

## **Annotation**

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

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### **“Ecological and trophic differentiation of fungal diversity in Zailiysky and Kungei Alatau”**

**General characteristics of the work.** The dissertation work is devoted to the study of biodiversity of microscopic fungi and fungus-like organisms of Zailiysky and Kungei Alatau. The main idea of the work is to revise the species composition of fungi; to establish the peculiarities of their ecological distribution and trophic habitat; and to identify rare, little-known and new species. Special attention is paid not only to the study of the species composition of fungi of the little-studied Kungei Alatau, but also to the comparative analysis of mycobiota of Zailiysky and Kungei Alatau.

**Relevance of the research topic.** The global nature of changes in the biosphere, observed in recent years, implies a deep crisis of the environment, sharp reduction of biodiversity and natural resources. The problem of biodiversity conservation has been elevated to the rank of world priorities. One of the most negative factors affecting the state of biodiversity is irrational economic activity. As a result of economic activity, humans leave in the biosphere a very poor and extremely standard set of plants, animals, fungi, etc., capable of surviving in disfigured ecosystems.

Kazakhstan has signed and ratified global environmental conventions: Convention on Biological Diversity; UN Framework Convention on Climate Change; UN Convention to Combat Desertification; Ramsar Convention on Wetlands and others.

In 2002, the document “Global Strategy for Plant Conservation” was adopted, which is an action plan for the conservation of the planet's flora. In this regard, much attention is currently paid to the study of biodiversity, as global anthropogenic disturbances of ecosystems have a detrimental effect on all groups of organisms, including the fungal component. As a consequence, inventory of mycobiota and identification of patterns of geographical distribution of fungi remains one of the topical problems of mycology. Especially relevant is the study of biodiversity in some unexplored regions, such as some ridges of the Northern Tien Shan.

Mountain ecosystems of Kazakhstan are centers of botanical diversity, but increasing anthropogenic pressure (development of natural areas, exploitation of industrial facilities, deforestation, mining, development of new lands for farms, increasing residential and recreational pressure, use of chemicals) negatively affects natural ecosystems and, first of all, their plant and fungal component. At the same time, there is a change and simplification of the composition and structure of mycobiota, reduction of the ranges of rare and endemic species, penetration and spread of alien species of fungi. The study of fungi of Zailiysky and Kungei Alatau is of special importance, as most of them are closely related to plants and have a significant impact on them: various species are pathogenic for plants, weakening

them and even leading to their death; some species decompose organic residues, accelerating the process of mineralization of organic matter; some fungi are hyperparasites, colonizing hyphae and conidiophores of phytopathogenic fungi.

**The aim of the work is:** Identification of ecological and trophic differentiation of fungi diversity of Zailiysky and Kungei Alatau.

**To achieve this goal, the following tasks were solved:**

1. Conduct mycological survey of the territory of Zailiysky and Kungei Alatau ridges belonging to the Northern Tien Shan;
2. Determine species diversity of mycobiota of Zailiysky Alatau and Kungei Alatau;
3. Identify the peculiarities of ecological distribution (distribution by gorges and altitude zones) of fungi of Zailiysky and Kungei Alatau;
4. Map the locations of some commonly found fungi;
5. Establish trophic predilection of fungi of Zailiysky and Kungei Alatau;
6. Identify rare, little known and new species of fungi of Zailiysky and Kungei Alatau.

**Object of research.** Fungi-micromycetes of the Zailiysky and Kungei Alatau.

**Research Methods.** Samples were collected using the route method during the growing season from 2018 to 2023 on the territory of the Zailiysky and Kungei Alatau ridges. The geographic location of each collection site was recorded using GPS (Germin). The collection of herbarium material, drying, preparation of temporary preparations and their study were carried out according to generally accepted methods. The observations were carried out using a Polyvar light photomicroscope with Nomarski interference optics and a Levenhuk MED D45T LSD at various magnifications (from 10<sup>x</sup> to 100<sup>x</sup> with oil immersion).

Identifiers, atlases, illustrated editions, as well as reference books and monographs of domestic and foreign scientists on individual taxa were used for fungi identification.

