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Fish toxicology

CONCENTRATION OF PCBs AND SELECTED PESTICIDES IN BOTTOM SEDIMENTS, ZEBRA MUSSEL AND IN SOME MORE IMPORTANT FISH SPECIES OF THE SZCZECIN LAGOON

ZAWARTOŚĆ PCBs I WYBRANYCH PESTYCYDÓW W OSADACH DENNYCH, W RACICZNICY I W WAŻNIEJSZYCH GATUNKACH RYB ZALEWU SZCZECIŃSKIEGO

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The objective of the present study was to determine concentration levels of p,p'-DDT and its metabolites (p,p'-DDE and p,p'-DDD) as well as γ-HCH and PCBs in bottom sediments, zebra mussel and in 3 more important fish species.

INTRODUCTION

The waters and bottom sediments of the Odra River are characterised by high level of biogenic and toxic compounds (Anonymous 1997; Protasowicki 1997). This situation has been attributed to a number of large urban and industrial agglomerations, mining and chemical enterprises, and lands under intensive cultivation located within its tributary.

A particular threat to water environment is posed by stable synthetic polychlorinated compounds. These include numerous mass-chlorinated pesticides commonly used, within this tributary area, in farming, forestry, preservation, and medicine since the world war II until the 1970s. Due to their high chemical persistence, resistance to atmospheric conditions and insolubility in water they are characterised by high accumulation factors both in water basins, bottom sediments in particular, and in hydrobiotic organisms (Ciereszko 1988, 1993, 2001a, 2001b; Philips and Spies 1988; Roots 1990, 1991; Protasowicki et al. 1993).

In spite of the ban on the DDT usage in Polish farming since 1976 it still remains in bottom sediments, soils of the fields, pastures and forests from where it is being washed into the water courses and then into the inland water basins, seas, and oceans. Besides

DDT, still in use in some tropical countries, codestilating with a vapour is transferred with the air currents to our latitude (Delbeke and Joris 1988; Gregor and Gommer 1989; Colombo et al. 1990).

At present polychlorinated biphenyls (PCBs) are presumed to be dominating synthetic compounds in the aquatic environment. These are policyclic hydrocarbons comprised of two connected phenyl rings saturated with different numbers of chlorine atoms. PCBs are among most persistent synthetic compounds because of their resistance to pH changes, low (if any) susceptibility to biodegradation with no ability to conduct electricity and characterised by low vapour pressure.

They were used in a variety of industrial branches and have become components of many commonly used products. That enabled them easy penetration into environment. All these compounds are highly persistent, toxic and have high bioaccumulation coefficients.

The aim of present surveys was to estimate the content of p,p'-DDT, its metabolites (p,p'-DDE and p,p'-DDD), γ-HCH, and total PCBs in bottom sediments, zebra mussel and in 3 more important fish species of the Szczecin Lagoon.

MATERIAL AND METHODS

The materials used in surveys were botoom sediments collected with the Van Veen's samplerer from 8 locations at the Szczecin Lagoon. The zebra mussels (*Dreissena polymorpha*) present at 3 sampling locations only, were collected by the dredge (Fig. 1). Fish species subjected to analysis (zander, *Sander lucioperca*, roach, *Rutilus rutilus*, common bream, *Abramis brama*) caught in the central part of the Szczecin Lagoon were supplied by commercial fishermen. All samples were collected in October 1995.

