

Spatial Distribution of PCBs in Flounder, Perch and Lamprey from the Gulf of Gdańsk, Baltic Sea

Jerzy Falandysz, Adriana Dembowska, Lidia Strandberg, Bo Strandberg*
and Christofer Rappe*

Department of Environmental Chemistry & Ecotoxicology, University of Gdańsk,
18 Sobieskiego Str., PL 80-952 Gdańsk, Poland

*Institute of Environmental Chemistry, Umea University, S-901 80 Umea, Sweden

Abstract

Measurements of concentrations of all PCB congeners found in biological matrices in the environment are demonstrated for flounder, perch and lamprey collected from the spatially different sites in the coastal area of the Gulf of Gdańsk in 1992 to indicate differences/similarities in pattern, concentration and sources of pollution. Flounder and perch collected at the Gdynia site were twice more contaminated with PCBs than fish at the Gdańsk site, while flounder from the outlet of the Vistula River showed lowest contamination. Apart from the concentrations also the pattern of PCB congeners largely differed between three sampling sites with an evidence of the input of fresh PCBs upstream of the Vistula River and also somewhere at the Gdynia site and aged pattern at the Gdańsk site. The range of total PCB concentration was between 910 and 9400 ng/g lipids, while TCDD TEQs of non- and mono-*ortho* PCBs between 0.0098 and 0.16 pg/g lipids, and between 0.0005 and 0.068 pg/g wet wt.

Key words: Polychlorinated biphenyls, chlorobiphenyls, PCBs, CBs, non-*ortho* PCBs, mono-*ortho* PCBs, fish, flounder, lamprey, perch, Baltic Sea, pollution, food.

Introduction

Polychlorinated biphenyls (PCBs) are primarily industrial chemicals and many congeners of chlorobiphenyl that are absent in technical PCB formulations are microsynthesized during municipal waste combustion (1, 2). Since their discovery in wildlife in 1966 and Yusho disaster in 1968 (3, 4) PCBs become a matter of concern in environmental sciences and medicine for several decades.

Here we examine, if there exist and differences or similarities in spatial and species dependent distribution in concentration and pattern of pollution with PCBs in coastal area in the south-western part of the Gulf of Gdańsk using flounder, perch and lamprey as a biological matrix and a non-destructive extraction and clean-up method coupled to a HRGC/LRMS and HRGC/HRMS technique.

Materials and Methods

Fish (flounder, perch and lamprey) were caught in south-western part of the Gulf of Gdańsk from June 2 to July 1, 1992 (Figure 1). The analytical method used for determination of PCBs including non- and mono-*ortho* isomers and congeners is a part of a multi-residue procedure allowing to determine simultaneously many organochlorines and polynuclear aromatic hydrocarbons (PAH) (5). After homogenisation of the sample with anhydrous sodium sulphate and subsequent extraction lipids were removed by means of the polyethylene film dialysis with further fractionation of the aliquot of the extract using a Florisil gel column or by HPLC with an activated carbon column (6-8). Total PCBs were determined by means of HRGC/LRMS, while non- and mono-*ortho* PCBs by means of HRGC/HRMS (8, 9). Isotopically labelled [$^{13}\text{C}_{12}$] - CB congeners (nos. 77, 80, 101, 118, 126 and 169) were used as an internal and recovery standard, respectively, to compensate for possible losses during the clean-up procedure.

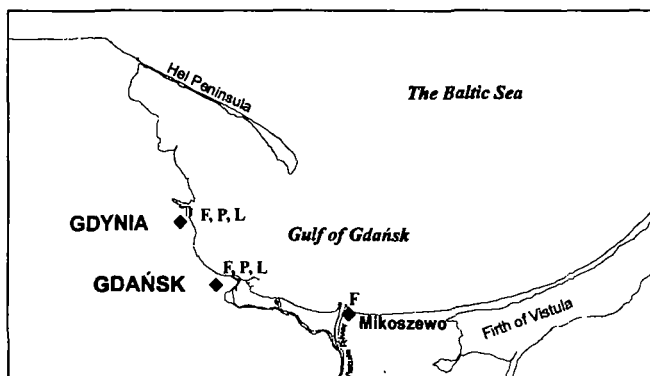


Fig. 1. Sampling sites (F, flounder; P, perch and L, lamprey).

Results and Discussion

The lipid weight normalised non- mono-*ortho* and total PCB concentrations are much higher in flounders, perch and lamprey at the Gdynia site than at the Gdańsk or Mikoszewo site, respectively (Table 1).

