Pentachlorobenzene, Hexachlorobenzene and DDTs in a Pelagic Food Chain in the Baltic Sea

Jerzy Falandysz*, Dorota Danisiewicz*, Lidia Strandberg*, Bo Strandberg, Per-Anders Bergqvist**, Christoffer Rappe**** Department of Environmental Chemistry & Ecotoxicology, University of Gdańsk, ul. J. Sobieskiego 18, PL 80-952 Gdańsk, Poland* and Institute of Environmental Chemistry, Umea University, S-901 87 Umea, Sweden**

Abstract

The concentrations, bioaccumulation and biomagnification features of DDTs (DDTs: *o,p'*-DDT, *p,p'*-DDT, *o,p'*-DDD, *p,p'*-DDD, *o,p'*-DDE, *p,p'*-DDE and DDMU), pentachlorobenzene (PCBz) and hexachlorobenzene (HCBz) 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 Sea. Except of *o,p'*-DDE in fish and mammal, and DDMU and PCBz in mammal, the BAF and BMF values of all other compounds determined were higher then 1. *p,p'*-DDT and pentachlorobenzene showed highest bioaccumulation potential in herring (the factors 16 and ~8, respectively) and *p,p'*-DDE in harbour porpoise (factor 10). Harbour porpoise when compared to herring, its main food item, seems to posses much better potential to metabolise *p,p'*-DDT and also a high capacity to metabolise PCBz.

Key words: Organochlorines, DDTs, pentachlorobenzene, PCBz, hexachlorobenzene, HCBz, plankton, herring, harbour porpoise, bioaccumulation, biomagnification, food web.

Introduction

Organochlorines like DDTs and HCBz are known to bioaccumulate and biomagnify in aquatic biota, however, there are no data available on behaviour of those chemicals, and including also PCBz, when are transferred throughout a food web in the southern part of the Baltic Sea.

In the present study, mixed subsurface phyto- and zooplankton, herring and harbour porpoise were analysed for PCBz (pentachlorobenzene), HCBz (hexachlorobenzene) and DDTs (*p,p'*-DDT, *o,p'*- DDT, *p,p'*- DDD, *o,p'*-DDD, *p,p'*-DDE, *o,p'*-DDE and DDMU), and to determine bioaccumulation features of those chemicals in a pelagic food chain in the southern part of the Baltic Sea.

Experimental Methods

The subsurface mixed phyto- and zooplankton sample and three whole individuals of herring *Clupea harengus* were collected in the Deep of Gdańsk and the Gulf of Gdańsk in 1992,

respectively, and four blubber samples from harbour porpoise *Phocoena phocoena* were collected in 1991-1993.

The samples were spiked with $^{13}C_{12}$-labelled *p,p'*-DDT and just prior to GC/MS with [$^{13}C_{12}$]- 2,2'4,5,5'-pentachlorobiphenyl (PCB No. 101) as internal and recovery standards. In brief, after sample homogenisation and grounding with an excess of anhydrous sodium sulphate, the obtained powdered mixture was extracted in open wide bore glass column (length 1.5 m, i.d. 4 cm) with 500 ml mixture of acetone and *n*-hexane (2.5:1) and 500 ml of *n*-hexane and diethyl ether (9:1). Bulk lipid removal was performed by means of semipermeable polyethylene membrane dialysis method, and the dialysate was split into two parts, of which 10% was used for analysis of DDTs, HCBz, PCBz, some other pesticides and bulk of PCBs, and 90% for planar compounds. The extract was fractionated on a dry packed Florisil column with, and the analyte was collected in fraction 1 and 2 (ml). The eluate was microconcentrated, spiked with a recovery standard and evaporated to a final volume of 30 μl with tetradecane as a keeper. The analyses were carried out by HRGC/LRMS using selected ion recording (SIR) on a Fisons MD 800 coupled to a Fisons GC 8000. A non-polar capillary column (J & W DB-5, 60 m x 0.32 mm i.d., film thickness, Bellefonte, PA, USA).

Results and Discussion

DDTs, and next HCBz, were quantified in all matrices in a highest concentration, while PCBz was detected only in herring (Table 1). The composition (%) of DDT compounds is given in Figure 1, and bioaccumulation (BAF) and biomagnification (BMF) factors, respectively, from plankton to herring and from herring to harbour porpoise of the xenobiotics investigated in Figure 2.

