ABSTRACT

dissertation for the degree of Doctor of Philosophy (PhD) in the educational program "8D05108 - Geobotany" **Kulymbet Kanat Kairatuly «Ecological and biological features and assessment of the state of coenopopulations of a rare, endemic, medicinal species *Adonis tianschanica* (Adolf) Lipsch. in order to preserve biodiversity»**

General characteristics of the work. The dissertation work is devoted to the ecological and biological features and assessment of the state of coenopopulations of a rare, endemic, medicinal species *Adonis tianschanica* (Adolf) Lipsch. in order to preserve biodiversity.

The relevance of research. With each passing year, anthropogenic impact on nature is increasing, making the issue of biodiversity conservation highly relevant. International organizations emphasize the necessity of preserving biodiversity, as reflected in the Convention on Biological Diversity and the Global Strategy for Plant Conservation. In Kazakhstan, efforts are also being undertaken to conserve biological diversity. The impact of negative factors on rare species can lead to their extinction, which is a global problem. The extinction of a biological species is an irreversible process, since each genotype is unique and cannot be reproduced. Therefore, the loss of a species with its unique properties means its final extinction. Conservation of rare plant species and prevention of their extinction has become one of the key tasks of ecologists and biologists around the world. In the research of rare plant species, the population level is of particular importance. This is explained by the fact that any plant species exists in nature in the form of local populations, and the processes occurring in these populations determine the dynamics of their development and sustainability.

Conservation of biodiversity is aimed not only at protecting individual species, but also at preserving unique plant communities. Only a small part of the communities are preserved at a certain level in nature reserves, but there is no single list of reference data on endangered and rare plant communities. This highlights the importance of their further study and protection. Some of them are of particular interest as benchmarks for maintaining a stable species ratio. Plant communities with a narrow geographical distribution may be lost as a result of accidental events, which makes it necessary to strengthen measures to protect them. The preservation of rare and endangered species is possible only through the protection of their communities.

The population of *A. tianschanica* is rapidly decreasing, and in some regions of Kazakhstan there is a threat of complete extinction of populations of this species. Currently, an assessment of the population status in the main regions of its distribution is required.

A comprehensive study of *A. tianschanica* cenopopulations in Ketpen, Zhetysu (Dzungarian) and Terskey Alatau, including a study of their distribution, abundance, density, age structure, as well as an analysis of soil conditions, ecological and areal features, including the molecular genetic diversity of populations, underlines the relevance of this work.

The object of research: Five cenopopulations of the *A. tianschanica* plant: 1,2-cenopopulations - Ketpen ridge, Kegen pass; 3,4-cenopopulations - Zhetysu (Dzungarian) Alatau, Tekeli gorge; 5-cenopopulation - Terskey Alatau, Saryzhaz.

The purpose of research: Assessment of ecological and biological features and the state of cenopopulations of the rare, endemic medicinal species *Adonis tianschanica* (Adolf) Lipsch. in order to preserve biodiversity.

Research objectives:

1. Study of changes in natural and climatic conditions in the distribution area of *A. tianschanica* (Adolf) Lipsch.

2. Study of the ecological and phytocenotic association of cenopopulations of *A. tianschanica* (Adolf) Lipsch.

3. Study of the physico-chemical properties of the soil of cenopopulations of *A. tianschanica* (Adolf) Lipsch.

4. Assessment of the state of *A. tianschanica* (Adolf) Lipsch. cenopopulations based on their abundance, density, and age structure.

5. Genetic diversity and the degree of interpopulation differentiation in *A. tianschanica* (Adolf) Lipsch. cenopopulations.

Research methods. Geobotanical, morphological, molecular genetic methods, as well as methods of geoinformation systems and remote sensing of the Earth were used in the research work.

Scientific novelty of the research. For the first time, a comprehensive study of the cenopopulations of the rare, endemic, and medicinal species *A. tianschanica* has been conducted under the conditions of Ketpen, Terskey and Zhetysu (Dzungarian) Alatau, taking into account data on its distribution, structural characteristics, climatic conditions, soil properties, and molecular-genetic traits.

