PCBS AND CHLOROORGANIC PESTICIDES IN THE LAKE BAIKAL SEAL TISSUES

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1. INTRODUCTION

Within the international cooperation for Lake Baikal ecosystem investigation, three institutes carried out the study of chlorinated hydrocarbons (pesticides, PCBs) in the Lake Baikal seal. The lake was chosen because of its geographic position as it can be regarded as a pure reservoir where the named toxicants may appear only as the result of a distant (global, regional) transfer[1)]. Among all the representatives of the lake water organisms a special attention was paid to the studies of the PCBs and other chloroorganic pesticides accumulation in the Baikal seal, particularly in their hypodermic fat. Baikal seal (*Phocasibirica*) is the top of the main lake's trophic chain thus it is the most important indicator of lake pollution[2)]. Seal tissues contain enough fat that, as known, is accumulating chloroorganic toxicants[3,4)]. Systematic study of PCBs and Σ DDT accumulation in the seal tissues was started by Russian scientists in 1978. Based on data on organic chlorine levels in organs and tissues of Baikal seal various authors[5] consider environmental pollution by these compounds in the Baikal Lake region to be determined by long range transboundary transport and regard them as background level. However, some recent studies that were carried out jointly with Italian scientists and papers [6)] are indicating the tendency of chloroorganic toxicants accumulation in the tissues of Baikal Lake water organisms, especially in blubber of seals.

2. MATERIALS AND METHODS

Every year during spring (May) and autumn (September) period hunters are shooting a limited amount (based on ecologists recommendations) of seals. Normally, tissues samples were taken from these animals. Sometimes animals were caught specially to take samples. The age of the seals was from some month to 20 years. The material was extracted in Soxhlet apparatus with residue analysis grade redistilled n-hexane as solvent. Sulphuric acid clean-up was followed by Florisil column chromatography.

A Perkin-Elmer mod. 8700 gas chromatograph, equipped with ECD and 30 m * 0.2 mm (i.d.) SPB-5 bonded phase (0.25 m film thickness) fused silica capillary column from Supelco was used. The carried gas was argon-methane (95:5), 100 kPa, split ratio 66/1; injector and detector temperatures were 220 and 280° C respectively; oven temperature: 100° C 10 min, then to 280° C at 3° C/min and hold 40 min. The Russian and Italian scientists used similar methods (in the Institute for Experimental Meteorology - Gasochrom devices). Analysis results of the same seal tissue samples showed a good coincidence (SD < 30%).

3. RESULTS AND COMMENTS

The levels of PCBs and DDT (and their metabolites) found in the tissues of the Baikal seals are very low. If you compare these values (Tab. 1) with those of seals of coastal areas of the Canadian Arctic or Greenland [7,8] they are closely similar, whereas the values, found in seals from the Baltic Sea and North Sea are much higher than those of Lake Baikal.

Table 1: Results of seal's fat analysis, mg/kg

Species	Years	PCBs	Σ DDT
North Sea *Phoca vitulina*	1970-1979	152 100 16 15 12	15 9 7 5 2
North Sea *Phoca vitulina*	1988-1989	39 26 22 22 20 18 15 10 8 7 6	5 5 3 3 3 4 1 1
Baltic Sea *Halichoerus grypus*	1970-1988	140 100 53 49 45 38 35 32 19	420 210 42 20 10 9 4
Baltic Sea *Phoca hispida*	1973-1982	110 110 100 89 76 73 69 49	200 130 100 88 76 62
Lake Baikal *Phoca sibirica*	1985-1988	6 5 4 3 1	5 5 4 3 2
Lake Baikal *Phoca sibirica*	1991	7 5 5 5 3	9 6 4 4 2
	1993	16 14 13 7 1	17 12 11 9 6 5

In the Tab. 2 and 3 there are presented data by Dr. Bobovnikova et. al on PCB and Σ DDT content in hypodermic fat of Baikal seals in 1982 - 1989. It is not possible to say that analyses data of 1991 showed significant increase of chloroorganic toxicants concentrations (Tab. 1), but from the other hand, the decreasion of their content as also not detected as in the seal fat from other reservoirs.

The analysis of samples obtained in 1993 showed some increase of PCBs and Σ content (Tab. 4). There is no longer any doubt that chlorinated hydrocarbons enter oceans, seas via rivers. It appears that only 2% of one of the most common chlorinated hydrocarbons (PCBs) enters the oceans via rivers, while 98% enters via the atmosphere. The 2% contribution by rivers has a small influence on ocean pollution but it could be much higher when the river flows into a lake. This is the case of Baikal, where the large Selenga river flows into the middle part of the lake. Since the hydrographic basin of the Selenga river is well populated by man and much industrialized, many contaminants enter the lake. Chlorinated hydrocarbons of agricultural use are still entering the lake and since they all have low water solubility they are associated with floating particles concentrated at the water surface. These pass into the food chain because photosynthetic organisms seek the surface, zooplankton feed upon them, fish upon zooplankton and mammals upon fish.

