PCBs in a Pelagic Food Chain in the Southern Baltic Proper

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Abstract
The concentration, pattern, bioaccumulation and biomagnification features of many chlorobiphenyl congeners including non- and mono-*ortho* chlorine substituted members have been determined in a pelagic food chain including mixed phyto- and zooplankton, herring (*Clupea harengus*) and harbour porpoise (*Phocoena phocoena*) collected from the southern part of the Baltic Proper.
TCDD TEQs of non- and mono-*ortho* PCBs in plankton, herring and harbour porpoise were 0.0016, 0.016 and 0.25 pg/g lipids, respectively. Mono-*ortho* PCBs were a major contributors to TCDD TEQs and occupied between 40 - 88 %. Concentrations of total PCBs in plankton, herring and harbour porpoise were 210, 1300 and 10000 ng/g lipids, respectively, and for marine mammal were lower than reported in specimens stranded in the Polish coastal waters in 1989-1990. Herring and harbour porpoise apparently bioaccumulate many PCBs found in their food, and the values of BAF of PCBs were <10 in herring and <35 in harbour porpoise. Harbour porpoise clearly is able to metabolise the most toxic non-*ortho* PCBs (no. 77, 126 and 169) and only a few of mono-*ortho* PCBs (no. 114, 123 and 156), while all non- and mono-*ortho* PCBs are bioaccumulated by herring.

Key words: Polychlorinated biphenyls, chlorobiphenyls, PCBs, CBs, non-*ortho* PCBs, mono-*ortho* PCBs, plankton, herring, harbour porpoise, Baltic Sea

Introduction

Polychlorinated biphenyls (PCBs) are environmental toxins that were produced in large quantities worldwide in the past (1, 2). Those chemicals can cause adverse effects on wildlife health and environmental quality (2, 3).

In this paper congener specific analysis including the most toxic non- and mono-*ortho* planar PCBs is presented. Toxicity of PCBs was estimated by the TCDD toxic equivalence approach.

Materials and Methods

The subsurface mixed phyto- and zooplankton sample and three individuals of herring (*Clupea harengus*) were collected in the Depth of Gdańsk and the Gulf of Gdańsk, and four blubber samples from harbour porpoise (*Phocoena phocoena*) were collected in Polish coastal zone of the Baltic Sea in 1991-1993. The analytical method used based on nondestructive extraction, clean-up of the samples and final HRGC/LRMS and HRGC/HRMS determination was presented in another paper (4).

Results and Discussion

Concentrations of non-*ortho*, mono-*ortho* and total PCBs in plankton, herring and harbour porpoise are presented in Table 1, and in Figures 1-3 are given the patterns and bioaccumulation factor (BAF) values of those substances, respectively.

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 plankton, herring and harbour porpoise.

	Plankton	Herring	Harbour porpoise	
Compound		1 (3)	n=4	
Non-*ortho* PCBs				
No. 77	0.24	1.4	0.13 ± 0.01	0.11 - 0.17
No. 126	0.05	0.62	0.095 ± 0.013	0.07 - 0.13
No. 169	0.13	0.14	0.031 ± 0.004	0.02 - 0.04
Mono-*ortho* PCBs				
105	13	96	97 ± 21	63 - 150
114	0.44	5	3.1 ± 0.7	1.8 - 4.7
118	26	240	430 ± 96	250 - 610
123	2	11	1.3 ± 0.3	0.66 - 1.4
156	4.3	35	24 ± 5	14 - 38
157	1.1	7.5	12 ± 3	5.8 - 19
167	4.6	29	69 ± 17	39 - 110
189	0.17	1.3	7.9 ± 3	3.2 - 16
Total PCBs	210	1300	10300 ± 2500	5700 - 16000
*TEQs (lipids)	0.0016	0.016	0.25 ± 0.05	0.17 - 0.35
*TEQs (wet weight)	0.00003	0.0015	0.21 ± 0.04	0.15 - 0.31
Lipids (%)	1.9	9.0	87 ± 3	77 - 92

*based on 1997 World Health Organization (WHO) TCDD TEFs for fish (plankton and herring) and mammals (harbour porpoise).