- For the first time, an analysis of climatic conditions and their changes in the cenopopulations of *A. tianschanica* has been conducted.

- For the first time, the floristic composition of plant communities involving *A. tianschanica* in the conditions of Ketpen, Terskey, and Zhetysu (Dzungarian) Alatau has been identified and described.

- For the first time, a physico-chemical characterization of the soils within the distribution range of *A. tianschanica* cenopopulations has been carried out.

- For the first time, an assessment of the age spectrum, abundance, and density of *A. tianschanica* cenopopulations has been performed.

- For the first time, an analysis of the density and condition of *A. tianschanica* cenopopulations using remote sensing methods has been conducted.

- For the first time, phylogenetic studies of *A. tianschanica* populations have been performed.

Theoretical significance. The research allowed for a comprehensive assessment of the ecological and biological characteristics of the *A. tianschanica* plant. Its theoretical significance is based on several key aspects: during the study, the life strategies of *A. tianschanica* cenopopulations in various ecological zones were determined. This allowed us to understand the peculiarities of the adaptation of this plant to various climatic and soil conditions. The study of the phytocenotic composition of *A. tianschanica* cenopopulations made it possible to determine its

role in various communities. The results of the phylogenetic analysis revealed the evolutionary relationships of *A. tianschanica* populations and their genetic diversity. This forms a new theoretical basis for studying the phylogenetic position of this species and the history of its distribution. In the course of the study, the distribution areas of *A. tianschanica* cenopopulations were identified based on map diagrams and geographical data. This allowed us to determine the environmental factors affecting the spread of the plant, as well as analyze the biogeographic features of rare plants. This study complements the methodological foundations of the science of nature conservation, providing a theoretical basis for the development of measures for the restoration and conservation of ecosystems.

Practical significance of the work. The results of the dissertation demonstrate practical significance in preserving the cenopopulations of the rare, endemic and medicinal species *A. tianschanica*, as well as in assessing their ecological status. These studies can be applied in the following areas: in areas with low genetic resistance of *A. tianschanica* populations (for example, Tekeli and Saryjaz), special measures for their protection should be introduced. Expansion of protected areas is recommended to preserve the habitat of the species. Reducing the pasture load in the natural environment can increase the viability of *A. tianschanica* cenopopulations. The introduction of environmental measures is proposed to preserve soil fertility and reduce erosion. The analysis of climatic data for 1980-2019 revealed changes in temperature and precipitation in the distribution area of *A. tianschanica*. This information can be used for regional environmental monitoring. Assessing the impact of climate change on rare plants will allow predicting their future distribution and developing adaptation measures. The results of the study can serve as the basis for scientific papers in the field of ecology, botany, biogeography and nature conservation. The developed area maps of the species will help environmental organizations and local authorities in planning measures to manage biodiversity.

The main provisions submitted for defense:

- As a result of the analysis of climatic indicators for the period 1980–2019, changes in precipitation and temperature regimes were identified. When evaluating temperature data, the *Chelsa* database was recognized as the most reliable source.
- In 1,2-cenopopulations, 45 plant species were recorded; in 3,4-cenopopulations, 66 species; and in 5-cenopopulation, 38 species. The dominant families were identified as Asteraceae, Poaceae, Rosaceae, Ranunculaceae, and Scrophulariaceae.
- Leached mountain chernozems were found in 1,2-cenopopulations, mountain-meadow soils in 3,4-cenopopulations, and southern mountain chernozems in 5-cenopopulation. It was confirmed that the high content of nutrients (nitrogen, phosphorus, and potassium) creates favorable conditions for *A. tianschanica*.
- Due to the low genetic diversity of populations in Tekeli and Saryzhaz, they must be placed under special protection.
- To preserve the species' habitat, it is recommended to restore ecosystems, reduce grazing pressure, and expand protected areas.

