THE EFFECTS OF FORMALIN AND OTHER PARASITICIDES UPON OXYGEN CONCENTRATIONS IN PONDS

By RAY ALLISON
Agricultural Experiment Station
Auburn University
Auburn, Alabama

INTRODUCTION

The use of parasiticidal chemicals in fertilized ponds and in those receiving supplemental feeding creates problems in parasite control work. In addition to the possible toxic effects to fish, the parasiticide may be toxic to other animal life and to aquatic plants. The sudden death and decay of large numbers of phytoplankton and zooplankton may cause a severe oxygen depletion in water and death of fish.

OBSERVATIONS

Observations were made on the oxygen content of three ponds treated with formalin for parasite control. These ponds varied from 12.4 to 22 acres in size and each was stocked with approximately 3,000 channel catfish (*Ictalurus punctatus*) and 100 largemouth bass (*Micropterus salmoides*) per acre. Each pond received from 3 to 6 applications of fertilizer after stocking and was fed Auburn No. 2 (Prather, 1958)[1] fish feed at the rate of approximately 2,000 pounds per acre per year. In the spring of 1961, the fish in these three ponds became heavily infected with *Cleidodiscus pricei* and *Scyphidia* sp. Following the application of 15 ppm formalin the oxygen concentration dropped so low in one of these ponds that a complete kill of the fish occurred.

Four days after the kill occurred in this pond, the oxygen content was 1.7 ppm at the surface. It was observed that water at the bottom of the overflow from the pond (vertical drop of 8 feet) had 5.5 ppm oxygen. This suggested aeration by pumping. A pump was installed which delivered a 4-inch stream of water to 30 feet from the pond edge with the water falling from a height of 6 feet to the pond surface. The oxygen profile before pumping was as follows:

Depth	O_2 (*ppm*)	CO_2 (*ppm*)
2′	1.6	6.0
4′	1.5	6.1
6′	1.1	8.8
8′	0.0	30.2

After pumping 25 minutes, there was 3.7 ppm oxygen at a depth of 18 inches, 150 feet from the pump; 3.7 ppm 225 feet from the pump and 3.5 ppm 430 feet from the pump. The oxygen profile at 430 feet from the pump after 3 hours and 20 minutes pumping was as follows:

Depth	O_2 (*ppm*)
18″	3.5
4′	3.9
6′	3.2
8′	0.0

The oxygen content of the other two ponds decreased considerably following the application of formalin but no deaths occurred. The oxygen and carbon dioxide concentrations in one of the ponds are presented in Table I. The latter ponds had received several marginal treatments of potassium permanganate prior to the formalin treatment. Since this chemical is a strong oxidizing agent, it may have partially satisfied the existing B.O.D., thereby reducing the B.O.D. that resulted from the decomposition of plankton killed by the formalin treatment.

EXPERIMENTS

Formalin in Ponds—Replicated experiments were conducted in twelve ¼-acre and four 1-acre ponds to determine the effects of formalin in ponds receiving

1 Prather, E. E. Further Experiments on Feeds for Fathead Minnows. Proc. 12 Annual Con. S. E. Assoc. Fish and Game Comm. 1958.

