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# DISTRIBUTION OF PCB AND DDT AMONG HUMAN TISSUES

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**ABSTRACT**

Samples of various tissues taken at autopsy from 22 subjects were analysed for PCB and DDT and its metabolites by GLC method. As expected the concentrations in fat were by far the highest in the body. The lowest concentrations were found in the spleen. The distribution among various tissues seems to be similar in women and men. Correlations between PCB or DDT concentrations and age of subjects were calculated.

In industrial exposures as well as in studies of populations exposed to chemicals in the general environment there is a need to evaluate risks of exposure. For cumulative chemicals monitoring programmes may be useful in this respect. A correct evaluation of data from such monitoring programmes need to be based on information concerning the distribution and biological half time of the studied chemical in man. For PCB (polychlorinated biphenyls) data are very incomplete in this respect as recently pointed out by international health authorities[1,5]. The present study aimed at furnishing some additional data on these aspects.

## MATERIALS AND METHODS

Tissue samples were obtained at autopsy from the departments of Pathology and Forensic Medicine of the Odense University Hospital and comprised 17 male and 5 female subjects aged 0–65 years from the Funen area of Denmark. The sampling was made during the period 1976–1978. Samples were stored in glass containers at −30 °C until analysed 0–2 months after the sampling.

The pesticide residues in the samples were quantified by application of a method described by the Laboratory of the Government Chemist, London. The method comprised homogenization of the sample by an ultra turrax homogenizer, mixing with sand and sodium sulphate and extraction with redistilled petroleum ether (b.p. 56–64 °C). Further purification of the extract

was obtained by extraction in dimethylformamide/hexane (saturated solution). The sample was thereafter subjected to separation on an aluminum oxide column with hexane as elution medium. Final purification was obtained by chromatography on heat activated $SiO_2$ (with 3%water w/w). This column was first eluted with petroleum ether (this eluate contains PCB and the main part of DDE etc.) and thereafter with petroleum ether containing 15% ethyl ether (v/v). The last mentioned eluate contained remaining amounts of DDE, DDT and DDD etc.

Final analysis was performed by GLC (gas liquid chromatography) in a Perkin Elmer 3920 instrument with EC detector. Column: glass (183 × 0.6 cm). Column filling: 5% DC-200, 7.5% QF1 on Chromosorb W,HP. 80/100. Column Temperature 196 °C, detector temperature 225 °C, gas flow (90% argon 10% methan) 40 ml/min.

| | | | |
|---|---|---|---|
| Standards: | DDT | 100 pg/µl | (analytical grade compounds from Polyscience Corp. Evanston Ill. USA) |
| | DDD | 100 pg/µl | |
| | DDE | 50 pg/µl | |
| | PCB | 1 ng/µl | (Clophen A-60 from Farbenfabriken Bayer Ag, Leverkusen W. Germany) |

Application 5 µl per injection.

## RESULTS AND DISCUSSION

The results of analysis of PCB, DDT, DDE and DDD are given in the tables 1–3. The PCB values represent total polychlorinated biphenyls calculated according to peaks no. 8 and 10 of a standard (Fig. 1 clophen A60) and the corresponding peaks obtained from the sample. When using all the various peaks in the clophen A60 standard and all the peaks obtained in the chromatogram from the samples, no appreciable difference was detected in relation to using only peaks 8 and 10. This procedure was possible to carry out for a number of samples of fat tissue and liver tissue, but for some of the other tissues the concentrations were too low and did not allow this type of calculation. Peaks 8 and 10 were always the most prominent peaks in the chromatogram and in no case did any other PCB peak exceed these two peaks. The similarity of the chromatogram clophen A-60 and human tissue is in accord with the results of Jensen and Sundström[3].