The main results and conclusions of the research. The results of the assessment of the ecological and biological features and the state of cenopopulations

of the rare, endemic and medicinal species *A. tianschanica* for the conservation of biodiversity allow us to draw the following conclusions:

1. During the period 1980–2019, the average temperature and annual precipitation were compared based on data from the *Chelsa* and *WorldClim* databases. Eight maps were created for temperature data comparison, and since the Chelsa database has a higher spatial resolution (1 km), it was recognized as more accurate. Additionally, *Chelsa* data were found to be more reliable in terms of precipitation levels.

2. At the Kegen pass, 45 plant species (from 17 families) were identified, with dominant families including Asteraceae, Crassulaceae, Poaceae, Rosaceae, Ranunculaceae, and Scrophulariaceae. In the Tekeli gorge, 66 species (from 29 families) were recorded, with Poaceae, Rosaceae, and Ranunculaceae being dominant. In the Terskey Alatau, 38 species were found, with Asteraceae, Poaceae, and Caprifoliaceae being predominant. The total number of *A. tianschanica* individuals across the studied areas was 106, with a strong positive correlation observed between the height of generative individuals and the number of shoots.

3. Various soil types were identified in the studied areas: leached mountain chernozems in 1.2-cenopopulations, mountain-meadow soils in 3.4-cenopopulations, and southern mountain chernozems in 5-cenopopulation. Humus content reached 9.13%, indicating high soil fertility. The pH level ranged from 7.1 to 8.4, indicating alkaline soil characteristics. The high nutrient content (NPK) in the topsoil layers creates favorable conditions for the growth of *A. tianschanica*.

4. Young generative individuals (g_1) dominated the cenopopulations, accounting for 29.6–50% of individuals. Wind strength and habitat conditions negatively impact the viability of some cenopopulations. Cenopopulation density varied between 1.3 and 3.1 individuals/m²: CP-1: 2.7 individuals/m². CP-2: 3.1 individuals/m². CP-3: 1.6 individuals/m². CP-4: 1.9 individuals/m². CP-5: 1.3 individuals/m². The distribution ranges of each cenopopulation were mapped based on geographic coordinates and cartographic data.

5. As a result of the phylogenetic analysis, it was established that 2-population (Tekeli gorge) is isolated, whereas 1-population (Kegen pass) and 3-population (Terskey Alatau) are genetically close to each other. The remaining populations originate from separate groups. Genetic diversity is highest in 1-population, while in 2-population and 3-population, it is relatively low. Due to their low adaptation to various external factors, conservation and protection measures are required.

Approval of the work. The results and main findings of the dissertation were presented and discussed at international scientific conferences:

- International Conference of Students and Young Scientists "Farabi Álemi" (Almaty, Kazakhstan, 2020);
- International Scientific and Practical Conference "Current Issues in Biotechnology: From Laboratory Research to Production," dedicated to the 80th anniversary of Professor, Academician of the National Academy of Sciences of the Republic of Kazakhstan Azhap Akhmetovna Zhubanova (Almaty, Kazakhstan, 2021);

- International Scientific Conference "Aspects of Biodiversity Conservation," dedicated to the 80th anniversary of Professor, Academician of the National Academy of Sciences of the Republic of Kazakhstan Mukhitdinov Nashtay Mukhitdinovich (Almaty, Kazakhstan, 2021).

Publications. The research results have been published in 8 scientific papers, including: 1 article in an international journal indexed in the Scopus database; 4 articles in national scientific journals included in the list of the Committee for Quality Assurance in Education and Science of the Republic of Kazakhstan; 2 articles and 1 thesis in collections of materials of international scientific conferences.

The personal contribution of the doctoral student. The doctoral candidate independently conducted a comprehensive analysis of scientific literature, developed the research methodology, and carried out experimental and theoretical studies. The candidate was actively involved in data collection, processing, and interpretation, as well as in formulating conclusions and recommendations. Additionally, the doctoral candidate personally prepared and published scientific articles, presented research findings at international and national conferences, and participated in discussions and expert evaluations related to the dissertation topic.

The scope and structure of the dissertation. The dissertation consists of 109 pages and includes the following sections: list of symbols and abbreviations, introduction, literature review, materials and methods, results and discussion, conclusion, as well as a list of references containing 226 items. The dissertation includes 18 tables, 39 figures, and 3 appendices.