

BIOACCUMULATION OF POLYCHLORINATED BIPHENYLS AND ORGANOCHLORINE PESTICIDES IN SELECTED FISH SPECIES AS AN INDICATOR OF THE POLLUTION OF AQUATIC RESOURCES IN VOJVODINA, YUGOSLAVIA

M. Vojinovic-Miloradov*, P. Marjanovic**, D. Buzarov*,
S. Pavkov*, Lj. Dimitrijevic* and M. Miloradov***

*University of Novi Sad, Institute of Chemistry, Novi Sad, Yugoslavia

**State Water Board of Vojvodina, Novi Sad, Yugoslavia

***University of Novi Sad, Department of Civil Engineering, Novi Sad, Yugoslavia

ABSTRACT

Long term pollution of selected aquatic resources of Vojvodina with polychlorinated biphenyls (PCB's) and organochlorine pesticides (OCP's) has led to high degree of bioaccumulation of the above chemicals along the food chain. This paper documents the bioaccumulation in two fish species commonly found in rivers and canals of Vojvodina, common carp (*Cyprinus Carpio*) and pike (*Exos lucinus*). Samples of fish, sediment and water were collected from the Danube, Sava and Tisa rivers and a fish farm "Ečka" which is supplied with water from the river Tisa and river Begej.

All samples were analysed by highly sensitive capillary column GC using EC detectors. Samples were analysed for spectrum of compounds and are presented here as total PCB's and OCP's.

The results show that the studied compounds are present in water samples at very low concentrations (PCB's in concentrations at or below the limit of detection, OCP's in concentrations below the legally allowable concentrations by Yugoslav norms). The sediment samples contain the studied compounds at significantly higher concentrations but still within the expectable range. Fish tissue contained elevated concentrations, and especially so the tissue of the top predator in the food chain, the Pike, showing that bioaccumulation has occurred. Of special concern are the extremely high concentrations of PCB's in the tissue of fish samples collected from river Sava indicating the still existing effects of pollution by PCB's in the watershed of the river Sava.

KEYWORDS

Water; sediment; fish; pesticides; PCB's, bioaccumulation, gas chromatography; surface waters, agriculture, trace organics.

INTRODUCTION

Vojvodina is a province in Northern Serbia, Yugoslavia. It is a part of the Panonian plains along the rivers Danube, Sava and Tisa and is an area where agriculture is highly developed. Long history of pesticide use in the province has resulted in significant pollution of natural systems with these compounds and residues of persistent pesticides presently banned in the country can still be found in many of the natural systems. Old fish farms are especially vulnerable since long term sediment accumulation in the farm ponds has occurred.

Pesticide accumulation along the food chain in aquatic systems of Vojvodina has only recently received due attention and work on the study of pesticide residues in aquatic ecosystems is rapidly advancing. The data presented in this paper are the results of the preliminary research carried out to identify the problem and those areas that warrant further study in the future.

Besides the problems with pesticides, the surface waters in Vojvodina are also subjected to pollution by PCB's which are brought to the province mainly by airborne transport but also by active water transport from areas in which extensive pollution by PCB's have historically occurred. Such is the case of PCB discharge which occurred at Semič electro industrial plant in Slovenia and other locations in the tributary watersheds in the watershed of the river Sava and other similar incidents (Jan *et al.*, 1978; Brumen *et al.*, 1984). The effects of such incidents are still felt all along the Sava river and PCB's accumulation in fish tissue has been documented by the research presented in this paper.

METHODS

For the purposes of this research samples of fish, sediments and water have been collected at a number of locations along the river Sava, river Danube, river Tisa and at a number of locations in the main pond of the "Ečka" fish farm.

Fish samples were collected by standard seining equipment and processed in a standard ichthyological way (age determination, weight and length determination, sex determination, stomach content analysis and similar). Fish tissue samples for the analysis of pesticide and PCB content were taken from the back muscle of a number of the biggest fish samples collected.

