Bull. Environ. Contam. Toxicol. (1985) 35:322–330

Bulletin of Environmental Contamination and Toxicology

Organochlorine Hydrocarbon Residues in Sediments of Two Different Lagoons of Northwest México

M. T. L. Rosales, R. L. Escalona, R. M. Alarcón, and V. Zamora

Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Apartado Postal 70-305, 04520 México, D.F. México

The Yavaros lagoon system in Sonora Mexico and the Huizache-Caimanero lagoon system in Sinaloa Mexico (Fig.1) are areas of considerable economic importance given their high shrimp production. They are located in zones with different climate, drainage characteristics, agricultural activity, soil composition and movement of particulates, parameters which have been reported by Livingstone (1978) to be important factors in the accumulation of organochlorine residues.

In order to study the distribution and concentration of organochlorine compounds in these lagoons, they were measured in organisms (Rosales 1983) and sediments of the two areas.

The Yavaros complex consists of the Yavaros, Moroncarit and Etchoropo Lagoons. Each of these lagoons receives drainage water from an extensive agricultural area based on the River Mayo waters. The climate of this area is semi-arid with low rainfall. The Huizache-Caimanero system consists of a large two-basined lagoon located between the Baluarte River in the southeast and the Presidio River in the northwest. The lagoons are communicated with the rivers through two narrow channels 10 km long. The Huizache-Caimanero area has a tropical climate with high summer rainfall (Ortega 1976).

In the present study the analysis of the concentration of organochlorine compounds in sediments of the two lagoon systems during a period of 21 months allows us to suggest the relative importance of the different factors that affect the accumulation of these compounds.

1 Contribution No. 356 of the Instituto de Ciencias del Mar y Limnonogía, UNAM.

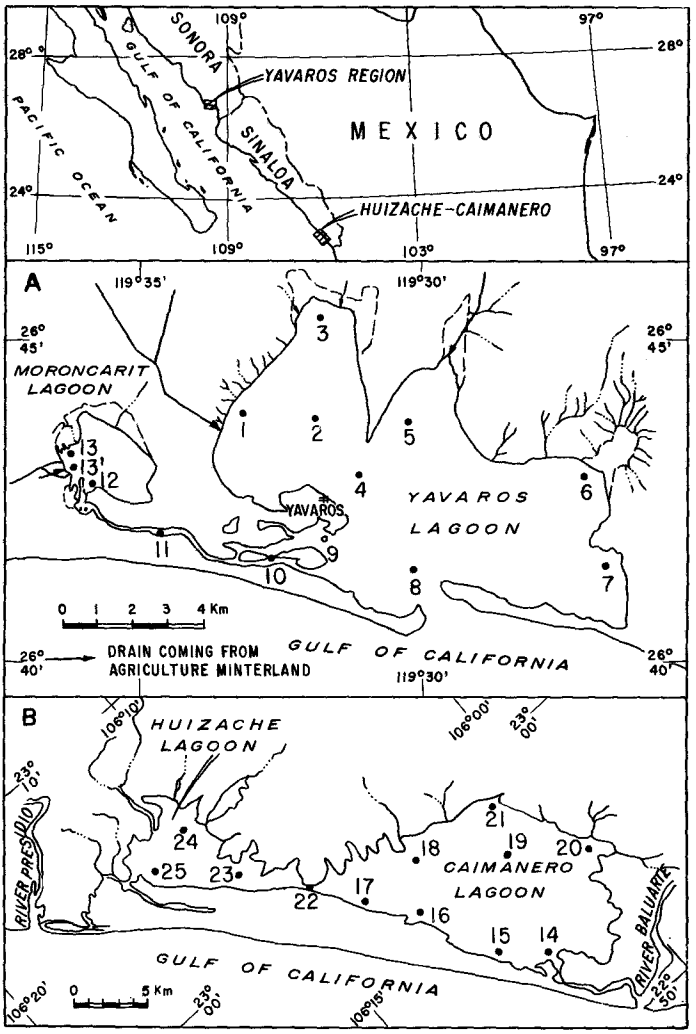

FIGURE 1.- A) Yavaros lagoon showing sampling station in the lagoon B) Huizache-Caimanero complex showing sampling station in the lagoon