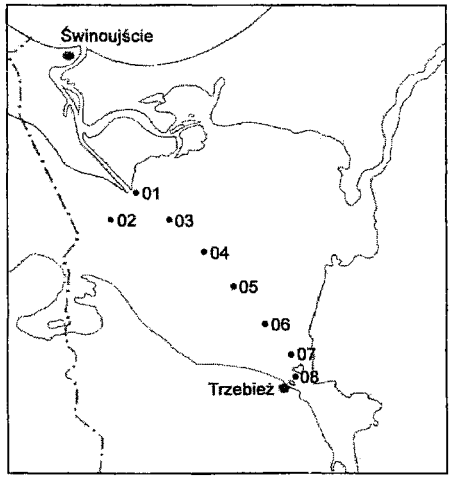

Fig. 1. Distribution of the sampling sites in the Szczecin Lagoon

Preparation of the bottom sediment samples for analysis started with careful mixing and preliminary drying in the laboratory at room temperature. Next, 100-g samples were grinded up in a mortar and 10-g subsamples were transferred into 100 cm^3 conical flasks. For extraction of the estimated compounds, 50-cm^3 mixtures of acetone : hexane (2.5 : 1) followed by hexane : ethyl ether (9 : 1) were used. Both extracts were gathered into 200 cm^3 conical flask and, when condensated to a 2 cm^3 in volume, transferred, qualitatively, do 10 cm^3 calibrated conical tubes with a glass stopper. The tubes contents were subjected to further condensation under warm air current to the volume of 1 cm^3 and purified first with 7% SO_3 in concentrated H_2SO_4 and next with 5% KOH in 96% C_2H_5OH. As to estimate the dry matter, the initially dried 5 g sediment subsamples were collected and subjected to further 30 min drying at 105°C. As to analyse these compounds in zebra mussels, the soft body parts of 10 specimens were homogenised and 10 g subsamples grinded with anhydrous Na_2SO_4 into friable uniform mass extracted and purified according to the procedure mentioned above. The same method was applied for estimation of the compounds under surveillance in fish muscles. The 10-g subsamples of dorsal muscle collected from under the dorsal fin were subjected to analysis. Each fish species was represented by 5 specimens collected at random and analysis was conducted in three repetitions.

Qualitative and quantitative analysis of PCBs was carried out by the "Chromatron GCHF 18.3" gas chromatography equipped with tritium capture detector (ECD) under following conditions:

- glass column was 3 m long and of 3 mm in diameter, filled with Chromosorbent Q 100–120 mesh, 3% V-101 fluid phase,
- carrying gas: nitrogen, flow rate: 30$cm^3 \cdot min^{-1}$,
- temperature of column and detector: 200°C, feeder temp.: 240°C.

RESULTS AND DISCUSSION

Presence of the estimated compounds was confirmed in all samples tested (Table 1). The highest concentration of γ-HCH in dry matter of the bottom sediments was recorded at sampling site 07, with half the concentration at sites 03 and 06 and much lower levels at the other sites. Concentration of γ-HCH in zebra mussels was twice as high as in the fishes tested.

In the bottom sediments the highest concentrations of p,p'-DDT and its derivatives p,p'-DDE and p,p'-DDD as well as Σ DDT were found at site 07. Moreover, much higher p,p'-DDT levels than at other site were noted at sites 02 and 03. Concentrations of p,p'-DDE were quite high in bottom sediments at sites 03 and 06. The highest concentration of p,p'-DDD were found in sediments collected at site 07, with concentrations at site 02 and others being respectively, by half or much lower. Concentration of Σ DDT in bot-

tom sediments oscillated in a broad range. The highest concentrations were noted in the southern part of the Szczecin Lagoon at site 07 while those in the northern part, at sites 02 and 03 were half as high. The lowest contamination level was recorded at site 05. For comparison, the concentrations of chloroorganic pesticides in the bottom sediments of the upper stretch of the Odra River ranged from 1.6 to 33.0 $\mu g \cdot kg^{-1}$ (Jastrzębska et al. 2001). These concentration are below the permitted levels in soil (2–6 $mg \cdot kg^{-1}$) according to Polish, English, American, and German national standards. The highest concentrations of total PCB were found out at 4 sampling sites, both in southern part (sites 07, 06) and northern part (sites 02, 03) of the Szczecin Lagoon (Fig.1).

Table 1

Polichlorinated carbohydrates in bottom sediments and hydrobionts of the Szczecin Lagoon

