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Organochlorine Residues in Organisms of Two Different Lagoons of Northwest Mexico[1]

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Organochlorine compounds, such as DDT and polychlorinated biphenyls (PCBs), are environmentally persistent compounds which have a capacity for bioaccumulation and biomagnification and produce acute toxicity patterns on aquatic organisms (JOHNSON 1968).

The level of pesticide residues in an estuary is a function of several factors such as agricultural activity, regional rainfall, drainage characteristics, soil composition, movement of particulates, and metabolic activity as has been reported by LIVINGSTONE (1978).

The present study aimed to examine the concentration of organochlorine compounds in two lagoon systems with different backgrounds: the Yavaros lagoon system in Sonora and the Huizache-Caimanero lagoon complex in Sinaloa Mexico (Fig. 1). These two lagoons in N.W. Mexico are of considerable economic importance, especially in regard to their shrimp production. The Yavaros complex consists of the Yavaros, Moroncarit, and Etchoropo lagoons, each of which receives drainage water from an extensive agricultural hinterland; the Huizache-Caimanero system consists of a large two-basined lagoon lying between and having access to the rivers Presidio and Baluarte. The climate of the two areas is different; the Yavaros area is semi-arid with low summer rainfall, while the Huizache-Caimanero area is a tropical zone and has a much higher summer rainfall (ORTEGA 1976).

The levels of organochlorine pesticides (total HCH, total DDT, heptachlor epoxide, aldrin, endrin and dieldrin were measured in several organisms during a one year period.

MATERIALS AND METHODS

The sampling sites for the collection of the specimens were a function of the accessibility of the organisms

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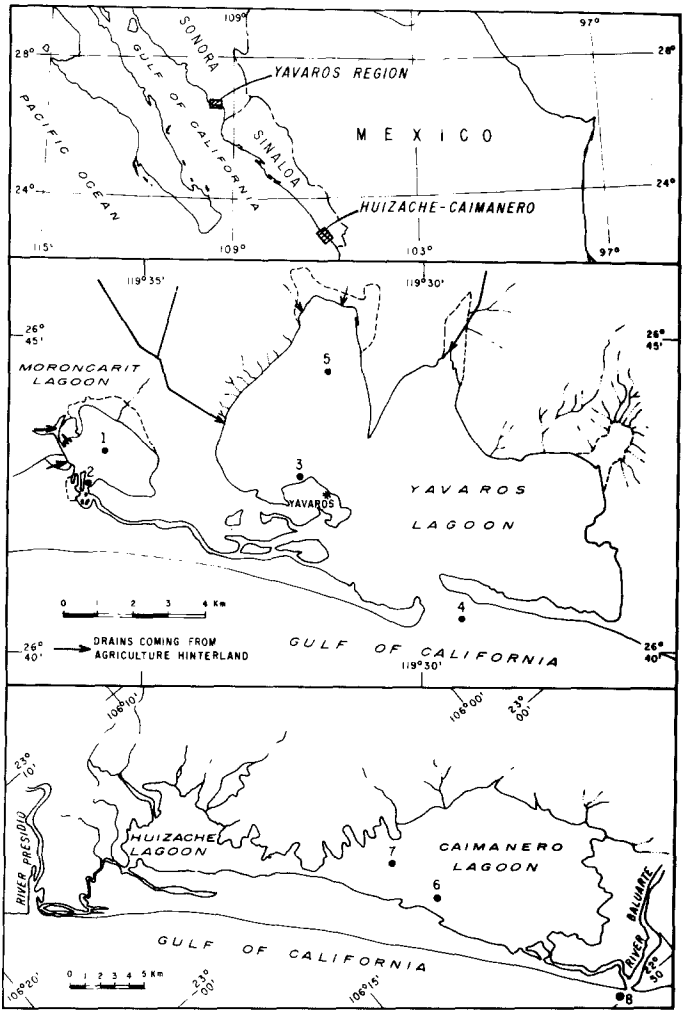

FIG 1 - A.-YAVAROS LAGOON SHOWING SAMPLING STATION IN THE LAGOON
B - HUIZACHE-CAIMANERO LAGOON COMPLEX SHOWING SAMPLING STATION IN THE LAGOON

and are shown in Fig. 1. Samplings were carried out every three months starting in April 1980. All samples were wrapped in aluminum foil, frozen with dry ice in the field, and kept frozen until analysis. Clam, shrimp, and small fish samples were usually pooled composites of 3 to 15 individual organisms.

Animal samples were dissected, weighed and dried by lyophilization. Dorsal muscle tissue was taken for fishes; clam samples included the entire body except the shell; shrimp samples included the entire body except the head and the carapace. Total sample size was usually less than or equal to 10 g.