Analyses were carried out using capillary columns installed in a Varian 1400 electron capture GC. Three different columns were used in the analysis: 1. glass, 1.18 m long, 0.3 mm diameter, 1.3% GE SF-96+5.3% FS1265 on supercoport 100-120 mesh, 2. glass, 2m long, 2 mm diameter, 3% OV-1 on chromosorb WHP 80-100 mesh, and; 3. glass, 2.5m long, 3 mm diameter, 5% OV-101 on chromosorb W-DMCS-AW 80-100 mesh. Standard methods for use with the above columns were used in the analysis (Polyshuk *et al.*, 1977; Vojinović *et al.*, 1990).

RESULTS AND DISCUSSION

From a number of samples that were analyzed only characteristic results are presented in figures 1 to 3. Due to the differences between sampling sites, differences in the age of individual fish samples and other factors beyond experimental control standard errors are significant but considering that this was only a preliminary study they are acceptable.

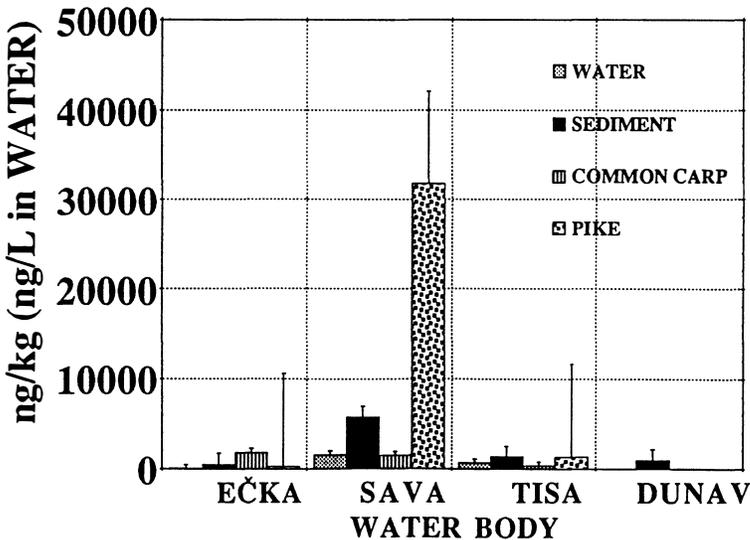


Fig. 1. PCB's IN SOME SURFACE WATERS OF VOJVODINA, YUGOSLAVIA

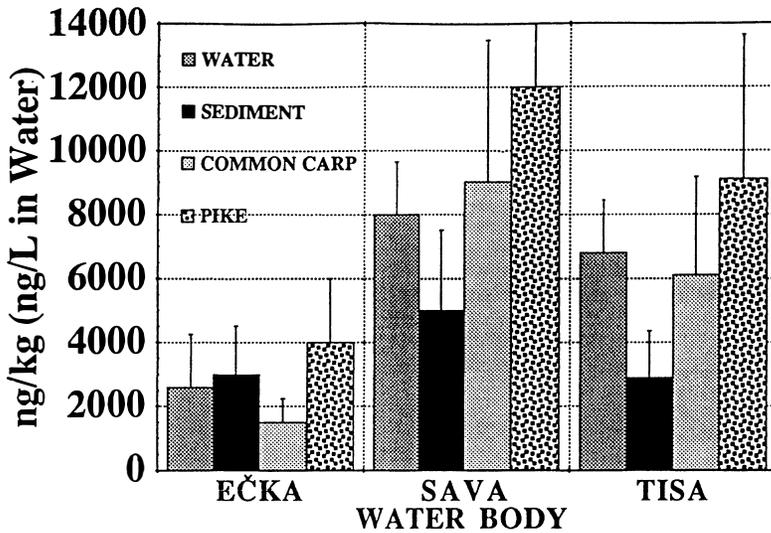


Fig. 2. TOTAL HCH'S IN SOME SURFACE WATERS OF VOJVODINA, YUGOSLAVIA

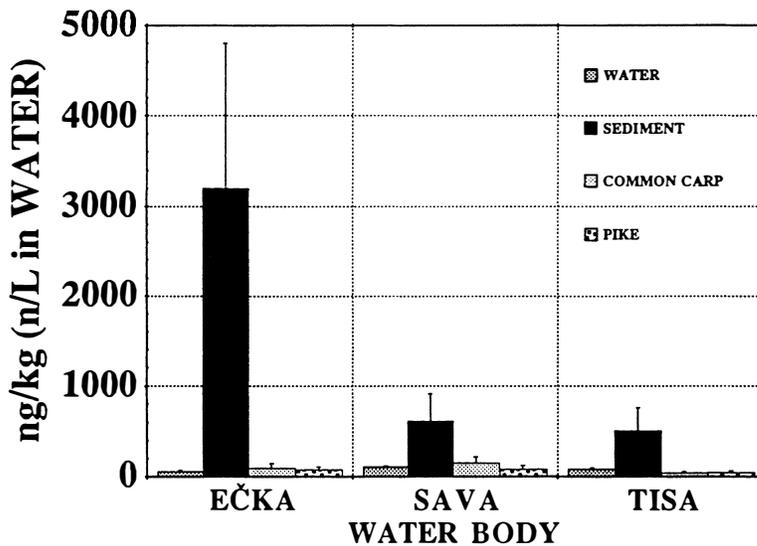


Fig. 3. DDT IN SOME SURFACE WATERS OF VOJVODINA, YUGOSLAVIA

Highest concentrations of DDT were observed in the sediments of the "Ečka" fish farm which was expected considering the age of the farm ponds and the long term accumulation of sediments in the ponds. It is interesting to note that biomagnification of DDT has not occurred indicating that DDT is buried in deeper sediment layers. Present work is carried out with stratified sediment sampling to confirm this. Similar conclusions are valid for DDT content in the sediments and fish of the rivers Sava and Tisa.

The observed concentrations of DDT in water, sediment and fish are within the corresponding ranges reported by others for different aquatic systems (Kerckhoff *et al.*, 1982; Pavkov *et al.*, 1987). River Tisa system is the least polluted system of the four studied systems even though it drains the most intensively harvested land.

