BIOLOGIJA
2024. Vol. 70. No. 2–3. P. 71–77

ISSN 1392-0146 eISSN 2029-0578
DOI: https://doi.org/10.6001/biologija.2024.70.2–3.1

New challenges regarding the environmental and sanitary condition of Ukrainian water bodies

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Today Ukraine is faced with new challenges that have a significant impact on natural water bodies and aquaculture. As a result of hostilities, there is an additional pressure on aquatic ecosystems. Unfortunately, large territories with important fishery complexes of Ukraine are either occupied, located in the war zone, or mined. Currently it is impossible to carry out comprehensive monitoring investigations into the actual environmental condition of inland water bodies of Ukraine. Therefore, in order to establish a true picture of the state of the water fund of Ukraine, an analytical review of publications was performed. Unfortunately, after the large-scale hostilities on the territory of Ukraine, a significant number of water bodies changed their status according to saprobic indicators. The situation is difficult with the reservoirs of the Dnipro River Cascade, which accumulate all pollutants released into the water from the catchment area. The destruction of the Kakhovka Hydroelectric Power Station led to a massive killing of all biota, including fish. The reservoirs are mostly polluted by biogenic, organic and surface-active substances, oil products, phenols, pesticides, and heavy metals. Even in the pre-war period, the problem of water pollution required immediate decisions, and with the beginning of the full-scale war, it became one of the most urgent tasks for Ukraine. Today, Ukraine's water bodies suffer from pollution by pyrogens, fuel, and lubricants after rocket attacks and even from the total destruction of fish farms, water reservoirs, i.e., the Kakhovka Reservoir. Therefore, monitoring of the environmental condition of inland water bodies of Ukraine will provide an opportunity to assess their real condition and, in the future, to select the complex of methods aimed for their restoration.

Keywords: ecological problems, water pollution, water quality

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INTRODUCTION

Currently, in wartime conditions, it is difficult to find a water body uncontaminated by human activity. Deterioration of water quality of natural water bodies is an extremely serious problem in Ukraine. In particular, this issue became of primary importance after full-scale hostilities on the territory of our country. After the shelling of the country with rockets, drones, and other weapons, most aquatic ecosystems received household waste and waste from industrial enterprises and animal farms. That is why it is very important to know about the quality of water in the water bodies of Ukraine. This is necessary not only to state the fact whether the water is clean or polluted but also for the development of measures for improving the ecological condition of the water bodies of Ukraine in the post-war period. The purpose of the work was to describe the problem of water pollution in Ukraine after the outbreak of full-scale hostilities.

METHOD

Sampling was complicated due to the occupation and mining of large areas of our country. That is why for assessing the ecological conditions of the inland water bodies of Ukraine and the prospects for their restoration in the post-war period we selected publications, which would allow describing the actual picture. An analytical review and selection of articles were based on the materials and methods that describe the sanitary and environmental conditions of the water fund of Ukraine, especially during military operations in the country.

RESULTS

Today Ukraine is facing new challenges that have a significant impact on natural water bodies and aquaculture and are related to the control of water quality by chemical and toxicological indicators. However, biological methods of research are a priority, since in 2000, the European Framework Water Directive 2000/60/EU of 23 October 2000 of the European Parliament and the European Council was developed to define the limits of community action in the field of water policy (Directive, 2000). It involves the transition from chemical-analytical to biological control of water quality and the environmental condition of water bodies.

Biological control is a system of assessing the condition of water bodies using the biological properties of biota. This is due to the fact that all processes in ecosystems more or less affect the groups of living organisms, the structural and functional organisation and physiological conditions of which reflect the cumulative impact of the aquatic environment on the quality of surface waters.

According to the Directive, the assessment of the ecological condition of water bodies is carried out for a five-level classification: high, good, moderate, bad, poor water class. This document also obliges EU countries to harmonise and unify approaches to the management and protection of water resources. In 2014, the Association Agreement between Ukraine and the European Union was signed, after which our state intensified own efforts to solve environmental problems and began the green transformation of economic development (Association Agreement between Ukraine and the EU, 2014).

