

Annotation

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

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**" The current state of Chara algae in South and South-East Kazakhstan
and prospects for their application"**

General characteristics of the work. The dissertation work is aimed at determining the current state of the diversity of chara algae of Southern and Southeastern Kazakhstan and the prospects for their use.

Relevance of the research topic. Currently, the study and conservation of biological diversity is considered one of the most important issues, both theoretically and practically.

In particular, a comprehensive study of individual and poorly studied groups of plants is of particular importance. The group of plants, the diversity of which has not been studied enough in Kazakhstan, also includes representatives of the department of chara algae. Despite the fact that the diversity of chara algae is relatively small compared to other algae departments, they are an important part of ecosystems, since they form a significant biomass and can serve not only for water purification, but they can also be used to determine the purity of reservoirs. Currently, there is a high risk of reduction, up to extinction, of the biological diversity of the chara growing in the water bodies of Kazakhstan, since in the country most of the reservoirs are exposed to drying out, shallowing as a result of inefficient use of water resources and climate change.

In this regard, one of the most pressing issues to date is the study of the species richness of chara algae in the reservoirs of Southern and South-Eastern Kazakhstan, and the prospects for their use in monitoring and agriculture of the country.

The aim of the work is: The study of the diversity of chara algae in the reservoirs of South and South-East Kazakhstan and their ecological and biological features.

To achieve this goal, the following tasks were solved:

1 To study the species composition of chara algae in the reservoirs of Southern and South-Eastern Kazakhstan using morphological and molecular methods;

2 To identify the communities of microalgae accompanying the found species of charophytes for the ecological characteristics of the species of charophytes and to conduct a comparative analysis of them in the reservoirs of the studied region;

3 To assess the influence of environmental factors on the distribution of charophyte species across different reservoirs based on environmental indicators and indications for associated microalgae communities;

4 To determine the economic importance of chara algae;

5 To identify rare, endangered and promising species of chara algae with justification of measures for their protection.

Object of research.

Chara species of algae in reservoirs of South and South-East Kazakhstan.

Scientific novelty of the study.

The paper presents the results of studying the species composition of algae in 55 reservoirs of the regions of South and South-East Kazakhstan, of which 32 objects were studied for the first time. As a result of our research, 12 species and 1 variation of chara algae and 220 species of accompanying microalgae belonging to 8 departments, 15 classes, 37 orders, 64 families, 107 families were identified from the reservoirs of South and South-East Kazakhstan.

For the first time in Kazakhstan and the interspecific variations *Chara globata* W. Migula and *Chara aspera* var. *subinermis* Kutzing were found and recorded in the algal flora.

And there is also a great similarity in structure and size of the hara algae of Southern and Southeastern Kazakhstan with the hara species from the semi-desert reservoirs of the State of Israel.

A comparative analysis of the species composition of chara and accompanying microalgae from the surveyed reservoirs was carried out. As a result, it was found that the height of the reservoir above sea level, the value of mineralization and the pH of the water play an important role in the distribution of species of chara and the species composition of their communities.

An assessment of the influence of environmental factors on the distribution of chara species across different reservoirs has been carried out. Bioindicational studies of the ecology of the chara algae of Kazakhstan have been carried out. In the course of the research work, the diversity of the occurrence zones of chara algae species in potential conditions can serve as a tool for monitoring climate change. It became known that the reservoirs of South and South -East Kazakhstan with a high concentration of protons (pH) are suitable for the habitat of these algae species.

The indicator types of chara communities were determined and their distribution by ecological groups in the studied region was analyzed, the results of the distribution of chara species were plotted on statistical maps.

DNA was isolated and sequenced from samples of chara algae from reservoirs and watercourses of South and South - East Kazakhstan and a comparative characteristic of the species similarity of chara algae from reservoirs of two arid regions: Israel and Kazakhstan was compiled by comparative molecular genetic method and PCR analysis of genetic polymorphism using microsatellite loci, on the basis of which for the first time for chara of these regions a phylogenetic tree has been constructed.

An experiment on productivity dynamics using chara biomass was conducted for two plant species.

Scientific and practical significance of the work. The scientific and practical significance of the work lies in the identification and identification of the biological diversity of algae in the reservoirs of South and South-East Kazakhstan with the identification of threatened and widespread species that can be used for monitoring water quality and biotechnology. The names of the identified species

were adapted to modern taxonomy for the first time. The possibility of using molecular genetic methods in the field of algology, with the help of new methods and classical taxonomy is proved.

A bioindicational assessment of the condition of the studied water bodies is given by studying the diversity of communities of chara algae in the reservoirs of South and South-East Kazakhstan. The obtained results on the analysis of ecological groups of algae and statistical methods applied here for the first time can be used in monitoring and show the significance of the dissertation work from the scientific and practical side.

The results of the research work can be used in the training of specialists in biology and biotechnology in higher educational institutions of the country, in the preparation of textbooks, recommendations and demonstration manuals in nature and environmental protection institutions, as well as in the creation of a database of algae in general, and the results of this work can be used in the creation of a flora inventory algae of Kazakhstan.

The results of the work can be used for the conservation of some arid rivers and lakes, the conservation of endangered species of chara algae and their use for reproduction and cultivation, as well as in the national economy and crop production as fertilizer, fish feed, when cleaning reservoirs, ponds.

The main provisions put forward for protection. The species composition of the chara algae of the reservoirs of South and South-East Kazakhstan, taken as an object of research, is 12 species and one variety identified using morphological and molecular methods.

