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Organo-chlorine Insecticides and PCBs in River Nile Water, Egypt

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Organo-chlorine insecticides and polychlorinated biphenyls (PCBs) are know to maintain their stability in the aquatic environment for long periods (Higgins and Burns 1975).

The presence of trace quantities of organo-chlorine and PCBs in natural waters may generate concern in regard to public health. DDT, DDE and PCBs were reported to induce the formation of hepatic enzymes in birds and mammals (Risebrough et al 1968, Wurster 1969, Holden 1972).

Permissible limits for p,p̃-DDT, lindane and endrin in water supplies are 1, 3 and 0.2 µg/L respectively (Train, 1979, WHO 1982). Standards for PCBs in drinking water supplies have not been established. However, a level of 0.001 µg/L was suggested for fresh water supplies (Train 1979).

Direct application of insecticides, leaching from treated agricultural lands and discharge of wastewaters present the major sources of water pollution by such organics (Faust and Aly 1964). In Egypt, organo-chlorine pesticides are still used for economic reasons. Meanwhile, wastewaters after primary treatment are frequently discharged into the river. Consequently, the present study aims to identify and measure the concentration of organo-chlorine insecticides and PCBs liable to reach River Nile in the Delta region where intensive agricultural and industrial activities are going on.

MATERIAL AND METHODS

Water samples were collected from River Nile at five sites namely, Cairo, Al-Mansora, Demiatt, Kafr Al-Ziat and Rosetta (Fig 1). Grab samples were collected across the river at the given sites, during March, May and September 1982. Samples were collected, once per month, in 2-litre glass bottles previously cleaned by 15% methylene chloride in n-hexane (v;v). The combined extracts were

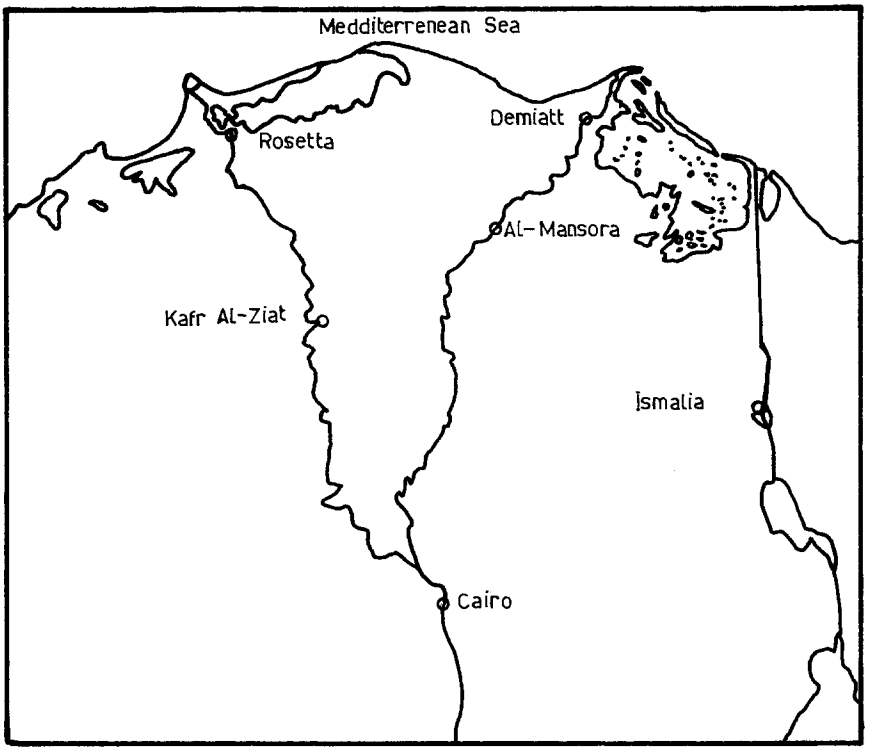

Fig 1. Schematic map showing sampling sites

passed through a column of anhydrous sodium sulphate. The dried extracts were concentrated to 5 mL using a kuderna-Danish (K.D) evaporator. Further concentration of the extracts to 2 mL was achieved by using a micro synder-reflux column fitted to the K.D. tube in a hot water bath. Clean-up and separation of PCBs from organo-chlorine insecticides were followed according to the Environmental Protection Agency (EPA) methods (1974). Chemical names of the tested compounds are to be found in Analytical Reference Standards (Watts 1981).