The war caused large-scale and serious damage to the environment and led to both immediate and long-term negative consequences for people's health, the state of ecosystems, including aquatic ones, and the economy of Ukraine and beyond.

Unfortunately, large territories with important fishery complexes in Ukraine are occupied, located in the war zone, or are mined. Therefore, currently it is impossible to conduct comprehensive monitoring investigations about the actual condition of the water fund in these territories. As soon as possible, Ukraine should pay attention to the issue of eliminating and reducing the immediate risks of deteriorating human health and the environmental state caused by the war.

Although currently all actions in various spheres of activity are aimed at eliminating the general consequences of the war for the environment, they do not specifically relate to the assessment of the environmental condition of aquatic ecosystems and their potential for recovery in the post-war period, which should be a priority in enduring the sustainability of natural aquatic ecosystems and aquaculture farms in Ukraine.

Thus, one of the key biological methods for assessing the ecological and sanitary condition of water bodies is the assessment of water quality by microbiological indicators, since bacteria are the first and most informative components of the aquatic ecosystem biota, which quickly react to the increasing concentration of organic substances in aquatic environment (Antipchuk, 2003). Because of the problems faced by our country today, the assessment of water quality by the level of saprobity has become widely used. Since saprobity is the ability of aquatic organisms to live in water containing different concentrations of organic substances, the zones of saprobity are also determined by the microbiological indicators (Dvoretskyi, 2000; Methodical recommendations 2019).

Unfortunately, at the time of the large-scale hostilities in Ukraine's territory, a significant number of water bodies changed their status according to saprobic indicators. For example, in the pre-war period, our research of fishing water bodies in central Ukraine as to microbiological indicators demonstrated that according to the ecological and sanitary classification, the water quality ranged from the class 'clean', category 'fairly clean' to the class 'polluted', which corresponds to beta-oligosaprobic, and category 'conditionally polluted'. Usually, we observed this picture during the summer months at the highest temperatures (Savenko et al., 2020).

The assessment of water quality in fishponds according to the ecological and sanitary classification established that the water in the ponds was suitable for growing fish. Currently, during hostilities, in Kyiv region, our investigations (Savenko et al., 2022) have shown that according to microbiological indicators, the water of the same water bodies belongs to the 'contaminated' class, which corresponds to the alpha-mesosabric zone. As a result, this water is conditionally suitable for growing fish.

Unfortunately, the situation with the large rivers of Ukraine is not better. For example, the Dnipro River suffered the most after the start of the full-scale war. In addition to pollution by pesticides and other chemical elements that fell into the water from the fields during the rains, now pollution by pyrogens, fuel and lubricants after rocket attacks has been added, and even total destruction of a part of the water cascade, the Kakhovka Hydroelectric Power Station and the Kakhovka Reservoir (hromadske.ua: Public news).

The reservoirs of the Dnieper Cascade are most polluted by biogenic, organic and surface-active substances, oil products, phenols, pesticides, and heavy metals. The simultaneous presence of a large amounts of organic substances and ammonium nitrogen in water results in the formation of potent toxic substances.

In the long term, the post-war 'green' reconstruction should not be considered as a desirable or optional 'additional offer' but as an economic necessity for the fundamental transformation of Ukraine to a green and net zero economy. The results of the analysis and assessments of the latest scientific achievements for the repair of freshwater ecosystems are presented in HORIZON-CL6-2021-BIODIV-01 'Biodiversity and Ecosystem Services' (Horizon Europe 2021–2022).

This research is key for obtaining results that will hopefully have an important impact on biodiversity, food, health, water, and climate, and to achieving the goal of creating healthy and sustainable ecosystems by 2030.

