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Mobilization of Organochlorines from Female Lipid Tissue and Transplacental Transfer to Fetus in a Harbour Porpoise *(Phocoena phocoena)* in a Contaminated Area

J. C. Duinker and M. Th. J. Hillebrand

Netherlands Institute for Sea Research, P. O. Box 59 den Burg, Texel, the Netherlands

High concentrations of lipophilic organochlorines which accumulate in lipid tissue of marine mammals, such as PCB and Σ DDT (KOEMAN & VAN GENDEREN 1966, HOLDEN 1978) have been associated with reproductive failure of seals (OLSSON et al. 1975) and sealions (DE LONG et al. 1973, LE BOEUF et al. 1971) The concentrations in blubber, liver and other tissue in coastal areas near human activities (North Sea: KOEMAN & VAN GENDEREN 1966, HEPPLESTON 1973, KOEMAN et al. 1972, HEPPLESTON & FRENCH 1973, Baltic: OLSSON et al. 1975, HELLE et al. 1976b, California: DE LONG et al. 1973, LE BOEUF & BONNELL 1971) are several orders of magnitude larger than those in remote areas (KOEMAN et al. 1972, GASKIN et al. 1971). For some species, mean residue concentrations in blubber appear to be lower in adult females than in males (HELLE et al. 1976b, GASKIN et al. 1971, ADDISON & SMITH 1974). This observation led to the suggestion that females might lose organochlorines through parturition and/or lactation (GASKIN et al. 1971). The latter mechanism has been demonstrated recently to be significant for polar bears (BOWES & JONKEL 1975).

We have analyzed a fetus (20 cm) of a harbour porpoise for organochlorines. The female stranded on the beach of Texel (the Netherlands) on 6 November 1978 in a poor condition. She was transferred to the aquaria of Texel Museum. The fetus was produced the next day. The female recovered and remains presently in the dolphinarium at Harderwijk.

The residue concentrations in the fetus are of the same order of magnitude as the high values detected in specimens found dead along the Dutch coast (KOEMAN & VAN GENDEREN 1966, KERKHOFF & BOER 1977). The results suggest that a significant fraction of the body burden of organochlorines in the female can be transferred to the fetus. Sufficient material for analysis could only be obtained of kidney, liver and subcutaneous fat. Tissue extracts in n-pentane were cleaned up and fractionated as reported before (DUINKER & HILLEBRAND 1978). Identification and quantitation were done by electron capture gas chromatography on two columns of different polarities. p,p'-DDE was distinguished from the PCB peak with the same retention, by comparing chromatograms obtained before and after treatment of the extract with chromic acid, oxidizing p,p'-DDE and leaving PCB unchanged (Fig. 1). No corrections for blanks were necessary. All components in the list of organochlorine concentrations (Table 1) have been further identified by combined gas chromatography-mass spectro-

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metry in the selected ion monitoring mode. The very low value for the extractable lipid fraction in the fat and the high value for the liver are probably due to the early stage of fetal development.

The highest concentrations of organochlorines are those of PCB and -though an order of magnitude smaller-Σ DDT and dieldrin. The concentrations are similar to those in adults found dead. Concentrations of each individual compound on a lipid basis in liver, kidney and fat of the fetus are only slightly different. The populations of harbour seals (Phoca vitulina) and harbour porpoises in Dutch coastal waters have been strongly declining during recent years (REYNDERS 1978, VERWEY 1975). In fact, the latter species has practically vanished. The chromatograms of extracts of juveniles and adults have a striking resemblance with those of the fetus in the number, positions and the relative intensities of the various peaks. The PCB pattern fits closely to a standard mixture with a high degree of chlorination, Phenoclor DP6(Fig. 1). Several early eluting peaks of e.g. di- and trichloro-PCB components, being pronounced features in the chromatograms of extracts of food sources of the harbour porpoise, such as shrimps, are weak or absent in those of the fetus and adults. A direct comparison of the concentrations of organochlorines in the fetus with those in the tissue of the female from which it originates cannot be made yet. However, they should be similar to those detected in dead adult specimens stranded along the coast. Thus, mobilization from female lipid tissue and transplacental transfer is the likely source of the lipophilic organochlorines present in fetal tissue of the harbour porpoise.

TABLE 1

Residue concentrations of organochlorines in the fetus of a harbour porpoise, expressed in $\mu g g^{-1}$ on an extractable lipid basis, and extractable lipid content of tissue in % of wet weight

	Kidney	Liver	Subcutaneous fat
PCB (Phenoclor DP6)	34	50	59
p,p'-DDE	7.2	11.8	9.2
p,p'-DDT	4.5	5.2	12.5
p,p'-DDD	1.5	3.5	2.5
o,p'-DDD	1.3	3.4	2.5
Dieldrin	2.0	4.7	2.5
Hexachlorobenzene	0.7	1.3	0.1
α -hexaclorocyclohexane	0.2	0.3	0.3
γ -hexaclorocyclohexane (lindane)	0.2	0.3	0.2
extractable lipid	1.5	21	0.6

