**ABSTRACT**

of the dissertation for the degree of Doctor of Philosophy (PhD)
in the specialty "8D05101-Biology"

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on the topic **"Distribution and subspecies diagnosability of the Turkestan lynx (*Lynx lynx isabellinus* Blyth, 1847) in the Northern Tien Shan"**

**General description of work.** The dissertation work is devoted to the study of the distribution and modeling of suitable habitats of the Turkestan lynx (*Lynx lynx isabellinus* Blyth, 1847) in the Northern Tien Shan, the assessment of the influence of lynx prey on its spatial distribution, altitude movements and daily activity rhythms, as well as the analysis of the phylogeographic structure of the lynx for taxonomic and environmental purposes.

**Relevance of the research topic.** The active development of the mountains of Central Asia has led to the significant ecosystems deterioration, including a decrease in the number of mountain species of plants and animals, as well as habitat loss and fragmentation. Large carnivorous mammals, including the rare Turkestan lynx (*Lynx lynx isabellinus* Blyth, 1847), play a decisive role in maintaining ecosystems and providing ecological services. This subspecies of the Eurasian lynx (*Lynx lynx* L., 1758) inhabits the mountains of Central and South Asia and is particularly susceptible to anthropogenic pressure, as a result of which it was listed in Appendix II of the International CITES Convention. In Kazakhstan, the Turkestan lynx is listed in the Red Book of the Republic (Status III, a rare subspecies, the range and number of which are declining). The cryptic behavior, the general sparseness of populations, as well as the inaccessibility of lynx habitats complicate its research, and full-scale studies on this carnivore have never been previously conducted, including in the Northern Tien Shan, one of the key lynx habitats in Central Asia.

The subspecific differentiation between the Turkestan lynx in the Tien Shan and the Altai lynx (*Lynx lynx wardi* Lydekker, 1904) in the Altai has also not been previously studied in detail. The recognition of the Turkestan lynx as a distinct subspecies directly affects how researchers and the public view it, and has important implications for both its study and conservation. Thus, for conservation and taxonomic purposes, it is most relevant to conduct the first phylogenetic and thorough morphometric studies to determine the taxonomic position of lynxes in Kazakhstan and adjacent territories.

In view of natural and anthropogenic threats, it is relevant to conduct research, the results of which will assist in creating strategies for the Turkestan lynx conservation. As the first step towards conservation measures, it is crucial to: study the distribution of the Turkestan lynx in the Northern Tien Shan; analyze the factors influencing its spatial and behavioral ecology; determine the taxonomic status of the Turkestan lynx and establish the regions delimiting the ranges of this lynx from the neighboring populations.

**The aim of the research:** to study the current distribution of the Turkestan lynx in the Northern Tien Shan Mountains and determine its taxonomic status.

**Research objectives:**

1) Study the current distribution of the Turkestan lynx in the Northern Tien Shan and adjacent territories;
2) Assess the impact of environmental factors on habitat suitability and climate change on the future distribution of the lynx in the region
3) Study effect of prey base and feeding behavior on spatial and altitudinal distribution and rhythms of activity of the lynx;
4) Determine the systematic position of the Turkestan lynx based on morphological and molecular genetic analysis;
5) Develop recommendations for the conservation of the Turkestan lynx in the Northern Tien Shan Mountains.

**The object of research:** Turkestan lynx inhabiting the Northern Tien Shan Mountains.

**Research methods.** In the work, we used field zoological methods (visual observations, footprint tracking, identification and registration of various traces of the lynx and prey vital activity), questionnaire, remote sensing (camera trapping), morphometric, statistical, molecular-genetic and cartographic methods.

**Scientific novelty of the research.** For the first time, the modern distribution of the Turkestan lynx in the Kazakhstani part of the Northern Tien Shan was determined.

For the first time, models of the lynx habitat suitability in the Northern Tien Shan, as well as a forecast of their suitability in the region under the conditions of climate change for the year 2100 were created.