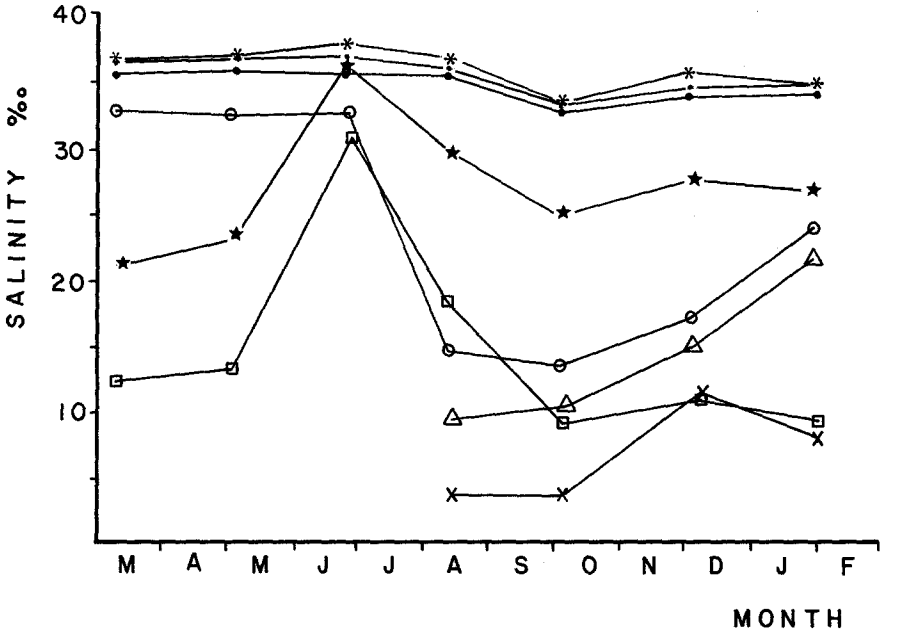

FIG. 2. Salinity in the study area during a one year period (1975 - 1976). Caimanero Estero (X), Caimanero Basin (Δ), Huizache Basin (O), Moroncarit Lagoon (□), Moroncarit Estero (★), Yavaros Basin: outer (•), middle (•), inner (*) (ORTEGA 1976).

The samples were extracted for 4 h with 200 mL of hexane in a Soxhlet apparatus, and the final extract was taken to a final volume of 250 mL. 25-mL aliquots were evaporated to dryness under a hood, the residue was weighed, and this weight was recorded as extractable fat.

A 50-mL aliquot of the extract was cleaned up by quantitatively transferring the sample to a column (35 x 10 mm) of alumina deactivated with 3% water and eluting the column with 15 mL of hexane. The eluate was then concentrated to 1.0 mL and quantitatively transferred to a silica column deactivated with 3% water (35 x 10 mm). The column was eluted first with 15 mL of hexane; this fraction contained: DDE, aldrin, heptachlor, and PCBs; the column was then eluted with 10 mL of 10% diethyl ether in hexane solution; this polar fraction contained: lindane, heptachlor epoxide, dieldrin, endrin, TDE, op-DDT and pp-DDT; the eluates were concentrated to 1.0 mL. Samples and standard solutions were analyzed with a gas chromatograph equipped with a ^{63}Ni electron-capture detector on two glass columns packed with 8% DC-200 and 6% QF-1 on 80/100 mesh Cromosorb W/HP. Inlet, column, and detector temperatures were 225, 185, and 250°C, respectively; carrier gas was nitrogen at 50 mL/min.

Table 1. Concentration of Various Organochlorine Pesticides in Fish Muscle (in ppb wet-weight basis).

Species analyzed	Date	Locality (station)	N	Extr. Fat %	HCH	Heptachlor epoxide	Dieldrin	Endrin	Aldrin	DDT
Mugil cephalus (striped mullet)	July/80	Moroncarit (1)	3	5.4	--	0.94	6.33	--	--	1.60
	July/81	Moroncarit (2)	3	7.5	2.50	0.81	5.64	7.33	0.52	5.14
	Oct./80	Yavaros (4)	11	8.2	1.36	0.35	1.80	--	--	0.37
	Jan./81	Yavaros (5)	3	6.0	1.40	0.45	5.60	1.72	--	2.02
	Apr./81	Yavaros (4)	6	7.0	1.69	2.84	7.60	4.80	0.40	1.92
	Jan./81	Caimanero (7)	4	13.9	1.77	0.40	1.00	--	--	11.73
Mugil curema (white mullet)	Jan./81	Yavaros (4)	4	6.7	1.22	2.94	10.50	7.60	--	1.90
	Oct./80	Caimanero (6)	3	11.2	--	--	--	--	--	6.87
Scomberomorus maculatus (mackerel)	Oct./80	Yavaros (4)	2	8.3	0.79	--	5.73	0.65	--	1.20
	Jan./81	Yavaros (5)	1	4.3	0.60	--	0.50	--	0.22	2.44
Paralichtys woolinaria (flounder)	Jan./81	Yavaros (5)	1	8.9	1.11	0.65	--	T	--	6.50
Centropomus pectinatus	Jan./81	Yavaros (4)	1	3.8	0.43	T	1.40	--	--	1.00
Centropomus robalito	Oct./80	Caimanero (6)	1	11.1	0.40	--	1.38	--	--	1.10

T = Traces

RESULTS AND DISCUSION

The results obtained for the different samples expressed in terms of ng/g wet weight of tissue are given in Tables 1 and 2.