Gas liquid chromatography (GLC) was applied for the identification and measurment of the insecticides and PCBs. A Varian 3700 GLC, equipped with Ni^{63} electron capture detector, and a glass column (4mm I.D. and 2 meter length) was used. The column was packed with 4% SE 30+6% QF on 80/100 Chromosorb W. The column, injector and detector temperatures were 200 ^{o}C,250 ^{o}C and 300 ^{o}C, respectively. Nitrogen was used as a carrier gas at a flow rate of 40 mL/min. Minimum detection limit for BHC, lindane and PCBs was 0.1 µg/L, that for chlordane, endrin, dielrin was 0.15 µg/L and for DDT and its metabolites was 0.2 µg/L.

Table 1. Organo-chlorine and PCBs residues in River water (ng/L), March 1982.

Compound	Sampling Site				
	Cairo	Kafr-Al Ziat	Rosetta	Demiatt	Al-Mansora
BHC	0.5	0.6	0.1	1.6	0.1
Lindane	0.1	13.4	1.5	4.2	3.8
Endrin	5.9	16.5	4.2	10.8	13.8
p,p̃-DDE	5.8	10.8	0.2	5.8	7.2
p,p̃-DDD	2.8	23.2	16.8	11.2	28.7
p,p̃-DDT	0.1	24.2	11.6	11.5	11.5
DDT*	8.6	58.4	28.4	28.5	47.4
Total O.C**	15.0	88.7	34.1	34.1	65.0
PCBs	19.3	59.3	5.6	8.5	15.6

* DDT = Sum of (p,p̃-DDT, p,p̃-DDE + p,p̃-DDT).

** Total O.C. = Total concentration of organo-chlorine residues.

RESULTS AND DISCUSSION

Residues of BHC, lindane, endrin, p,p̃-DDT, p,p̃-DDE and p,p̃-DDD were identified in all river water samples studied. Results given in Tables 1 to 3 present the concentration levels of organo-chlorine insecticides and PCBs found in water during March, May and September, 1982, respectively. Chlordane, o,p̃-DDT and aldrin were not detected. That may be attributed to the limited use of these chemicals and to their less persistence compared with the other organo-chlorine insecticides (Higgins and Burns 1975). In general, residue levels of the studied compounds in the river samples followed the order: DDT > Endrin > lindane > BHC. According to Edwards (1978) persistence of organo-chlorine insecticides followed the order: DDT > dieldrin > lindane > chlordane > heptachlor > aldrin.

Available results revealed slight variations, at a given sampling site, in residue levels of the organo-chlorine insecticides and PCBs during the period of investigation. However, considerable variations in their concentration in water do exist according to the sampling sites. Results given in Table 4 present the general trends for the distribution of studied compounds in the River Nile Water. Highest concentrations of BHC, lindane, endrin,

Table 2. Organo-chlorine and PCBs residues in River Nile water (ng/L), May 1982.

Compound	Sampling Site				
	Cairo	Kafr-Al Ziat	Rosetta	Demiatt	Al-Mansora
BHC	2.8	15.4	0.1	1.2	0.1
Lindane	0.4	18.9	1.8	4.4	8.5
Endrin	5.8	18.9	8.8	15.4	9.4
p,p̃-DDE	5.4	13.4	0.6	7.3	7.9
p,p̃-DDD	3.0	22.6	18.4	7.4	27.7
p,p̃-DDT	1.5	22.8	14.4	10.6	11.0
DDT*	9.9	58.8	33.4	25.3	46.6
Total O.C**	18.9	112.0	44.0	46.3	46.5
PCBs	20.7	40.6	7.8	9.3	14.5

* DDT = Sum of (p,p̃-DDT + p,p̃-DDE + p,p̃-DDD).

** Total O.C. = Total concentration of organo-chlorine residues.

p,p̃-DDT and its metabolites, and PCBs were found in the river water at Kafr Al-Ziat. At that location a refinary and pesticide-packing firms discharge their wastewaters into the river. At Rosetta, which is down stream with respect to Kafr Al-Ziat, the residue levels of the studied compounds were considerably decreased. Evapouration, adsorption on suspended clays and uptake by aquatic organisms may contribute to the observed decline in residue levels. However, the concentration of the isolated organo-chlorine and PCBs compounds at Rosetta were still much higher compared with that found in the river at Cairo (Table 4). At Al-Mansora, the concentration of organo-chlorine insecticides was considerably higher compared with that at Cairo. Al-Mansora represents one of the most productive agricultural areas in the Nile Delta. The observed increase in residue levels at that location reflects the extensive use and leaching of insecticides. However, residues of PCBs in the river water at Cairo exceeded that found at Al-Mansora. At Demiatt, down stream with respect to Al-Mansora (Fig 1), the concentration of endrin, p,p̃-DDT and p,p̃-DDE nearly maintained the same levels observed at Al-Mansora. However, lindane, p,p̃-DDD and PCBs showed considerable decline in their concentration