MATERIALS AND METHODS

Sediment samples were collected seasonally (January, April, July and October) during a 21 month period. The sampling sites are shown in Fig. 1; however given the changes in water levels of the different lagoons the sampling sites first chosen were not always accessible. The sampling site 13 which was chosen in the first trip in the Moroncarit lagoon could not be reached in succesive trips, therefore site 13' was sampled instead in all the remaining trips. The water level at the Huizache-Caimanero lagoons is strongly dependent on a precipitation evaporation cycle (Ortega 1976). Navigation in the Huizache lagoon was only possible on

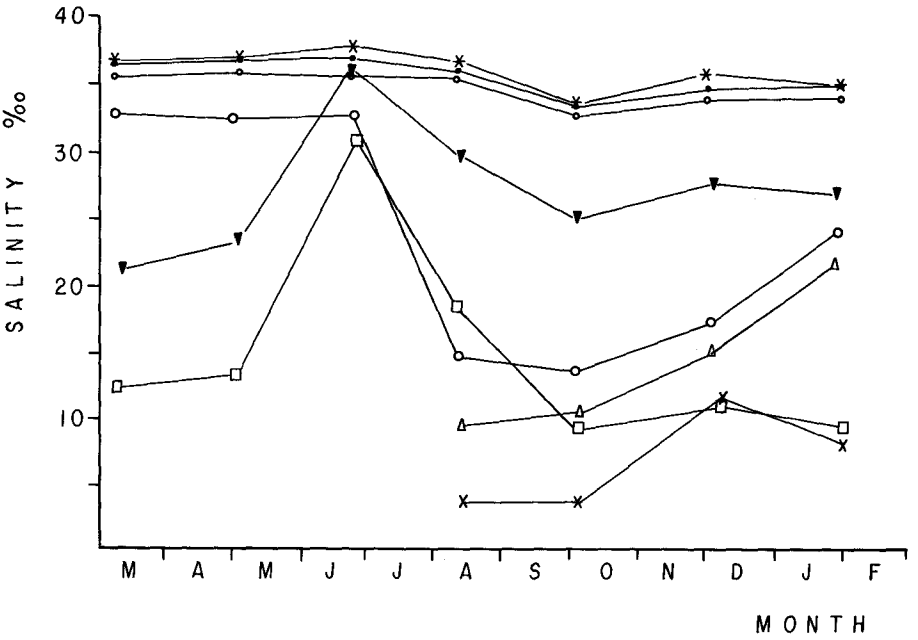

FIGURE 2. Salinity in the study area during one year period. Caimanero Estero (X), Caimanero Basin (Δ), Huizache Basin (o), Moroncarit Lagoon (□), Moroncarit Estero (▼), Yavaros Lagoon (outer) (•), Yavaros-Lagoon (middle) (•), Yavaros Lagoon (inner) (✳) (A.A. Ortega 1976).

the October sampling trips, and the number of sampling sites in Caimanero Lagoon was reduced during the January April and July trips given the low water level which was not sufficiently high as to permit the boat to reach all the sampling points.

Sediment samples were taken with the aid of a grab sampler, immediately transferred to prewashed glass jars and finally deep frozen until analysis. The homogenized wet sediment was divided into two portions, one of the portions was dried in an oven to determine the amount of water present; the dry sediment was then used to measure the percentage of organic matter by oxidation with potassium dichromate and titration with ferrous sulfate (Gaudette 1974), the second portion was dried by lyophilization and extracted for 4 h with 200 ml of hexane in a Soxhlet apparatus. The extract was cleaned by elution through alumina and silica columns as described for the organisms (Rosales 1983). Sediment extracts containing sulphur were treated with metalic Cu prior to G.C. analysis in order to remove sulphur.

The volums of the eluates were reduced to 1 or 2 ml and analysed 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 chromosorb W/HP, inlet, column and detector temperatures were 225°, 180° and 250°C respectively; carrier gas was nitrogen at 50 ml/min.

