C. To public health?
D. To agriculture?
E. To the re-use of water?

IV. What standards of measurement do we have to determine the extent and harmful effects of pollution?
A. How effective are bio-assays?
B. Can bio-assays provide us with a means to detect, evaluate and measure?
C. Can chemical tests take the place of bio-assays? How? In what way?

V. What methods of pollution-control should we have or strive to attain?
A. Should we advocate the abolition of all pollution?
B. Do we wish to stop pollution regardless of the effect it might have upon business in our states?
C. Can we ever control pollution without a knowledge of what pollution is and what harm it does?
D. Should pollution control be vested in a state water control board?

SUMMARY

The above outline was presented to the assembly and the discussion proceeded section by section through the outline.

The definition of pollution as presented and accepted by the panel was of particular interest. The definition follows: pollution is the addition of any material that hinders the use of water for any purpose. The definition permits the addition of any material in any amount that does not harm the water for the use desired, thus permitting fertilization, but labels over-fertilization and other harmful materials as pollutants. Pollution becomes the addition of "too much" of anything.

The adoption of the definition by the panel limited the need for discussion upon the second and third sections of the outline. The question of water standards attracted considerable attention. Opinion tended to emphasize the difficulty of making standards to meet the needs of water used for different purposes, since different uses require different standards.

The value of bio-assays was stressed. Chemical tests were felt to be worthwhile but they do not necessarily determine the toxicity or harmful effects of the pollutants. Bio-assays and chemical tests are neither opposites nor parallels in purpose. Bio-assay tells the effect upon life and sometimes the presence of chemicals in too small a quantity to be tested chemically, while the chemical test tells what the material is.

Since pollution is the addition of harmful materials it was agreed that we should advocate the abolition of all pollution.

BIOLOGICAL ASPECTS OF STREAM POLLUTION CONTROL IN ARKANSAS

By M. L. Wood

Arkansas Water Pollution Control Commission

Although the Arkansas Water Pollution Control Commission recognizes that the combined work of the biologist, the chemist and the engineer is necessary to obtain a complete picture of any given stream pollution problem, the Commission has since its inception in 1949 been without the services of one or more of these basic technicians. Usually during its operative periods the Commission had only engineers on its staff and its work was; therefore, of necessity, restricted to surveys of waste treatment plants. With the increasing local demand for pollution abatement work on the Lower Ouachita River it became all too apparent that additional monetary assistance to the Commission was essential if the necessary abatement work was to be undertaken. Outside sources of funds were found, one being a $15,000.00 sum from the Governor's Emergency Fund. Because of the magnitude of the problem in that it involved over 3,500 possible sources of pollution, 115 miles of the Ouachita River and the entire stream mileage in four sub-basins of the river, it was obvious that the study should be as thorough as possible in all aspects.

Work on two sub-basins was completed by September 1, 1956, with the remaining work in the other two sub-basins to be started this month. The possible pollution sources included chemical industries, municipal sewage, oil production, oil refining and pulp and paper making. To obtain a complete picture, it was necessary to inspect each possible source of pollution, measure flows, make chemical analyses on both the waste and the receiving stream above and below the point of entry of the waste and conduct biological tests at the same points in addition to conducting bioassay tests on the wastes to determine their toxicities. It is with the biological phase of the study that this paper is concerned.

Although the Commission was still without a biologist on its staff, the invaluable assistance of the Arkansas Game and Fish Commission and the United States Public Health Service was obtained to enable the Commission to make the necessary studies. Mr. J. B. Anderson, Regional Biologist of the U. S. Public Health Service, Dallas office, supervised the bottom sampling program and the bioassay program and identified the collected bottom organisms. Mr. Jack Atkins, biologist with the Arkansas Game and Fish Commission conducted the bioassay toxicity studies which covered a three-month period.

Many complaints of pollution from the area in question centered about sudden fish kills and the decline of good fishing conditions. Since these allegations indicated wastes toxic to either fish or their food organisms or both, bottom organism counts were made at various times during the survey on the streams in question. Bottom organisms were counted by obtaining a one sq. ft. bottom sample with a Kemmer Sampler at points above and below points of entry of pollution. Twenty-four hour composite samples of the stream flow were obtained at the same time for chemical analysis. The bottom sample organisms were separated by screening and preserved in formalin solution for identification. Although all of the data collected in this phase of the survey has not yet been assembled, the following results seem typical for the particular type of pollution evident in this stream.

