Review Article

Taxonomic Structure and Quantitative Indicators of Benthic Invertebrates of the Varvara Reservoir in the Kura Cascade

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Abstract

This review summarizes published information on the taxonomic structure and biomass distribution of macrozoobenthic communities in the Varvara Reservoir, Azerbaijan. This basin, the last link of the Kura cascade, is a unique ecosystem with an average shallow depth of 3–4 meters and an extensive Phytophilous vegetation cover of 89.9%. Modern literature emphasizes that macrozoobenthos are sensitive bioindicators in determining water quality and assessing ecosystem health, and that they respond rapidly to environmental stress factors. This review is based on published studies that reported systematic sampling of five major biotopes (lithophile, psammophile, pelophile, pelo-psammophile, and phytophile) within the Varvara Reservoir. According to the reviewed literature, 113 species and forms of invertebrates belonging to 22 systematic groups have been reported from the reservoir. Among these organisms, chironomid larvae constitute 38.1% of the species diversity with 43 species, providing absolute dominance in taxonomic terms. Mollusks constitute the dominant component of the benthic biomass and represent the principal biomass component of the ecosystem. In particular, Phytophilous biotopes cover a large part of the basin, forming both a safe shelter and an abundant food source for benthic organisms. Diurnal water level fluctuations and cold water flows associated with the operation of the Mingachevir HPP directly affect the stability and metabolic processes of benthic communities in the coastal zone. The species Paramysis lacustris and Pontogammarus robustoides introduced to the basin have successfully adapted to the ecosystem and qualitatively enriched the food base of important fish species. The results reveal the high biological potential of the reservoir. Collectively, the reviewed studies indicate the high biological potential of the reservoir and provide a scientific basis for sustainable water-resource management and fishery conservation. In addition, the impact of high population densities of Melanopsis mollusks on parasitological risks in the region was also assessed.

Keywords: Varvara Reservoir, macrozoobenthos biomass, bioindicator

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1. Introduction

Macrozoobenthos communities are one of the most sensitive biological tools used to assess the health and water quality of river and reservoir ecosystems [1]. Due to their close association with bottom sediments and their limited mobility, macrozoobenthic organisms serve as valuable biological indicators, reflecting long-term physical and chemical changes in aquatic ecosystems and functioning as a "living archive" of environmental conditions. Modern scientific literature emphasizes that macrozoobenthos react very rapidly and significantly to environmental stress factors such as anthropogenic pollution and the construction of reservoirs [2], [3]. Therefore, it has become a global standard to determine the ecological status of a water body not just by instantaneous physical measurements, but by monitoring changes in the structure of macrozoobenthos communities. In particular, chironomid larvae, oligochaetes, and various mollusk species are considered the most reliable bioindicators of the degree of water pollution and oxygen regime.

The cascade of reservoirs constructed along the Kura River, Azerbaijan's largest and most important waterway, plays a strategic role in conserving the country's freshwater biodiversity and managing its water resources [4].

Historical studies on the hydrofauna of the Kura River have revealed that the species diversity, which was limited in the river environment before the construction of reservoirs, has been enriched with the transformation of ecosystems into lake environments [5]. The Varvara reservoir (Figure 1), one of the last and shallowest links of the cascade, has been systematically studied by Azerbaijani hydrobiologists since the 1950s [6]. The fundamental works of scientists such as Professor A.H. Gasimov and A.R. Khalilov have established the patterns of distribution of invertebrates in this basin on a scientific basis. Determining the biological potential of the Varvara reservoir is not just an academic interest, but is also important for protecting the food base of critically important fish in the basin [7].

Figure 1. Location map of the Varvara reservoir.

The main feature that distinguishes the Varvara reservoir from other water bodies in the Kura cascade is its unique hydrological regime, in which the water coming from the Mingachevir Hydroelectric Power Plant (HPP) is regulated on a daily basis. This operating mode creates a constant ecological stress on benthic organisms in the coastal zone, causing sudden and sharp fluctuations in water level every day. Although Varvara's shallow structure, averaging 3–4 meters, and dense phytophyte cover reaching 90% act as a refuge against such factors, it has not yet been fully clarified how this mechanism works by modern ecological criteria.

The aim of this review is to summarize and synthesize the available scientific literature on the taxonomic structure, species diversity, biomass distribution, and ecological significance of macrozoobenthic communities in the Varvara Reservoir. Particular attention is given to habitat-specific community composition, hydrological influences, and the importance of benthic organisms for fisheries and ecosystem management.