As shown in Table 1, the number of samples from female subjects is very limited. Nevertheless it seems reasonable to conclude that the concentrations in the various tissues are similar to those of men. The concentrations of PCB and Σ DDT in adipose tissue were similar to those recently reported for human subjects in Denmark by Kraul and Karlog[4] and Finland by Hattula and co-workers[2]. Also the distribution among various organs seems to be similar in women and men. The highest concentrations were found in the adipose tissue and the average concentration in fat exceeded by a factor of 15 or more the

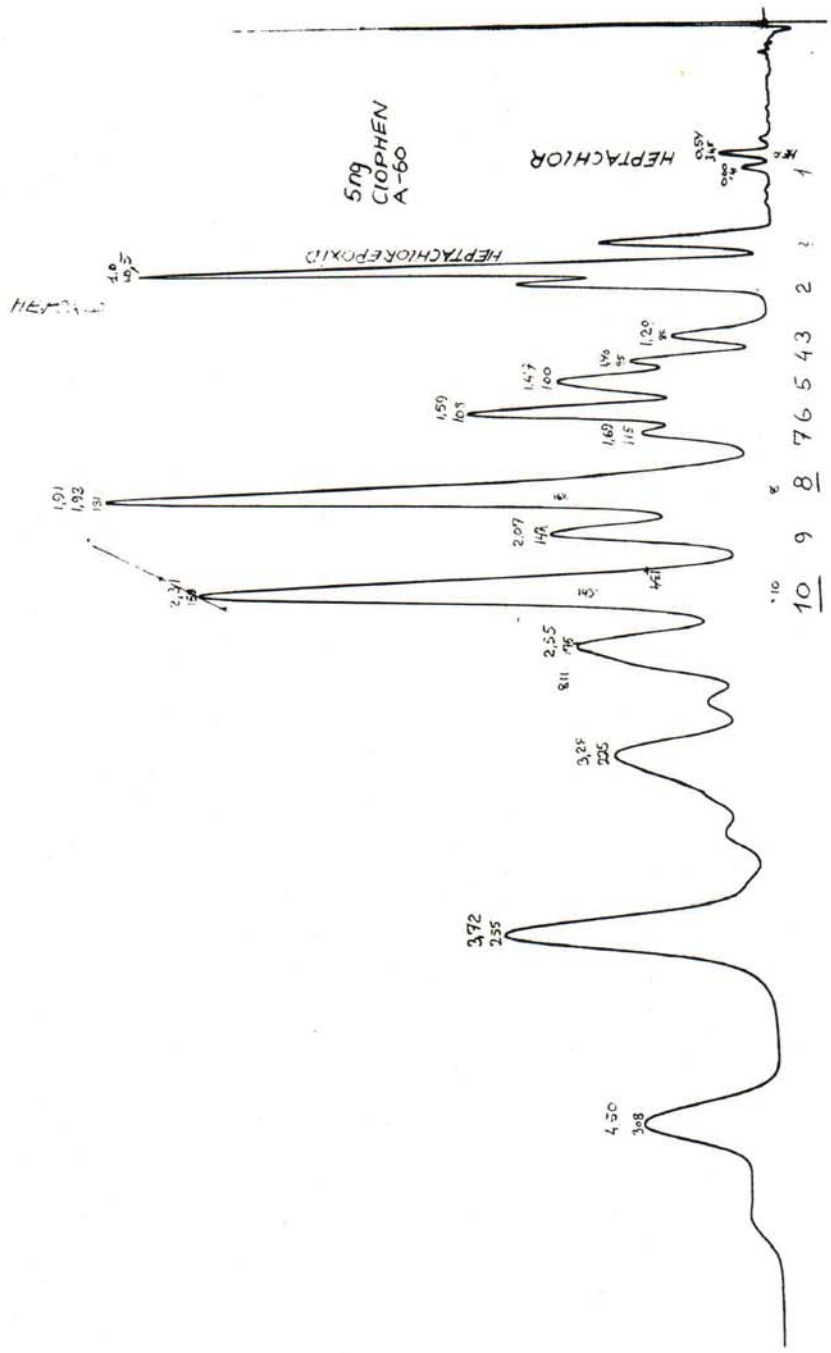


FIG. 1 – Chromatogram of 5 ng of Chlophen A60 Standard. Peaks 8 and 10 were used for quantification of PCB in human tissue samples.