HCH content in the analysed samples is highly variable but consistently shows highest content in the samples from the river Sava. Bioaccumulation of HCH has been confirmed along the path sediment-bottom feeding fish species-predators except for the samples from the fish farm. This could be explained by the annual fish harvest from the farm and the lack of long term exposition of the fish to the dominating environmental conditions in the ponds and a relatively high HCH content in the fish farm sediments.

PCB content in the samples that were analysed is of special concern considering the possible health effects of this substance. Future attention should be specifically devoted to the study of PCB content in the organisms from Sava river since unusually high concentrations of the substance have been detected in the analysed samples. This was to a certain effect expected considering the history of PCB pollution of the Sava river but the magnitude of the problem has been surprising. Relatively high concentration of PCB's in sediments in comparison with the concentrations in common carp muscle tissue are the result of the changing content of PCB's in sediment with time and space.

CONCLUSIONS

The results of the reported study indicate that significant problems may exist with long term pollution of aquatic resources in Vojvodina with PCB's and OCP's.

In all examined samples residues of the studied compounds have been found. Special attention needs to be devoted to the study of man made aquatic systems such as fish farms. Artificial ponds and lakes which are used for intensive fish farming are vulnerable to long term degradation due to pollution by persistent organic substances which is not necessarily the case with the streams and rivers since washout of these systems may occur during floods. In the future, consideration should be given to new and innovative fish farm operating procedures to minimize the pollution problem of these productive systems.

It seems more than likely that PCB's originate from areas outside of Vojvodina and that airborne transport is responsible for their occurrence in local aquatic systems. It should be noted that atmospheric transport of toxic persistent PCB's and other organics from source regions and subsequent deposition to receptors (most often water) it is the most important pathway for distributing anthropogenic organic chemicals globally.

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