Table 3. Organo-chlorine and PCBs residues in River Nile (ng/L), September

Compound	Sampling Site				
	Cairo	Kafr Al-Ziat	Rosetta	Demiatt	Al-Mansora
BHC	1.8	10.0	0.1	1.5	0.1
Lindane	0.1	17.0	1.2	4.6	10.6
Endrin	3.8	13.7	5.2	14.8	9.3
p,p̃-DDE	2.0	10.8	0.4	12.6	6.6
p,p̃-DDD	2.3	18.4	17.6	6.8	28.2
p,p̃-DDT	1.2	20.3	13.0	11.0	9.2
DDT*	5.5	49.5	31.0	30.4	44.0
Total O.C**	11.1	90.2	37.4	51.3	63.9
PCBs	18.0	44.8	6.9	8.9	14.0

* DDT = Sum of (p,p̃-DDT + p,p̃-DDE + p,p̃-DDD).

** Total O.C. = Total organo-chlorine residues.

at Demiatt (Table 4). As a general trend, residue levels of the organo-chlorine insecticides followed in the order: Kafr Al-Ziat ⟩ Al-Mansora ⟩Demiatt ⟩ Rosetta ⟩ Cairo. In case of PCBs, the concentration levels tends to be: Kafr Al-Ziat ⟩Cairo ⟩Al-Mansora ⟩ Demiatt ⟩Rosetta. Results obtained also showed that percentage of p,p̃-DDT tends to increase in agricultural areas indicating recent pollution whereas the ratio of PCBs / DDT tends to increase in industrial and urban regions (Table 4).

Worth to be mentioned that residue levels of the studied compounds are still low compared with the permissible levels for drinking waters (Train 1979, WHO 1982). Meanwhile, the concentration of organo-chlorine insecticides in River Nile water is within the range reported for Rivers Avon and Frome (Kpekata 1975) and for Northern Missisipi water (Rihan et al 1978). However, Greichus et al (1978 a,b) reported much lower values for p,p̃-DDT and PCBs in several African lakes. Concentration of PCBs in River Nile is considerably lower than that reported for other rivers (Weith and lee 1971, Kpekata 1975, Nadeau and Davis 1976, Billings et al 1978).

Residue levels of the studied organo-chlorine and PCBs in the river water may affect aquatic life and / or lead to their accumulation into the food chain (Train 1979).

Table 4. Distribution of organo-chlorine and PCBs residues in River Nile (ng/L), during March, May and September 1982.

Compound	Cairo		Kafr Al-Ziat		Rosetta		Al-Mansora		Demiatt	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
BHC	0.5-2.8	1.7	10.-15.4	12.0	0.1	0.1	0.1	0.1	0.1-1.6	1.0
Lindane	0.1-0.4	0.1	13.4-18.9	16.5	1.2-1.8	1.5	3.8-10.6	7.6	4.2-4.6	4.4
Endrin	3.8-5.9	5.1	13.7-18.9	16.4	4.2-8.8	6.0	9.3-13.8	10.9	10.8-15.4	10.0
p,p̃-DDE	2.0-5.8	4.4	10.8-13.4	11.7	0.2-0.6	0.3	6.6-7.9	7.2	5.6-12.6	8.6
p,p̃-DDD	2.3-3.0	2.7	18.4-23.2	20.0	16.8-18.4	17.6	27.7-28.7	28.2	6.8-11.2	8.5
p,p̃-DDT	0.1-1.5	0.9	20.3-24.2	22.4	11.6-14.4	13.0	9.2-11.5	10.6	10.0-11.5	11.0
p,p̃-DDT		8.0		54.1		30.9		46.0		28.1
PCBs	18.0-20.7	19.3	40.6-59.3	48.2	5.6-7.8	6.8	14.0-15.6	14.7	8.5-9.3	8.9
%p,p-DDT/ DDT	11%		41%		42%		23%		39%	
PCBs/ DDT	2.4		0.9		0.2		0.3		.3	

DDT = Sum of (p,p̃-DDT + p,p̃-DDE + p,p̃-DDD)

Available results stress the need for adequate control and management of pesticide use and wastewater discharge into the aquatic environment.

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