

## **BIOACCUMULATION OF HEAVY METALS IN SELECTED ELEMENTS OF TROPHIC CHAIN OF ANTHROPOGENIC RESERVOIRS IN THE ASPECT OF ENVIRONMENTAL PROTECTION AND ECONOMICAL FUNCTION**

### **Summary**

As a result of matter flow through food chain, nourishing substances are passed to succeeding links, beginning from producers, through consumers and ending on reducers. Bioaccumulation process is followed by pollutants accumulation in trophic chain links in quantities which exceed values typical for abiotic elements of ecosystems.

In consideration of the fact that water reservoirs in Silesia region for many years have been subject to anthropopressure, the research have been undertaken in order to explain whether in local conditions the heavy metals contamination of biomass is a problem which needs intervention. The populations of the chosen fish species, which are important food chain link used for consumption, have been admitted as the most important element, because food contaminated with heavy metals can be dangerous for our health or even life. The *Minamata* disease being the result of intoxication of fish with mercury is a good example for illustrating the problem of heavy metal contents in fish from the area of greatly polluted Silesia region. Although analysis carried out in Sanepid laboratories or WZHW in Katowice are valuable because of being potential comparative material, however they have no character of a complex studies. It should be emphasized that in GOP area the research on general biological state of ichthyofauna, its species composition, dangerous infectants, scale of fish contamination, and also the cause of the state, have never been conducted.

Undertaking research on heavy metals bioaccumulation, the question has been put about the scale of the problem, about the influence of anthropopressure on the food contamination and also on how dangerous it could be for our health. It has been assumed that the research results will be a basis for indicating direction of activity in order to improve the actual state, the datum-point for formulating administrative decisions to inform about the state of environmental pollution, and a basis for eventual decisions restricting the usage of fish protein for consumption.

The cavity reservoirs were subject to complex and direct analyses (water, sediments, biological matter), in the central part of Upper Silesia Industry Region (GOP). At the same time other four reservoirs were analyzed, reducing research to water chemistry and bottom sediments. The Biala River in the locality of "Orzel Bialy" Plant in Olkusz, has been taken as a contaminated with heavy metals datum-point. It was assumed that comparison of this ecosystem being combination of river and pools with reservoir ecosystems will give the answer to the question about the scale of the problem. Taking into account the specificity of individual fish species, in particular the way of feeding (fito- and zooplankton phages, bent phages, predacious fishes) and also occurrence of accumulation, species diversity of ichthyofauna and biomass of fito- and zooplankton have been complied.

The most important element of the research was the compliance of the pollution level of age groups of the individual fish species, which was to give the answer to the question about the role of time factor in the accumulation process.

The research results showed that the state of water quality does not reflect the actual state of the environment. In the reservoirs which seem to have good quality water and small pollution of bottom sediments with heavy metals, there is a great metal contamination of vascular plants, plankton organisms and fish. This

indicates in the first place the complexity of the problem with the state of the environment, secondly it testifies about the great role that bioaccumulation plays in heavy metal transfer between individual biocenoses.

Plankton biomass as well as plants plays the role of bio-filter which catches and cumulates metals. Accumulation of metals in plant and animal organisms is different for individual species. The highest concentrations of heavy metals in analyzed plants (spearmint, cattail, and horsetail) were finding in root part. The heavy metals are accumulated in water plants in a given order:  $Zn > Co > Ni > Pb > Cu > Cr > Cd$ .

It has been found that top layers of bottom sediments contain higher metal concentrations than sediments occurring deeper. Good conditions (low pH, oxygen deficit) help the metals to pass from constant to liquid phase. The occurrence of calcium ions in water plays an important role in helping in catenation of metals in sediments and limiting their collection by plants. Heavy metals are also absorbed by invertebrate benthosous organisms, which subsequently being the food basis for fish, are the source of metals found in fish tissues. It is interesting that in insect larvae (*Ephemeroptera*, *Gammarus*, *Asellus*) occurred higher concentration of cadmium than lead, and it was observed that it was in connection with the concentration of these metals in water and sediments. This shows the role of ecological niche in bioaccumulation process.