The names of fungal species and authors are given according to Index Fungorum database, names of feeding plants - according to Plantarium, on-line plant identifier. The list of detected fungi, including 1123 species, is arranged according to the system adopted in the Mycobank database.

Maps of the locations of the most frequently occurring fungi were made using Google Earth program (version 7.3.4.8642).

**Scientific novelty of the study:**

- mycological survey of the Kungei Alatau territory was carried out for the first time;
- for the first time, the species composition of mycobiota of Zailiysky and Kungei Alatau, totaling 1123 species taking into account new taxonomic changes, has been revealed and its comparative analysis has been carried out;
- ecological and trophic status of fungi species of Zailiysky and Kungei Alatau was determined for the first time;
- three rare species, four little-known species, one new for the territory of Zailiysky Alatau, 21 new for the territory of Kazakhstan, of which 18 species are new

as a result of recent taxonomic changes, were identified for the first time in the study area.

**Scientific and practical significance of the work.** The scientific effect and significance of the work consists in the fact that for the first time the modern species diversity of fungi of Zailiysky and Kungei Alatau has been estimated, the peculiarities of ecological distribution (distribution by gorges, altitude zones) of fungi have been revealed, the points of locations of some widespread species of Zailiysky and Kungei Alatau have been mapped, the trophic predilection of fungi has been established. In the study area 29 species were identified, which are rare, little known or new for Zailiysky Alatau and for Kazakhstan. As a result of determining the ecological and trophic status of species, a group of parasitic fungi with about 700 species was identified, which has a significant impact on the growth and development of plants, as well as their yield. 42 species of fungi were found on the plants of Zailiysky Alatau, listed in the Red Book of Kazakhstan, while in Kungei Alatau only two were noted.

**Basic principles put forward during the defense:**

- The territory of Zailiysky and Kungei Alatau is characterized by a high species diversity of fungi-micromycetes.
- Host plant species composition and absolute altitude are determinant for the distribution of micromycetes.
- The vast majority of fungi are parasites on plants.

**Interrelation of work with the research program.**

Dissertation work was carried out within the framework of scientific-purpose program BR10264557 “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 years) and youth project AR08052881 “Obtaining domestic strains of fungi of the genus *Trichoderma* for soil improvement in agrobiocenoses”. All desktop and laboratory studies were carried out at the Institute of Botany and Phytointroduction (Kazakhstan).

**Main results and conclusions of the study.** The species composition of mycobiota of Zailiysky and Kungei Alatau, totaling 1123 species with account of new taxonomic changes, was revealed for the first time and its comparative analysis was carried out. It was found that the territory of the Zailiysky Alatau ridge is characterized by 934 species of fungi, including 25 species of oomycetes, 679 ascomycetes, 178 rust fungi, 50 smut fungi and one species of zygomycetes and zoopagous.

On the territory of Kungei Alatau 261 species of fungi were found, including one species of oomycetes, 195 ascomycetes, 57 rust fungi, 6 smut fungi and one species of zygomycetes and zoopagous fungi each. When mapping the locations of the most frequently occurring fungi, it was noted that, firstly, the distribution range of fungi is determined by the ranges of their host plants, and secondly – by climatic conditions of the habitat.

Three rare species, four little-known species, one new for the territory of Zailiysky Alatau were identified for the first time in the study area, 21 new for the territory of Kazakhstan, of which 18 species are new as a result of recent taxonomic changes. When

determining the ecological and trophic status of fungi species of Zailiysky and Kungei Alatau, it was found that all representatives of oomycetes are parasites.

The largest number of oomycete species was recorded on representatives of the family Brassicaceae (9 species), slightly less on Ranunculaceae (3 species), Lamiaceae (2 species), Asteraceae (2 species).

Representatives of ascomycetes can lead both saprotrophic and parasitic life, with the group of parasitic fungi being the largest ecological group, which includes 440 species. The classes Dothideomycetes and Leotiomycetes are dominated by parasitic species, while the class Taphrinomycetes is entirely represented by parasites.