TABLE I

EFFECT OF 10 PPM FORMALIN ON THE DISSOLVED OXYGEN AND CO_2 IN A 22-ACRE POND THAT HAD BEEN FERTILIZED AND FED*

	May 22, 1961				May 23, 1961			
	9:30 A.M. (*Before Treatment*)		3:40 P.M. (*After Stirring Formalin*)		8:40 A.M. (*After Heavy Cold Rain*)		3:00 P.M. (*Cloudy*)	
Depth (Feet)	*Concentrations in Parts Per Million*							
	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2
2	12.7	0.0	9.6	0.0	7.8	0.0	7.3	0.0
4	10.3	0.0	6.5	0.0	8.7	0.0	7.3	0.0
6	9.1	0.0	Tr.	15.4	4.0	0.0	0.3	31.9
8	8.6	8.8	Tr.	15.2	0.0	21.5	0.0	40.7
	May 24, 1961				May 25, 1961			
	9-10 A.M.		3:00 P.M.		8-10 A.M.†		2-3 P.M.	
	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2
2	5.7	0.8	5.2	1.1	2.8	5.5	1.8	7.2
4	4.0	1.5	4.5	2.7	0.2	8.5	0.7	8.3
6	2.0	14.8	0.0	17.6	0.0	12.8	0.0	14.3
8	0.0	34.3	0.0	38.5	0.0	24.4	0.0	18.1
	May 26, 1961				May 29, 1961			
	9-10 A.M.		3:00 P.M.					
	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2
2	3.0	7.4	5.4	0.0	. .	. .	. .	. .
4	2.3	7.4	5.4	0.0	. .	. .	10.4	0.0
6	2.0	7.4	5.4	3.3	. .	. .	7.4	1.6
8	0.0	3.13	0.0	28.8	. .	. .	4.3	3.7

* This pond received an application of 110 pounds potassium permanganate on April 6, 13, and 18, 1960.

† Pump started at 10:00 A.M., May 25, 1961 and ran until 9:00 A.M., May 26, 1961.

no fertilization (0-0-0), incomplete fertilization (0-8-2), complete fertilization (8-8-2), and two rates of feeding. Each pond was treated with 15 ppm formalin between 11:00 a. m. and 5:00 p. m. on May 16, 1961. Waters were analyzed to determine the effects of the formalin treatment on the dissolved oxygen content of each pond (Table II).

TABLE II

OXYGEN CONCENTRATIONS IN PONDS BEFORE AND AFTER TREATMENT WITH 15 PPM FORMALIN

Fertilization or Feeding	*Ponds*	May 16, 1961 *				May 17, 1961		May 18, 1961		May 19, 1961	
		9-11 A.M.		2-5 P.M.		9-11 A.M.		8-10 A.M.		9-11 A.M.	
		2 ft.	4 ft.	2 ft.	4 ft.	2 ft.	4 ft.	2 ft.	4 ft.	2 ft.	4 ft.
		Oxygen Concentrations in Parts Per Million									
0-0-0	F-18	8.8	8.8	8.0	9.0	7.3	7.6	7.1	8.2	6.4	4.5
	F-21	8.8	8.0	8.0	8.6	7.1	6.5	6.5	6.2	5.3	2.5
	F-24	8.8	7.8	8.0	7.2	7.1	7.2	6.8	5.8	4.7	1.9
	F-27	8.3	8.0	7.2	6.8	6.5	6.2	5.2	5.1	4.2	3.2
0-8-2	F-16	10.0	10.0	9.6	12.0	8.7	7.5	3.8	3.0	2.6	2.8
	F-19	11.9	9.6	12.0	10.8	8.0	7.8	4.0	2.7	1.6	3.6
	F-22	10.9	6.9	12.2	9.0	8.0	7.1	6.4	4.0	3.2	0.2
	F-25	10.4	7.5	9.6	6.5	7.6	4.6	2.6	1.6	1.0	0.7
8-8-2	F-17	13.6	11.9	13.2	12.0	9.2	8.8	4.0	4.2	4.8	4.0
	F-20	11.5	9.7	12.7	10.1	8.6	6.8	2.8	2.2	2.0	0.9
	F-23	9.2	2.8	8.7	1.8	6.8	2.1	2.0	0.2	0.6	0.1
	F-26	7.9	1.0	8.0	0.5	6.6	2.2	1.2	0.1	1.8	0.2
Auburn No. 2 Fish Feed 3% Level	E-7	12.0	4.0	10.6	6.0	7.3	6.8	3.6	2.6	1.0	0.2
	E-8	13.0	8.0	12.0	8.8	9.2	9.2	5.2	6.2	2.2	2.0
Auburn No. 2 Fish Feed 4% Level	E-5	11.5	4.2	9.8	7.4	6.1	5.9	1.2	0.3	1.5	1.2
	E-6	10.4	5.6	9.2	3.4	7.0	4.6	5.4	0.2	0.5	0.4

* Each pond treated with 15 ppm formalin 11:30 A.M., May 16, 1961.
F - Ponds—One-fourth acre. E - Ponds—One acre.