TABLE 1

PCB and Σ DDT in various tissues from the Danes (mg/kg wet weight). Women, post mortem material (5 individuals).

| Tissue | PCB | PCB (% of concentration in fat) | Σ DDT* | Σ DDT (% of concentration in fat) |
|---|---|---|---|---|
| Fat | 2.204 | 100.0 | 2.305 | 100.0 |
| Basal ganglia | 0.046 | 2.1 | 0.059 | 2.6 |
| M. psoas | 0.128 | 2.2 | 0.087 | 3.8 |
| Spleen | 0.034 | 1.5 | 0.071 | 3.1 |
| Liver | 0.146 | 6.6 | 0.061 | 2.7 |
| Kidney | 0.057 | 2.6 | 0.031 | 1.4 |
| Ovary | 0.027 | 1.2 | 0.083 | 3.6 |

* Σ DDT = (DDE + DDD) 1.11 + DDT (all on mg/kg wet basis).

TABLE 2

PCB and Σ DDT in various tissues from the Danes (mg/kg wet weight). Men, post mortem material (17 individuals).

| Tissue | PCB | PCB (%of concentration in fat) | Σ DDT* | Σ DDT (% of concentration in fat) |
|---|---|---|---|---|
| Fat | 2.237 | 100.0 | 1.549 | 100.0 |
| Basal ganglia | 0.114 | 5.1 | 0.161 | 10.4 |
| M. psoas | 0.066 | 2.9 | 0.072 | 4.7 |
| Spleen | 0.042 | 1.9 | 0.044 | 2.8 |
| Liver | 0.141 | 6.3 | 0.168 | 10.8 |
| Kidney | 0.058 | 2.6 | 0.038 | 2.5 |
| Testis | 0.069 | 3.1 | 0.042 | 2.7 |

* Σ DDT = (DDE + DDD) · 1.11 + DDT (all on mg/kg wet weight)

concentration in any other tissue. The 2nd greatest concentration was found in the liver; about six per cent of the concentration in fat. The concentration in basal ganglia and in testis were somewhat lower and the lowest concentration was found in the spleen. It was about 1.5% of the concentration in fat.

The person with the highest concentration of PCB in the tissues was a fisherman aged 29 years, who had 0.72 mg/kg in the liver, 0.485 mg/kg in the basal ganglia and 1.071 mg/kg in the testis. This person died from cancer of the testis, and is not included in the data presented in the table, since the values deviated very much from those of other persons included in the study.

TABLE 3
Ratio between concentration of PCB and DDT in brain and other tissues (mg/kg wet weight).

| | | This study | | | Kraul and Karlog[4] | | |
|---|---|---|---|---|---|---|---|
| | | Brain | Liver | Fat | Brain | Liver | Fat |
| Women | PCB | 1 | 3.17 | 47.9 | 1 | 3.5 | 81 |
| | Σ DDT* | 1 | 1.03 | 39.1 | 1 | 7.2 | 112 |
| Men | PCB | 1 | 1.2 | 19.6 | 1 | 3.5 | 81 |
| | Σ DDT* | 1 | 1.0 | 9.6 | 1 | 7.2 | 112 |

*Σ DDT = (DDE + DDD) · 1.11 + DDT (on basis of mg/kg wet weight)

The ratios between concentrations of PCB and Σ DDT in the brain, liver and adipose tissue are shown in Table 3. Similar data from Kraul and Karlog[4] are also included in these tables for comparison. In both sets of data brain concentrations are lower than liver concentrations and these latter are lower than the concentrations in fat tissue. The numerical values of the relationships vary somewhat between the two studies but it should be kept in mind that for women very few observations were included in the present set of data. However, for men also there were some differences. These differences seem to be most prominent between the brain and the liver, whereas the liver: fat ratio was more similar between the present study and the one by Kraul and Karlog. A possible reason for this is that different parts of the brain were used in the two studies. Whereas Kraul and Karlog used whole transversal slides of the brain, basal ganglia were used in the present study. Kraul and Karlog reported high correlation coefficients between various tissues. In the present study the correlation in some instances approached statistical significance.

