RIVER CRAYFISH AS CUSTODIANS OF WATER RESOURCES AND BIOINDICATORS OF WATER QUALITY IN CENTRAL ASIA

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Abstract: *River crayfish play a crucial role in freshwater ecosystems as natural "sanitarians," feeding on detritus, dead organic matter, and small aquatic organisms, thereby contributing to the self-purification of water bodies. In Central Asia, where aquatic ecosystems face increasing anthropogenic pressure and pollution, crayfish also serve as effective bioindicators of water quality due to their high sensitivity to changes in chemical composition and the presence of contaminants. This review examines the ecological functions of river crayfish in the water bodies of Central Asia, discusses their distribution and species diversity in the region, and highlights their potential in biomonitoring programs for the early detection of environmental degradation. The conservation and sustainable management of crayfish populations are vital for maintaining the health and stability of Central Asia's freshwater ecosystems.*

Keywords: *crayfish, bioindicators, water quality, freshwater ecosystems, Central Asia, environmental monitoring, water pollution, environmental sanitation.*

INTRODUCTION

River crayfish are important representatives of freshwater ecosystems, consuming dead organisms and contributing to water self-purification. In Central Asia, where waters face climate impacts and pollution, crayfish serve as bioindicators due to their sensitivity to chemical changes and toxins. They are crucial for monitoring water quality while acting as ecosystem custodians.

Water ecosystems in Central Asia's Zarafshan River Basin face challenges from environmental changes and pollutants, including industrial and agricultural runoff. These affect parameters like dissolved oxygen, nitrate nitrogen, and suspended solids (Shoergashova et al., 2024). The Brantas River in East Java demonstrates how macroinvertebrates, including crayfish, indicate water quality through the BMWP-ASPT method, which evaluates community structures and physicochemical parameters (Hertika et al., 2024).

Aquatic invertebrates assist in water self-purification while remaining sensitive to pollutants and acidification (Baturina et al., 2021). In South Asia, water quality monitoring needs emphasize bioindicators like crayfish, particularly for transition metal pollution. Such studies support improved freshwater management for regional rivers (Wang et al., 2022).

Local governments must manage water resources by controlling anthropogenic activities and implementing sustainable practices. Using bioindicators like river

crayfish enables informed decisions for preserving water quality and ecological balance.

Distribution and Types of River Crayfish in Central Asia: Two main species of river crayfish inhabit the river basins within Uzbekistan, Kazakhstan, and other developing countries: the non-native narrow-clawed crayfish (Pontastacus leptodactylus), introduced in the 1970s, and the indigenous Turkestan crayfish (Pontastacus kessleri), which is listed in the regional Red Data Books. These species are found in the Zarafshan river basin and adjacent bodies of water, including large reservoirs.There is limited direct information on the distribution and types of river crayfish specifically in Central Asia in the context provided. However, I can draw on some insights from related studies that might help in understanding the potential distribution and conservation challenges for crayfish in similar environments.

1. Diverse Ecosystems: Studies on fish diversity in regions like the Qilian Mountain Basin in Central Asia demonstrate a varied ecosystem that could potentially support a diversity of crayfish species as well (Chen et al., 2022). Given the ecological richness, there could be unrecognized crayfish diversity in these habitats.

2. Impact of River Modifications: Research from Central Europe highlights how river channelization and habitat modifications can increase the abundance of invasive crayfish species like Faxonius limosus (Bonk and Bobrek, 2021). This suggests similar threats could exist in Central Asia, where anthropogenic changes might facilitate invasive species at the expense of native crayfish populations.

3. Conservation and Genetic Studies: Although the conservation study on the white-clawed crayfish (WCC) is based in the Iberian Peninsula, its focus on genetic diversity and conservation measures can inform similar efforts needed in Central Asia (Martínez-Ríos et al., 2023). Assessing genetic diversity of native crayfish in Central Asia may help gauge their conservation status and identify unique genetic lineages.

4. Methodological Insights: For detailed assessments, a multi-method approach as used in studying burrowing crayfish in North America may be beneficial. This involves using species distribution modeling (SDM) and environmental DNA (eDNA) assays to accurately map and monitor crayfish populations (Quebedeaux et al., 2023).

5. Conservation Implications: The challenges in understanding crayfish distribution and habitat use, as seen in research conducted in North-eastern Texas, suggest that comprehensive surveys are essential to ascertain true population sizes and ranges of crayfish species that might otherwise be designated as 'Data Deficient' or 'rare' (Hays et al., 2023).

