PCB Residues in Plankton and Sediment in the Southwestern Coast of Finland

by R. R. LINKO, P. RANTAMAKI, and K. URPO
Department of Biochemistry, University of Turku, Finland

Since Jensen in 1966 first identified polychlorinated biphenyls (PCB's) in the Swedish environment, numerous studies have shown their world-wide distribution at all environmental levels.

Analyses of fish samples have shown that the Baltic Sea is rather contaminated by both DDT and PCB compounds (JENSEN et al. 1972a). The PCB levels in the fish from coastal areas give strong evidence of local pollution (LINKO et al. 1974; OLSSON et al. 1973). According to OLSSON et al. (1973) it seems possible to believe that plankton is the chief means by which PCB's are introduced into the Baltic Sea food chain.

However, only few investigations have been carried out on PCB levels in organisms which are at low trophic level in aquatic food chains. The purpose of this study was to determine residues of PCB's in the plankton from the Turku Archipelago off the southwestern coast of Finland. Preliminary experiments were also made to find PCB's absorbed into the sediment.

Materials and Methods

Plankton and sediment samples were collected during summer and autumn 1972-73 from around the biological experimental station situated in the island of Seili in the middle part of the archipelago 15 miles southwest of the city of Turku.

Plankton samples were taken with a 150 μ Hensen net either trawling at the distance of 20-30 meters from the boat and at a depth of 1-1.5 meter during 15-30 minutes at a speed of about 2 knots (i.e. surface catching) or alongside of a standing boat at a depth of 10-40 meter (i.e. depth catching). The sampling sites and other data are presented in Table I.

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Table I

PCB residues in plankton and sediment samples

Date	Sampling site	Depth meters	PCB's ppm lipid weight	PCB's ppm wet weight	Lipid per cent
PLANKTON					
Surface catching					
73-10-12	North of Seili[a]	1-1.5	70	0.58	0.8
73-10-10	South of Seili[a]	"	6	0.04	0.7
"	"	"	15	0.09	0.6
"	"	"	10	0.06	0.6
73-11-06	"	"	4	0.04	1.1
"	"	"	5	0.05	1.0
"	"	10	9	0.09	1.0
"	"	"	20	0.23	1.2
73-06-06	East of Seili[a]	1-1.5	67	0.75	1.1
"	"	"	16	0.11	0.6
"	"	"	23	0.35	1.5
"	"	"	43	0.32	0.7
73-06-18	"	"	15	0.05	0.3
73-07-13	"	"	16	0.16	0.9
73-07-14	"	"	8	0.07	0.9
"	"	"	9	0.09	1.0
"	"	"	9	0.08	0.9
73-10-10	Shipping route[b]	"	10	0.09	1.0
"	"	"	14	0.10	0.7
73-10-11	Open sea[c]	"	5	0.05	1.1
Depth catching					
72-08-17	North of Seili[a]	0-40	8	0.04	0.5
72-09-21	"	0-25	51	0.20	0.4
73-09-04	"	0-30	28	0.18	0.6
72-08-18	South of Seili[a]	0-15	77	0.35	0.4
72-09-21	"	0-20	30	0.14	0.4
73-09-04	"	0-10	30	0.17	0.6

Table I (contin.)

Date	Sampling site	Depth meters	PCB's ppm lipid weight	PCB's ppm wet weight	Lipid per cent
73-09-18	South of Seili[a]	0-10	54	0.38	0.7
73-10-10	"	0-23	4	0.05	1.2
73-11-06	"	0-20	14	0.11	0.8
"	"	0-27	17	0.18	1.0
73-10-12	East of Seili[a]	0-28	56	0.40	0.7
73-09-18	Southeast of Seili[a]	0-13	13	0.08	0.6
73-10-11	"	0-21	56	0.56	1.0
73-10-11	Open sea[c]	0-15	40	0.36	0.9
Mean value			25	0.19	0.8
Range			4-77	0.04-0.75	0.3-1.5
SEDIMENT					
73-09-18	North of Seili[a]		11	0.02	0.2
73-09-19	South of Seili[a]		12	0.01	0.1
73-10-10	"		6	0.01	0.2
73-10-12	East of Seili[a]		6	0.01	0.2
73-09-19	Southeast of Seili[a]		8	<0.01	<0.1
73-10-11	Open sea[c]		52	0.02	<0.1
Mean value			16	0.01	0.1
Range			6-52	0.01-0.02	<0.1-0.2

[a] about 1 miles from the island of Seili

[b] about 12 miles from Turku on the shipping route

[c] about 4 miles south of the island of Nauvo

Plankton was sieved through a 106 µ net, and the quantity remaining on the sieve was packed in glass bottles and frozen. Some plankton samples were taken for microscopic observation for their composition. Sediment was collected with a Agassiz-trawl, sieved through a 10-mm screen and dried at room temperature. Precautionary measures were taken to avoid contamination during collection and handling, e.g. by washing nets, samplers and jars and by checking the paint and hydraulic fluids of the boat by extraction with hexane and analyzing with GLC (JENSEN et al. 1972b).