RESULTS AND DISCUSSION

The physical description of the sediment samples and the mode* water level at sampling points are given in Table 1. In stations with great variation in the water level the range of change is given. The concentration of organochlorine residues at each sampling station expressed in ug/Kg dry weight basis are given in Fig. 2. Yavaros Area: The higher concentrations of organochlorine compounds in the Yavaros area are usually found from October to January; however there is not a clear distribution pattern. The highest values observed are: HCH 10.45, Heptachlor 5.4, Aldrin 1.85, Heptachlor Epoxide 4.29, Dieldrin 5.85 and total DDT 7.62 ug/Kg. Sampling points in the Yavaros lagoon (station 1 to 8) have the lowest values. The values are higher in Moroncarit lagoon (station 12 & 13) and in the estero linking Moroncarit and Yavaros lagoons (station 9,10/11). Station 9 has the highest value in the Yavaros system.

The salinity pattern in the Yavaros system (Fig. 3) (Ortega 1976) shows that the Yavaros lagoon has an uniform salinity of approximately 37% which reflects a high marine influence. In the Moroncarit area the agricultural drain effects predominate over the marine influence. An increase in salinity is observed in June, values vary from around 12°/$_{oo}$ to around 32°/$_{oo}$. This might be due to a lower supply from the agricultural drains and to the fact that is the month with the highest temperature (30°C) and the highest evaporation rate (280 mm) in one year period (Ortega, 1976). Lower salinity conditions are restored at the lagoon in October implying a higher contribution from the agricultural drains and an increase in the hydrocarbon concentration in sediments.

Huizache-Caimanero Area: Organochlorine hydrocarbons concentration in the Huizache-Caimanero system is higher in July (Fig. 2, stations 15 to 20). The concentration of these compounds apparently follows and anual cycle which is related to the evaporation precipitation cycle of these lagunes. The salinity pattern of the area is shown in Fig. 3 (Ortega 1976). The evaporation

*Mode - water level that occurs with greatest frequency during the study period.

