AN EVALUATION OF ANTIMYCIN AS A SELECTIVE BLUEGILL TOXICANT UNDER VARYING CONDITIONS OF pH [1]

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ABSTRACT

The TL_m for bluegill and redear sunfish was determined in the laboratory using standard bioassay procedure and water from two sources. A considerably larger concentration of antimycin was required to kill fish of the same size under field conditions. Probable reasons are discussed. Selective kills of bluegill and redear were attempted in the field under pH values ranging from 6.4 to 9.6. The antimycin concentration required under these various conditions is discussed. Total kills following selective kills showed size selectivity as well as species selectivity.

INTRODUCTION

Selective or partial poisoning using rotenone was practiced as a management technique as early as 1945. Other toxicants have been used with varying success. When antimycin was found to be a fish toxicant it attracted widespread attention by fishery management personnel.

Antimycin is an antifungal antibiotic isolated from the bacteria *Streptomyces* sp. and identified by Dunshee, Leben, Keitt, and Strong (1949). Strong (1956) reports the chemical nature of antimycin as such that alkaline degradation occurs resulting in antimycic acid and a neutral fragment. Its degradation in water is accelerated in the presence of light, high pH, and warm temperatures. Derse and Strong (1963) demonstrated antimycin to be a powerful fish toxicant, being 100% lethal to goldfish *(Carassius auratus)* under laboratory conditions at a dilution of one part per billion. These investigators further reported that antimycin is rapidly degraded since the toxicity of 1 ppb concentration was eliminated after one day and 100 ppb concentration after seven days. The rapid degradation and reported low toxicity to higher animals led Derse and Strong to suggest that it might be useful in fishery management. Lennon and Walker (1964) conducted laboratory tests to determine the effects of antimycin concentrations of 0.01 ppb to 120 ppb on 24 species of fresh water fish. Antimycin was toxic to the 24 species tested. Those species most resistant to antimycin include the black bullhead *(Ictalurus melas)*, yellow bullhead *(Ictaluras natalis)* and channel catfish *(Ictalurus punctatus)*. Among the most sensitive are brown trout *(Salmo trutta)*, brook trout *(Salvelinus continalis)*, white sucker *(Catostomus commersoni)*, gizzard shad *(Dorosoma cepedianum)* yellow perch (*Perca flavescens*), and bluegill (*Lepomis macrochirus*). Radonski and Wendt (1966) observed that yellow perch could be selectively eliminated with low concentrations of antimycin. This led the authors to an interest in evaluating antimycin as a selective toxicant under conditions of water quality encountered in the Southeast.

MATERIALS AND METHODS

Toxicant

In the form which is available commercially under the trade name Fintrol, antimycin is formulated on sand grains in a ratio of 99%

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sand to 1% antimycin. The product used in these investigations is known as Fintrol-5. The active ingredient is formulated on silicon so that it is released uniformly as it sinks through five feet of water.

Test Fish

Fingerling bluegill and redear *(Lepomis microlophus)* were obtained from federal hatcheries in Millen, Georgia and Marion, Alabama. Test animals were acclimated for not less than seven days in the water and at the temperature at which they were tested.

Laboratory Procedure

In general, the bioassay procedures outlined in Standard Methods were followed. All tests were conducted at a temperature of 13°C., ±0.5°C. The bioassay vessels were 3-liter and 15-liter glass containers. For each test the 3-liter vessels contained one or two fish and the 15-liter vessels held five to ten. The containers were chemically cleaned following each test. Those vessels receiving the highest antimycin concentrations in one test were used for the controls in the following tests. This procedure insured that residues would not bias the experiments.

Stock solutions of antimycin were made by placing one gram of Fintrol-5 in 500 ml. of distilled water. This was shaken vigorously and allowed to stand 10 to 20 minutes. The desired concentrations were obtained by taking aliquots from the stock solution. A new stock solution was made for each test. Duration of the tests ranged from 24 hours to 96 hours. The number of controls for each group amounted to no less than 10% of the number of fish for that group. Dissolved oxygen concentration was monitored by the Winkler method throughout the experiments in both control and test vessels.

Tap water and water transported from Lake Lanier, a large reservoir approximately 40 miles from Athens, was used for the experiments. Tap water was cooled and aerated for a minimum of three days prior to use on test animals.

A flowing system was used to maintain a constant temperature. Three 400-gallon fiberglass tanks were arranged such that water could be pumped from a tank containing a cooler and the acclimating fish to two tanks containing the bioassay vessels. The bioassay tanks were elevated approximately 20″ above the holding and cooling tank. This arrangement allowed the water which was pumped to these tanks to flow back to the holding and cooling tank. The rate of flow was great enough to maintain a constant temperature throughout the system.