In addition to the chlorine containing compounds studied (alpha-, beta-, and gamma-HCH, dieldrin, endrin, aldrin, heptachlor epoxide, DDT and metabolites) other chlorinated compounds were sometimes observed, but were not investigated in view of the scarce number of samples that showed them.

It is observed that aldrin, endrin, and heptachlor epoxide were not always detected; aldrin was found just in three samples and then only in very small quantities; HCH (all isomers) was detected in all samples; the highest value found was 2.50 ng/g. Dieldrin was observed in all the samples, with a value of 10.5 ng/g in the most contaminated sample.

The salinity patterns of the area reflect the effect of the rivers, agricultural drains, and outer sea. Fig. 2 shows the salinity variations of the two areas during a one year period (ORTEGA 1976). The Yavaros lagoon has a uniform salinity of approximately 37°/$_{oo}$ that reflects a high marine influence. In the Moroncarit area, the influence of the agricultural drains predominates over the marine effects. Nevertheless in June, the salinity values observed reflect a high marine influence; this water movement could explain the lower residue values observed in the organisms for the October sampling in the Yavaros area.

The salinity distribution over a year in the Huizache-Caimanero lagoon shows that there is a high evaporation in the area from March to June and an extensive drying of the lagoons, with mean salinity increasing due to evaporation; in July with the start of the rainy season, the lagoons are rapidly filled and the salinity falls quickly. The restricted circulation in the system could explain the higher DDT values found for the fish samples from Caimanero lagoon (sampling sites 6 and 7). The relatively low agricultural activity in the area as compared with the Yavaros region would seem to imply much lower levels of pesticide residues in organisms from the Huizache-Caimanero lagoons. However, the results indicate that the poor flushing characteristics of this system can lead to similar or even higher organochlorine levels in bottom-feeding fish such as the mullet.

We do not have enough data to predict a seasonal variation in the levels of halogenated hydrocarbons; it is apparent however that there is a lower value for Mugil

Table 2. Concentration of Various Organochlorine Pesticides in Crustacean Decapods and Mollusks (in ppb wet-weight basis).

Species analyzed	Date	Locality (station)	N	Extr. Fat %	HCH	Heptachlor epoxide	Dieldrin	Endrin	Aldrin	DDT
Penaeus stylirostris (Blue shrimp)	July/80	Moroncarit (1)	12	1.8	0.23	0.67	3.87	--	--	2.00
	Oct./80	Yavaros (4)	15	1.9	0.11	0.21	1.40	--	--	0.85
	Oct./81	Yavaros (4)	51	2.0	0.46	0.89	0.62	0.40	T	0.80
	Jan./81	Caimanero (8)	13	2.5	1.00	0.34	1.06	--	T	0.55
Trachypenaeus similis pacificus (Rock shrimp)	Jan./81	Yavaros (5)	3	2.1	0.78	1.24	1.06	--	T	0.55
Penaeus vanamei (white shrimp)	Oct./80	Caimanero (8)	12	1.9	0.60	1.00	2.04	--	T	0.42
	July/81	Moroncarit (2)	12	2.5	1.71	1.10	1.88	0.21	0.68	1.33
Callinectes arcuatus (crab)	Oct./80	Caimanero (8)	5	12.4	0.12	0.19	0.37	--	--	0.23
	Jan./81	Yavaros (5)	5	2.1	0.47	0.30	1.20	T	--	0.25
Megapitaria squalida (clam)	July/80	Yavaros (3)	16	4.7	0.54	1.20	7.12	3.23	--	7.00

T = Traces

Table 3. Comparative Average Concentrations of Organochlorine Residues (wet weight basis) in Organisms from Different Areas.

Area	Organisms	Residue concentration (ng/g)		
		HCH	Dieldrin	DDT
England*	Crangon crangon (brown shrimp)	4	9	13
Germany*	Crangon crangon (brown shrimp)	4	0.5	2.0
Mexico**	Penaeus stylirostris	0.7	1.7	0.9
U.S.A.***	Ostrea lurida	--	26	54
Mexico**	Megapitaria squalida	0.5	7.1	7.0
Mexico****	Mugil sp	--	--	3.6
Mexico**	Mugil cephalus	1.7	4.7	3.8

* GOERKE (1979) ** This work *** BUTLER (1973)
**** SECRETARIA DE MARINA (1974)

cephalus and Penaeus stylirostris in the October sampling in the Yavaros area.

In general, levels of DDT and dieldrin residues in organisms of the two areas studied are lower than the range of values reported in the literature as is shown in Table 3. The concentration of organochlorine compounds found in this work are a good deal below the widely accepted standards that represent a hazard to human health (500 ng/g wet wt. for DDT and 100 ng/g wet wt. for dieldrin) (AMICO 1979).

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