The ecological group of saprotrophs includes 294 species. The group of mycophilic fungi is represented by 14 species from the class Sordariomycetes and is noted only in the Zailiysky Alatau. Hyperparasites count two species from the class Dothideomycetes: *Ampelomyces quisqualis* parasitizes powdery mildew fungi, *Sphaerellopsis filum* parasitizes rust fungi.

The maximum number of ascomycete fungi species using plants as a substrate or host was registered in the families Rosaceae (96 species of fungi), Asteraceae (77), Poaceae (62), Fabaceae (52). In 9 families 15-34 species of fungi were recorded: Apiaceae (34 species of fungi), Salicaceae (34), Polygonaceae (29), Caprifoliaceae (26), Lamiaceae (23), Pinaceae (21), Betulaceae (19), Ranunculaceae (18), Scrophulariaceae (15). On 11 families of plants 8-14 species of fungi were found, on 29 families – 2-7 species of fungi.

All species of rust fungi are parasites and affect representatives of 43 plant families. The greatest number of species of Pucciniomycetes was observed on representatives of the family Asteraceae (27 species), slightly less - on Rosaceae (22 species), Poaceae (19), Ranunculaceae (15 species), Fabaceae (13 species), Apiaceae (12), Polygonaceae (10) and Lamiaceae (8 species).

Smut fungi are obligate parasites and affect 81 species of host plants from 15 families. Most of the smut fungi parasitize cereal plants (33 species), representatives of the families Asteraceae (8 species) and Ranunculaceae (6). 44 representatives of smut fungi are characteristic of monocotyledonous plants.

On plants of Zailiysky Alatau, listed in the Red Book of Kazakhstan, 42 species of fungi were found, whereas in Kungei Alatau only two species were found on plants from the Red Book.

**Personal contribution of the author to the work.** The dissertation work is the result of many years of research (from 2018 to 2023), carried out personally by the author. The doctoral student carried out: field studies in the territory of Zailiysky and Kungei Alatau, collection and identification of microscopic fungi, analysis of the taxonomic structure of mycobiota of the research territory, processing and analysis of the results, writing the text of the dissertation.

**Approbation of the work.** The results of the dissertation work have been reported and published at international scientific and practical conferences:

- at the International Scientific Conference of Students and Young Scientists “Farabi əlemi”. Almaty, Kazakhstan, 2019;
- at the XVIII International Scientific and Practical Conference “Problems of Botany of Southern Siberia and Mongolia”. Barnaul, Russia, 2019, 2020, 2021;

- at the IV All-Russian Plant Protection Congress “Phytoprotective technologies in ensuring independence and competitiveness of the agroindustrial complex of Russia”. St. Petersburg, Russia, 2019;
- at the BIO Web of Conferences 24: “Plant Diversity: Status, Trends, Conservation Concept”, 2020;
- at the All-Russian Conference with participation of foreign scientists, Novosibirsk, Russia, 2020;
- at the International Mycological Forum. Moscow, Russia, 2020, 2022;
- at the International Scientific and Practical Conference “Study, conservation and rational use of the plant world of Eurasia”, dedicated to the 90th anniversary of the Institute of Botany and Phytointroduction. Almaty, Kazakhstan, 2022;
- at the international scientific-practical hybrid conference “Actual issues of natural science and modern approaches to biological education”, dedicated to the 80th anniversary of the honorary professor of the Kazakh National Women's Pedagogical University Kozhantaeva Zh. Zh. Almaty, Kazakhstan, 2023.

**Publications.** The main content of the dissertation has been published in 28 printed works, including: 7 articles in international peer-reviewed journals with impact factor indexed in Scopus and/or Web of Science; four articles in publications included in the list of scientific publications recommended by the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan; two monographs and 15 articles in the proceedings of international and national conferences, 10 of which are foreign.

**Structure of the dissertation.** The thesis is set out in 228 pages of computerized text and consists of the following sections: Denotations and abbreviations, Introduction, Literature review, Materials and methods of research, Results and discussion, Conclusion and List of references of 275 titles. The work includes 16 tables, 103 figures and 6 appendices.