UDC 504.064.3:621.317:574

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SCIENTIFIC FUNDAMENTALS OF BUILDING SYSTEM OF BIOMONITORING OF WATERS OF SURFACE SOURCES OF WATER SERVICE

The purpose. To determine theoretical and methodological bases of building system of biological monitoring of waters of surface sources of water service. **Methods.** Analogies and opposing, system analysis andsynthesis. **Results.** Problems biomonitoring researches are analyzed and scientific bases of system of biomonitoring of surface waters are specified. **Conclusions.** For scientific justification of expediency of building system of biomonitoring of waters of surface sources of water service the “administrative” concept of environmental monitoring is used. Principles coordinated with it are formulated and use of innovative methodological baseline which is stipulated by the integrated approach to biomonitoring researches is offered.

Key words: theoretical and methodological bases, system of biomonitoring of waters, surface sources of water

Pollution of the water environment in our time reaches catastrophic scales. Most aquatic ecosystems are so degraded that it is very difficult to recover their condition, and sometimes it is simply impossible. This requires a respectful attitude to the water resources on our planet, especially fresh water, without which human life and other living creatures are impossible [1, 2, 3]. In this connection, the issue of using fast and reliable methods of detecting water pollution, finding sources of these contaminants, their prevention and elimination becomes relevant. A special role in this should be played by environmental monitoring, which, in addition to complex physico-chemical and aerospace methods, has simpler but less effective research methods in its arsenal. These include bioindication and biotesting - components of biological monitoring, which, on the basis of which it is possible to monitor water ecosystems without high material costs with high reliability [4]. However, the application of biomonitoring studies for drinking water has a number of features that require a thorough theoretical

justification. Therefore, it is expedient to determine the leading concept and formulation of the basic principles of biological monitoring as one of the most important components of eco-monitoring of surface sources of drinking water supply.

Analysis of recent research and publications. Over the past decade, biological monitoring of the status of reservoirs has been devoted to numerous studies in our country and abroad [4-15]. The active involvement of biological control methods, as evidenced by world experience, makes it possible to objectively assess the cumulative effect of anthropogenic factors on the state of reservoirs. Among them, the standardized methods of bioindication and biotesting are particularly popular [4-7, 11-13]. However, not all of them are sufficiently effective under different conditions of pollution of the water environment. Thus, biomonitoring of drinking water supplies often requires the use of more sensitive species of organisms or reactions of creatures in comparison with existing unified ones. In this regard, most researchers propose to review the modern theoretical and methodological basis of water biomonitoring and to offer innovative research methods [4-6, 8-14].

Goal of research is formulate and ground the main principles of the system of biological monitoring of surface waters.

Materials and methods of research. Definition of the leading concept and creation of principles of the system of biological monitoring was carried out on the basis of generalization of literary sources using the methods of system analysis and synthesis, including methods of analogy and opposition.

Research results. Biological monitoring of water over a long period of time was only used in combination with other research methods, which could identify the causes of deviations from the normal reaction of certain organisms or groups [7, 9, 10]. In the case of drinking water and drinking water, biomonitoring studies were limited to carrying out bacteriological and parasitic analyzes to detect indicative forms of microorganisms. And only, starting from 2010, in the DSanPin 2.2.4-171-10 together with the physical,

chemical, microbiological and parasitological parameters, it is proposed to determine the toxicity index of water (T) with the help of bioassay [7, 9]. True, in this case, it is also emphasized that it is expedient to use it "... in the case of contamination of drinking water with unknown toxic compounds and chemicals, for the determination of which there are no research methods ...". That is, biotesting is used extremely limited - to determine the complementary integral indicator of water quality. It is believed that "... the toxicity index of drinking water, which does not contain unidentified components, should not exceed 50% regardless of the test objects used, which can be daphnia, infusoria, etc." [7]. However, unidentified pollutants in the environment are so numerous and diverse that not only drinking water but also water of surface water sources should be constantly investigated using biological monitoring methods. It is this approach that will protect people from the use of water of undesirable quality.

