

ANNOTATION

dissertation for the degree of Doctor of Philosophy (PhD)
in the specialty «8D08401 - Fish Industry and Industrial Fishery»

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**«Study of the phenetic diversity and biological
variability of acclimatized and cultured herds of *Oncorhynchus mykiss*
in the Balkhash basin**

General description of work. The current state, distribution and life cycle, phenotypic variability of wild populations and cultural stocks of rainbow trout in the reservoirs of the Balkhash basin, their biological indicators, morphological features are described, and data on the use of wild populations and the implementation of sustainable aquaculture are provided.

Relevance of the research topic. Rational management of biological resources involves regulating the structure of wild populations and cultural fish stocks [1, 2]. Identification of individual fish throughout their lives is necessary for scientific research and selection work, which is especially important when studying changes in their biological properties over time. Molecular genetic research methods are not always suitable for analyzing large samples, and do not always allow one species to be quickly distinguished from another. For this purpose, various types of tags (markings) are used - from simple cutting of fin rays to modern microchips and electronic transmitters. However, practice shows that the use of all types of markings affects individuals, changing their biological characteristics [3]. In such cases, phenotypes are used, that is, discrete morphological features [4, 5]. Phenotypes reflect the genetic characteristics of specific individuals, and the frequency of their manifestation indicates the genetic structure of the population and other groups of a certain species [6]. Therefore, in recent decades, interest in phenetics has increased significantly due to the need for a quick and effective solution to the problems of managing wild populations and cultural herds of animals, as well as for understanding the adaptive characteristics of organisms and the influence of the environment on the implementation of genetic information [7].

Rainbow trout, or mykiss *Oncorhynchus mykiss* (Walbaum, 1792), is one of the most important aquaculture species in the world [8, 9, 10]. As a result of targeted acclimatization measures, several schools of rainbow trout were formed in the reservoirs of the Balkhash basin. Wild producers were brought from the rivers of Kamchatka and released into the Bolshoy Kakpak, Tentek, Emel, Ile rivers, as well as into the Bozymbay and Bolshoy Urukty lakes [11]. Cultured rainbow trout were acclimatized from fish farms in Czechoslovakia to the high-mountain lakes of Lower and Middle Kolsay, and then individuals from these populations were released into the Chilik River basin [12]. Despite the successful acclimatization of the cultured form of trout, reproduction of the wild form was recorded only in the Bolshoy Kakpak River.

Currently, rainbow trout imported from Poland and Denmark are bred in fish farms in the Almaty region.

Purpose of the work. To determine the current state and study the phenetic diversity and biological variability of acclimatized and cultural stocks of rainbow trout in the Balkhash basin.

Research objectives. In accordance with the purpose of the work, the following tasks were completed:

1. Determine the current distribution and life cycle of rainbow trout in natural water bodies of the Balkhash basin;
2. Study the phenotypic variability of wild populations and cultured stocks of rainbow trout in water bodies of the Balkhash basin;
3. Compare biological parameters of wild populations and cultured stocks of rainbow trout;
4. Describe the morphological features of wild populations and cultured stocks of rainbow trout;
5. Provide recommendations on the use of wild populations of rainbow trout and sustainable aquaculture in the Balkhash basin.

Objects of research. Wild populations of rainbow trout in the reservoirs of the Balkhash basin (Lake Lower Kolsay, Kakpak River) and cultured stocks of rainbow trout of Polish and Danish origin.

Research methods. In carrying out the tasks of the work, fisheries, cartographic, morphometric, phenotypic and multivariate statistical methods were used.

Scientific novelty of the research.

Approximately 50 years after the first introduction, the state and current range of the rainbow trout population in the Balkhash Basin were determined.

The growth rate, length-weight parameters, sexual maturity characteristics, and various life strategies of wild rainbow trout populations inhabiting the Balkhash Basin were studied.

For the first time, phenotypic variability of wild populations and farmed stocks of rainbow trout grown in farms in the Balkhash Basin was studied using body fragments.