Another observation made in the present study is the statistically significant correlation between age and pesticide concentrations in samples of fat. In Figure 2 PCB concentrations in adipose tissue for both sexes are plotted against age ($r = 0.61$ $p < 0.005$). A correlation with age was also found for DDT ($r = 0.54$ $p < 0.02$). The correlations with age indicate a very long biological half-time for these substances in human adipose tissue. Because of the limited size of the present material the biological half-time was not calculated. It may be assumed, however, that it will be of the order of a decade.

To summarize the present investigation, which is still in progress, has provided evidence indicating that it is possible to calculate the biological half--time of PCB from its accumulation in human adipose tissue. Further

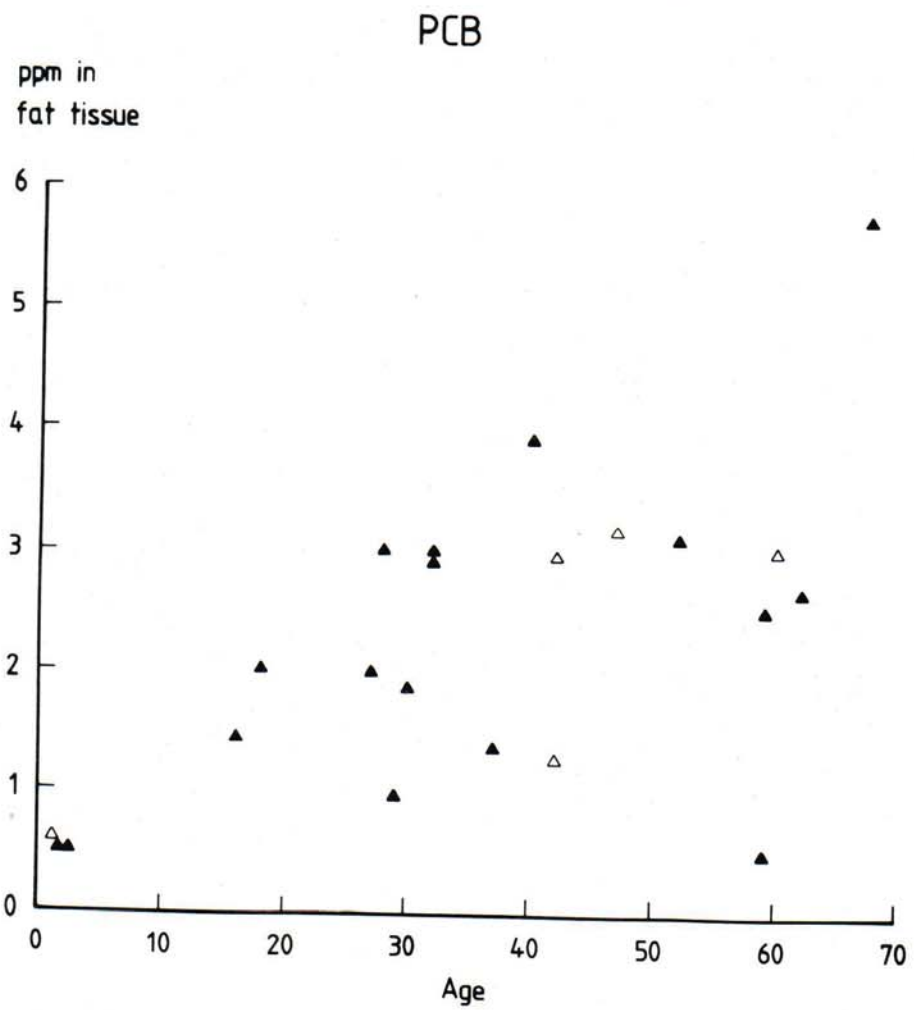


FIG. 2 – Relationship between concentration of PCB in fat tissue (mg/kg wet weight) and age. Filled symbols indicate men, open symbols are women.

investigations into the relationship between concentrations in various tissues are necessary in order to find out whether fat- or bloodsamples are more adequate for use in monitoring programmes. In the criteria document produced by WHO[5] evaluations were based on skin effects. However, identification of critical organs for low level PCB-toxicity in humans appears to need further evaluation. This would be of interest in order to improve possibilities to assess risks as based on biological monitoring programmes.

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