Relevance of the assessment of the status of reservoirs stimulated the emergence of various methods of bioindication and biotesting in the directions: the search for the most sensitive indicators and test objects, informative functions of individual creatures, groups and hydro ecosystems, the development of rapid research methods and provision of their specialized equipment base, etc. As a result, you can observe a range of authoring techniques that differ significantly among themselves [5, 6, 8-12]. In addition, there is a big gap between scientific developments and their implementation in environmental practice. Many techniques that have passed the complex certification process are often not used by accredited laboratories as a result of the lack of material resources for the acquisition of new equipment and the lack of motivation to master the new or improved methods of biomonitoring [5, 9]. Therefore, due to the inadequate funding and complexity of a number of proposed methods for implementation, it is advisable to develop those that are simple and fast to implement and can be carried out on existing equipment in laboratories. In addition, since the overall toxicity of water is due to various causes and is manifested in varying degrees, it is advisable

individually for each water source to offer a monitoring and control system in which the most sensitive organisms and methods of research will be applied in accordance with the nature of the pollution of the water environment. First of all, it concerns water sources of water supply and drinking water, which biomonitoring studies on water utilities in Ukraine were decided to be carried out using the same techniques as sewage [7]. Consequently, the analyzed problems of biomonitoring indicate its lack of efficiency in relation to certain types of water and the expediency of reviewing the monitoring system, starting with the theoretical basis, that is, defining the concept and developing the principles.

The co-conceptual basis for the biological monitoring of surface water should be in line with the leading concept of eco-monitoring, which in the last decades has been determined by R.E. Mann and I.P. Gerasimov [16]. As a component of environmental monitoring, biomonitoring can not go beyond its formula "observation - control - management". At the same time, the modern system of biomonitoring research must necessarily include all the components of this formula, especially when the methods of biological monitoring are the main, and in some cases even the only ones, in conducting eco-monitoring of waters. It is worth dividing the biomonitoring of waters intended for food-drinking use from the biomonitoring of more polluted waters.

Biological monitoring of water from surface water sources is a system for monitoring and monitoring the state of these waters and controlling their quality using living objects (organisms, cultures, populations, biocenoses, etc.) that are characterized by increased sensitivity to violations of the ecological balance of the aquatic environment and at the same time have the ability to intensify self-cleaning processes and provide water bioremediation. The response of monitor organisms to deviations from the norm in such a system should be fast and adequate and should be recorded at different levels of biological organization (genetic, genomic, cellular, tissue, organism, population and / or biocenotic). That is, under such conditions, biomonitoring

studies will be coordinated with environmental monitoring and will allow not only to determine the state of the water and make forecasts for its changes, with the help of which it is possible to prevent any violations occurring in water bodies or to timely clean water.

The formulation of the principles of the system of biomonitoring, as well, should be considered within the framework of the principles of environmental monitoring of water, which has a regional character [4, 16]. In accordance with the above provisions, the following principles of biological monitoring of water of surface drinking water supply sources are defined (Fig.):

