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BIOECOLOGICAL FEATURES OF STONEFLIES (INSECTA, PLECOPTERA) IN THE MACROZOOBENTHOS OF LAKES IN THE LOWER REACHES OF THE AMU DARYA RIVER

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ABSTRACT
This article examines the bioecological characteristics of stoneflies (Insecta: Plecoptera) in the macrozoobenthos of lakes in the lower reaches of the Amu Darya River. Their distribution, ecological associations, and role in aquatic ecosystems in the arid region are discussed. It is established that stoneflies are characterized by low species diversity and uneven distribution, which is associated with high water mineralization, oxygen deficiency, and an unstable hydrological regime. It is shown that they are sensitive bioindicators and are found predominantly in areas with good aeration and low anthropogenic load.
KEYWORDS: *Plecoptera, Macrozoobenthos, Amu Darya, Lakes, Bioecology, Aquatic Insects, Bioindication.*

INTRODUCTION

Stoneflies (Plecoptera) are one of the most ecologically sensitive groups of aquatic insects, whose larvae develop primarily in clean, well-aerated freshwater bodies. They are widely used in hydrobiological studies as bioindicators of water quality, as their presence is closely associated with low pollution levels and stable hydrochemical conditions. The lower reaches of the Amu Darya are one of the most ecologically complex regions of Central Asia, where natural water exchange processes are significantly disrupted by anthropogenic impacts, irrigation water use, and fluctuating water flows. Lake ecosystems in this area are characterized by high spatial and temporal variability of hydrological parameters, including fluctuations in water levels, increased salinity, eutrophication, and periodic dissolved oxygen deficiency.

Under these conditions, the structure of macrozoobenthos undergoes significant changes, which affects the composition and abundance of individual taxa, including stoneflies. Studying the bioecological characteristics of Plecoptera in such extreme conditions allows us not only to assess their adaptive capabilities but also to use them as indicators of the state of aquatic ecosystems.

MATERIALS AND METHODS

The studies were conducted using generally accepted hydrobiological methods (Zhadin, 1960; Abakumov, 1983). The study sites were lakes in the lower reaches of the Amu Darya River with varying mineralization, hydrological regimes, and levels of anthropogenic load. Macrozoobenthos was collected in the coastal and near-watershed zones using hydrobiological nets and an Ekman-Burge grab sampler. Sampling was conducted seasonally to account for the influence of temperature and hydrological factors.

In the laboratory, stonefly larvae (Plecoptera) were sorted and identified using identification guides (Kutikova and Starobogatov, 1977), and their composition, abundance, density, and distribution across biotopes were determined. Hydrochemical parameters of the water (temperature, O_2, pH, and mineralization) were analyzed simultaneously (Alekin, 1997). The data obtained allowed us to evaluate the relationship between environmental conditions and the presence of Plecoptera in the macrozoobenthos.

RESULTS AND DISCUSSION

Research has shown that stoneflies (Plecoptera) in the lakes of the lower Amu Darya are represented by an extremely limited number of species, reflecting the region's unfavorable environmental conditions for this group of aquatic organisms. Their occurrence is markedly fragmented and confined to isolated, relatively ecologically stable sections of the water bodies. These sections are characterized by comparatively more favorable hydrochemical parameters, primarily increased dissolved oxygen content, lower mineralization, and the presence of microhydrodynamic conditions conducive to water aeration.

In most of the surveyed water areas, especially in zones with a high degree of evaporation and salinity, representatives of Plecoptera were completely absent, which indicates their high ecological sensitivity to changes in the salt and oxygen regime. The highest density of stonefly larvae was recorded in the littoral zones of the lakes, where well-developed aquatic and semi-aquatic vegetation is present, creating additional conditions for oxygen retention and the formation of more stable microhabitats. In addition, these areas are characterized by moderate water exchange or weak currents, which prevent stagnant processes and improve the oxygen regime. Under such conditions, the most favorable ecological niches for the

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development of Plecoptera larvae are formed, resulting in their local but stable occurrence.

In contrast, central deepwater areas and zones with high mineralization and salinity were characterized by a virtually complete absence of stoneflies. This is due to a combination of unfavorable factors, including a deficiency of dissolved oxygen, elevated salt concentrations, and the accumulation of organic matter in bottom sediments, leading to the development of anaerobic processes. Such conditions exceed the ecological tolerance of most Plecoptera representatives, confirming their status as a stenobiontic group with narrow ecological requirements.

A comparative analysis of the macrozoobenthos structure revealed that stoneflies account for a small proportion of the total biomass of the bottom communities in the studied lakes. In terms of numbers and biomass, they are significantly inferior to more resilient and eurybiontic groups, such as chironomid larvae (Chironomidae), oligochaetes (Oligochaeta), and some crustaceans, which demonstrate high adaptability to changing environmental conditions, including increased mineralization and organic pollution.

Despite their low abundance and limited distribution, stoneflies remain a significant ecological player in these ecosystems. They participate in organic matter breakdown processes, facilitating the mineralization of detritus and the incorporation of organic material into biogeochemical cycles. Furthermore, Plecoptera larvae are an important link in food chains, serving as food for a number of fish species and other aquatic predatory invertebrates, thereby ensuring energy transfer within the ecosystem.

The results obtained generally confirm that the presence of stoneflies can be considered a reliable bioindicator of relatively stable and ecologically favorable areas of the lower Amu Darya River's water bodies. Their presence indicates adequate oxygen levels and relatively low water mineralization, while the absence or a sharp decline in the abundance of Plecoptera indicates degradation of the aquatic environment, increased salinization, eutrophication, and a deterioration in the overall ecological condition of the water bodies.

CONCLUSION

Thus, stoneflies (Plecoptera) in the macrozoobenthos of the lower Amu Darya lakes are characterized by low species diversity, limited distribution, and high ecological sensitivity. Their distribution is closely linked to the hydrochemical parameters of the environment, primarily the dissolved oxygen content and water mineralization. In the arid and anthropogenically transformed ecosystems of the lower Amu Darya, Plecoptera representatives persist only in localized areas with relatively favorable conditions. The obtained data confirm the feasibility of using stoneflies as a bioindicator group for monitoring the state of aquatic ecosystems in the region and assessing the degree of their anthropogenic transformation.

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