Of the 55 surveyed reservoirs, in 32, we found for the first time chara algae.

Methods of microalgae bioindication, statistical mapping and analysis of the relationship with environmental indicators were used for the ecological characteristics of the found species of chara algae.

Rare and demanding protection species of *Chara globata* W. Migula and *Chara aspera* var. *subinermis* Kutzing have been identified and their distribution in the studied region with justification of measures for their protection.

It has been established that anthropogenic pollution of water bodies poses a great threat and can lead to a reduction in the species composition of chara algae.

The economic importance of chara algae as growth stimulators of agricultural crops has been established.

Main results and conclusions of the study.

The main results and conclusions of the study are divided into 5 groups:

1 A total of 12 species and 1 form of chara algae were identified from the reservoirs of South and South-East Kazakhstan, as well as 220 species of microalgae belonging to 8 departments, 15 classes, 37 orders, 64 families and 107 families. As a result of the research, the species *Chara globata* W. Migula and *Chara aspera* var. *subinermis* Kutzing were identified for the first time for the algoflora of Kazakhstan, and the latter as evidence of intraspecific variability in the region. The characteristics of the genetic polymorphism of chara algae by microsatellite loci were developed by the method of comparative molecular genetic methods and PCR for chara algae in the reservoirs of Southern and South-

Eastern Kazakhstan and chara algae of Israel, similar in ecology to Kazakhstan, sequencing was carried out and a phylogenetic tree was created, as a result of which, according to NCBI data, *C. vulgaris*, *C. contraria* High similarity of the matK nucleotide sequence of gymnophylla algae with populations in other regions was found. These data are based on morphological features and sequence data such as *Chara vulgaris*, *Chara contraria*, and *C. gymnophylla* confirmed our definition as an alga.

2 As a result of the study, materials were collected from 55 reservoirs of South and South-East Kazakhstan, of which, for the first time, chara species were found in 32 water bodies. In addition, *Chara vulgaris* and *Ch. contraria* were demonstrated among the detected chara algae, while *Ch. aspera* var. *subinermis*, *Ch. kirghisorum* and *Ch. tomentosa*, *Ch. canescens*, *Nitella hyalina* were rare.

3 It is established that reservoirs of South and South-East Kazakhstan with a high pH concentration are favorable for the habitat of chara algae species, with a constant water temperature, salinity decreases with sea level, and as the height above the level decreases, the salinity index increases, with an increase in altitude, diatom species of algae are found, which are indicators of organic pollution from the each time, self-purification occurs, the number of saprophytes decreases, and saproxenes increase their share in communities.

4 3% and 6% extracts of *C. dominii* algae collected from the Kapshagai reservoir were used as fertilizer for wheat (*Triticum* L.) and radish (*Champion Raphanus sativus* L.). As a result, radish growth rate prevailed with the addition of 3% algae extract to the soil. And the results of the wheat study showed that the growth rate of wheat grown with the addition of 6% algae extract prevailed. The addition of chara algae to the soil as a fertilizer showed the effectiveness of plant growth and development.

5 According to the results of the study of the distribution of chara, one endangered species was identified in the IUCN categories (*Ch. kirghisorum*) and five species with a low risk of extinction (*Chara aspera* var. *aspera*, *Chara dominii*), *Chara globata*, *Nitella hyalina*, *Nitellopsis obtusa*).

Personal contribution of the author to the work. The author of the dissertation work has made a full contribution in choosing the form and concept of the study, determining the purpose of the work, setting the research task, planning and performing experiments, generalizing and processing the data obtained.

Interrelation of work with the research program. The dissertation work was carried out by the dissertator himself and funded under 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). All laboratory studies were performed at the Institute of Botany and Phytointroduction (Kazakhstan), and bioindication, comparative molecular genetic analysis of algoflora. They were performed at the Institute of Evolution of the University of Haifa (Israel) during a doctoral student's internship abroad with funding from 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:

- International Scientific Conference of Students and Young Scientists "Farabi Alemi" (Almaty, Kazakhstan, April 6-9, 2020);
- VII International Scientific and Practical Conference "Science and Education In the Modern World: Challenges of the XXI Century", Astana (Nur-Sultan), Kazakhstan October 22, 2020
- International Scientific Conference of Students and Young Scientists "Farabi Alemi" (Almaty, Kazakhstan, April 6-7, 2021);
- International Scientific and Practical Conference "Modern problems of Biology and Biotechnology" Almaty, Kazakhstan, May 27, 2021
- International Scientific and Practical Conference " Aspects of Biodiversity Conservation "(Almaty, Kazakhstan, November 26, 2021);
- International Scientific Conference of Students and Young Scientists "Farabi Alemi" (Almaty, Kazakhstan, April 6-8, 2022);
- International Scientific and practical conference dedicated to the 90th anniversary of the Institute of Botany and Phytoinroduction (Almaty, Kazakhstan, September 7-9, 2022).
- VI All-Russian Scientific Conference and schools of young scientists with international participation (Moscow, Russia, September 12-18, 2022).
- The 8th "Aquatic Biodiversity" International Conference, September 20th – 22th 2022, Sibiu, Romania.

Publications. Based on the research results, the author published 20 scientific papers; including 2 articles in the journals Q1, Q2 included in the Web of Science and Scopus database, 1 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, 15 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, 270 literature sources and 2 appendices. The research paper consists of 134 pages, 5 tables and 28 figures.