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PESTICIDE RESIDUES OF TWENTY MISSISSIPPI DELTA LAKES

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ABSTRACT

In 1969 the pesticide concentrations of 20 randomly selected Delta Lakes were evaluated by gas chromatograph. The DDT complex and toxaphene were the prevalent pesticides found in water, fish and bottom sediment. Lake waters were generally low in pesticide residues. Pesticide residues of DDT+metabolites and toxaphene in fish flesh ranged respectively from 0.15-10.60 p.p.m. and 0.0-20.0 p.p.m. Bottom sediment contained from 0.02-3.58 p.p.m. DDT+metabolites, while toxaphene ranged from 0.0-2.47 p.p.m. All lakes surveyed were found to contain pesticides.

INTRODUCTION

In recent years fishing has declined in the Delta Region of Mississippi. It was

generally believed that insecticides were responsible for this decline. During 1967 and 1968 two lakes, Wolf and Mossy, were studied under D-J Federal Aid Project F-19-R and results showed that insecticides were the primary cause for the decline of Wolf Lake fishing.

The present survey of the Delta Lakes was undertaken to determine the extent of insecticide pollution. Earlier investigators, Ferguson, et al. (1967), Barthel, W. F., et al. (1969), Bingham, (1969), Prather and Ferguson (1966), and Finley, et al. (1970), have found insecticides in water, bottom sediment and fishes from the Delta Region.

PROCEDURES

All Yazoo Mississippi Delta fishing lakes were classified geographically as outside the levee and inside the Mississippi River Levee. Twenty lakes were then chosen in a random fashion by Dr. D. W. Hayne, Leader of Cooperative Statistical Project, North Carolina State University. Four lakes were located inside the levee, while the remaining 16 were outside.

A listing and brief description of these lakes follows.

1. Bear Lake is a shallow (less than 8 ft. deep) 8 acre lake located in Leflore County. It is very clear and is choked with submergent vegetation. Cypress trees surround the lake and several small fields are nearby.
2. Old Orchard, a 60 acre lake, is also in Leflore County and is less than 8 feet deep. The water is usually murky and small bushes grow over most of the lake. Very little farmland surrounds the lake.
3. McIntyre Lake is approximately 3 miles long and 300 feet wide and is located in Leflore County. It is a deep lake (up to 40 ft.) with steep banks. Each end has some shallow water with cypress trees. A small amount of farmland is nearby.
4. Matthews Brake, located in Leflore County, is a 700 acre lake. American lotus and water lillies cover most of the shallow lake. It is clear and has numerous small coves. Trees and/or stumps cover about half of the area. Very little farming is nearby.
5. Goose Lake is located in Issaquena County and is about 500 feet wide and approximately one mile long. Each end is very shallow, while the middle of the lake is up to 18 feet deep. Most of the lake is open water with trees and several fields surrounding it.
6. Buzzard Bayou is a shallow, muddy lake of 300 acres located near the Tallahatchie River in Tallahatchie County. Numerous dead trees and snags are present in the water. Some farmland is near the lake.
7. Thompson Lake is located in Warren County and is 100-150 yards wide and about two miles long. The lake is fairly clear and shallow at each end. It is surrounded by large cypress trees and has minimal farm drainage.
8. Roebuck Lake is 22 miles long and 150-250 yards wide. It is located in Leflore County. Duck weed and dead trees cover nearly one third of the lake. The banks and water surface are decorated with numerous pesticide drums.
9. Chotard Lake is in Issaquena County and is one of the four lakes behind the river levee. The water level varies greatly from season to season. Willows line the banks of the 980 acre Oxbow Lake. There are no fields nearby.
10. Albemarle Lake is another of the old Oxbow Lakes located behind the levee in Issaquena County. It contains 560 acres and looks very much like Chotard Lake.
11. Whittington Lake, 3600 acres, is behind the levee in Bolivar County. It is mostly open water with willows along the banks. The water level varies greatly and some areas of the lake are 75 feet deep. No fields are nearby.

