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THE ROLE OF INVERTEBRATES IN BIOINDICATION OF AQUATIC ECOSYSTEMS AND SUSTAINABLE FISHERIES

In the context of rapid environmental change and increasing anthropogenic pressure on natural resources, the issues of protecting aquatic ecosystems and ensuring the sustainable use of their resources are becoming ever more relevant. One of the key components of this process is bioindication – a method of assessing the state of the environment using living organisms. Invertebrates, due to their high sensitivity to environmental changes, play a crucial role in determining the health of aquatic ecosystems.

Aquatic invertebrates are of particular importance within the fisheries sector. They not only serve as bioindicators but also constitute a vital component of aquatic ecosystems, supporting the development and maintenance of fish populations. The influence of invertebrates on the structure and functioning of ecosystems can be traced through their responses to changes in water quality, temperature, oxygen levels, and other environmental factors.

Within the framework of sustainable fisheries, it is essential not only to utilize fish resources efficiently but also to ensure the balanced functioning of ecosystems, where invertebrates act as natural regulators and bioindicators. Disturbances in their populations may indicate ecosystem degradation and can have long-term consequences for fishery productivity.

In this context, studying the role of invertebrates as bioindicators in aquatic ecosystems is an important aspect of promoting sustainable fishery development, conserving biodiversity, and improving the management of natural resources.

Invertebrates, particularly arthropods (such as water fleas, mosquito larvae, crayfish, and others), are highly sensitive to changes in aquatic environments. Their presence, diversity, and abundance allow for the assessment of water quality since they quickly respond to pollution, oxygen fluctuations, and other stressors. For example, certain aquatic invertebrates serve as indicators of contamination by heavy metals or organic compounds (Table 1).

Invertebrates occupy a significant position in aquatic food chains, serving as food for fish and other aquatic organisms. This ensures efficient energy

and nutrient transfer within ecosystems, forming the foundation for stable fish populations. As primary detritivores, invertebrates also help maintain ecological balance by decomposing organic matter that enters aquatic environments (Table 2).

Table 1

**The role of invertebrates as indicators of water quality:
main species and influencing factors**

Invertebrate species	Indicator of water condition	Water parameters responded to
<i>Daphnia magna</i> (water flea)	Indicator of organic pollution	Oxygen, organic matter
<i>Astacus astacus</i> (crayfish)	Indicator of heavy metal pollution	Nitrates, heavy metals, temperature
<i>Culicidae</i> larvae (mosquito larvae)	Indicator of general water pollution	Organic pollutants
<i>Physa fontinalis</i> (pond snail)	Indicator of oxygen stress	Oxygen, organic pollution

Table 2

**Relationship between water quality and invertebrate abundance
in aquatic ecosystems**

Water quality	Invertebrate abundance (ind./m ²)	Species diversity (number of species)
Clean (bioindicator class 1)	100–150	High (more than 20 species)
Moderately polluted (bioindicator class 2)	50–80	Medium (15–20 species)
Polluted (bioindicator class 3)	10–30	Low (fewer than 10 species)
Heavily polluted (bioindicator class 4)	0–10	Absence of some species

Changes in aquatic ecosystems associated with anthropogenic factors—such as water pollution, temperature shifts, or habitat loss—can lead to significant alterations in invertebrate populations. For instance, elevated water temperatures may reduce the abundance of thermosensitive species, while contamination with heavy metals decreases overall species diversity.

In the context of sustainable fisheries, it is essential to consider the ecological balance of aquatic ecosystems, particularly the role of

invertebrates in maintaining healthy conditions for fish. They can be used as bioindicators for monitoring ecosystem health, as well as natural components in aquaculture systems, where their presence reflects the stability and natural functioning of the environment.

In the broader framework of sustainable water resource management, invertebrates play a critical role in maintaining ecological balance. They are not only key components of food webs but also effective bioindicators of aquatic ecosystem health. The sensitivity of invertebrates to water quality fluctuations allows their use in pollution monitoring and ecological assessment—necessary for sustaining stable conditions for fisheries development.

Understanding their ecological role enables the formation of more efficient approaches to sustainable water management, especially in fisheries, where invertebrates can be used to support natural conditions for fish rearing. However, anthropogenic factors—such as pollution, temperature changes, and oxygen fluctuations—must be considered, as they directly affect invertebrate populations and, consequently, overall ecosystem health.

Preserving the biodiversity of aquatic invertebrates and their habitats is a vital element of ecological stability. Therefore, achieving sustainable fishery development requires integrating ecological knowledge, bioindication methods, and modern approaches to water resource management.

References

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