For the first time, the impact of prey base and feeding behavior of the lynx on its biotopic distribution and daily activity was determined.

For the first time, full-scale morphometric and phylogenetic studies were carried out to determine the taxonomic position of the Turkestan lynx in Kazakhstan and the Northern Tien Shan. Morphometric and phylogenetic comparative diagnosably of three possible subspecies: European (*Lynx lynx lynx* Linnaeus, 1758), Altai and Turkestan lynx showed that the Turkestan lynx is a separate subspecies, and the Altai lynx is a variation of the Siberian lynx (*Lynx lynx wrangeli* Ognev, 1928).

**The theoretical value of the research.** The results obtained significantly expand knowledge in the field of lynx ecology and biology in the conditions of the mountains of the Northern Tien Shan and neighboring regions. The spatial distribution, altitude movements, daily activity of a rare and elusive carnivore have been studied. The interrelation of the “predator-prey” model between the lynx and the prey species has been studied. At the morphological and molecular-genetic levels, the intraspecific classification of the Eurasian lynx has been studied, thereby the approximate boundaries of the distribution of the lynx in Kazakhstan and Eurasia as a whole have been considered.

**The practical value of the research.** The results of the studies are used to justify the conservation of a rare and vulnerable lynx in the study area. The data obtained as a result of distribution modeling and in the course of studies of the phylogeographic

structure of the lynx population formed the author's recommendations for the subspecies conservation in protected areas in the south-east of Kazakhstan. A database on the genetics and ecology of the Turkestan lynx in Kazakhstan and the world has been created and is constantly updated, which makes possible to develop a strategy and principles for the conservation and management of subspecies populations at the international level. The results will contribute to the improvement of environmental work in protected areas, and, in turn, the development of ecological tourism in the region.

The results of the research will be used to maintain the Wildlife Cadastre of the Republic of Kazakhstan, the Red Book of the Republic of Kazakhstan, to improve the network of protected areas. Potential consumers are the Committee for Forestry and Wildlife of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan, Ministry of Science and Higher Education of the Republic of Kazakhstan, Universities, Research institutes, and protected areas.

**The main statements for defense:**

1) The Turkestan lynx inhabits all large gorges of the Ile, Kungei, Terskey Alatau and Uzynkara ranges in the Northern Tien Shan. An efficient way for determining the lynx occurrence in these gorges was registration with automatic surveillance cameras – camera traps.
2) The most suitable habitats for the Turkestan lynx in Eurasia are in Kazakhstan, in particular, the Northern Tien Shan and Zhetisu Alatau Mountains. Stable populations of the Turkestan lynx have been found in protected areas of the Northern Tien Shan – in the Ile-Alatau National Park in the Ile Alatau and the Kolsai kolderi National Park in the Kungei Alatau.
3) It is expected that, due to the climate change, suitable habitats for the Turkestan lynx in the Northern Tien Shan and adjacent territories will reduce by 2100.
4) The main impact on the spatial distribution of the Turkestan lynx is exerted by altitude, including the specifics of the vegetation cover and the level of snow cover, and the presence, migration and daily activity of the main prey species – tolai hare and Siberian roe deer.
5) Based on the morphometric and molecular genetic data obtained, it has been determined that Altai lynx is not isolated as a subspecies, and is a variation of the Siberian lynx. The subspecies status of the Turkestan lynx in the Northern Tien Shan is warranted. The conservation status of the Turkestan lynx in the south-east of Kazakhstan and neighboring countries should be preserved.