Field Procedures

Considerable care was taken in calculating surface area and volume of water in the five study areas. In measuring the surface, several parallel lines were placed across the surface of the pond. Their lengths were plotted on graph paper. The number of lines-per-pond and the distance apart varied according to the shape of the pond. Depth measurements were taken at 10-foot intervals along each line for calculating the volume.

The toxicant was applied from a paper cup or glass jar having a perforated lid. The agent was sprinkled into the propwash turbulence of outboard motors for the purpose of allowing time for the active ingredient to dissolve in falling to the bottom. The toxicant was applied in early morning in order to take advantage of low pH.

Following the application of low concentrations for selective kills, a total kill concentration of antimycin or rotenone was applied in four of the ponds to evaluate the results of the selective kill. Where antimycin was used for the total kill, live cages were placed in the pond at two-day intervals to determine the residual quality of the toxicant.

RESULTS

Bioassay results demonstrated that concentrations of 0.1 to 0.2 ppb were adequate to kill all bluegill from 1″ to 3″ in length in both water types. However, in the field at a pH similar to that of the laboratory concentrations of 5 to 10 times greater were required. Detailed results of bioassay work is to be presented in a dissertation at the University of Georgia.

Tables 1 and 2 summarize the results of the study. At a pH of 6.4 (Pond I) of 2251 bluegill 0-5" long all but 48 were killed and 27 of the 6-8" bluegill were eliminated with a 0.5 ppb application. At the higher pH of 8.2 in Pond II, all bluegill and redear from 0-5" were killed at a 1.2 ppb concentration, but only 19 of 25 in the 6-8" group. At an intermediate pH of 7.3 (Pond IV), a 0.5 ppb concentration eliminated bluegill of all size classes.

TABLE I — SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE STUDY AREAS.

Pond	Surface Area	Acre Feet	pH (Mid-afternoon)	(1M) Temperature	Total Hardness	Antimycin Conc. Selective	Antimycin Conc. Total
I	2.81	8.43	6.4	22°C	5 p.p.m.	0.5 p.p.b.	5.0
II	.51	1.12	8.2	17°C	15 p.p.m.	1.2 p.p.b.	—
III	.51	1.49	9.6	18°C	15 p.p.m.	1.0 p.p.b.	—
IV	1.03	6.61	7.3	19°C	8 p.p.m.	0.5 p.p.b.	5.0
V	1.09	3.08	7.2	27°C	31 p.p.m.	0.5 p.p.b.	—
						1.0 p.p.b.	

TABLE II — A SUMMARY OF FIELD RESULTS

Size (Inches)	Selective Kill (Number of fish)			Total Kill (Number of fish)		
	Bluegill and Redear	Largemouth Bass	Golden Shiner	Bluegill and Redear	Largemouth Bass	Golden Shiner
Pond I						
0-6	2203	1	—	48	4	—
6-9	27	1	—	6	97	—
9-13	16	1	—	101	41	—
13+	0	0	—	0	24	—
Total	2246	3	—	155	166	—
Pond II						
0-6	1643	0	762	0	0	4
6-9	19	4	24	6	0	8
9-13	3	4	6	1	0	0
13+	0	0	0	0	3	0
Total	1665	8	792	7	3	12
Pond III						
0-6	4730	76 (fry)	464	—	—	—
6-9	96	0	9	—	—	—
9-13	0	0	0	—	—	—
13+	0	0	0	—	—	—
Total	4826	76	473	—	—	—
Pond IV						
0-6	1060	7	—	—	0	—
6-9	174	14	—	—	0	—
9-13	1	6	—	—	0	—
13+	0	3	—	—	2	—
Total	1235	30	—	—	2	—
Pond V						
0-6	2704	0	—	24	0	204
6-9	123	1	—	2	5	1
9-13	0	0	—	0	17	42
13+	0	0	—	0	5	5
Total	2827	1	—	26	27	252

Of the four major species represented in this study, bluegill were found to be the most susceptible to antimycin and largemouth bass *(Micropterus salmoides)* the least. Bluegill and redear were grouped because of field identification difficulties. However, empirical observations indicate that they responded to the toxicant in much the same manner.

