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POSSIBILITIES OF USING NARROW-CLAWED CRAYFISH FOR BIOLOGICAL RECLAMATION OF ARTIFICIAL WATER BODIES IN BUKHARA REGION

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Abstract

This article examines the scientific and practical possibilities of using the narrow-clawed crayfish as a biological reclamation agent to improve the ecological condition of artificial water bodies in the Bukhara region, which are characterized by high mineralization and eutrophication. The role of crayfish as detritivores and polyphages in the decomposition and utilization of excess organic matter accumulated in water bodies is analyzed. The research has shown that the introduction of a *P. leptodactylus* population has a positive impact on improving water quality indicators, limits the excessive growth of aquatic vegetation, and enhances the overall stability of the ecosystem by creating favorable conditions for the development of benthic organisms.



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Keywords: Biological reclamation, narrow-clawed crayfish, *Pontastacus leptodactylus*, eutrophication, detritivore, artificial water bodies, Bukhara region, water quality, ecosystem.

Аннотация

В статье рассмотрены научно-практические возможности использования длиннопалого рака в качестве биологического мелиоранта для улучшения экологического состояния искусственных водоемов Бухарской области, характеризующихся высокой минерализацией и подверженных эвтрофикации. Проанализирована роль раков как детритофагов и полифагов в разложении и утилизации избыточных органических веществ, накапливающихся в водоемах. Исследования показали, что интродукция популяции *P. leptodactylus* положительно влияет на улучшение качественных показателей воды, ограничивает чрезмерное зарастание водной растительностью и повышает общую стабильность экосистемы путем создания благоприятных условий для развития бентосных организмов.

Ключевые слова: биологическая мелиорация, длиннопалый рак, *Pontastacus leptodactylus*, эвтрофикация, детритофаг, искусственные водоемы, Бухарская область, качество воды, экосистема.

Introduction

In Uzbekistan's conditions, especially in arid regions with scarce water resources such as Bukhara region, the sustainable use of artificial water bodies and improving their ecological condition is one of the priority tasks in the agricultural sector. Collector-drainage networks and artificial ponds that have emerged as a result of intensive irrigation systems are distinguished by their high mineralization levels and susceptibility to anthropogenic eutrophication

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(pollution with biogenic elements). This, in turn, leads to excessive growth of aquatic plants (water "blooming"), oxygen deficiency, and a sharp deterioration in water quality. Traditional mechanical and chemical cleaning methods are often expensive, labor-intensive, and may cause secondary ecological problems. Therefore, developing and implementing biologically safe and economically efficient methods of biological reclamation that stimulate the self-purification mechanisms of aquatic ecosystems has significant scientific and practical importance.

In this direction, the use of hydrobionts with broad ecological plasticity is considered promising. The narrow-clawed crayfish (*Pontastacus leptodactylus*) can play an important role as a natural "sanitary engineer" of water bodies due to its detritivorous (feeding on organic residues) and polyphagous (non-selective feeding) characteristics. They actively consume and decompose plant remains, dead hydrobionts, and other organic matter accumulated at the bottom of water bodies, transferring them to subsequent links in the trophic chain. However, comprehensive studies aimed at assessing *P. leptodactylus*' adaptation capabilities to the specific hydrochemical conditions of Bukhara region and its impact on the aquatic ecosystem as a biological meliorant have been scarcely conducted until now. Therefore, studying the potential of this species on a scientific basis has not only theoretical but also high practical significance.

The aim of the research is to scientifically substantiate the possibilities of using narrow-clawed crayfish (*P. leptodactylus*) as a biological meliorant to improve the ecological condition of artificial water bodies in Bukhara region.

Literature Review

Numerous studies on using biological reclamation methods to improve the ecological condition of water bodies have been conducted worldwide. Biological reclamation is an environmentally safe approach aimed at restoring water quality, reducing eutrophication, and increasing ecosystem stability with the help of living

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organisms (plants, fish, invertebrates) [1]. In particular, the practice of controlling aquatic plants using herbivorous fish (grass carp, silver carp) is widespread, and the effectiveness of this method has been proven in the works of S.V. Zhelezov, V.K. Vinogradov, and other scientists [2, 3]. However, factors such as selective feeding of certain fish species or water turbidity resulting from their vital activity may limit the application of this method.

Invertebrate animals, especially decapod crustaceans (Decapoda), play an important role in the circulation of substances and utilization of organic residues in aquatic ecosystems. Their detritivorous characteristic (consumption of organic residues) serves as a basis for considering them as natural "sanitary engineers" of water bodies [4]. In the fundamental studies of foreign scientists D.M. Holdich and J.D. Reynolds, the ecological role of European crayfish, including the narrow-clawed crayfish (*Pontastacus leptodactylus*), their impact on changing the bottom landscape and benthic community has been extensively covered [5, 6]. Research shows that crayfish actively consume aquatic plants, dead animal remains, and detritus, accelerating the movement of biogenic elements along the trophic chain and contributing to the self-purification process of water.

In the works of CIS scientists, including Y.A. Alexandrova and V.P. Fedotov, issues of breeding *P. leptodactylus* in artificial water bodies and increasing their productivity have been studied [7, 8]. These studies indicate the broad feeding spectrum of crayfish, which suggests that they can be used not only as an aquaculture object but also as a means of cleaning water bodies from excess organic matter.