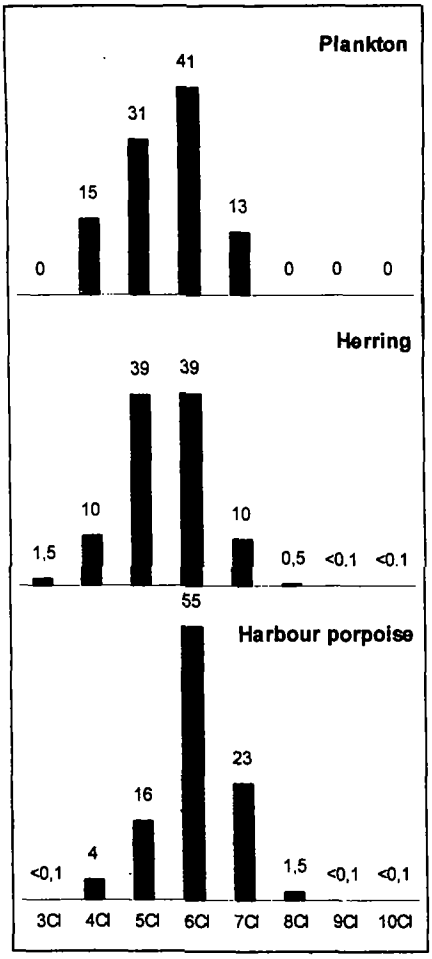

Fig. 1. Pattern (%) of PCB homologue groups in biota examined.

There are only small differences in the pattern of PCB homologue groups and total PCB in organisms lower in their position in marine food web such as plankton and herring, while the pattern observed for harbour porpoise is much different (Figures 1 and 2). There is a high enrichment in octa-, hepta- and hexachlorobiphenyls in blubber of harbour porpoise when compared to herring, while tri- tetra- and pentachlorobiphenyls are apparently metabolized by that marine mammal.

Among the many congeners of PCBs quantified in biota examined, five peaks (no. 138/160/163/164, 132/153, 118, 110 and 101) were the most contributing (>5%) individuals in plankton and herring, while five other peaks (no. 132/153, 138/160/163/164, 149, 182/187 and 180) were the most contributing (>5%) in harbour porpoise.

The absolute concentration of three non-*ortho* coplanar PCBs in blubber of harbour porpoise in this study is much lower than was noted in animals examined in 1989-1990 (5), and the pattern is similar.

Three most toxic non-*ortho* PCBs are apparently biomagnified in herring when related to plankton (Table 1), while harbour porpoise apparently can metabolise these congeners. Also some of mono-*ortho* PCBs, i.e. no. 114, 123, 156 are metabolised by harbour porpoise, and no. 105, 118, 157, 167 and 189 are biomagnified.

The BAF values of most of PCBs in herring when related to plankton are between 3 and 11 and similar BAF values were observed for DDTs (6), while a somewhat higher (up to 23) for some congeners of chloronaphthalene (7). Harbour porpoise apparently bioaccumulate many PCB congeners - BAF up to 34 for decachlorobiphenyl (Figure 3). The values of BAF of selected chlorobiphenyls in harbour porpoise are similar as for some constituents and metabolites of pesticide chlordane (8), while 4.9 was recorded for hexachlorobenzene (HCBz) and between 2 and 10 for DDT and its analogues (DDTs) (6). When compared to PCBs, chlordane, DDTs and HCBz the xenobiotics such as chloro-naphthalenes and pentachlorobenzene are much less retained by harbour porpoise (6, 7).