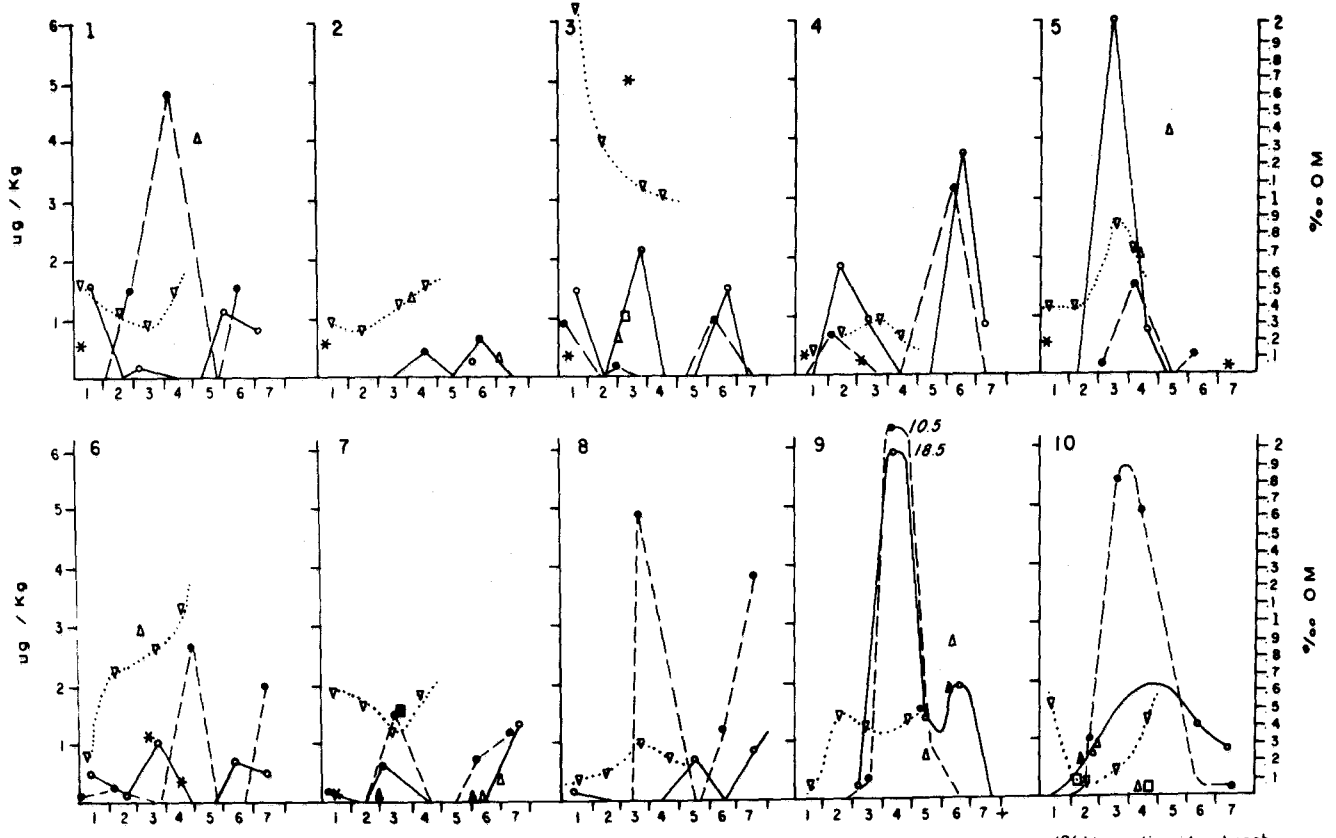

FIGURE 3 -Concentration of organochlorine pesticides (ug/Kg dry weight basis) and organic matter content (%) in sediments at each sampling point during the study period (1 = apr 80, 2 = july 80, 3 = oct 80, 4 = jan 81, 5 = apr 81, 6 = jul 81, 7 = oct 81). HCH (○), DDT (○), Heptachlor (▲), Dieldrin (✱), Heptachlor expoxide (□), Aldrin (▲), Endrin (■), Organic Matter (▽).

