convention on Biological Diversity and FAO, one of the priorities is the conservation of biological diversity, important for agriculture or agrobiodiversity and one of the goals of Sustainable Development is the effective use of forest resources and the prevention of biodiversity loss.

The Mountain systems of Kazakhstan are a natural habitat for many rare and endemic plant species. Of scientific interest are the fruit forests of Kazakhstan, which are a special type of plant formations where many useful and endemic plants grow, such as wild relatives of cultivated plants. Great interest is the *Malus sieversii* (Ledeb.) M. Roem (Sievers apple tree), an endemic of the Tien Shan mountains with a valuable gene pool.

It has been proven that relict wild apple forests are the genetic center that contributed to the emergence of many cultivated varieties of apple trees. *M. sieversii* is listed in the Red Book of Kazakhstan and the International Red List (IUCN) (1981, 2014). However, there is a high risk of their disappearance from natural ecosystems. According to Academician A. Dzhangaliev, who examined wild fruit forests in Dzhungar Alatau, populations of wild apple trees decreased by 30% from 1948 to 2007.

So, the study of plant communities with the participation of wild apple trees and the development of scientific foundations for the conservation of its natural populations, which are of global importance for the forestry and agroindustry complex, food production, and the implementation of food security programs (FAO), become relevant.

The dissertation was conducted using scientifically sound traditional and modern methods. It aimed to study the current state of populations and new variety-clones of *M. sieversii* in Dzhungar Alatau, along with their condition in the second half of the last century. Additionally, the dissertation aimed to develop principles and methods for restoring declining plant communities that involve *M. sieversii*.

The comparative study of wild apple trees in *in-situ* and *ex-situ* conditions can provide a solution to the problem of rational forest resource management.

The aim of the work is: The aim of this work is to study new *Malus sieversii* variety-clones of the Dzhungar population in both *in-situ* and *ex-situ* conditions.

To achieve this goal, the following tasks were solved:

1. Assess the current state of the *M. sieversii* Dzhungar population in its natural habitat.
2. Study of new variety-clones of *M. sieversii* from the Dzhungar population under *ex-situ* conditions;
3. Assessment of new *M. sieversii* forms and variety-clones' fruit raw materials for chemical-technological and antioxidant properties from the Dzhungar population.
4. Analysis of the genetic diversity of forms and variety-clones of *M. sieversii* by establishing relationships with the natural population and clarifying the phylogeny within the species;
5. Development of recommendations for breeding and practice.

Object of research.

New variety-clones and coenopopulations of *Malus sieversii* (Ledeb.) M. Roem in the Piktovaya Shchel, Mushabay, Krutoe gorges of the northern macroslope of the Dzhungar Alatau.

Scientific novelty of the study.

- A comprehensive study of 10 coenopopulations of the Sievers apple tree population was conducted for the first time in the gorges of the Dzhungar Alatau.
- The floristic composition of communities involving *Malus sieversii* in the studied gorges was fully clarified, and a comparative analysis was carried out for the first time.
- The ontogenetic spectrum of *Malus sieversii* of the Dzhungar population was determined for the first time;
- An introduction assessment of new variety-clones of *Malus sieversii* was carried out for the first time;
- For the first time, the biochemical composition and antioxidant capacity of the fruits of new forms and variety-clones of *Malus sieversii* from the Dzhungar population were analyzed;
- For the first time, a molecular genetic analysis of the forms and new variety-clones of *Malus sieversii* of the Dzhungar population was carried out based on ISSR markers;
- For the first time, the relationship and intraspecific phylogeny of *Malus sieversii*'s variety-clones and natural forms were clarified using the nucleotide sequence of the ITS (internal transcribed spacer) and chloroplast genome markers (trnL-trnF and intron rps16).
- For the first time, the selected forms and variety-clones of *M. sieversii* have been included and registered in the international NCBI database under ITS number LR588511-LR588525; trnL-trnF LR588526-LR588530; rps16 intron MK994749–MK994766 nucleotide sequence of the ITS DNA marker.

Scientific and practical significance of the work.

The results obtained from the study provide information on the current state of *M. sieversii* in Dzhungar Alatau. This information will be used to supplement the management of the Zhongar-Alatau State Scientific Research Enterprise with new scientific data. The molecular genetic study materials will help in planning the restoration of natural populations of *M. sieversii* in Dzhungar Alatau using genetically pure variety-clones of the Sievers apple tree. The data obtained on the floristic and phytocenotic composition will be included in the regional publications "Green Book of the Almaty Region" (2023) and "Red Book of the Almaty Region" (2023). The fruits of natural forms and variety-clones of *M. sieversii*, selected based on their chemical and technological composition, can be used in the fruit industry.

Basic principles put forward during the defense

- Current state of *M. sieversii* Dzhungar population;
- The floristic composition of the plant communities that include *M. sieversii* was studied.
- Age composition of 10 coenopopulations of *M. sieversii* in the gorges of Dzhungar Alatau;
- Introduction of *M. sieversii* variety-clones;
- Assessment of chemical-technological and antioxidant properties of *M. sieversii* from the Dzhungar population.
- Study of genetic diversity and relatedness of cultivar clones and forms of *M. sieversii*;

Main results and conclusions of the study.