Those ponds receiving no fertilization showed considerably less oxygen depletion than those receiving 0-8-2 and 8-8-2. The oxygen concentration in all replications of the former treatment remained well above the critical level for fish production. In two replications of each of the latter treatments the oxygen concentration dropped to a dangerously low level for fish life, and death of fish would probably have resulted had these ponds not been artificially aerated by pumping.

Two rates of feeding were duplicated in 1-acre ponds. The oxygen concentration in both replications of these two treatments approached the critical level for fish life and the death of fish was prevented by artificial aeration by pumping.

In the above ponds, where the oxygen content decreased to critical levels, mechanical means of aeration were utilized. In one of these ponds receiving complete fertilization (F-23), the oxygen content decreased to 0.6 ppm and 0.1 ppm at 2 and 4 feet, respectively (Table II). After stirring for 1 hour with a 5-horsepower outboard motor, the oxygen content increased to 2.9 ppm and 2.8 ppm at 2 and 4 feet, respectively. In another of these ponds (F-26), the oxygen content decreased to 0.4 ppm and 0.6 ppm and the CO_2 increased to 14.9 ppm and 23.9 ppm at 2 and 4 feet, respectively. After 1 hour of pumping and the addition of 30 pounds of $Ca(OH)_2$, the oxygen content increased to 1.7 ppm at 4 feet and the CO_2 decreased to 8.5 ppm at 2 feet. On the following afternoon the oxygen was 2.33 ppm at 2 feet and the CO_2 had decreased to 1.1 ppm and 6.1 ppm at 2 and 4 feet, respectively.

Various Chemicals in Plastic Pools—As a result of the observations in ponds, an experiment was conducted in plastic pools, 9 feet in diameter and 30 inches deep, to determine the effect of certain chemicals upon the dissolved oxygen content of water. These pools were filled with water and fertilized periodically for 2 weeks prior to the experiment. Each of two pools received one of the following: no chemical, 3 ppm potassium permanganate, 15 ppm formalin, 25 ppm formalin, 1 ppm methylene blue and 5 ppm methylene blue. This experiment was conducted from September 6 through September 9. The surface temperature ranged from 26.1° C. to 29.5° C. The oxygen content of pools treated with 3 ppm potassium permanganate remained essentially the same as that of the controls. All of the other chemicals tested resulted in a considerable reduction in the dissolved oxygen content. On the third day after treatment most of these began to recover (Table III).

TABLE III

THE AVERAGE OXYGEN CONCENTRATION IN DUPLICATE PLASTIC POOLS TREATED WITH VARIOUS CHEMICALS

	9/6*	9/7		9/8		9/9	11/8†		11/9		11/10		11/13-14	
	2pm	*10am*	*2pm*	*9am*	*5pm*	*N*	*am*	*pm*	*am*	*pm*	*am*	*pm*	*pm*	*am*
	Oxygen Concentrations in Parts Per Million													
Untreated Controls	9.7	11.4	9.5	12.7	8.1	10.1	9.0	9.6	8.0	8.3	7.0	7.4	8.4	8.2
15 ppm Formalin	10.5	7.1	4.9	9.1	9.4	11.4	9.2	10.0	8.1	8.1	6.5	6.8	6.7	6.6
25 ppm Formalin	10.9	7.4	4.5	4.6	7.7	9.9	. .	. .	. .	. .	. .	. .	. .	. .
3 ppm $KMnO_4$	11.6	11.8	9.3	12.7	8.3	10.1	9.5	9.8	8.9	7.6	6.5	6.9	8.4	7.9
1 ppm Methylene Blue	10.8	7.5	7.4	9.5	7.4	9.3	. .	. .	. .	. .	. .	. .	. .	. .
5 ppm Methylene Blue	9.5	7.6	4.9	7.4	4.9	5.3	. .	. .	. .	. .	. .	. .	. .	. .