12. Lake Washington is a large, shallow, 5000 acre lake in Washington County. About one fourth of the lake consists of cypress trees in about two to three feet of water. The lake is fairly clear. There is a moderate amount of farming near the lake.
13. Eagle Lake is a 4,700 acre lake in Warren County. Several wooded areas are in the lake. The old Osbow Lake is mostly open water and has a large amount of shallow water. A fairly large amount of the lake's drainage is from farmland.
14. Fish Lake is about one half acre with a maximum water depth of two feet. It is in a wooded area of Sharkey County. Duck weed covers the entire surface of the water.
15. Four-Mile Lake, located in Humphreys County, is a 134 acre lake which is usually muddy. The shoreline of the lake has some trees along it, while the drainage is mostly farmland.
16. Alligator Lake is an 18 acre dogleg lake in Warren County. It is in a wooded area and is fairly clear. Its drainage system is largely farmland.
17. Sky Lake is a long slender lake in Humphreys County. It is about three miles long, one fourth mile wide and very shallow. Its drainage is farmland.
18. Moon Lake is a 2200 acre Oxbow Lake in Coahoma County. The shoreline is dotted with trees. Several wooded areas are present in the lake. Farms surround the lake.
19. Twin Lake is the larger of the two small lakes by the same name in Leflore County. Fields surround most of the shallow 40 acre lake.
20. Hubbard Lake is located behind the levee in Coahoma County. It differs from the other three lakes behind the levee in that it is only about 60 acres and has numerous snags and trees.

Each lake was divided into four approximately equal areas. These areas are referred to as stations. A table of random numbers, Steel & Torrie, (1960), was used to select five transects and a point along each transect in every area. A stainless steel sewage sampler, minus the BOD bottler, was lowered to the bottom and raised to the top of the water at a uniform rate to obtain water from all depths. After thorough mixing, 200 ml. was poured into a half-gallon glass jug to form 1/5 of a composite sample. Repetition of this process along each of the five transects made up one station. The liter of water was returned to the laboratory and extraction was begun at the earliest possible time; usually the following morning. Extraction was accomplished with a hexane-pet. ether (85%-15%) solvent. The glass jugs containing one liter of lake water and 100 ml. of hexane-pet. ether solvent were rotated on mechanical rollers for one hour. The extract was separated from the water by means of a separatory funnel. The water was washed twice with 25 ml. of solvent and the glass jug was washed once.

The extract and wash were combined and filtered through a 2" column of anhydrous sodium sulfate for removal of trace amounts of water. The extract was evaporated in Kuderna-Danish evaporators to a 5 ml. volume and chromatogrammed via dual column electron-capture gas-liquid chromatography. All samples were analyzed with a Micro-Tek 220 gas chromatograph equipped with tritium foil electron capture detector cells. Columns used were 3% DC-200 on 100/120 mesh Gas Chrom Q and 9% QF-1 on 100/120 mesh Gas Chrom Q.

Operating parameters were as follows:

Temperature: Detectors - 185°C
Inlets - 220°C
Column Oven - 175°C

Carrier Gas: Nitrogen.

All samples were screened for 17 organohalide insecticides. Only p,p'-DDE, p,p'-TDE, p,p'-DDT and toxaphene were routinely found.

Mud samples were taken with a 6″ Ekman Dredge. One dredge load was taken at each point and approximately the top centimeter of mud in the dredge was scooped off to form one of the five composites of the sample. In the laboratory the composite sample was thoroughly mixed with a paint shaker. A 100 gram sub-sample was dried in an oven to obtain the dry weight of the mud. A solvent mixture of 150 ml. hexane and 50 ml. isopropyl alcohol was added to a second 100 gram sub-sample. The mud solvent mixture was revolved on a ferris-wheel extractor for four hours. The solvent extract was decanted off and necessary cleanup procedures were performed. The sample aloquots were then chromatogrammed.

Ten fish (bluegill 4″-8″ long) were taken from any place on the lake by any means available, placed in polyethylene bags and frozen. In the laboratory the 10 fish were scaled and the head and viscera removed. The bodies of the 10 fish, comprised of the backbone, flesh and fins, made up one sample. The head and viscera comprised another sample. A 10 gram sub-sample of these was extracted with hexane in a Waring laboratory blender. Required cleanup was performed and samples chromatogrammed.

FINDINGS

The Oxbow Lakes selected for analyses behind the Mississippi River levee, Hubbard, Chotard, Whittington and Albemarle, are void of trees or brush except along the shoreline. In general, these lakes contained low amounts of insecticides in the water, bottom sediment and fish (Tables 1, 2, 3). At that time they were polluted very little by insecticides.

The remaining 16 lakes show varying degrees of insecticide pollution. Twin Lake was the most polluted lake surveyed, while Thompson, Bear and Matthews Brake contained only trace amounts of insecticides.