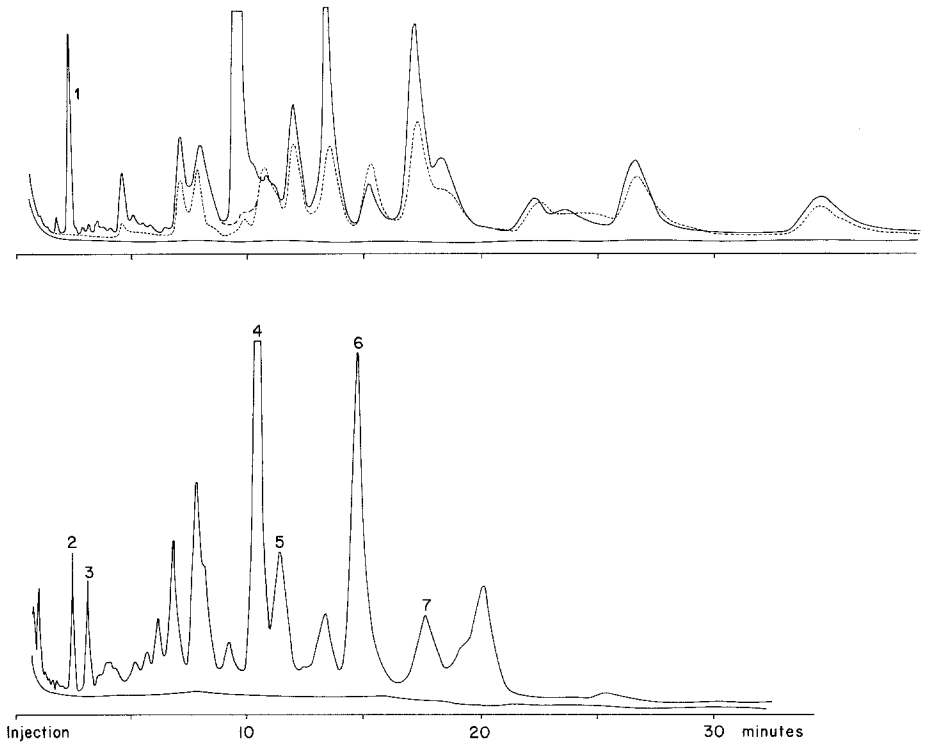

Fig. 1. Chromatograms of liver extract of fetus, cleaned up over alumina and fractionated over a silica column (both treated with CH_2Cl_2), eluted with hexane (first fraction, top chromatograms) and with a 10% diethyl ether in n-hexane solution (second fraction, lower chromatograms). Blank chromatograms, involving the complete procedure without sample, arve given as solid curves in the lower parts of top and bottom pictures. ———— sample extract, ... Phenoclor DP 6,------- sample extract after oxidation with chromic acid. 1:hexachlorobenzene, 2:α-HCH, 3:Y-HCH, 4:dieldrin, 5:o,p'-DDD, 6:p,p'-DDD, 7:p,p'-DDT. p,p'-DDE is quantified as the difference of ———————— and - - - - - - - in the first fraction (ret.time 9.6 min) Column: 1.8 m,1.5% SP 2250-1.95% SP 2401 on 100-200 mesh Supelcoport at 215°C. Carrier gas Ar/CH_4 90:10,^{63} Ni ECD. The second column used for identification was 3% DEGS- 1% H_3PO_4 on Chromosorb W-AWDMCS at 200°C.

Analizing milk and blubber in females and their pups of the grey seal, ADDISON & BRODIE (1977) calculated that 15% of the total body burden of PCB and 30% of Σ DDT could be transferred from the female to lactating pups. The available data do not allow a very accurate value for the loss by transplacental transfer to the fetus to be calculated. However, on the assumptions that 1) the concentrations on a lipid basis of a particular organochlorine in the fetus is of the same order as in the pregnant female, 2) the residue concentrations in the lipids of the fetus

do not change dramatically during pregnancy, or at least do not decrease, 3) the relative contributions of lipid material to total body weight in fetus and female do not differ, and 4) the weight of the pup is 1/6 of that of the female (10 and 60 kg), some 15% of the total body burden of organochlorines may be transferred from female to fetus.

If this mechanism is a general phenomenon in marine mammals, it will assist in explaining the presence of lower organochlorine residues in pregnant and lactating harbour porpoises and Baltic Ringed seals than in non-pregnant females (HELLE et al. 1976b), and the lower concentrations in adult females than in males that have been observed in harbour porpoises (GASKIN et al. 1971), Arctic Ringed seals (ADDISON & SMITH 1974) and Baltic Ringed seals (HELLE et al. 1976b). It also assists in explaining the presence of residue concentrations in pups (HEPPLESTON 1973, HEPPLESTON & FRENCH 1973, JONES et al. 1976). A correlation between residue concentrations and age or sex may be valid for other species as well. The fact that it has not been found in a number of studies (HEPPLESTON 1973, HEPPLESTON & FRENCH 1973) is not surprising taking into account the complex mechanisms of accumulation from food, metabolism and excretion (JANSSON et al. 1975, JENSEN & JANSSON 1976). High tissue concentrations of PCB and Σ DDT have been associated with abnormally low reproduction rates observed in the populations of Baltic Ringed Seals (HELLE et al. 1976 a,b) and California sealions (DE LONG et al. 1973, LE BOEUF & BONNELL 1971). Mobilization of the compounds from female lipid tissue during pregnancy and passage through the placental barrier into fetal tissue may be an important factor that should be considered when estimating the effects of these compounds on populations of marine mammals, particularly in contaminated areas where significant amounts can be transferred to the fetus.

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