**Connection with the plan of the main scientific works.** The dissertation work was carried out within the framework of national and international projects and programs: AP05133572 "Patterns of the spatial structure and biotopic distribution of rare and economically important species of mammals in the protected and recreational areas of the Northern Tien Shan as a basis for their conservation and rational use" (Institute of Zoology MSHE RK), 2018-2020; ID 29126-1-Nazerke Bizhanova "Population and conservation status of the Turkestan lynx (*Lynx lynx isabellina* Blyth,

1847) in the Kazakh part of the Northern Tien Shan" (Rufford Foundation, Rufford Small Grants, UK) – project leader, 2019-2021; OR11465437 "Development of a national electronic data bank on the scientific zoological collection of the Republic of Kazakhstan, ensuring their effective use in science and education" (Institute of Zoology MSHE RK), 2021-2022; BR10965224 "Development of the cadastre of the fauna of the Northern Tien Shan to preserve its genetic diversity" (Institute of Zoology MSHE RK), 2021-2023.

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**Approbation of work.** The research results were reported and discussed: at the International Scientific Conferences of Students and Young Scientists "Farabi Alemi", Almaty (2020, 2021, 2022); at the International Conference "XVI International Scientific Conference for Students and PhD Students", Ivan Franko National University, Lviv, Ukraine (2020); International Regional Conference "Rufford Foundation and Biodiversity Conservation of Northern Eurasia", Moscow, Russia (2021); Round table "Problems of modern scientific research during a pandemic", al-Farabi KazNU, Almaty (2021); at the International Symposium "The 5th Symposium on EuroAsian Biodiversity", Almaty, Kazakhstan and Mugla, Turkey (2021); at the International Conference "International Year of Mountains: Conservation of Biological Diversity of Mountain Ecosystems of Kyrgyzstan", Bishkek, Kyrgyzstan (2022), at the 49th International Annual Conference of IETS, Lima, Peru (2023); at the International Conference "Zoological research in Kazakhstan in the XXI century: results, problems and prospects", Almaty (2023). Research reports have been presented in all semester and annual scientific seminars of PhD-doctoral students at al-Farabi KazNU, Almaty (2019, 2020, 2021, 2022); at a scientific and technical seminar on monitoring rare mammals at the head office of the Ile-Alatau State National Natural Park, Almaty (2020); at the annual meetings of the Academic Council and the Council of Young Scientists of the Institute of Zoology, Almaty (2020, 2021, 2022). The work was discussed at a seminar on wildlife conservation, High Tech Academy, Almaty (2020); at International seminars on the theory of change and SMART, IUCN S.O.S., online, United Kingdom (2020); trainings on SMART and monitoring of carnivorous mammals, Snow Leopard Network, online, USA (2021); lectures and seminars of the Model OIC, ICYF-ERC, Baku, Azerbaijan (2021); trainings "Discovering new species

using DNA sequences", Colombo, Sri Lanka (2021). The research has been discussed with specialists during short-term and long-term internships at the Zoological Research Museum at Lomonosov Moscow State University, Moscow, Russia (2021); in the Laboratory of theriology of the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia (2022); at the Faculty of Biological Sciences, Universiti Sains Malaysia, Georgetown, Penang, Malaysia (2022).

The research conducted has been discussed in an interview in the documentary film "Marveilles de la nature" about the wildlife of Kazakhstan, France (2021); on a podcast on ZhuldyzFM radio, Almaty (2022). Based on active scientific activity during the research period, the badge "Best Young Scientist of the CIS 2021" was received, International Center "Genius", Astana (2021); Honorary Representative Award at the 4th Executive Model OIC Summit was received, Baku, Azerbaijan (2021).

**Publications.** 15 papers have been published on the topic of the dissertation, including 4 articles in journals recommended by the list of the Committee for Control in the Sphere of Education and Science (CCSES) of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 2 papers in journals indexed in the Web of Science and Scopus database (Q1 and Q2), 2 articles in other publications, 7 reports and abstracts of International conferences.

**The volume and structure of the dissertation.** The dissertation consists of an introduction, a literature review, materials and methods, results and their discussion, a conclusion, and a list of literature sources from 256 titles. The volume of the work is 116 pages, and contains 13 tables, 43 figures and 5 appendices.