After the frozen plankton samples had been partially thawed and subsequently homogenized, they were mixed with anhydrous sodium sulfate, dried overnight and Soxhlet-extracted with a mixture of hexane, acetone, diethyl ether, and petroleum ether (2.5:5.5:1:9). The sediment samples were treated in a similar way after air-drying. The extracted fat was weighed and cleaned with TLC on Silica Gel G as described by LINKO et al. (1974). For comparison also concentrated sulfuric acid treatment was used for cleaning-up of the residue.

The GLC analyses were conducted on a Varian Aerograph 2440 gas chromatograph equipped with ^{3}H-electron capture detectors. Pyrex glass tubes, 0.20 cm in inner diameter and 183 cm long, were packed with 6 % GE SF-96 (methyl silicone) on Chromosorb W (60-80 mesh, acid washed and DMCS treated). The column temperature was 192° C, that of the injection block 210° C and that of the detector 220° C. The flow rate of the carrier gas (nitrogen) was 75 ml/min. For the quantitative determination of PCB's the heights of the four highest peaks (No. 3,7,8,10) were summed. The profile of the PCB peaks matched closely that of Clophen A 60, which was used as a standard.

Results and Discussion

When a preliminary study on PCB contamination in the plankton and sediment in the Turku Archipelago was made, the results shown in Table I were obtained. Plankton contained relatively high amounts of PCB's, the mean values being 0.19 ppm on a wet weight basis and 25 ppm on a lipid basis, the ranges of variation being 0.04-0.75 ppm and 4-77 ppm respectively. The PCB concentration in plankton was on about the same level

as that in fish obtained from the same archipelago when calculated on a lipid basis. For example, pike contained on the average 21 ppm and Baltic herring 8 ppm of PCB's (LINKO et al. 1974). The latter fish feeds mainly on plankton in the pelagic zone of the sea. Table I shows also that the plankton collected by surface catching usually gave lower PCB values than that taken by depth catching. The composition of the plankton samples varied greatly, but the main content was Copepoda zooplankton. There were also fluctuating quantities of Centrales diatomaes. However, according to HOLDEN (1973) the species composition of zooplankton may have little influence on the PCB levels in zooplankton samples.

The results obtained in this study on the PCB level of plankton resemble those arrived at by other investigators studying different sea areas. Thus mixed plankton from the Stockholm Archipelago contained from 3 to 35 ppm of PCB's on a fat weight basis (JENSEN et al. 1972b). HOLDEN (1973) reported the PCB values in zooplankton from the northeastern Atlantic to be 0.01-0.12 ppm wet weight (0.1-5.5 ppm in lipid) and from the Firth of Clyde, including highly polluted areas, 0.08-2.2 ppm wet weight (0.1-17.1 ppm in lipid). The results obtained by RISENBROUGH and VREELAND (1972) on zooplankton taken from the continental Atlantic shelf area varied from 2.4 to 260 ppm PCB's in lipid weight with a median value of approximately 40 ppm. There were also surprisingly high concentrations of PCB's in plankton collected from the open North and South Atlantic ranging from 0.02 to 0.64 ppm on a wet weight basis and from 7 to 120 ppm on lipid basis. The ratio of PCB's to the total DDT substances was comparatively high in their plankton samples. In the present study plankton was also found to contain very small amounts of DDT substances in comparison with PCB's, in contrast to the results obtained on fish (LINKO et al. 1974). The reason why plankton may be exposed to PCB's to a greater extent than fish is not known. More knowledge must first be obtained concerning the solubility and absorption properties of different PCB's. It is apparent, however, that plankton is an important link in the introduction of PCB's into aquatic food chains. Surface absorption of PCB's by plankton allows these substances to remain in the aquatic environment for a long time without sinking to the bottom. The concentrations of PCB's in the sediment samples were rather low compared to those in plankton (Table I). Sources of PCB pollution in the

Turku Archipelago may be the local inputs from ships and boats as well as sewage sludge.

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