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TO THE DEVELOPMENT OF EXPERT EVALUATION OF THE EFFECT OF ANTIFOULING COATINGS IN EXPERIMENT AND PRACTICE IN WATER SUPPLY

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The problem of fouling of hydraulic constructions, watercrafts, water supply and treatment systems is well known in applied and technical hydrobiology. In terms of development of this problem it is possible to identify several directions and key issues that require their development. Its can be formulated as follows:

- identification of the composition of periphyton organisms that may form fouling, focusing on the most aggressive forms and species of hydrobionts, including invasive species;

- assessment of quantitative development, dynamics of community formation, biotic interactions in biocenoses, tolerance of certain fouling species to environmental factors;

- development of methods and measures for fouling control, limitation of negative impact, and possible biopositive effects (intensification of self-purification processes, bioresource production);

- development of hydrobiological research methods, as well as practical express-methods for assessing qualitative and quantitative characteristics of fouling in techno-ecosystems.

This publication dealing with to the latter task. Long-term experience of interaction between hydrobiologists and practitioners in the field of energy and water supply has shown that there is a need to develop quite simple and effective informative methods of fouling assessment in the absence of basic hydrobiological knowledge.

As for the composition of fouling, many years of research experience have shown that these periphyton communities are, as a rule, oligomixed, and the number of species and forms dominant in terms of biomass in fresh waters does not exceed a dozen, although the lists of hydrobionts noted in periphyton communities amount to many dozens [1]. The most important ones include: attached dreissenid mollusks, bryozoans, sponges, and in some cases hydroid polyps. Among mobile forms, gastropods, some crustaceans (Gammaridae, Corophiidae) can reach high abundance. Of plants, filamentous algae of different taxonomic affiliation, some mosses (Bryophyta) may be of significant importance in the fouling. To simplify the description of the composition of the main organisms, as well as to unify the information, we propose to use the fouling formula.

For purely technical assessments, the cenoecomorphological approach can be used, since making assessments at the level of individual species is not only more laborious, but sometimes not more informative. For example, it is reasonable not to distinguish two species of dreissenids, but to characterize fouling by one cenoecomorph – attached filter feeding molluscs. As with other colonial forms, fouling by bryozoans can be assessed based on the nature of the colony the degree of substrate coverage by the colonies, and the two-dimensional or three-dimensional structure. Several components of the formula were identified: dreissenids (D), bryozoans (B), sponges (S), mobile forms (Oligochaeta, Chironomidae, O-Ch), crustaceans (Gammarida, Corophiidae, G), gastropods (Gs), remains of organisms, detritus (T), filamentous algae (Fa). An atlas for identification of key forms of fouling hydrobionts has been prepared for practitioners.

The total biomass of all organisms can be determined in laboratory conditions for quantitative assessment of the fouling degree. However, this is rather laborious process that requires the selection and professional sorting of samples. A 5-point scale

was proposed for rapid assessment, and comparison of assessment results showed good correlation with biomass indices.

For a long period, since 2014, we tested different coatings in the Kaniv Reservoir [2, 3]. Substrates made of inert viniplast were used for control comparison. Thus, based on the assessment of composition, quantitative development in each case, a fouling formula (FF) can be drawn up, where a general assessment of fouling intensity is given. Letters denote dominant forms with an estimate of their % of coverage.

For example, the 2023 study showed that for galvanized (Zn) steel with an exposure for 132 days (from May to September), the fouling formula was follows: FF=1.1/D-7/B-2/S-5/T-10. An overall fouling score was 1.1 (fractional values occur due to the estimation and subsequent averaging over several experimental substrates). The values after the letter designations indicate the average % coverage by a given fouling group. A small colony of sponges, bryozoans, and detritus was noted here in addition to single individuals of Dreissena. For viniplast the total score was 3.8, the formula differed from the previous one: FF=3.8/D-45/B-34. The predominance of dreissenids over bryozoans during this period of study was not significant. The total score of the fouling power for the modified coating based on alkyd enamel PF-115 and antifouling additive N,N-dibutylundecenamide (DBUA, 10%) was 3 points, the formula was: FF=3/D-28/B-21. For these coatings, as well as for vinyl plastic, the degree of coverage for bryozoans and zebra mussels was similar.

After 118 days of exposure (May-September, 2024), the composition of the coating on the surface of the experimental substrates and its assessment differed for each group of organisms, as indicated by the fouling formula for each substrate. For the modified coating based on PF-115 enamel and antifouling additive undecylenic acid (UA, 10%), the formula was FF=3.3/D-39/B-10/T-5. Similar to that for PF-115+DBUA (10%) coating (FF=3.7/D-48/B-14/T-3), dreissenids were predominant, and detritus in the form of dead bryozoan colonies was also noted. On viniplast (FF=4.9/D-66/B-4) the dominance of dreissenids was overwhelming, and detritus was not noted. At the same time, on zinc coating (FF=0.9/D-0.4/B-1/T-16), detritus in the form of slime films was dominant with very low abundance. It can be concluded that the effectiveness of the coatings was not high, although it can be seen that the fouling by Dreissena was lower than in the control.

In fact, the procedure for assessing the properties and quality of antifouling coatings is a hydrobiological experiment aimed at revealing the dynamics, patterns of microsuccession of periphyton communities on specially prepared experimental substrates (ES). Although we are interested, as a rule, in the final result after long-term exposure, the final biomass on a particular substrate, knowledge of succession is also important, especially since it can provide a more informative characterization of the properties of antifouling coatings.

The studies have shown that there are at least two models of succession of periphyton communities on experimental substrates in the conditions of the Kaniv reservoir. According to one, there is a continuum development of communities with

predominance of dreissenids. According to the other one, the succession continuum is interrupted by mass development of bryozoans. The use of rapid methods of fouling assessment allows us to monitor these processes promptly, for example, even without sampling, e.g., from photographs of experimental substrates.

Thus, the proposed express method of evaluation proved to be quite effective, deserves attention and further development.

References

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