INVERESK STUDIES

The basic objective of these experiments was to study the consumption of various PCB products in model ecosystems.

This was a joint project carried out by Inveresk Research International (Scotland) and Monsanto Europe (Belgium).

Self-suporting model ecosystems were established at Inveresk. These consisted of tanks, measuring 120 x 30 x 30 cm, containing 67 litres of water; sediment and detritus covered the base to an average depth of 1 cm. Clumps of weed were placed at each end to provide shelter for crustacea, molluscs and fish. The fish were three-spined sticklebacks (gasterosteus aculaetur). Crustacea were introduced to the tanks at intervals to provide food for the fish.

Known amounts (2.7 mg) of various PCB products were introduced into these systems and, after a period of eight weeks, estimates were made of the total residue in each system. The distributions of these residues among various phases of the systems were also estimated.

After allowing the systems to equilibrate, 2.7mg each of Aroclors 1254, 1242, 1016 and MCS 1043 were added to pairs of tanks. Since the experiment was conducted in two phases, Aroclor 1254 was used in two tanks in each phase. Tanks to which no PCB was added were also included as blank controls.

After eight weeks the tanks were emptied. Five or ten litre samples of water were passed through polyurethane plugs and the extracted PCB estimated by glc. From these measurements the total PCB contents of the waters were estimated. Fish, weed and mud were carefully removed and weighed and appropriate samples were analysed for PCB so that the total residues in these phases could be estimated. The tank walls, which were covered with algae, were washed with acetone and the estimated PCB contents of these washings were included with the weed totals. The mud also contained the crustacea and molluscs.

The estimated PCB residues for the various phases are shown diagrammatically in Fig. 1 and Table I.

In addition, the concentrations of PCB residues in water and fish were estimated. These are shown in Table II.

The levels of PCB residues in the blank control tanks were found to be insignificant.

DISCUSSION

Fig. 1 shows that the apparent consumption of PCB product increases as the chlorine content is reduced. MCS 1043 disappears almost completely. Aroclor 1242 and 1016 show substantially similar degrees of disappearance, with Aroclor 1016 showing slightly lower residue of about 24%. Aroclor 1254 shows the least disappearance, although, apparently, only about 50% remains after eight weeks.

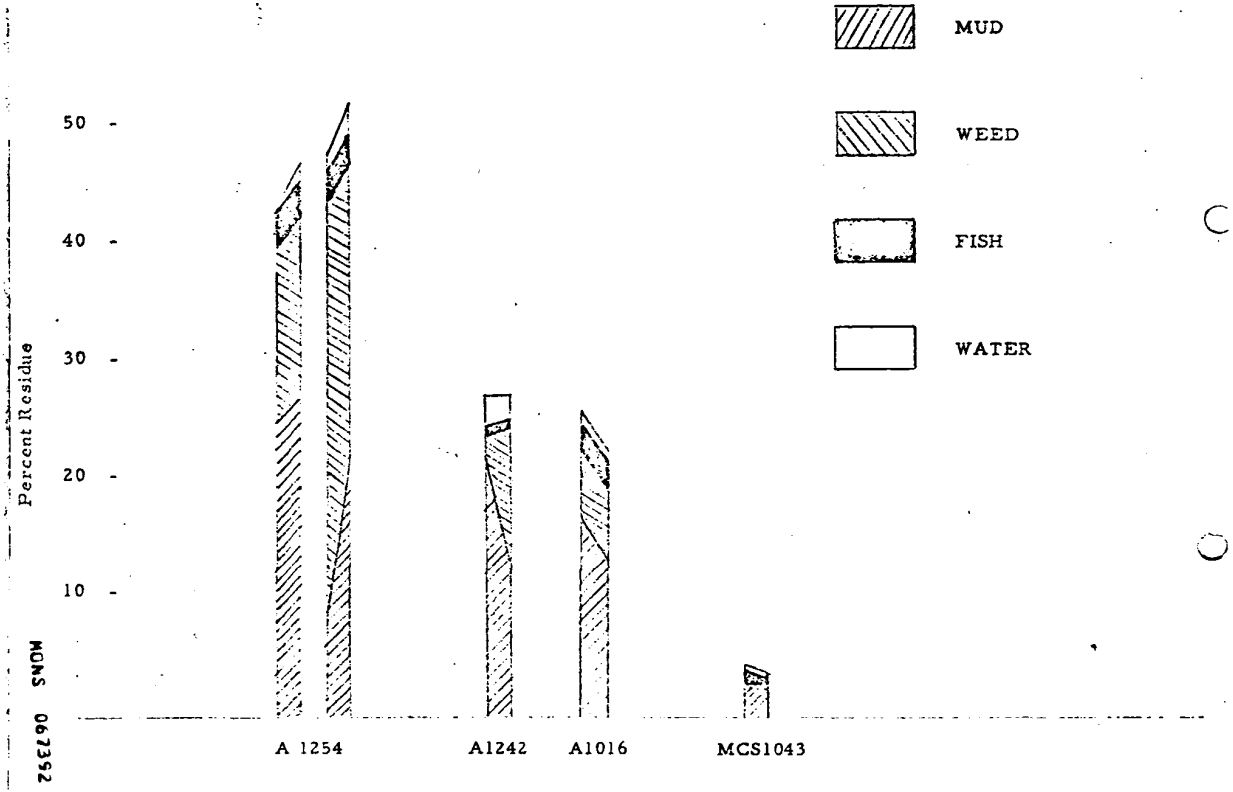
The results in Table II show a number of inconsistencies, probably due to inaccurate estimates of the lower chlorinated PCBs in relatively small samples. The analyses of Aroclor 1254 are probably reasonably accurate and the consistence of the results for this product supports this view. The ratio of concentration in fish to concentration in water for Aroclor 1254 ranges from about 30, 000 to 50, 000 and we believe this to be representative of the behaviour of Aroclor 1254 in such a system. It is appropriate to point out, however, that the Aroclor 1254 was introduced into the system at a concentration of 40μg/l and that using this as the base concentration, the ratio of concentration in fish to that in water would average only 560.