Table 1

DDTs, HCBz and PCBz in a pelagic food chain from the Gulf of Gdańsk (plankton, herring and harbour porpoise; ng/g on a lipid weight basis)

Compound	Material and concentration		
	Plankton	Herring	Porpoise
o,p'-DDT	ND	15	65
o,p'-DDD	28	14	55
p,p'-DDT	23	370	730
p,p'-DDD	130	230	1200
o,p'-DDE	1.6	ND (<0.30)	24
p,p'-DDE	110	590	6000
DDMU	6.9	45	36
DDTs	**290**	**1300**	**7900**
HCBz	11	41	200
PCBz	ND	8.4	ND
Lipids (%)	1.85	9.0	86.2

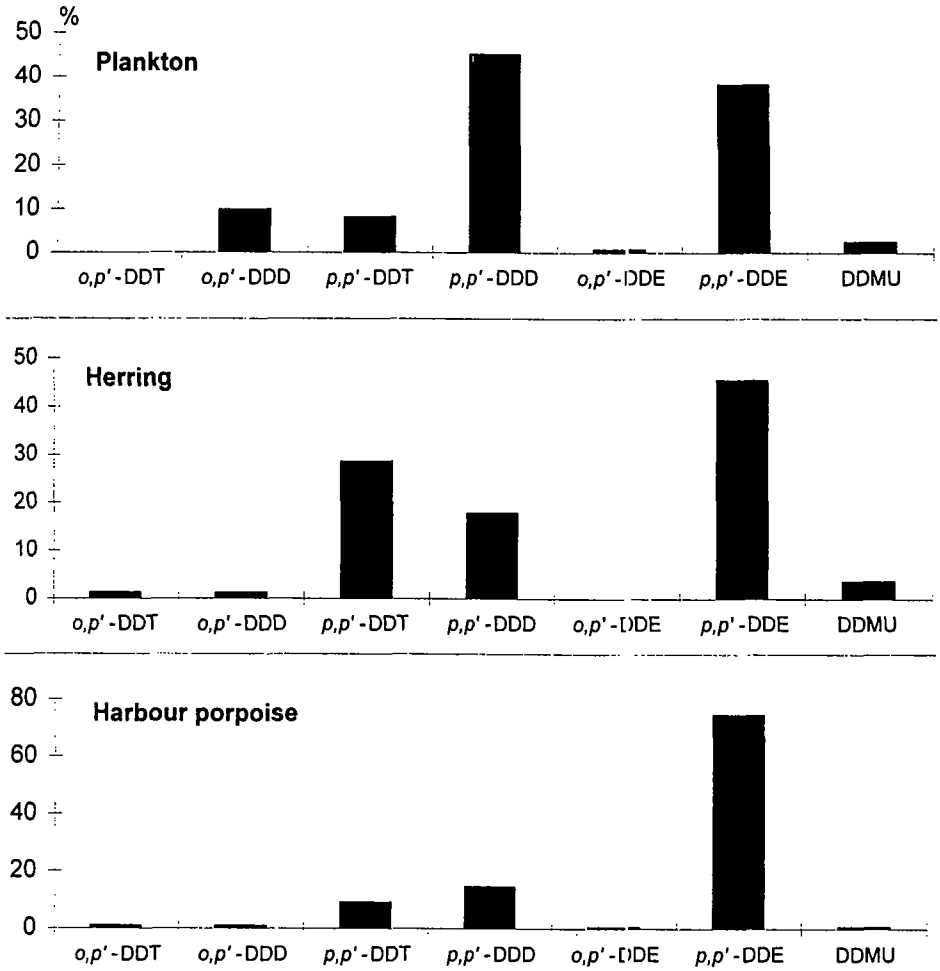

Figure 1. Composition (%) of DDTs in plankton, herring and harbour porpoise.

A lower food web organisms such as marine bacteroplankton, phytoplankton and zooplankton are generally considered to posses a very limited possibility to metabolise many persistent organochlorine compounds when compared to the animals higher in their position in a food web. The fingerprint of DDTs is totally different between the marine matrices investigated (Figure 1). Apparently, harbour porpoise is an animal capable to effectively metabolise *p,p'*-DDT when compared to herring and plankton. Earlier it has been found that harbour porpoise is a species capable to metabolise many congeners of chlorobiphenyl, some chlordane compounds and nearly all congeners of chloronaphthalene [1-3].