The insecticide content of water (Table 1) may vary from day to day. Residue levels in bottom sediment and fish seem to be more stable than those in water.

Four of the remaining 16 lakes were over 1000 acres in size. These lakes, Roebuck, Moon, Eagle and Washington, were considerably contaminated by insecticides. Roebuck was virtually void of game fish, while Moon, Eagle and Washington remained good fishing lakes. The insecticide concentration of Roebuck bottom sediment (Table 2) and fish (Table 3) was only slightly greater than the other three. Due to this similarity, the game fish populations of Moon, Eagle and Washington may be endangered by insecticides.

The largest range of insecticide pollution was found in the 12 lakes less than 1000 acres in size. Alligator, Fish, Four-Mile and Twin Lakes were considered by the authors to be highly contaminated. The p,p'-DDT+metabolites of Alligator bluegill flesh was 1.32 p.p.m., while the head and viscera content was 3.30 p.p.m. The bottom sediment of Alligator Lake contained 3.04 p.p.m. of p,p'-DDT+metabolites and 2.47 p.p.m. toxaphene. The insecticide content of Fish Lake bluegill was similar to that of Alligator, although the bottom sediment was considerably lower. Twin Lake bluegill flesh contained 10.60 p.p.m. of p,p'-DDT+metabolites and 20.00 p.p.m. taxaphene (Table 3). Head and viscera contained 29.00 p.p.m. of p,p'-DDT+metabolites and 35.00 p.p.m. toxaphene. The insecticide content of Twin Lake bottom sediment was high with p,p'-DDT+metabolites at 3.50 p.p.m. and toxaphene at 0.95 p.p.m. The flesh of Twin Lake bluegill containing 10.60 p.p.m. of p,p'-DDT+metabolites and 20.00 p.p.m. toxaphene is considered by the authors as potentially dangerous for human consumption. Although Four-Mile Lake was considerably lower in insecticides than Twin Lake, it was still considered highly polluted. The flesh of Four-Mile bluegill contained 3.03 p.p.m. of p,p'-DDT+metabolites and head and viscera concentration was 4.80 p.p.m.

McIntyre and Sky Lakes were moderately polluted, while Matthews Brake, Old Orchard, Buzzard Bayou, Thompson, Bear and Goose were relatively free of insecticide pollution.

In summary, none of the lakes behind the levee were polluted to any degree by insecticides. Of the remaining 16 lakes, 10 were polluted by insecticides to a considerable degree.

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Table 1. Pesticide analyses of water, p.p.b.

Lake	p,p'-DDE	p,p'-TDE	p,p'-DDT	Toxaphene
McIntyre	T	0.01	0.06	-
Eagle	0.01	0.01	0.04	-
Alligator	0.01	T	0.01	-
Moon	0.01	-	0.08	0.65
Hubbard	0.06	0.01	0.03	0.07
Twin	0.05	0.04	0.82	1.92
Sky	-	-	0.15	0.95
Bear	-	-	-	-
Chotard	0.01	0.01	-	-
Four Mile	0.02	0.07	0.20	1.51
Roebuck	0.01	0.07	0.09	0.17
Whittington	0.01	-	0.04	-
Goose	T	0.04	T	0.14
Fish	-	0.14	0.03	-
Matthews Brake	0.02	0.02	0.07	0.71
Washington	0.02	0.02	0.03	0.03
Old Orchard	0.02	0.02	0.05	0.45
Albemarle	T	T	-	-
Thompson	-	-	-	-
Buzzard Bayou	0.01	0.02	-	- T of Lindane

Table 2. Pesticide analyses of sediment, p.p.m.