The results of the studied cenopopulations of the Pikhtovaya, Mushabai and Krutoe gorges showed the ecological and phytocenotic plasticity of *M. sieversii* and the confinement of the cenopopulations we studied to the lower part of the forest-meadow belt (CP1, CP2, CP5) and the forest-steppe belt (CP3, CP4, CP6, CP7, CP8), observed certain altitude and temperature limits. In the Pikhtovaya gorge, cenopopulations of *M. sieversii* are found only on slopes that are highly moist and shaded. The species composition of these plant communities, which include *Malus sieversii*, is determined by the conditions of the area and consists of 142 species. *Rubus idaeus* L. was found in all three populations as part of the flora that accompanies the wild apple tree.

Analysis of the age composition revealed that the populations of *Malus sieversii* in Pikhtovaya Shchel are regressive. The populations in Pikhtovaya Shchel, Krutoe, and Kokzhota gorges have a right-skewed age distribution (right-sided age spectrum).

The regeneration of *M. sieversii* in these gorges is unsatisfactory. Young apple tree shoots are rare and usually die in the first years of life. The apple trees in the Mushabai and Krutoe gorges were classified as normal due to the presence of middle-aged trees in the coenopopulations. As a result of the biochemical and technological characteristics of *M. sieversii* variety-clones, we identified variety-clones and forms

with a high content of nutrients and biologically active substances. Selected variety-clones of the Sievers apple tree with a rich content of nutrients and biologically active substances in the fruits can serve as a valuable source for selection and fruit processing. Antioxidant analysis showed that the studied fruit samples have a pronounced antiradical ability.

Certain varieties of the Sievers apple tree have been selected for their high nutrient and biologically active substance content in the fruits. These varieties can be a valuable source for selection and processing. Antioxidant analysis has shown that the fruit samples studied have a strong ability to fight against free radicals.

Based on the findings of the molecular genetic analysis, it has been observed that there is a significant genetic exchange happening between different populations of the *M. sieversii* species. The ISSR-PCR analysis has shown that there is a high level of molecular genetic polymorphism within the species, which can be attributed to their unique biological and ecological characteristics.

Personal contribution of the author to the work. The author of the dissertation fully contributed to the selection of the form and concept of the study, determining the purpose of the work, setting the research task, planning and performing experiments, and generalizing and processing the data obtained.

Interrelation of work with the research program.

The dissertation work was completed by the PhD candidate himself and was funded within the framework of the program BR05236546 «Cadastral assessment of the current ecological state of flora and plant resources of the Almaty region as a scientific basis for effective resource potential management» (2021-2023 гг.). All cameral works and laboratory studies were performed at the Institute of Botany and Phytoinroduction (Kazakhstan), molecular genetic analysis to clarify the relationship and intraspecific phylogeny, studied varietie-clones and natural forms of *M. sieversii* was carried out in the taxonomic laboratory of the Botanical Garden at the University of Osnabrück (Germany) during the doctoral student's foreign internship with the funding of the Ministry of Education and Science of the Republic of Kazakhstan.

Testing the work.

The results and main provisions of the dissertation were presented and discussed at many international scientific conferences:

- IV (XII) International Botanical Conference Young Scientists in Saint-Petersburg (Russia, Saint-Petersburg, 2018);
- International Symposium «Ecology and evolution: New Horizons» (Russia, Ekaterinburg, 2019);
- Problems of botany in Southern Siberia and Mongolia: XVIII International Scientific and Practical Conference (Russia, Barnaul, 2019);
- International scientific conference of young scientists “Fundamental research and innovation in molecular biology, biotechnology, biochemistry” on the occasion of the 80th anniversary of the birth of academician Murat Abenovich Aitkhozhin (Almaty, Kazakhstan, 2019);

- International scientific and practical conference dedicated to “Kazakhstan tauelsizdigi: bioaluanturlilikti saktau aspectileri” dedicated to the 80th anniversary of Doctor of Biological Sciences, Professor, Honorary Member of the National Academy of Sciences of the Republic of Kazakhstan, Academician of KazNAEN Mukhitdinov Nashtay Mukhitdinovich;
- Problems of botany in Southern Siberia and Mongolia: XVIII International Scientific and Practical Conference (Russia, Barnaul, 2021).
- IV International Congress on Plant Breeding (Turkey, 2022);
- XVI Eucarpia Symposium on Fruit Breeding and Genetics (Germany, 2023);
- The 6Th Symposium on EuroAsian Biodiversity (Azerbaijan, Baku, 2023);

Publications. Based on the research results, the author published 17 scientific papers; including 2 articles in the journals Q3 included in the Web of Science and Scopus database, 4 article in foreign journals of the RSCI system, 3 articles in the journal recommended by the Committee for Quality Assurance in Science and Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 1 collective monograph, 7 publications in proceedings of international scientific conferences.

Structure of the dissertation. The dissertation includes definitions, notations and abbreviations, introduction, literature review, object and methods of research, results and their discussion, conclusion, 264 literature sources and 4 appendices. The research paper consists of 176 pages, 21 tables and 38 figures.