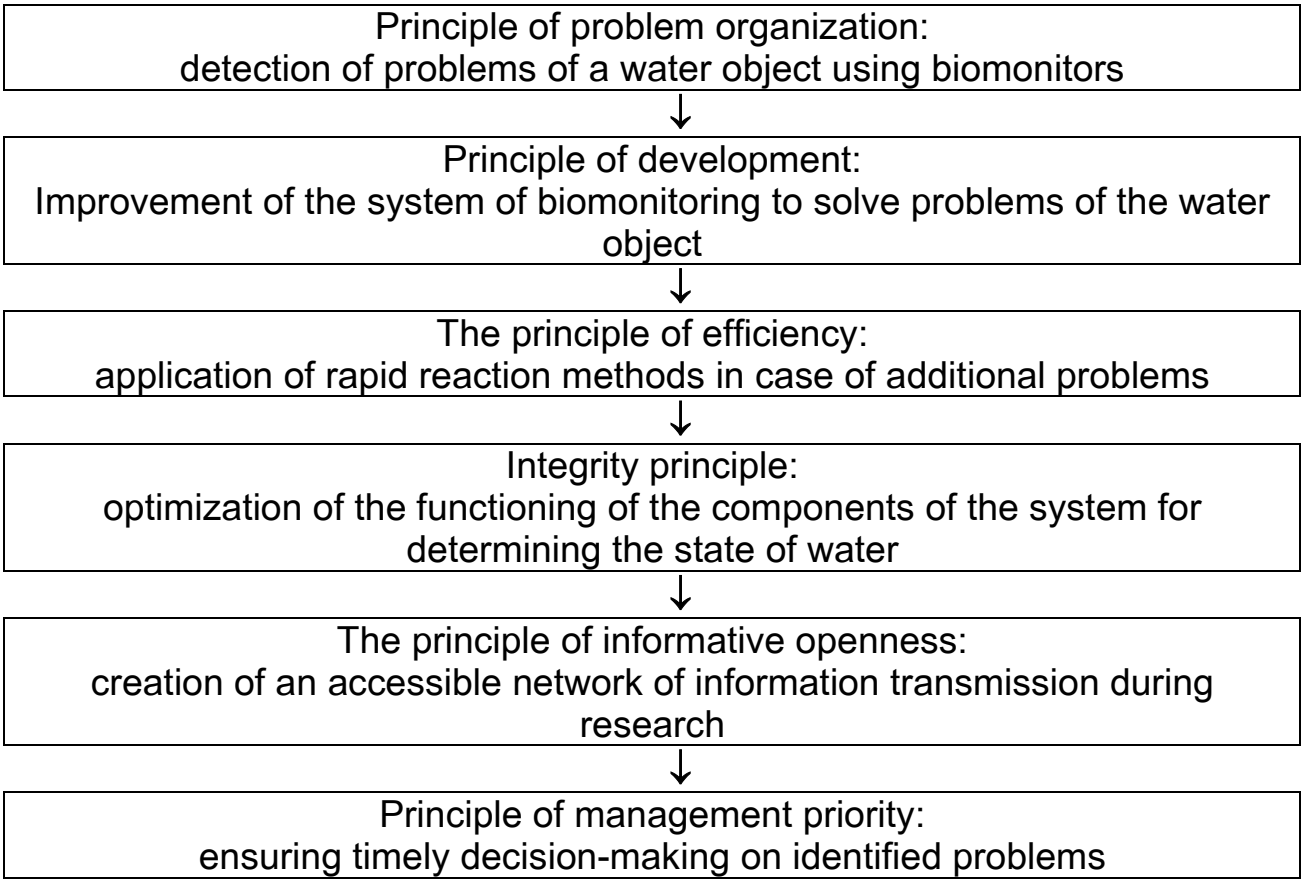

Fig. Basic principles of the system of biological monitoring of water of surface water sources

These principles allow us to consider biomonitoring as a complex system, which requires a multilevel integrated approach to water status control. From this perspective, the essence of the basic principles of the system of

biological monitoring of water of surface water sources should be more detailed:

1. The problematic organization of the biological monitoring system consists in theoretically and methodologically grounded maintenance of long-term observations of a certain water object using reliable and accessible methods of bioindication and bioassay (standardized and auxiliary) that can determine the priority indicators for identifying the most acute problems of water status, their causes and consequences (for example, the negative phenomenon of anthropogenic eutrophication in the reservoir, its causes and consequences - the use of nutrients in crop production eutrophication of water → water quality deterioration due to their "bloom" - can be detected by biological indication on macrophytes and fishes hub and bioassay - on daphnia and onions).

2. Development of the system of water biomonitoring involves the improvement of its components, first of all, the development, modernization and optimization of the observation network according to the state of waters with the use of certain organisms, populations and biocenoses, as well as a network controlling the occurrence of certain changes in their condition; introduction of automated multi-parametric measuring-information and telecommunication complexes, technologies of automated processing and analysis of data obtained from observation posts (expanding the network of field and laboratory research with the use of bioindicators, test organisms and biosensors; use of sensory devices such as daphniummeters, infusionmeters and others; the development of automated systems for monitoring the status of reservoirs, in particular, on the basis of the study of phytoplankton development processes, etc.).

3. The efficiency of biomonitoring research is expressed in the urgent processing of the data obtained, the analysis of the information provided and, at the same time, rapid and scientifically sound decision-making, which is extremely important, especially in critical situations. All information on emergency water pollution is urgent and should be immediately provided to

relevant environmental authorities and organizations. Moreover, bioindication and biotesting in such cases are much more informative than physicochemical analysis (the level of danger from discharges of crude or poorly cleaned waters, floods and floods, which can lead to significant pollution and complicate the epidemiological situation, are quickly determined by the involvement of organisms- biomonitors, such as aquatic bacteria, micro- and macrophytes, pelagic species of fish, invertebrates, lower and higher crustaceans, etc.).

4. The integrity of the system of biomonitoring is determined by a single normative, methodological and metrological support, unified technical components and the efficiency of the transfer of information, including the reverse, to determine the state of the water object from one of its parts to another (water pollution, which leads to a violation of the status of biocenoses , as well as decomposition of dead aquatic organisms, which in turn leads to deterioration of water quality, etc.). The process of integration and further functioning of the biomonitoring components and their integration into a single whole is considered rather problematic (since often it is only bioindication or biotesting of water quality, it is advisable to coordinate their implementation to ensure the unity of the system).