Also, we are looking forward to investigations by our foreign colleagues. For example, one of the promising methods is the bioremediation of wastewater, which is based on the use of algae and cyanobacteria to neutralise a wide range of organic pollutants. The green way to treat wastewater is more ecologically sustainable than

previous methods with other bacteria. Algae-based wastewater treatment systems are widely used due to their environmental sustainability and the absence of secondary pollutants. Depending on the type of the pollutant, physical and chemical properties of the wastewater, and the species of algae and cyanobacteria, these organisms can absorb and accumulate a wide range of organic pollutants at different rates. Cyanobacteria metabolise the toxic pesticide fenamiphos. Particularly, *Aulosira fertilissima* ARM 68 uses pesticides dichlophos, quinalphos, malathion, monocrotophos, and phosphamidon as additional sources of phosphorus in the presence of inorganic phosphate. Disadvantages of phytoremediation are the dependence of its efficiency on different pH levels, and some pollutants are impossible to utilise (Touliabah et al., 2022).

One of the methods of biological treatment of industrial wastewater and environmental recovery from a wide range of nitroaromatic compounds is the use of the *Rhodococcus opacus* bacteria strain. These bacteria mineralise and transform nitroaromatic and nitroamin compounds. The bacteria strain uses 2,4,6-trinitrophenol as a single source of carbon and nitrogen. In addition, bacteria of this species can use 2,4,6-trinitrotoluene (TNT), hexahydro-1,3,5-trinitro-1,3,5-triazine, 4-nitrophenol, and small amounts of 2,4- and 2,6-dinitrotoluene (Weidhaas et al., 2009).

It is shown that the strain of *Rhodococcus* sp. ZWL3NT uses 3-nitrotoluene (3NT) as the sole source of carbon, nitrogen, and energy for its growth. *Rhodococcus* sp. ZWL3NT can bio-transform 3NT at high concentration to the intermediate product, 3-methylcatechol. It was established, that the amount of used 3NT is equal to the amount of accumulated 3-methylcatechol, which indicates stoichiometric conversion of 3NT to 3-methylcatechol without synthesis of 4-methylcatechol (Yi-Zhou Gao, 2020).

Lamba (2022) studied aerobic and anaerobic degradation of TNT by the bacterial strain *Indiicoccus explosivorum* S5-TSA-19. It was established that the strain completely utilises TNT (120 mg/l) in the culture medium during the seven days (Lamba, 2022). Liu et al. (2020) demonstrated that *Pseudomonas strain* ZyL-01, isolated from activated sludge, can utilise CL-20 (hexanitrohexaazaisowurtzitane) for 14 days of incubation with glucose as a carbon source.

Enzymes of the *Enterococcus faecalis* species belong to different families of oxidoreductases and are involved in the recovery of nitro compounds. Nitrate reductase enzymes show that *E. faecalis* strains have a specific activity depending on the environmental conditions, the presence of substrates and cofactors. The lactic acid bacteria can be used for bioremediation of azo dyes or nitroaromatic compounds (Chalansonnet, 2017).

Today, Nile tilapia, Atlantic salmon, rainbow trout, olive flounder, common carp, grass carp and carp are grown commercially all over the world. Farming of these important fish species is expanding rapidly, and intensive farming practices can stress the fish and reduce their resistance to infectious diseases. The ecological strategy of combating infectious diseases in aquaculture is based on the use of probiotic strains of microorganisms. In aquaculture, there are many problems, such as stocking density, infectious diseases, overuse of antibiotics, water pollution, which can be solved with the help of probiotic lactic acid bacteria (Vasyliuk et al., 2023). Therefore, lactobacilli are classified as potential probiotic strains for aquaculture. The application of lactic acid bacteria together with feed increases their nutritional value, as microorganisms produce a wide range of digestive enzymes that actively participate in the process of digestion and decomposition of feed, and also have a positive effect on the growth of individuals and stimulate their reproductive activity. These factors clearly contribute to the active introduction of commercial probiotics based on the strains of lactic acid bacteria (Skrodenytė, Arbačiauskienė et al., 2024).