2. The Role of the Varvara Reservoir's Food Resources in Fisheries

The Varvara Reservoir is a specific link in the cascade on the Kura River, and the macrozoobenthos communities formed here play a necessary strategic role in the nutrition of fish of great importance, both in terms of quantity and quality. Studies reveal that mollusks, which make up the bulk of the biomass in the basin, play a crucial role in the diet of fish, but their heavy calcium-carbonate shells can make energy transfer somewhat difficult [8]. However, the massive development of 43 species of chironomid larvae and oligochaetes in muddy soils creates a high-calorie and easily digestible food environment, especially for young fish. The 1.00 g/m2 contribution to the annual biomass of successfully introduced mysids and semi-floating

crustaceans, such as Pontogammarus robustoides, directly contributes to the diversification of the food base and the increase in fisheries productivity. The Phytophilous zone serves as a favorable source for the restoration of the reservoir's natural food resources. In order to use the food base more efficiently in the future and increase fishing potential, it is essential to manage the hydrological regime and biological resources of the reservoir on a scientific basis. At the same time, maintaining constant control over the parasitological situation that may arise due to the mass density of mollusks is a task of strategic importance in terms of protecting the health of fish populations [8].

3. Literature Sources

This review is based on published scientific literature concerning the macrozoobenthic communities of the Varvara Reservoir. Relevant information was compiled from peer-reviewed journal articles, monographs, regional hydrobiological reports, and other published sources describing the taxonomic composition, biomass, ecological characteristics, and habitat distribution of benthic invertebrates. Particular attention was given to studies reporting observations from the five principal biotopes of the reservoir (lithophile, psammophile, pelophile, pelo-psammophile, and phytophile).

Information regarding species composition, biomass, dominant taxonomic groups, hydrological conditions, and ecological characteristics was extracted, compared, and synthesized to provide an integrated overview of the current knowledge on the reservoir's macrozoobenthic fauna. Taxonomic nomenclature follows the terminology adopted in the cited literature [9].

4. Taxonomic Composition and Ecological Characteristics

Published studies have documented 113 species and forms of benthic invertebrates representing 22 systematic groups in the Varvara Reservoir. Collectively, these studies demonstrate that the transformation of the Kura River into a reservoir ecosystem has promoted the establishment of a diverse limnophilic macrozoobenthic community.

The reviewed literature consistently identifies chironomid larvae as the most species-rich group, comprising 43 species (38.1% of the recorded fauna). Their abundance in pelophilous habitats highlights their ecological importance as a major food resource for benthic-feeding fish.

Published biomass estimates indicate that mollusks constitute approximately 71–89% of the total benthic biomass within the reservoir. Several studies attribute this dominance to environmental conditions favorable for the development of bivalves and gastropods. Among these, *Melanopsis praerosa* has been reported to reach particularly high population densities.

According to previous studies, seasonal and hydrological factors strongly influence macrozoobenthic community composition. Higher abundances are generally observed during autumn and winter, whereas summer populations decline because of elevated temperatures and insect emergence [10], [11].

Overall, the reviewed literature indicates that species with greater tolerance to environmental disturbance tend to dominate under conditions of frequent hydrological fluctuations (Table 1).

Table 1. Summary of published information on species richness and biomass characteristics of macrozoobenthos in the principal biotopes of the Varvara Reservoir.

Biotope Name	Number of Species	Biomass Range (g/m²)	Dominant Taxonomic Groups
Phytophilous	63	1,298 – 10,650	Mollusks, Chironomid larvae
Lithophilous	25	3,530 – 36,920	Leeches, Caddisfly larvae
Psammophilous	24	0,870 – 35,533	Mollusks, Oligochaetes
Pelophilous	32	0,229 – 1,963	Chironomid larvae, Oligochaetes
Pelo-psammophilous	28	0,015 – 19,217	Bivalve mollusks

4. Conclusion

The available literature indicates that the Varvara Reservoir supports a diverse and productive macrozoobenthic community that plays an important ecological role in sustaining fish populations. Existing studies also highlight the influence of hydrological regulation on benthic community structure. Future

investigations and long-term monitoring will further improve understanding of ecological changes within this reservoir.

In conclusion, the present findings indicate that the Varvara Reservoir currently supports abundant macrozoobenthic communities that constitute a significant food resource for fish. However, long-term monitoring is required to evaluate temporal stability and responses to hydrological regulation.

Author Contributions

Ali I. Huseynov conceived the study, conducted the literature review, performed the analysis, interpreted the findings, and prepared the original draft of the manuscript. Dr. Mahmud Humbatov supervised the research, provided scientific guidance throughout the study, critically reviewed and edited the manuscript, and approved the final version for publication.

Conflict of Interest

The authors declare no conflicts of interest.

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