For the first time, a multivariate statistical analysis of complete morphometric parameters of wild populations and farmed stocks of rainbow trout was conducted.

For the first time, it was established that wild rainbow trout caught from Lower Kolsay Lake and the Kakpak River are capable of adapting to cultivation in fish farms.

For the first time, sexual products were obtained from wild rainbow trout producers, artificially fertilized, and growth and mortality rates up to the larval stage were studied. For the first time in a fish farm, larvae from a wild population (male) and a cultured stock (female) of rainbow trout were artificially fertilized and obtained.

The theoretical value of the research. Studying the phenetic diversity and variability of introduced and cultured rainbow trout stocks can help to understand the mechanisms of adaptation and evolution in new ecosystems. Analyzing phenetic

diversity allows for a deeper understanding of how inter- and intraspecific differences, as well as environmental changes, affect the morphological and physiological characteristics of species. This has implications for theoretical models of biological variability and adaptation.

The practical value of the research. The study of biological variability and phenetic diversity can help develop effective strategies for fisheries management and conservation. Understanding the adaptive capabilities and needs of different stocks is crucial for maintaining their populations and ensuring stability. Additionally, to improve aquaculture practices, this knowledge can be used to develop new fish strains that are more productive and better adapted to the conditions of specific water bodies. The dissertation on this topic holds fundamental scientific importance, as well as practical significance for the sustainable management of natural resources and environmental protection.

The main statements for defense.

1. For about 50 years after the first introduction, rainbow trout did not spread beyond the river basins where they were originally introduced.
2. Large differences in growth rate, size, weight, and age at sexual maturity among rainbow trout populations indicate different survival strategies within populations, even in small water bodies.
3. Rainbow trout in the lower reaches of the Shelek River (Masak River) differ from those in mountainous areas in terms of body color.
4. Differences in morphometric features are observed between wild populations and cultured stocks of rainbow trout, as well as in sexual characteristics.
5. Individuals of Polish origin showed relatively high viability, while Danish stocks were distinguished by rapid growth.
6. Rainbow trout caught in Lower Kolsay Lake and the Kakpak River are capable of adapting to cultivation in fish farms.

Personal contribution of the author. The author was involved in collecting field material, conducting biological and morphological analyses of the caught fish, taking photographs, transporting live fish to farms for cultivation in pools, performing phenotypic analysis of various fish in the laboratory, and conducting quantitative and qualitative analysis along with statistical processing of the data. The obtained results were analyzed, and conclusions were drawn. The dissertation was written according to a plan developed by the domestic scientific supervisor. The author's contribution to the joint articles is equal to that of the other authors.

Approbation of work. The research results and main findings of the dissertation were presented at various international scientific conferences: the International Scientific Conference of Students and Young Scientists «Farabi World» (Almaty, Kazakhstan, 2021, 2022, 2023), Global Science and Innovations 2021: Central Asia International Scientific and Methodological Materials (Kazakhstan, 2021), the All-Russian Scientific Conference «Biology of Aquatic Ecosystems in the 21st Century: Facts, Hypotheses, Trends» dedicated to the 65th anniversary of I.D. Papanin RAS

(Borok, Russia, 2021), and the Proceedings of the International Scientific and Practical Conference 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 Kazakh National Academy of Natural Sciences Nashtay Mukhitdinovich Mukhitdinov «Independence of Kazakhstan: Aspects of Biodiversity Conservation» (Almaty, Kazakhstan, 2021).

Publications. Within the framework of the goals and objectives of the dissertation work, 10 scientific papers were published, including 6 abstracts at international scientific-practical and scientific-methodical conferences, 3 articles in the biological-ecological series of the scientific journal «Bulletin of KazNU», presented by the Committee for Quality Assurance in Education and Science of the Republic of Kazakhstan, as well as 1 article in the Scopus and Web of Science databases in the journal «*Animals*».

The structure of the dissertation. The dissertation consists of an introduction, three main chapters, a conclusion, and a list of 226 references. The total length of the work is 115 pages, which includes 34 tables, 35 figures, and 1 appendix.