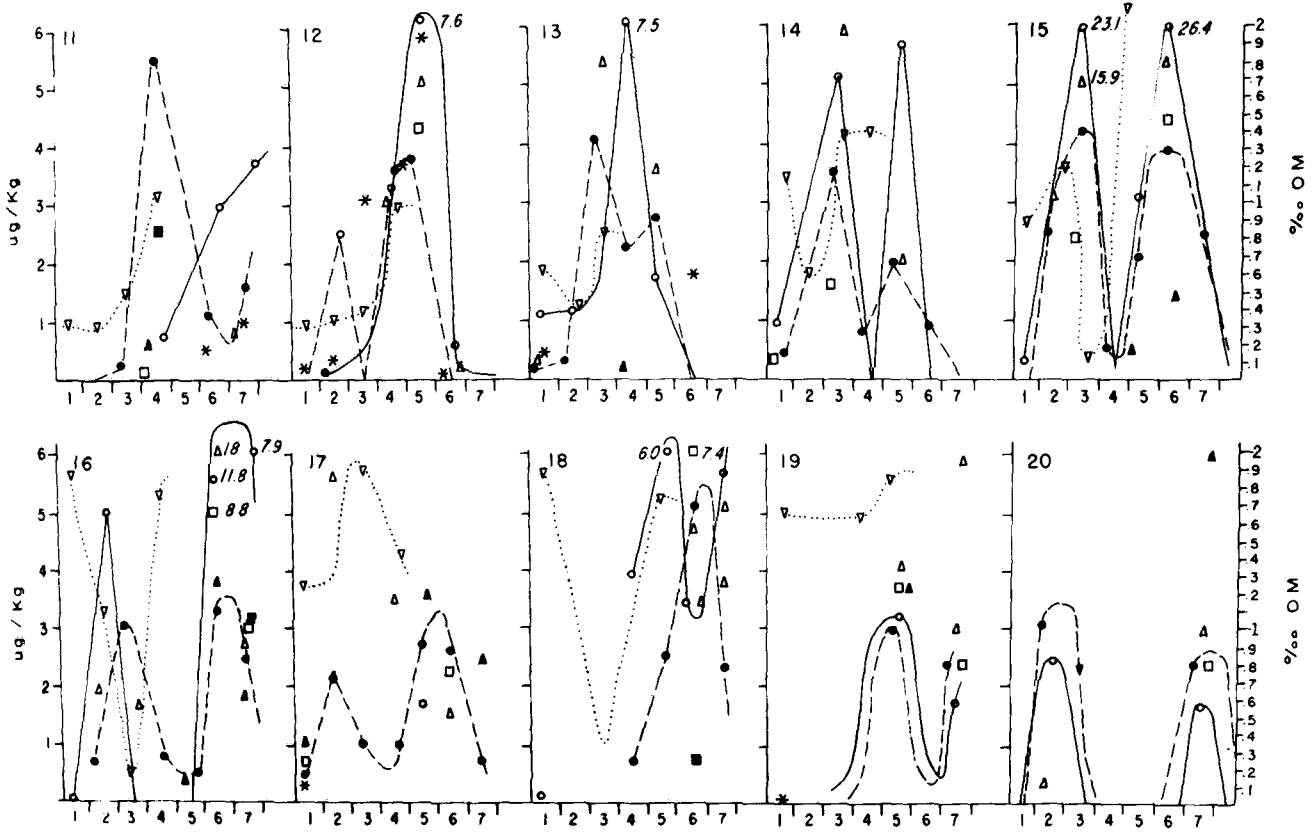

FIGURE 3 a-Concentration of organochlorine pesticides (ug/Kg dry weight basis) and organic matter content (%) in sediments at each sampling point during the study period (1 = apr 80, 2 = july 80, 3 = oct 80, 4 = jan 81, 5 = apr 81, 6 = jul 81, 7 = oct 81). HCH (o), DDT (o), Heptachlor (▲), Dieldrin (*), Heptachlor expoxide (□), Aldrin (▲), Endrin (■), Organic Matter (▽).

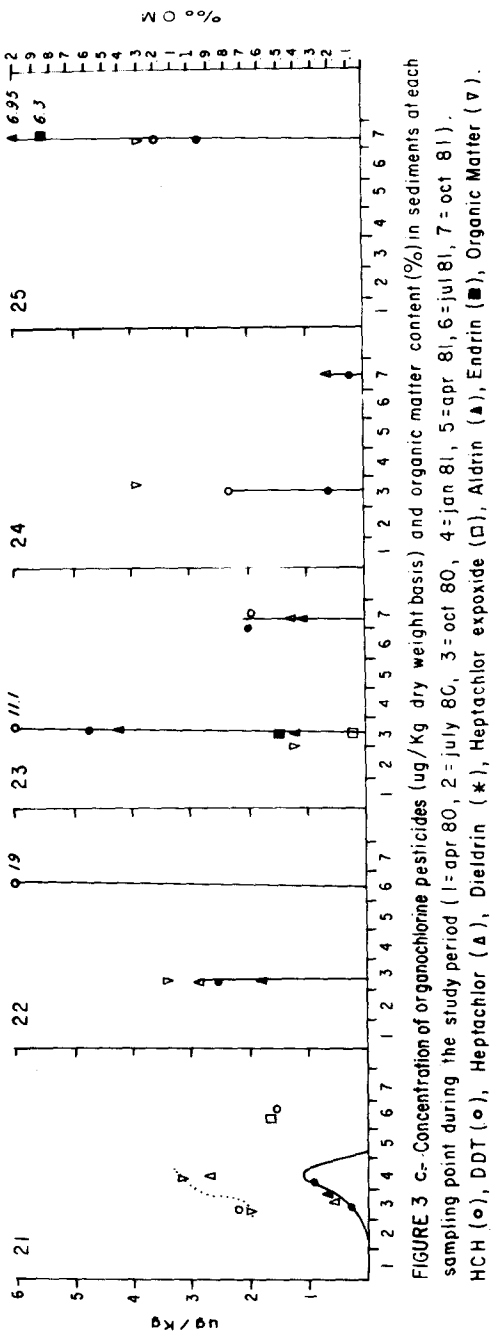

FIGURE 3 c.- Concentration of organochlorine pesticides (ug/Kg dry weight basis) and organic matter content (%) in sediments at each sampling point during the study period (1= apr 80, 2= july 80, 3= oct 80, 4= jan 81, 5= apr 81, 6= jul 81, 7= oct 81). HCH (o), DDT (o), Heptachlor (Δ), Dieldrin (*), Heptachlor expoxide (□), Aldrin (▲), Endrin (■), Organic Matter (▽).

is high in the area from March to June. As a consecuence a large area dry off and the average salinity goes up. In July with the start of the rainy season the lagoons are filled up causing the salinity to go down, it seems possible that rain water carries with it the particulates and the organochlorine hydrocarbons present in the particulates from the atmosphere (Windom 1976).