	Station No. 2 (Above Pollution)	*Station No. 1 (Below Pollution)*
pH	7.5	3.9
Cl	10.0 p.p.m.	6,400.0 p.p.m.
Organisms	34 Annelids	1 Coleoptera
	21 Diptera	
	3 Crustacea	
	1 Ephemeroptera	
Total	59	

The standards as set forth in the "Bio Assay Methods for the Evaluation of the Acute Toxicity of Industrial Wastes to Fish" by Doudoroff and others, were strictly adhered to. In all instances the figures which allowed the maximum safety for the fish were used. The fish used were small bluegill sunfish (*Lepomis Macrochirus*) of approximately 1.5 gms. weight, which were obtained by seining. Calion Lake, lying 14 miles northeast of El Dorado, served as the primary source of fish in the early stages of the testing. Later the barrow-pits along U. S. Highway 82, south of Strong, served as the primary source of fish because of the small size of the fish and their abundance. Fish were transported to El Dorado in milk cans and glass jars of 20 liter capacity. No aeration was used during transportation. The fish were placed in conditioning tanks filled with Calion Lake water, which served as a dilution water for all tests, and allowed to remain for one week or until such time thereafter that the mortality rate dropped below 10% for the preceding 72-hour period. For each test, which was carried out in 20 liter glass containers, 10 fish were used. In the testing of brines, each sample was aerated throughout the test, but for the test on industrial wastes, samples were not aerated. In any instance where the toxic factor might be oxidized, oxygen was furnished through the addition of thoroughly aerated dilution water. No supplementary aeration was used after the test had begun.

In any discussion of oil field brines when related to fresh water fish, the figure 7,000 p.p.m. of chlorides constantly appears. The blood of fresh water fishes has an osmotic pressure equal approximately to six atmospheres or about 7,000 p.p.m. chlorides. All of the tests of oil field brines were based on the chloride content of each since there was not believed to be any factor more toxic than chlorides in the brines. In each instance the total chloride content was determined by chemical analysis. Then with this figure as the basis, the amount of brine needed in 20 liters of water to prepare a certain concentration was calculated mathematically. Tests were set up with a spread of concentration above and below the figure of 7,000 p.p.m. After the tests were set up, these calculations were checked by chemical analysis of the brine content of each test solution to be sure of no mathematical error. Other pertinent data of the chemical nature of the solutions was checked and recorded to be sure they were well within the limits that had been set forth as being safe. All of the brines in the area were not tested because of the lack of time; however, many of the major producing formations were checked giving a spread of some 42,000 to 125,000 parts per million of chlorides in the oil field brines themselves.

The brines tested followed much the same toxicity patterns with median tolerance limits ranging from 10,500 p.p.m. chlorides in one formation to 8,100 p.p.m. chlorides for another formation on the 24-hour test basis. The amount of concentration that fish could stand was greatly reduced as the length of exposure increased; however as the concentration neared 7,000 p.p.m. of chloride the death rate dropped sharply. One test at 7,000 p.p.m. chloride was continued for 192 hours with 90% survival and without apparent ill effects to the fish. The same brine had proved lethal for 60% of the fish in a 48-hour period at a concentration of 10,000 p.p.m. chlorides. There is a partial explanation for the reason that some of the brines were found to be toxic at concentrations greater than 7,000 p.p.m. A test showed that calcium chloride was more toxic than sodium chloride but that a combination of the two brines in equal amounts became less toxic than the least toxic of the two individually—sodium chloride. Since the chemical analyses of the brines were for total chlorides, the combinations of sodium and calcium chloride were not checked but it is apparent that it is possible to construct brines that will not be toxic at concentrations greater than 10,000 p.p.m. The figure of 7,000 p.p.m. chlorides is not necessarily a safe one. The tests were carried out under ideal conditions and tested survival only; as to whether a fish could carry on the normal functions of foraging for food, and reproduction is not known and will require additional research and study.