Lake	p,p'-DDE	p,p'-TDE	p,p'-DDT	Toxaphene
McIntyre				
Wet	0.010	0.035	0.016	0.020
Dry	0.043	0.141	0.062	0.081
Eagle				
Wet	0.035	0.053	0.031	-
Dry	0.161	0.244	0.130	-
Alligator				
Wet	0.091	0.214	0.092	0.328
Dry	0.722	1.619	0.701	2.468
Moon				
Wet	0.020	0.056	0.061	0.148
Dry	0.127	0.265	0.281	0.730
Hubbard				
Wet	0.004	0.016	0.007	0.063
Dry	0.018	0.069	0.029	0.271
Twin				
Wet	0.083	0.158	1.030	0.331
Dry	0.234	0.445	2.908	0.946
Sky				
Wet	0.074	0.024	0.009	-
Dry	0.497	0.158	0.056	-
Bear				
Wet	0.003	0.011	0.004	-
Dry	0.024	0.080	0.032	-
Chotard				
Wet	0.001	0.007	0.004	-
Dry	0.002	0.027	0.007	-
Four Mile				
Wet	0.026	0.230	0.008	0.100
Dry	0.087	0.778	0.027	0.339
Roebuck				
Wet	0.021	0.102	0.006	0.024
Dry	0.074	0.379	0.020	0.086
Whittington				
Wet	0.001	0.005	0.004	-
Dry	0.002	0.012	0.013	-
Goose				
Wet	0.007	0.023	0.002	-
Dry	0.028	0.098	0.006	-
Fish				
Wet	0.004	0.018	0.017	0.022
Dry	0.007	0.038	0.036	0.045
Matthews Brake				
Wet	0.006	0.013	0.009	T
Dry	0.021	0.043	0.027	T
Washington				
Wet	0.039	0.055	0.011	-
Dry	0.144	0.198	0.024	-
Old Orchard				
Wet	0.010	0.038	0.007	-
Dry	0.038	0.146	0.026	-
Albemarle				
Wet	0.002	0.004	-	-
Dry	0.005	0.014	-	-
Thompson				
Wet	0.003	0.004	0.006	0.092
Dry	0.014	0.018	0.023	0.516
Buzzard Bayou				
Wet	0.013	0.036	0.015	-
Dry	0.139	0.122	0.005	-

Table 3. Pesticide analysis of bluegill, p.p.m.

Lake	p,p'-DDE	p,p'-TDE	p,p'-DDT	DDT+ Metabol.	Toxaphene
Lake: McIntyre					
Body	0.725	0.350	0.550	1.625	T
Head & Viscera	0.825	0.850	1.700	3.375	T
Lake: Eagle					
Body	0.625	0.500	0.800	1.925	T
Head & Viscera	1.485	0.945	1.620	4.050	T
Lake: Alligator					
Body	0.620	0.250	0.450	1.320	-
Head & Viscera	1.100	0.900	1.300	3.300	-
Lake: Moon					
Body	0.400	0.200	T	0.600	-
Head & Viscera	1.270	1.100	1.400	3.770	-
Lake: Hubbard					
Body	0.375	0.200	0.400	0.975	-
Head & Viscera	0.500	0.400	0.650	1.550	-
Lake: Twin					
Body	4.200	2.600	3.800	10.600	20.000
Head & Viscera	6.500	10.500	12.000	29.000	35.700
Lake: Sky					
Body	0.900	0.200	0.500	1.600	-
Head & Viscera	1.100	0.900	1.800	3.800	T
Lake: Chotard					
Body	0.525	T	T	0.525	-
Head & Viscera	0.490	T	T	0.490	-
Lake: Four-Mile					
Body	0.875	0.700	1.450	3.025	T
Head & Viscera	1.300	1.200	2.300	4.800	T
Lake: Roebuck					
Body	1.100	T	1.000	2.100	-
Head & Viscera	2.500	2.200	4.200	8.900	T
Lake: Whittington					
Body	0.250	T	0.250	0.500	-
Head & Viscera	0.325	0.200	0.800	1.325	T
Lake: Goose					
Body	0.350	0.250	0.400	1.000	-
Head & Viscera	1.050	0.600	1.150	2.800	-
Lake: Fish					
Body	0.850	0.600	1.050	2.500	T
Head & Viscera	1.700	1.100	2.100	4.900	T
Lake: Matthews Brake					
Body	0.400	0.250	0.250	0.900	-
Head & Viscera	0.475	0.400	0.600	1.475	-
Lake: Washington					
Body	0.950	0.650	1.100	2.700	-
Head & Viscera	2.600	1.600	2.700	5.900	T
Lake: Old Orchard					
Body	0.300	0.250	0.450	1.000	-
Head & Viscera	1.050	1.250	2.000	4.300	T
Lake: Albemarle					
Body	0.255	-	-	0.255	-
Head & Viscera	0.285	0.150	0.400	0.835	T
Lake: Thompson					
Body	0.150	T	T	0.150	-
Head & Viscera	0.400	T	0.450	0.850	-
Lake: Buzzard Bayou					
Body	0.250	0.250	T	0.500	-
Head & Viscera	0.755	0.900	1.000	2.655	T