Table 2: Results of the PCBs determination in the hypodermic fat of Baikal seals mg/kg

Age	Sex	1982	1983	1984	1985	1987	1988	1989
1 - 2 month	♂	4.7	2.9	6.2	4.6	1.2	5.7	1.3
	♂	3.1	-	-	5.0	1.2	-	2.2
	♀	3.2	3.0	4.3	4.0	0.8	3.3	2.0
	♀	-	-	-	2.2	1.2	5.7	2.1
3 years	♂	12.9	8.2	13.5	9.4	-	4.1	3.0
	♂	-	-	-	3.5	-	-	2.1
	♀	13.3	7.5	21.0	4.1	-	8.0	3.0
	♀	-	-	-	2.8	-	5.0	6.0
5 years	♂	-	8.8	5.3	12.8	9.0	7.9	11.3
	♂	4.1	-	-	8.3	9.0	3.2	3.7
	♀	9.1	7.3	16.1	11.3	2.9	6.5	4.4
	♀	7.3	-	-	10.7	4.0	3.4	8.7
10 years	♂	4.1	7.9	16.3	9.4	5.0	20.7	8.4
	♂	-	-	-	6.2	8.5	14.2	8.6
	♀	15.5	8.7	15.0	11.9	6.1	8.8	5.6
	♀	4.3	-	-	6.9	6.1	4.9	1.9
20 years	♂	10.9	7.0	23.5	6.8	7.6	9.6	19.5
	♂	8.1	-	-	11.8	14.5	9.9	12.0
	♀	-	-	19.3	13.1	18.4	9.4	12.7
	♀	-	-	-	16.5	17.4	3.5	14.0

Table 3: Results of the DDT determination in the hypodermic fat of Baikal seals mg/kg

Age	Sex	1982	1983	1984	1985	1987	1988	1989
1 - 2 month	♂	5.1	3.2	8.5	7.8	1.5	8.9	4.4
	♂	7.1	-	-	6.3	1.1	3.1	4.9
	♀	10.2	3.7	12.5	6.4	-	9.8	4.1
	♀	-	-	-	3.8	1.6	-	7.0
3 years	♂	12.1	-	13.6	8.2	-	17.5	11.3
	♂	-	-	-	12.9	-	-	11.2
	♀	11.4	-	17.6	7.4	-	13.1	10.2
	♀	-	-	-	6.6	-	13.7	16.3
5 years	♂	-	6.7	4.4	17.3	7.1	15.7	14.4
	♂	15.4	-	-	20.1	6.8	10.5	4.9
	♀	22.6	8.1	-	25.9	6.7	14.6	4.5
	♀	13.9	-	-	15.0	4.7	11.2	16.0
10 years	♂	15.4	20.3	23.2	13.6	12.8	64.1	13.7
	♂	-	-	-	9.7	16.9	17.2	13.0
	♀	25.2	11.0	13.4	14.4	17.0	14.9	5.1
	♀	12.6	-	-	16.2	16.8	12.3	5.7
20 years	♂	14.4	9.5	52.0	28.1	51.4	31.8	19.5
	♂	28.2	-	-	25.1	29.8	33.4	29.3
	♀	-	-	18.6	21.9	26.7	32.9	27.8
	♀	-	-	-	22.9	21.2	11.2	30.4

Table 4: Results of different chloroorganic toxicants determination in the Baikal seal fat, 1993, mg/kg

Sex	% of fat	p,p DDT	p,p DDD	p,p DDE	- HCCH	- HCCH	HCB	PCB
♀	90	7.5	1.2	8.2	l.d.	l.d.	0.02	16.2
♀	87	2.4	l.d.	2.8	l.d.	l.d.	l.d.	7.3
♀	93	2.6	l.d.	2.9	0.001	0.01	0.007	7.4
♂	95	3.0	0.8	4.8	l.d.	0.04	0.26	14.8
♂	84	4.9	0.6	5.2	l.d.	l.d.	0.014	14.8
♂	90	3.6	1.1	7.5	l.d.	0.015	0.002	13.6

Note: HCCH - hexachlorocyclohexane; l.d. - low detection limit.

4. CONCLUSION

As far as the trend is concerned, our data from materials caught in 1991 and 1993 varies from that report in 1985 and presented in the Tab. 2 and 3. Around the world decreasing levels of these substances in the environment and therefore in animal tissues are reported. The use of DDT has been banned in most countries and PCBs are used in the industrial sector and have also been banned in several countries. On a world basis PCB production has been drastically reduced but we have no reliable data on their use in the surrounding area of Lake Baikal and the development of industrial and agricultural activities in the Selenga river basin. The study of priority chloroorganic pollutants accumulation in tissues of Lake Baikal water organisms is indicating a necessity to continue biomonitoring and replacement of all chemicals that are used within Lake Baikal basin as insecticides in agriculture and forest industry. It is also necessary to take into consideration a possibility of toxicants transboundary carryover (DDT for example) for some countries of South-Eastern Asia that still is used in agriculture.

5. REFERENCES

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