Sampling sites		Concentration, $\mu g \cdot kg^{-1}$ dry matter					
		Γ-HCH	p,p'-DDT	p,p'-DDE	p,p'-DDD	Σ DDT	PCB
Bottom sediments	01	3.6 ±0.6	13.4 ±2.3	7.3 ±0.9	1.0 ±0.9	21.6 ±1.9	13.1 ±2.1
	02	9.4 ±0.8	65.8 ±4.8	18.4 ±1.8	22.4 ±1.8	106.5 ±6.7	69.1 ±4.9
	03	13.6 ±1.1	58.1 ±3.7	29.4 ±1.6	8.6 ±1.1	96.2 ±4.5	61.7 ±3.7
	04	6.4 ±0.7	32.7 ±2.1	10.7 ±0.9	6.1 ±1.0	49.5 ±2.7	12.0 ±1.6
	05	8.9 ±0.9	8.5 ±1.7	5.5 ±0.6	2.5 ±1.1	16.5 ±1.8	16.6 ±1.4
	06	12.4 ±1.3	21.6 ±1.9	21.1 ±1.4	5.3 ±0.8	48.0 ±1.4	77.5 ±3.8
	07	24.9 ±2.1	97.5 ±5.1	52.9 ±3.9	45.4 ±2.9	195.9 ±7.1	101.9 ±7.4
	08	8.9 ±0.4	8.4 ±1.4	5.5 ±0.7	2.5 ±0.2	16.3 ±0.9	16.4 ±1.1
Concentration, $\mu g \cdot kg^{-1}$ wet weight							
Zebra mussel	02	2.4 ±0.3	18.6 ±0.9	0.9 ±0.6	0.7 ±0.5	20.2 ±2.1	10.6 ±1.3
	04	3.5 ±0.2	21.6 ±1.4	2.4 ±1.4	2.2 ±0.6	26.2 ±1.9	54.0 ±3.6
	08	3.1 ±0.3	33.2 ±2.1	2.9 ±0.9	3.4 ±1.2	39.5 ±3.2	35.2 ±2.3
Fishes	Zander	1.5 ±0.2	19.8 ±0.9	6.1 ±1.1	4.3 ±0.7	30.2 ±2.3	26.4 ±1.9
	Roach	1.9 ±0.4	17.6 ±1.1	3.8 ±0.4	2.3 ±0.3	23.7 ±1.6	19.4 ±1.3
	Bream	2.0 ±0.3	30.8 ±2.6	17.0 ±0.9	16.9 ±0.4	64.7 ±3.4	29.2 ±3.2

Concentrations of p,p'-DDT per wet weight of the zebra mussel soft tissues and fish dorsal muscles were similar, while concentrations of p,p'-DDE and p,p'-DDD were higher in fishes (Table 1). The highest concentrations of PCBs were noted for aquatic organisms collected at site 04 while the lowest ones at site 02. In fish muscles, considerably higher concentrations of PCBs were recorded in common bream and zander than in roach.

Differences in concentrations of the compounds under survey in the bottom sediments from particular sampling sites of the Szczecin Lagoon can be explained by differentiated type of sediments due to dredging works and maintenance of the Świnoujście–Szczecin water-way.

CONCLUSIONS

1. The presence of the target compounds was determined in the bottom sediments and the aquatic organisms subjected to the present survey. The concentrations of these compounds were variable.
2. The highest concentrations of the compounds under survey in the bottom sediments was detected in the southern part of the Szczecin Lagoon and in zebra mussel in specimens collected at sites 04 and 08.
3. Among the tested fish species concentration of compounds under survey in the dorsal muscle tissue was highest for bream and the lowest for roach.

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ZAWARTOŚĆ PSBs I WYBRANYCH PESTYCYDÓW W OSADACH DENNYCH, W RACICZNICY I W WAŻNIESZYCH RYBACH ZALEWU SZCZECIŃSKIEGO

STRESZCZENIE

Celem niniejszych badań było określenie zawartości p,p'-DDT i jego metabolitów (p,p'-DDE i p,p'-DDD) oraz γ-HCH i PCB w osadach dennych, raciczniey i w 3 ważniejszych gatunkach ryb. Do analizy zastosowano metodę chromatografii gazowej. We wszystkich próbach stwierdzono obecność analizowanych związków. Największe stężenia γ-HCH wykryto w osadach dennych w południowej części Zalewu (07). W raciczniey w mokrej masie tkanek miękkich zawartości tego związku były dwukrotnie większe niż w analizowanych tkankach mięśniowych ryb.

W osadach największe koncentracje p,p'-DDT i jego metabolitów wykryto w punkcie 07., a PCBs na północy Zalewu w punktach 02. i 03. oraz na południu w punktach 06. i 07. Koncentracje p,p'-DDT w mokrej masie tkanek raciczniey i analizowanych ryb kształtowały się na podobnym poziomie. Największą zawartość Σ DDT stwierdzono w raciczniey w punkcie badawczym 08., a wśród badanych ryb w leszczu. Największe koncentracje PCBs występowały w raciczniey pozyskanej w punkcie 04. W mięśniach u leszcza i sandacza stwierdzono większe stężenia PCBs niż w mięśniach płoci.

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