Food is considered to be a main route of the intake of highly lipophilic (log $K_{O/W}$ > 5) and persistent xenobiotics to fish, and intake *via* the gills is a dominating route for chemicals with log $K_{O/W}$ value lower than ~5. When considering plankton as a main source of DDTs, HCBz, and PCBz for herring in this study both p, p' - DDT and pentachlorobenzene indicate a

highest bioaccumulation potential, and the BAF values are 16 and ~8, respectively (Figure 2). The BAF values for most of DDTs in herring are more then 1. Herring is the main source of food for harbour porpoise in the Baltic proper, and the BMF values (calculated as ratio of lipid weight porpoise to herring concentrations) are more then one for most of DDTs and for HCBz, and opposite to herring, harbour porpoise is a species capable to effectively biotransformate PCBz.

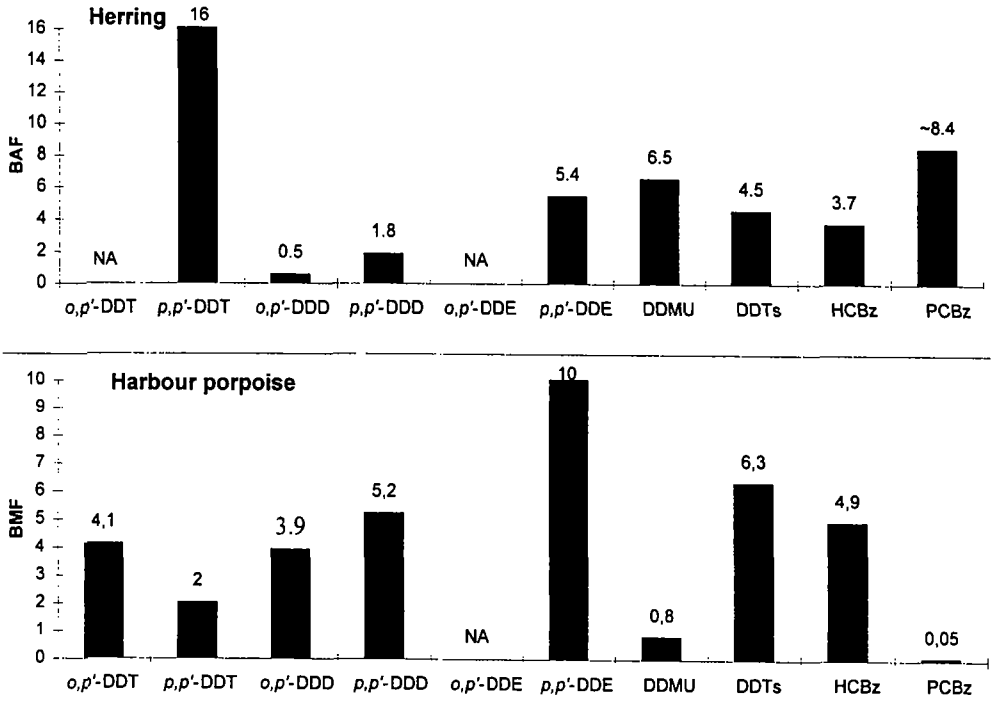

Figure 2. Bioaccumulation (BAF) and biomagnification (BMF) factors of DDTs, HCBz and PCBz in herring and harbour porpoise, respectively.

Acknowledgments

This research was supported by the Statens , Sweden (under the Valfrid Paulsson Professor Fellowship award to J.F.) and partly by the Polish Committee of Scientific Research (KBN) under grant DS.

Literature cited

1) Bruhn, R.; Kannan, N.; Petrick, G.; Schulz-Bull, D.E. and J. C. Duinker: Chemosphere, **1995**, 31, 3721-3732.
2) Strandberg, L.; Falandysz, J.; Strandberg, B.; Bergqvist, P-A. and C. Rappe: Organohalogen Compd. **1996**, 28, 478-481.
3) Falandysz, J. and C. Rappe: Environ. Sci. Technol. 30, **1996**, 3352-3370.