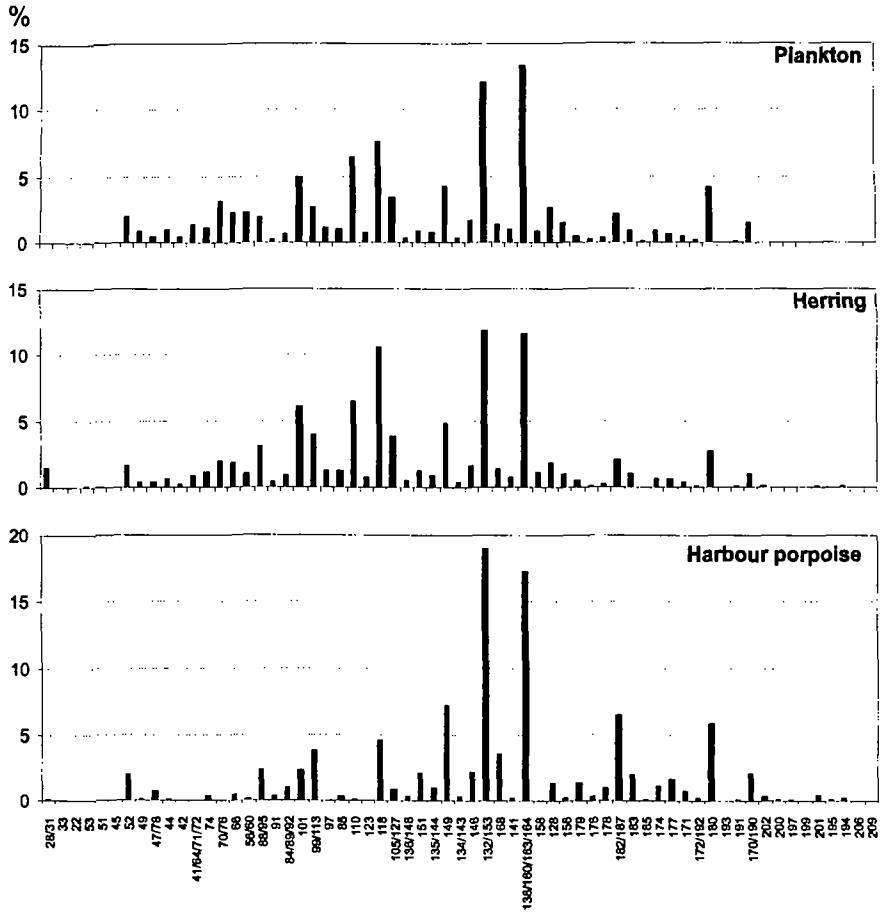

Fig. 2 Pattern (%) of PCBs in biota examined.

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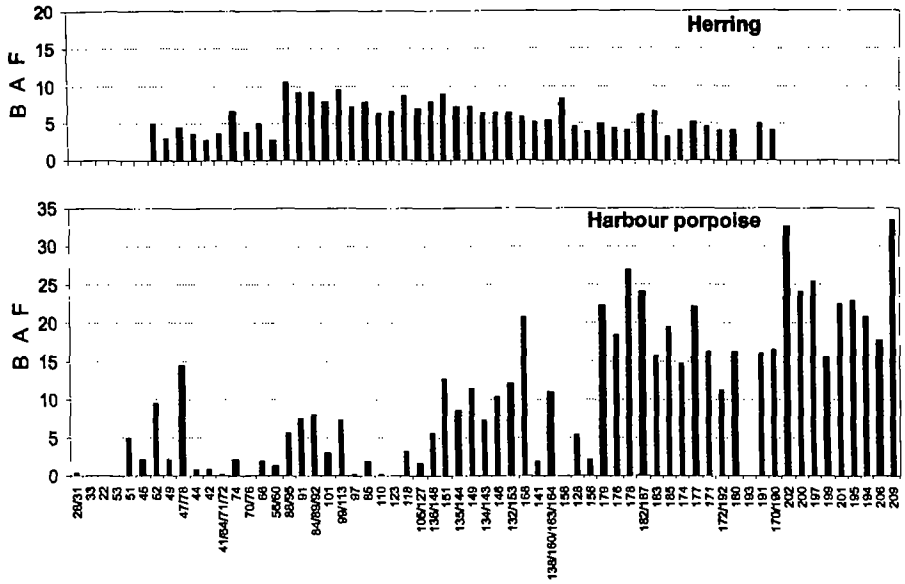

Fig. 3. BAF values of PCBs in herring and harbour porpoise.

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