They also improve the immunological system, disease resistance, and contribute to the transcriptomic profiles and internal microbial balance of host organisms (Sumon et al., 2022). Scientific research by Mazlumi et al.

(2022) is devoted to the isolation of lactic acid bacteria from the intestines of marine fish and study of their potential probiotic properties. Nineteen isolates of lactic acid bacteria were selected, including *Lactiplantibacillus plantarum*, *Lactiplantibacillus pentosus*, *Lactobacillus acidophilus*, *Levilactobacillus brevis*, *Pediococcus pentosaceus*, and *Pediococcus acidilactici*. Based on the obtained results on probiotic properties of the above-mentioned isolates, the priority of the isolates as means of biocontrol in the fishing industry was indicated. Therefore, the use of probiotics can solve some problems currently in fish farms of Ukraine.

CONCLUSIONS

Today, Ukraine is facing new challenges and problems in different spheres of activity, which have direct negative impact on the ecological conditions of the environment. The issue of water pollution required an immediate solution even in the pre-war period, and with the beginning of a full-scale war, it became one of the most important tasks facing the country.

Today, Ukraine's water bodies are polluted not only by industrial waste, pesticides, and other chemical elements that are released into water from the fields, but also by pyrogens, fuel, and lubricants after rocket attacks; some fish farms and water reservoirs, for example, the Kakhovka Reservoir, have been totally destroyed.

One of the most important biological methods for assessing the ecological and sanitary condition of water bodies is the assessment of water quality by microbiological indicators. Bacteria are the first and most informative component of the biota of the aquatic ecosystem, which quickly reacts to the release of organic substances into water bodies. Therefore, regular monitoring of the ecological conditions of water bodies will give an opportunity to obtain complex data for solving these problems.

Received 23 May 2024
Accepted 9 July 2024

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SANITARINĖS-EKOLOGINĖS UKRAINOS VANDENS TELKINIŲ BŪKLĖS SUKELTI IŠŠŪKIAI

Santrauka

Šiandien Ukraina susiduria su naujais iššūkiais, kurie daro didelę įtaką natūraliems vandens telkiniams ir akvakultūrai. Dėl karo veiksmų vandens ekosistemos patiria papildomą apkrovą. Didelės teritorijos, kuriose yra svarbūs Ukrainos žuvininkystės kompleksai, yra okupuotos, karo veiksmų zonoje arba užminuotos. Šiuo metu nėra galimybės išsamiai ištirti Ukrainos vidaus vandens telkinių ekologinę situaciją, todėl, siekiant gauti tikrą Ukrainos vandens fondų būklės vaizdą, buvo atlikta publikacijų analitinė apžvalga. Po plataus masto karo veiksmų Ukrainos teritorijoje daugelis vandens telkinių pagal saprobiškumo indeksą perėjo į kitą statusą. Sudėtinga situacija yra Dniepro kaskadų tvenkiniuose, kurie kaupia ne tik vandens atsargas, bet ir visus iš vandens rinktuvės atkeliaujančius teršalus. Kachovkos hidroelektrinės sunaikinimas nulėmė masinę žuvų žūtį. Padidėjo tarša biogeninėmis, organinėmis ir paviršiaus aktyviosiomis medžiagomis, naftos produktais, fenoliais, pesticidais, sunkiaisiais metalais ir kitomis medžiagomis. Vandens telkinių taršos problema buvo aktuali ir prieš karą, o prasidėjus plataus masto invazijai, tapo vienu iš svarbiausių Ukrainos uždavinių. Karo sąlygomis po raketinių smūgių Ukrainos vandens telkiniai kenčia nuo pirogenų, kuro ir tepalų, kai kurie žuvininkystės ūkiai ir net vandens saugyklos yra sunaikinti. Todėl vandens telkinių ekologinės būklės tyrimai suteikia galimybę spręsti šias problemas.

Raktažodžiai: ekologinės problemos, vandens telkinių tarša, vandens kokybė