5. Informational openness of the system of biomonitoring reflects the level of its organization to ensure the processes of information exchange between individual constituents and the environment. In particular, the necessary condition for the proper functioning of this system is the achievement of a state in which all results of observations and research become accessible not only to specialists, managers and their controlling units, but also to all strata of the population of Ukraine and the world community, which promotes the involvement of the general public (in including users) to the development of biomonitoring research programs (publications and reports in mass media and scientific publications, international information exchange, public bio monitoring, popularization of methods of biomonitoring of water, etc.).

6. The priority of the management or the organizational hierarchy determines target installations and urgent problems on the basis of which the biological monitoring system is built, its subdivisions and certain components (individual organisms, populations and biocenoses) are capable of detecting high sensitivity to general or specific water pollution, which timely provides the opportunity to make decisions aimed at solving the problems identified (taking measures to increase biodiversity, planting protective strips for delaying nutrients and preventing I therefore eutrophication of water bodies, use of micro- and macrophytes and benthic pelahialnyh animals are hubs of pollutants, water remediation and the use of sorbents, etc.).

Having defined the leading concept and principles of the system of water biomonitoring of surface water sources, it is necessary to propose a research methodology, which should be guided by this system. The modern methodological basis of biomonitoring research should be of an innovative nature [4-6, 8-10] and apply a comprehensive approach to their conduct [5, 13, 17, 18]. In addition, choosing the methodology of biomonitoring, it is necessary to take into account the origin and peculiarities of water pollution, the most critical changes in its condition, priority problems, climatic and weather conditions, etc.

Proceeding from the above, biomonitoring studies of water sources of surface water supply, along with generally accepted [4, 5, 7, 9], should include some specific methodological aspects, among them:

1) the application of coordinated methods of bioindication and bioassay (classical and innovative) aimed at detecting violations of the state of the water environment: natural and / or technogenic pollution, climate change, deterioration of the epidemiological situation, etc .;

2) the formation of sets of unified and auxiliary organisms, among which equally present vegetable and animal forms, and if necessary, in addition to them, representatives of other systematic groups, especially microorganisms (viruses, bacteria, actinomycetes, yeast);

3) the use of highly sensitive alternative, mainly life-time functions of unified biomonitors, with the help of which, in addition to significant violations of the state of water, their moderate and minor violations (determination of heart rate, phototaxis reactions, chlorophyll content, etc.) may also be detected;

4) control of the state of the aquatic environment in terms of acute and chronic toxicity and possible long-term consequences (allergenic, mutagenic, blastomogeneous, embryotoxic and / or teratogenic effects);

5) determination of ecological safety of water using different levels of organization of living matter - from molecular to ecosystem (on genetic, genomic, cellular, tissue, organism, population and / or biocenotic levels);

6) improvement and coherent application of tools, technical equipment, information and software intended for monitoring and monitoring of the state of water using biosensors, as well as for the creation of appropriate electronic databases and systematization of identified indicators;

7) development and implementation of water quality management measures aimed at preventing and / or eliminating hazardous contaminations and other violations of the ecological balance of the aquatic environment.

The presented aspects point to a significant expansion of the possibilities of biological monitoring and the need to avoid isolated studies that are still widely practiced in this direction and contribute to one-sided assessment of water status. Therefore, justifying the methodology of biomonitoring studies, it is important to consider that it was oriented towards coordinated bioindication and biotesting simultaneously and at the same time covered different levels of biological organization with the definition of indicators that can clearly identify the risk of water for humans and animals. The proposed methodology should be continuously improved, technically and technologically updated, including through information and software, but it still should not require the use of complex maintenance and expensive equipment and devices. In addition, the implementation of this methodology is a rather significant step in preventing and eliminating all kinds of violations of the ecological balance in reservoirs.

Thus, the definition of theoretical and methodological bases for the creation of a system for biological monitoring of water from surface water supply sources will allow for a review of the relation to biomonitoring studies, will help them to be systematized and conducted more effectively than traditional ways.

Conclusions

For the scientific substantiation of expediency of creating a system of biological monitoring of water of surface water sources, a "managerial" concept of environmental monitoring was used, the principles agreed with it were formulated and the application of the innovative methodological base was proposed, which is due to the integrated approach to conducting of biomonitoring research.

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