The whole understanding of the processes is complicated by the fact that samples at the Huizache basin were taken just on two occasions during the study period. The highest values observed in the Huizache-Caimanero system are: HCH 5.1, Heptachlor 18.2, Aldrin 6.95, Heptachlor Epoxide 8.8 and total DDT 16.4 ug/kg dry weight basis. Dieldrin was not detected in this area.

The concentration pattern observed in sediments of the Huizache-Caimanero area is in close agreement with the pattern observed in organisms (Rosales 1983), however in Yavaros the lowest concentration in organisms was observed in October while in sediments the concentration starts increasing in October.

Table 1. Mode and range water level at sampling points and physical description of sediment samples.

Sample Point	Mode Depth[a] (m)	Textural Descrip	Sample Point	Range Depth[b] (m)	Textural Descrip
1	0.5	silty sand	14	0.4-2.4	clay
2	1.5	sand	15	0.4-1.5	clay
3	0.5	mud	16	0.3-1.7	clay
4	1.4	sand	17	0.5-1.2	clay
5	0.5	sand clay	18	0.3-1.4	clay
6	0.5	clay	19	0.3-1.4	clay
7	0.4	sand	20	0.5	clay and silt
8	6.0	sand	21	0.5	clay and silt
9	1.0	sand	22	1.1	clay and silt
10	2.0	sand	23	1.0	clay and silt
11	2.3	sand silt	24	0.9	clay and silt
12	0.5	silty sand	25	1.0	clay and silt
13	0.4	clay			

(a) water level that occurs with greatest frecuency during the study period

(b) range of change of water level in station with great variations in water level

The persistence of HCH in submerged tropical soils is not very long due to the microflora degradation of this compound as has been reported by Macrae et al (1967); this agrees with the results found in the present work; the cycling presence of DDT in the Huizache-Zaimanero system was not expected.

The levels of organochlorine compounds determined in the areas studied are within the same order of magnitude to those reported by other authors, as Basturk (1980) found for the Eastern Mediterranean Coast of Turkey Total DDT values ranging from 3 to 21 ug/kg.

Acknowledgements. The authors gratefully acknowledge the financial support of Consejo Nacional de Ciencia y Tecnología of Mexico for the investigations carried out in this area and wish to tank Drs. A. Carranza and M. Rosales for their interest and constructive comments on the manuscript.

REFERENCES

Bastürk O, Dogan M, Salihoglu I, Balkas TI (1980) DDT, DDE and PCB residues in fish, crustaceans and sediments from the Eastern Mediterranean Coast of Turkey. Mar Pollut Bull 11: 191-185

Gaudette HE, Flight WR (1974) An inexpensive titration method for the determination of organic carbon in recent sediments. Sed Petrology 44: 249-253

Livingstone RJ, Thompson NP, Meeter DA (1978) Long term variation of organochlorine residues and assemblages of epibenthic organisms in a shallow north Florida estuary. Mar Biol 46: 355-372

Macrae IC, Raghu K, Castro TF (1967) Persistence and biodegradation of four commun isomers of benzene hexachloride in submerged soils. Agr Food Chem 15: 911-914

Ortega AA, Stephenson RR (1976) Some aspects of the hydrography and hydrochemistry of the Yavaros and Huizache-Caimanero lagoon complex in Northwst México. Centro Cienc del Mar y Limnol, Univ Nal Autón México, Final Report 60 p. México, D.F.

Rosales MTL, Escalona RS (1983) Organochlorine residues in organisms of two different laggons of northwest Mexico. Bull Environ Contam and Toxicol 30: 456-463

Windom HL, Duce RA (1979) Marine Pollutant Transfer. Lexington Books, Massachussets, USA

Received April 30, 1984; accepted June 12, 1984.