* Treated at 4:00 P.M. September 6, 1961.
† Treated at 5:00 P.M. November 8, 1961.

A similar experiment was conducted from November 8 through November 14, 1961. Treatments with 3 ppm potassium permanganate and treatments with 15 ppm formalin were replicated four times. Four pools were not treated and served as controls. The surface temperature varied from 16° C. to 20.5° C. Little difference was noted between treatments until the fifth day after treatment. At this time the oxygen concentration began to decrease in pools that received the formalin treatment. One series of analyses was made in pools filled with clear well water and treated with 15 ppm formalin. The oxygen content of these pools remained essentially the same as untreated controls.

One liter of water was taken from each pool before and after treatment in the experiments described above. The water was centrifuged and the plankton

was collected, dried and weighed. In both of the above experiments, the plankton content, in milligrams per liter, increased in the controls and potassium permanganate treatment. There was a decrease in the pools treated with formalin (Table IV).

TABLE IV

THE EFFECT OF VARIOUS CHEMICALS UPON THE AVERAGE WEIGHT* OF PLANKTON

	Date					
	September 6-9			*November 8-14*		
Treatment	*Before Treatment*	*After Treatment*	*Difference*	*Before Treat.*	*After Treat.*	*Difference*
Untreated Controls	11.0	13.8	+ 2.8	9.1	39.9	+30.8
15 ppm Formalin	37.8	14.0	−23.8	8.2	7.8	− 0.4
25 ppm Formalin	24.2	18.2	− 6.0	. .	. .	. .
1 ppm Methylene Blue	13.7	37.6	+23.9	. .	. .	. .
5 ppm Methylene Blue	23.1	13.8	− 9.3	. .	. .	. .
3 ppm $KMnO_4$	19.3	38.0	+18.7	12.6	23.9	+ 1.1

* Milligrams per liter.

CONCLUSION

It may be concluded from these experiments that the use of formalin in ponds having a heavy plankton bloom may cause severe oxygen depletion. It appears that this is due to the increased B.O.D. resulting from the sudden death and decay of large amounts of plankton. At higher temperatures this process occurs more rapidly and may cause a more serious problem if ponds are treated for parasite control during the summer months. In the event that it becomes necessary to treat for parasite control during the summer months, the oxygen content can be restored in small ponds by stirring with an outboard motor. In larger ponds, pumping appears to be the most feasible means of aeration. The CO_2 content can be controlled through the addition of $Ca(OH)_2$.

A STUDY OF TWO STREAMS RECEIVING DOMESTIC SEWAGE [1]

By WILMER A. ROGERS [2]
Bureau of Sport Fisheries and Wildlife
Marion, Alabama

ABSTRACT

A study involving macro-invertebrate populations, fish populations, and water quality determinations was conducted on Bicycle Path Creek and Parkerson Mill Creek, Lee County, Alabama, during a nine-month period in 1959. The streams, averaging 7.0 and 5.8 inches in depth and 10.0 and 12.8 feet in width, respectively, received domestic sewage from approximately half of the 16,000 inhabitants of Auburn, Alabama. Sewage was diverted from Bicycle Path Creek and pumped via a lift station to a sewage treatment plant located on Parkerson Mill Creek. The plant became operative about halfway through the study and the treated effluent was discharged into Parkerson Mill Creek.

Bottom organisms, which were collected at approximately two-week intervals from six stations on the two streams, were indicative of the polluted conditions, however, it was believed that not enough time had elapsed after the plant became operative for reinvasion by organisms used as indicators of unpolluted conditions. Organisms that could possibly have been classified as clean-water forms did not occur with any regularity or in significant numbers. Forms such as mayflies and stoneflies that are accepted indicators of clean waters were not found during this study.

1 This study was part of a thesis submitted to the Graduate Faculty of Auburn University in partial fulfillment of the requirements for a Master of Science degree in Fisheries Management, June, 1960.

2 Present Address: Fisheries Laboratory, Auburn University, Auburn, Alabama.