The mass populating of bottom sediments by (*Oligochaeta*), especially in polluted or eutrophisated water reservoirs takes a special importance. First of all these organisms may occur in mass number. They constitute the food basis for fish, especially bentophages. Oligochaeta feeding in the bottom, cumulate heavy metals in the end part of abdomen, which sticks out from the bottom and is the object of feeding of fish. Although these animals are resistant to the presence of heavy metals, however their resistance does not emerge from physiological resistance, but from the so called autotomy i.e. from the ability to cast away parts of the body which is excessively polluted. The heavy metals also cumulate in snail shells, liver and reproductive system. What can be seen from the above is that the animal organisms of benthos play significant role as a link in the process of absorbing heavy metals from the bottom, from where these metals as a result of feeding are absorbed by fish.

Concentrations of heavy metals in liver and digestive system of all analyzed species and particular individuals were decisively higher than in muscles. It points to the role played by the ability to physiological defense, which is also the element of bioaccumulation process. It can be taken as a rule that, concentration of heavy metals in muscles decreases with the size (or age) of fish. The differences that have been found in some cases should be explained by environmental conditions occurring in particular ecosystems. These conditions determine the composition of food basis as well as the level of its pollution. In particular ecosystems fish populations have for their disposal such food basis, which can form and exist in these conditions. Efforts were made in order to research also young stadiums of fishes and examine the fishes which come from natural growth in particular ecosystems. It has been proved that the content of heavy metals in tissues of the examined fishes many times exceeds permissible norms. However it should be emphasized, that featured regularities relate to fishes of particular size and from particular reservoirs. Therefore it is not possible to form final conclusions on the basis of these research results. Probably featured tendencies of metal concentration changes in fish tissues will be similar for biological matter from other reservoirs of Silesia region. However it cannot be prejudged *a priori* about their pollution level. For this speak also the research results which show that muscle tissue cumulates the smallest quantities of heavy metals. In case of lead the highest concentrations accumulate in bones, next in scales and liver. The positive occurrence is the already mentioned tendency of reducing

concentration of metals in muscles with the size (age) of fish. Unfortunately it cannot be assumed, that in case of fishes of a particular age and size the metal concentrations will attain in muscle tissue permissible values.

The research results show that the pollution of particular elements of environment which are links of trophic chain pose a serious problem from the ecological point of view and are dangerous for human life. In cavity reservoirs in central part of GOP in fito- and zooplankton, vascular plants and ichthyofauna, as a result of bioaccumulation there occurs a concentration of heavy metals which has a character of contamination. It is a positive occurrence that there is a tendency where metal concentration reduces in muscles with the size and age of fish. Unfortunately the level of concentration does not allow assuming that the contamination with metals will attain permissible values in the fish of particular age and size. Because the food contaminated with heavy metals can be dangerous for human health and life, in this case it is meat of fish which live in polluted water ecosystems; the scope of potentiality of using anthropogenic water reservoirs for fish breeding seems to be limited. First of all in the aspect of fishing which is a very popular form of recreation in Silesia. The reservoirs of industrial origin (excavations and cavities), also the reservoirs which are researched are not the source of water supply, but have economic importance only as a recreation and fishing places.

The situation found as a result of research does not look optimistic, and shows necessity of undertaking activities in order to reduce the negative consequences of the actual state. The heavy metals concentrations in fish coming from the reservoirs of central part of GOP were many times exceeded. This shows the necessity of analyzing and verifying the possibilities of their usage for consumption purposes. In the light of research results, in particular cases fishing should be treated rather as a sport only than the way of getting food.

The research results show the necessity to look for the way which will limit the heavy metals mobility, like for example by controlling buffer capacity and if necessary e.g. liming the reservoirs. Also reclamation could be taken into account, i.e. removal of bottom sediments as the place of heavy metals accumulation.

Manager or user of the reservoirs responsible for the way of their exploitation and also for fishing industry should aspire to get proper knowledge about the state of the quality of environment in particular ecosystems and also be aware of the consequences of this state. That is why he should inform people about actual situation.

The number of analyzed samples, the range of conducted analyses and recurrence of research results show that these results are not accidental. The research results point to the socially fundamental problem arising from bioaccumulation process. The pollutants are cumulated "individually" by respective taxons. The number of these occurrences takes the form of a wider occurrence, in which the heavy metals go into the transfer track, passing from one link to another, the top of which from the ecological point of view in the water ecosystem are fish, and from economic and social point of view are people who consummate them.

Therefore from the social point of view it is necessary to continue research in order to see whether heavy metal contamination of trophic chain of biomass, is an accidental occurrence and applies to only some particular reservoirs or maybe it is unfavorable regularity which is true in the bigger area of Silesia region.