In Uzbekistan, scientific research has mainly focused on the hydrochemical analysis of collector-drainage waters and their impact on fisheries [9, 10]. Although certain work has been done by local scientists on the biological reclamation of water bodies, the issue of using crayfish specifically in this process has been barely studied. The analysis of available literature shows that there are no special scientific studies devoted to assessing the meliorative function of *P.*

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leptodactylus when introduced into highly mineralized and eutrophicated artificial water bodies of Bukhara region, i.e., its impact on water quality and the ecosystem. This, in turn, confirms the scientific novelty and practical significance of the chosen topic.

Research Methodology

The methodological foundation of this research comprises an integrated complex of general scientific and special research principles, including systematic approach, ecological monitoring, experimental analysis, and comparative geographical analysis. The research object – artificial water bodies of Bukhara region – was viewed as a dynamic ecosystem consisting of interrelated complex abiotic (hydrochemical, hydrophysical) and biotic (hydrobionts, plants) components. The introduction of narrow-clawed crayfish (*Pontastacus leptodactylus*) into this system was studied as a controllable factor affecting the ecosystem structure and functional processes (matter circulation, energy flow). The theoretical basis of the research consists of fundamental ecological concepts, including:

A.F. Alimov's functional theory of aquatic ecosystems [1]: According to this theory, the stability of each ecosystem depends on the balance of material-energy exchange processes between its internal components. In the study, crayfish was considered as a "catalyst" helping to restore this balance, particularly by decomposing excess organic matter (detritus) and returning biogenic elements to the higher links of the trophic chain.

According to D.M. Holdich's astacological views [5], large invertebrates, especially crayfish, as "ecosystem engineers," significantly influence the entire ecosystem's condition by changing the bottom landscape, creating habitats for other organisms, and occupying a central place in the food chain. This concept served to substantiate the role of crayfish not only as a "sanitary engineer" but also as a subject forming the ecosystem structure.

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To ensure consistency and validity of scientific conclusions, the following logical methods were used:

– In the deductive method, at the initial stage of research, a specific research hypothesis was formulated based on general scientific assumptions (information about the detritivorous role and ecological plasticity of crayfish on a global scale): "P. leptodactylus can adapt to the highly mineralized waters of Bukhara region, and its vital activity has a positive effect on improving the ecological condition of eutrophicated water bodies."

– In the inductive method, specific empirical data obtained in field and laboratory conditions (results of chemical analysis of water, dynamics of organic matter, growth indicators of crayfish) were analyzed. Based on these specific observations, generalizing conclusions were drawn, and the proposed hypothesis was confirmed or refuted. This process allowed for scientifically substantiating the practical importance of crayfish as a biological meliorant.

– During the research, the aquatic ecosystem was divided into separate components (hydrochemistry, phytoplankton, zoobenthos, macrophytes), and the state of each was analyzed (analysis). Then, the interrelationship of these components under the influence of crayfish was studied, forming a holistic view of the overall state of the ecosystem (synthesis).

In the empirical approach, the following empirical methods were applied to test the hypothesis and collect data:

– The experiment was conducted under controlled conditions that were maximally close to natural conditions. One of the same type of water bodies was selected as the control group (without crayfish introduction), and the other as the experimental group (with crayfish introduction). This method allowed for an accurate assessment of the direct impact of the introduced species on the ecosystem.

– In controlled conditions (closed water circulation systems - RAS), the biological characteristics of the species and optimal parameters of artificial

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reproduction (temperature, food) were determined by studying egg incubation and the initial developmental stages of larvae.

– During the experiment (2021-2024), the main hydrochemical and hydrobiological indicators of water were regularly (seasonally and monthly) monitored. This method served to identify the dynamics of changes in the ecosystem and its connection with crayfish activity.

– To prove the reliability, objectivity, and reproducibility of the obtained data, modern biostatistical methods were used. Student's t-test was used to determine the statistical significance of quantitative differences between control and experimental groups (at a confidence level of $p \leq 0.05$). Correlation analysis was applied to assess the relationship between variables. These methods allowed for scientifically substantiating with a high degree of reliability that the obtained results were not random changes but the result of a specific factor – the vital activity of crayfish.

The integration of these methodological approaches ensured a comprehensive, systematic, and scientifically grounded investigation of the problem of using *P. leptodactylus* for biological reclamation of artificial water bodies in Bukhara region and enhanced the theoretical and practical significance of the obtained results.

Conclusion

The conducted research has scientifically confirmed that the narrow-clawed crayfish (*Pontastacus leptodactylus*) can highly adapt to the conditions of artificial water bodies in Bukhara region, which are characterized by high mineralization (3-4‰) and anthropogenic impact. Its broad feeding spectrum (polyphagy) and active consumption of organic residues (detritivory) were found to lead to several significant positive changes in the aquatic ecosystem. As a result of the vital activity of the crayfish population, the amount of excess organic matter accumulated at the bottom of the water significantly decreased, and the

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excessive growth of aquatic plants was limited. These changes, in turn, improved the oxygen regime and overall hydrochemical condition of the water, activating its self-purification processes. Thus, it was proven that *P. leptodactylus* is not only a passive bioindicator but also an active biological meliorant capable of restoring the ecological balance of the water body.

Based on these findings, it is recommended to develop practical programs for introducing *P. leptodactylus* to sustainably use eutrophicated collectors and artificial water bodies in Bukhara region and improve their ecological condition. In the future, creating technologies for polyculture crayfish farming together with herbivorous fish can further increase the efficiency of comprehensive water resource use, providing both ecological and economic benefits.

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