The patterns of three- through deca-CB homologue groups are shown in Figure 2. Flounders collected at the Mikoszewo site contained in higher proportion tri-, tetra-, hepta-, octa- and nona-CBs and in lower proportion penta and hexa-CBs that specimens at the Gdynia and Gdańsk sites. There are also a site and species differences/similarities in PCB

homologue group pattern between the Gdańsk and Gdynia sites for perch and lamprey, respectively. A site specific differences/similarities in patterns of total PCBs between the Gdańsk, Gdynia and Mikoszewo sites are more distinct (Figures 3 and 4) when compared to the patterns of homologue groups (Figure 2). The pattern of total PCBs in flounders collected in the Gulf of Gdańsk close to the outlet of the Vistula River (at the Mikoszewo site) is very characteristic to fresh PCB input, and to some degree the same picture is for flounder, perch and lamprey collected at the Gdynia site. The patterns of total PCBs in fish at the Gdańsk site, what is contrary to the Gdynia and Mikoszewo sites, resembles „aged” PCBs and is similar to the pattern found in stickleback from the beach zone in the Gulf of Gdańsk (10). Apparently, a low chlorinated PCB mixture with a much higher value of the ratio of chlorobiphenyl no. 52 to chlorobiphenyl no. 138 (plus nos 160, 163 and 164) in flounder from the outlet of the Vistula River when compared to other sites indicates an input of fresh PCBs somewhere upstream the river. The total load of PCBs transported by the Vistula River to the Gulf of Gdańsk during 12 months in 1991/1992 was relatively small, *i.e.* 5.0 kg (9), what can explain relatively slight contamination of flounder at the Mikoszewo site.

Table 1. The concentrations of non-*ortho*, mono-*ortho*, total PCBs (ng/g lipids) and TCDD TEQs of non- and mono-*ortho* PCBs (pg/g lipids) in flounders, perch and lamprey

Compound	Species and site						
	Flounder			Perch		Lamprey	
	Gdy*	Gda	Mik	Gdy	Gda	Gdy	Gda
Non- <i>ortho</i> PCBs							
No. 77	9.2	7.2	2.2	15	3.2	0.56	1.6
No. 126	4.1	2.2	0.41	7.4	2.6	1.6	0.61
No. 169	0.074	0.055	0.04	0.11	0.064	0.11	0.089
Mono- <i>ortho</i> PCBs							
105	1400	610	38	680	240	270	69
114	79	36	2.6	31	12	13	3.2
118	2500	1300	100	1600	660	610	180
123	180	71	7.4	87	23	22	11
156	430	150	16	300	87	100	26
157	120	38	3.1	74	21	24	6.3
167	300	110	14	190	62	83	19
189	8.6	3.0	0.97	6.4	3.4	3.1	1.6
Total PCBs	9400	4800	910	6400	3000	1700	1000
**TEQs (lipids)	0.14	0.072	0.0098	0.16	0.053	0.042	0.015
**TEQs (wet weight)	0.068	0.003	0.0005	0.0097	0.0028	0.0026	0.0034
Lipids (%)	4.8	4.2	4.8	6.0	5.2	6.3	22.6

*Gdy (Gdynia), Gda (Gdańsk), Mik (Mikoszewo)

**based on 1997 World Health Organization (WHO) TCDD TEFs for fish

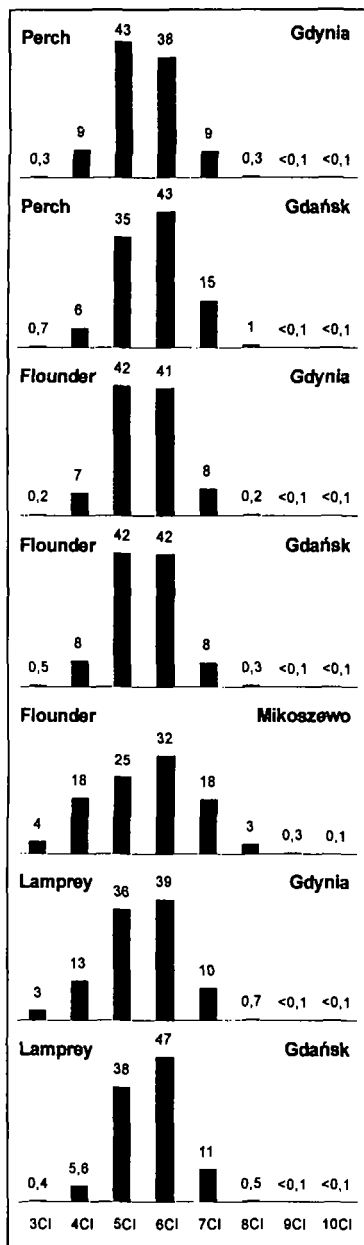


Figure 2. Pattern (%) of PCB homologue groups in perch, flounder and lamprey.