In Pond I there were at least 169 largemouth bass present. With the exception of 3 individuals, they were unaffected by the 0.5 ppb application. Likewise in Pond V, more than 99% of all bluegill and redear were eliminated by a concentration of 0.5 ppb while only one small bass was killed. An application of 1.0 ppb in the same pond six days after the 0.5 ppb application killed all but two of the remaining 27 bass. In Pond IV, two bass remained alive although all other fish had been killed with the 0.5 ppb application. Three of the eleven present in Pond II survived a 1.2 ppb concentration. Bass fry were killed at Pond III at a concentration which severely reduced bluegill.

The results clearly demonstrate a size selectivity for bluegill. In Pond I 98% of the bluegill and redear 0-5" in length were killed at the 0.5 ppb concentration, 78% of the 6-8" group were killed but only 15% of those greater than 9 inches long were killed in the selective treatment.

DISCUSSION

When selective kill concentrations are applied, three to six hours are required before fish begin to die. Distressed and dying fish exhibit characteristic behavior. Lethargy, swimming onto the shore, and a general uncontrolled swimming motion is typical. Fish began to surface 15 to 45 minutes after application of five or more parts per billion.

In Ponds I, IV, and V the same concentration was used. The pH was 6.4, 7.3, and 7.2, respectively, yet only two large bass survived in Pond IV. A possible explanation for the fact that fewer fish were killed in Ponds I and V is that not all the active ingredient dissolved as the sand sank to the bottom, thus there was some loss to the sediment. Most of Pond I is less than 5 feet in depth whereas in Pond IV approximately 80% of the pond is deeper than 5 feet. Additional evidence to support this conclusion was apparent in Pond V which was also quite shallow. Here the sand formulated preparation was placed in a liter of acetone, shaken vigorously and allowed to stand 20 minutes before applying to the pond. At the same concentration and at similar pH values, a higher percentage of the total number of bluegill and larger fish of this species were killed in Pond V than in Pond I.

Another factor which may account for the greater kill in Pond IV is that a 0.5 ppb concentration was calculated for the total volume even though the pond was thermally stratified. The presence of dead tadpoles after the application of the total kill concentration of 5 ppb suggests that thorough mixing did not occur since tadpoles were not killed at this concentration in other ponds. Bioassay results of Lennon and Walker (1964) indicate a much higher concentration is required to kill tadpoles than that required for fish.

Field trials substantiate the laboratory results of Lennon and Walker (1964). Golden shiners *(Notemigonus crysoleucas)* survive in greater numbers than do bluegills as was evident in Ponds II and III. Although the Pond III study was not followed by a total kill, three seine hauls revealed the presence of large numbers of shiners but very few bluegill less than 5 inches in length.

CONCLUSIONS

(1) Antimycin has potential as a selective bluegill toxicant in some situations.

(2) A liquid form of antimycin would be more desirable in shallow ponds.

(3) Bass fry were killed at concentrations which kill bluegill.

(4) Total kill concentrations in these ponds detoxify within 7 to 10 days.

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THE BIRTH OF A CATIONIC POND SEALANT*

By Joseph A. Scroppo[1] and Andy L. Price[2]

I want to thank the members of the American Fisheries Society for inviting us here to present our paper, "The Birth of a Cationic Pond Sealant." Having chosen this metaphor, I'd like to begin by reminding you that this was no simple birth. The gestation period, as you will discover, required nine years of hard labor.

In our paper we will attempt to give you a brief outline of the development of a cationic pond sealant which has been named POND-SEAL TM.

Nine years ago, Armour embarked upon a program to develop a chemical which would help to conserve one of our vital resources—water. As we all know, water is lost through seepage, evaporation, and useless transpiration. To give you some idea of the staggering sum of water lost through seepage each year from farm ponds in the United States alone, I would like to give you some figures. There are approximately 2.25 million farm ponds in the United States.[3] The farmer relies upon these ponds for irrigation, water supply for his animals, wildlife conservation, and fire protection. The average size of these ponds is one acre at a depth of three to four feet. One acre foot of water is equivalent to 325,851 gallons.[4] Thus, the average farm pond holds 1,300,000 gallons of water. If we multiply this figure by 2.25 million (the number of farm ponds in the United States), we arrive at a total of three trillion gallons of water contained in farm ponds of the United States. (For those of you who don't include this figure in your budgeting, this is the number three (3) followed by 12 zero's.) Now, if only two inches per day were lost from these ponds—two inches in some cases is a very minimal seepage loss—if only two inches were lost per day, this would amount to an annual water loss of forty-seven trillion, six hundred thirty-two billion, five hundred million gallons (47,632,500,000,000 gal-

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[3] E. L. Gambell, "Two Million Farm Ponds Backstop America's Streams," 1966 Annual Meeting, Soil Conservation Society of America.

[4] Calculated.