The results for Aroclor 1242 and 1016 are more difficult to interpret. In the first series of experiments the ratio of concentration in fish to that in water was about 2, 000 whereas in the second series the results for Aroclor 1016 show ratios ranging from 100, 000 to 200, 000. The reasons for these major discrepancies are not known and we are unable to reconcile the two series. The small sample sizes (average fish weights were only three to four grammes total) and the low levels in water made accurate estimation difficult. In the case of MCS 1043, where most of the product had disappeared, the problem was accentuated by some non-PCB interference on the chromatograms; in this case the background interference was such that the figures quoted are maxima and the true values probably much less.

It is also important to note that for the samples containing Aroclor 1254 the chromatograms showed relatively little change from that of a standard chromatogram. For Aroclors 1242 and 1016 and particularly for MCS 1043 quite major changes in the chromatograms were observed. Since only the higher boiling peaks remain relatively unchanged these tend to be used for quantification and hence the PCB levels are almost certainly overestimated.

Figure 1

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TABLE I

	Tank N°	Product	Water	Percent Residue Fish	Weed	Mud	Total
Series 1	1	-	-	-	-	-	-
	2	A 1242	2.6	0.4	4.6	19.7	27.3
	3	A 1254	0.9	3.3	14.4	25.5	44.1
	4	-	-	-	-	-	-
	5	A 1242	2.0	0.3	11.9	13.0	27.2
	6	A 1254	1.1	3.3	15.8	20.9	47.1
Series 2	1	A 1254	1.6	2.4	35.5	8.5	48.0
	2	A 1254	2.3	2.6	25.7	21.9	52.5
	3	MCS 1043	0.7	0.7	0.2	3.0	5.0
	4	MCS 1043	0.4	0.0	0.2	3.0	5.0
	5	A 1016	0.6	2.4	6.2	16.8	26.0
	6	A 1016	0.3	4.2	4.4	13.7	22.6
	7	-	-	-	-	-	-
	8	-	-	-	-	-	-

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TABLE II

	Tank N°	Product	Concentration ($\mu g/l$) (Water)	Concentration ($\mu g/g$ (Fish wet wt)	Ratio Fish/Water
Series 1	1	-	-	-	-
	2	A 1242	1.1	2.4	≃ 2,000
	3	A 1254	0.4	18	≃ 45,000
	4	-	-	-	-
	5	A 1242	0.8	1.4	≃ 2,000
	6	A 1254	0.45	18	≃ 40,000
Series 2	1	A 1254	0.6	29	≃ 50,000
	2	A 1254	0.9	24	≃ 30,000
	3	MCS 1043	0.3	6.7	≃ 20,000
	4	MCS 1043	0.3	0.6	≃ 3,000
	5	A 1016	0.2	22	≃ 100,000
	6	A 1016	0.1	32	≃ 200,000
	7	-	-	-	-
	8	-	-	-	-

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