The mayfly nymph which is regularly found in the stomach analysis of the bluegill was used for one series of tests with a brine from one particular formation. As shown by the test, the mayfly nymph had a 24-hour tolerance limit of 10,000 p.p.m. chlorides which dropped to 3,600 p.p.m. chlorides as the median tolerance limit for 72 hours. These results readily show that a figure of 7,000 p.p.m. chlorides, although safe for fish survival, is in excess of the maximum amount of chlorides that is acceptable in a stream to maintain a biological balance.

Two refinery effluents were tested. The effluents were collected near the holding ponds at each refinery and the waste was transported in filled, tightly stoppered bottles to the field laboratory. Tests were set up immediately upon reaching the laboratory. Dilutions were based on a percentage of volume of the wastes in each test solution. This was done inasmuch as "Methods for Sampling and Analysis of Refinery Wastes" by the American Petroleum Institute lists some 15 possible toxic factors in refinery wastes and there was not sufficient time to check for the concentration of each of these factors. In preliminary tests two fish were placed in three liters of 50% effluent which had been previously aerated for 1½ hours with the result of one fish dying at the end of 24-hour period and the other at the end of the 48-hour period. At the same time, two fish had been placed in 50% effluent which had not been aerated, in this case both fish were dead in four hours. Further tests were conducted using 10 fish in 20 liters as was standard in all of the other tests. The results found were that both wastes were extremely toxic and that aeration and prolonged retention of the wastes lowered their toxicities. A sample of an industrial waste effluent receiving stream was taken at a point where it entered the Ouachita River. Samples were transported to the field laboratory in full tightly stoppered bottles. Inasmuch as the most toxic factors apparent in this particular effluent were sulfides, dilutions were prepared based on the per cent of waste but the amount of sulfides in each solution was recorded. Dilution water was oxygenated for some 24 hours previous to setting up the tests. The test showed a very definite drop off in toxicity between 1.5 milligrams per liter of sulfide and one milligram per liter of sulfide. After allowing the sample of the effluent to stand for 24 hours and then conducting another analysis, the sulfide concentration was found to have increased from 9.7 milligrams per liter to 20.53 milligrams per liter of sulfide through anerobic decomposition of the organic matter. Tests were again set up based on sulfide content alone with the same result as previously noted—a definite break in toxicity between 1.5 milligrams per liter and 1.0 milligrams per liter of sulfides. In the preliminary test conducted on this particular waste, the fish placed in a 100% sample of the waste were dead in 10 minutes; however, the 100% sample of the same water after oxygenation of five hours previous to placing of fish in the effluent was not toxic to the fish at the end of a 72-hour period.

These toxicity studies were the first conducted by the Commission and although some analytical and engineering work must be done in addition to these studies, it is believed that they will prove extremely valuable in presenting the pollution picture in the Lower Ouachita River Basin.

PRELIMINARY STUDIES ON TILAPIA MOSSAMBICA PETERS RELATIVE TO EXPERIMENTAL POND CULTURE [1]

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ABSTRACT

Preliminary studies were conducted on the exotic cichlid, *Tilapia mossambica* Peters to determine the possibilities of incorporating this fish into the farm ponds and lakes in the Southeast.

In an 18-week experiment in concrete ponds, *T. mossambica* proved to be a more efficient fish than the bluegill, *Lepomis macrochirus* Raf. In feeding experiments *T. mossambica* gave 2.97 times greater growth than did the bluegill, in fertilization 1.69 times, and in manuring experiments 1.97 times greater growth than the bluegill.

Food habit studies conducted revealed that planktonic forms of plants and animals made up the bulk of the diet under natural conditions.

The minimum temperatures tolerated by *T. mossambica* were determined in a thermostatically controlled cold room. This fish ceased feeding at approximately 60° F., and deaths began at 52 to 58° F. with 100 per cent mortality occurring at 47 to 49° F.

The conclusion reached was that this fish cannot survive the winter conditions in most of the Southeast.

INTRODUCTION

The exotic cichlid, *Tilapia mossambica Peters,* has been the subject of much speculation in certain tropical countries of the Orient in recent years. The quest of the fisheries workers of these various countries for a fish of fast growth rate, large reproductive capabilities, and a palatableness suitable for wide human consumption has apparently been satisfied to a great extent by this particular fish.

[1] A portion of a thesis submitted to the Graduate Faculty of the Alabama Polytechnic Institute in partial fulfillment of the requirements for the degree of Master of Science in Fisheries Management, June, 1955.