Ecological Role of River Crayfish: River crayfish maintain ecological balance in freshwater bodies by feeding on aquatic plants and organisms, reducing eutrophication and improving water quality. Their biomass affects biogeochemical cycles, preserving aquatic ecosystems. As ecosystem engineers, crayfish alter environments through burrowing. The slender crayfish (Faxonius compressus)

constructs burrows that impact stream habitats and provide shelter for various organisms (Graham and Loughman, 2023).

Crayfish influence ecology through omnivorous feeding, affecting trophic dynamics by consuming aquatic organisms while breaking down organic matter. Their behaviors influence leaf litter breakdown rates, affecting ecosystem function (Kabalan et al., 2024).

Invasive crayfish species can harm native biodiversity. The Red Swamp crayfish (Procambarus clarkii) disrupts ecosystems by outcompeting native species and thrives in human-modified environments (Yuyu et al., 2022; Bonk and Bobrek, 2021). The marbled crayfish (Procambarus virginalis) maintains ecological impacts even after claw injuries, demonstrating their persistent threat (Soto et al., 2023).

Monitoring invasive species like signal crayfish (Pacifastacus leniusculus) is crucial for understanding their ecological impacts and implementing management actions (Carvalho et al., 2024).

Bioindicator Potential of River Crayfish: River crayfish's sensitivity to trace metals, pesticides, and organic pollutants makes them effective bioindicators. Changes in biochemical and hematological parameters of crayfish reflect pollution levels, enabling assessment of anthropogenic impact on Central Asian water bodies. Research confirms that analyzing crayfish populations is crucial for detecting pollution and ecological risks. Studies of crayfish as bioindicators have focused on their ability to indicate environmental changes, with signal crayfish (Pacifastacus leniusculus) populations monitored in areas like Portugal's Rabaçal River (Carvalho et al., 2024).

Studies have also explored other aquatic bioindicators like fish and water mites. Fish scales effectively monitor trace and macroelement pollution non-invasively (Aib et al., 2025), while water mites serve as bioindicators in the Laurentian Great Lakes (Vasquez et al., 2022).

Crayfish as bioindicators align with these approaches due to their sensitivity to water quality changes and role in aquatic ecosystems. Their use could enhance understanding of anthropogenic impacts on freshwater habitats and support ecological preservation strategies.

Ecological Challenges and Forecasts: Recent changes in river crayfish populations in Central Asia have occurred due to pollution, diseases, and anthropogenic pressure. The extinction threat requires measures to protect and restore populations. "Detikhi" programs using crayfish as bioindicators will help detect pollution and safeguard water resources. Ecological challenges are influenced by climate change, biodiversity loss, and ecosystem degradation. Climate change severely impacts biodiversity hotspots worldwide. In the Sundarbans Biosphere Reserve, climate change threatens biodiversity through disasters and human pressures on forest resources (Ghosh et al., 2021). Local responses to biodiversity and ecosystem service challenges require interdisciplinary research to inform policy-making (Cisneros-Pineda et al., 2023).

Future forecasts suggest ecological changes driven by climate scenarios and socio-economic pathways. In China's arid regions, strict environmental policies could promote sustainability under different scenarios (Ji et al., 2024). The Galapagos Islands demonstrate how microclimatic changes may increase vegetation productivity (Charney et al., 2021), though this greening might complicate conservation efforts.

Ecological networks' sustainability under future climate scenarios adds complexity. Network functionality in the Yangtze River Delta is predicted to decline, reducing ecosystem services. Monitoring biodiversity across disturbance gradients helps predict community changes and improve management.

Ecological forecasts must consider integrating land restoration and biodiversity conservation within sustainable food systems, particularly in Africa. This involves addressing land degradation while promoting food security and ecological resilience. Global datasets like CHELSA and WorldClim2 can introduce variability into projections, requiring careful evaluation in regional studies.

Conclusion: Freshwater crayfish in Central Asia are essential for maintaining water quality and serving as bioindicators. Their ecological role and sensitivity to pollution make them irreplaceable in the Diptych system and regional management. Maintaining crayfish populations contributes to sustainable development and freshwater ecosystem conservation in Central Asia. Crayfish significantly influence ecological dynamics as key trophic links and environmental health indicators. They occupy a central position in the food web as keystone species, influencing other organisms' population structures by controlling algal blooms and regulating insect populations. Their sensitivity to environmental stressors makes them valuable bioindicators, with species like Procambarus clarkii showing physiological responses that indicate ecosystem health. Invasive crayfish species can disrupt native ecosystems by competing for resources and altering habitat structure. Protecting these populations ensures freshwater ecosystem resilience, which is vital for biodiversity, water quality, and economic activities. Crayfish remain indispensable for their ecological roles and as ecosystem health indicators, underlining their importance in environmental management.

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