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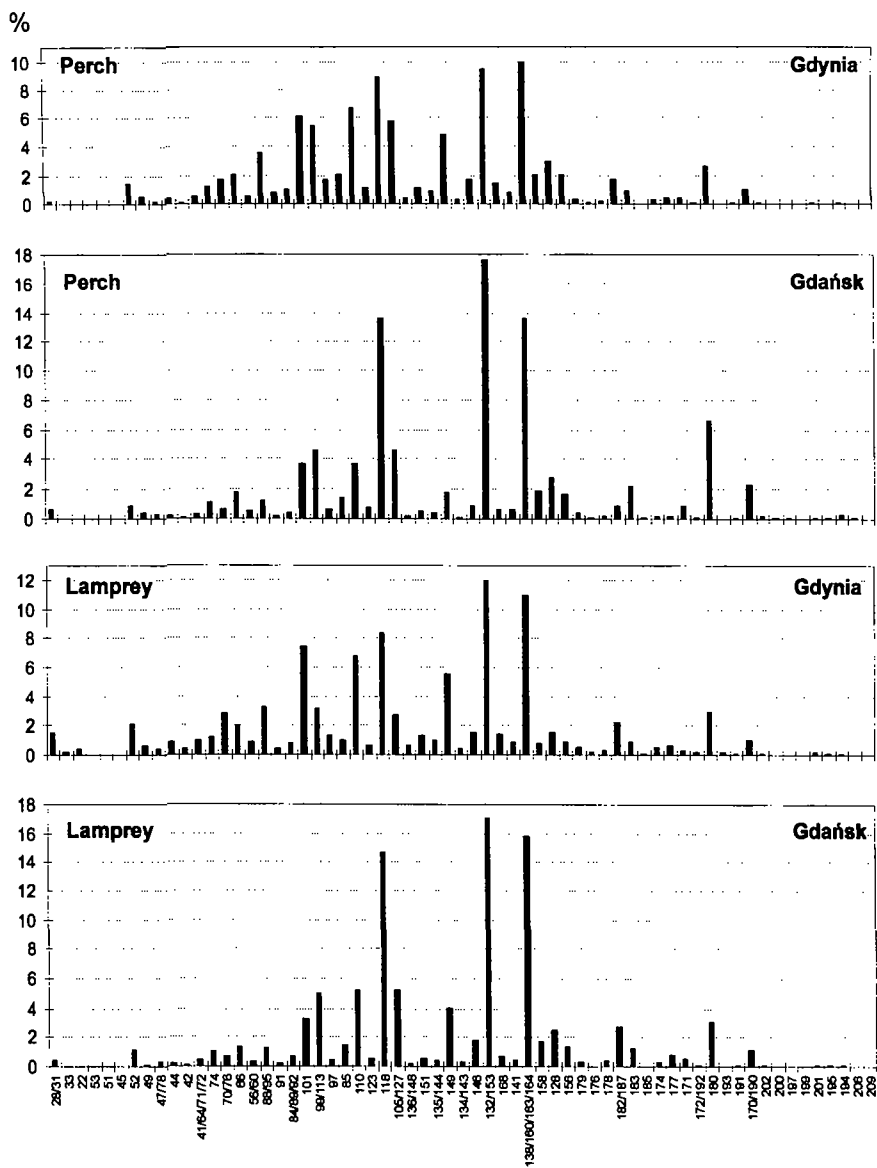


Figure 3. Pattern (%) of total PCBs in perch and lamprey.

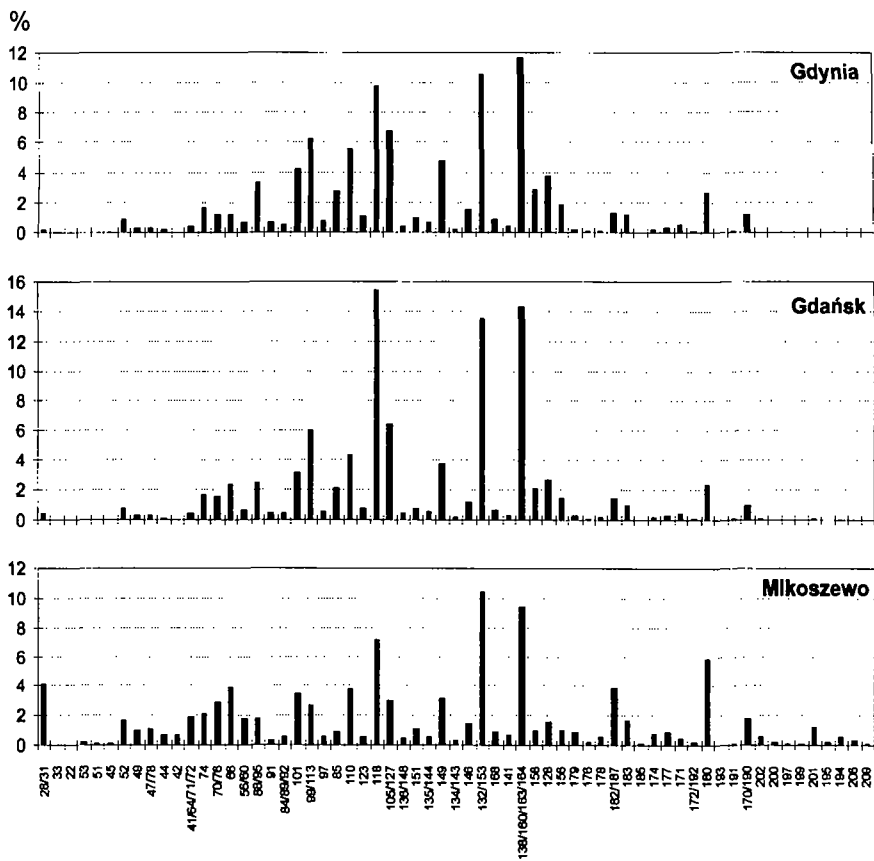


Figure 4. Pattern (%) of PCBs in flounder.