bass, but it appeared that possibly the marked fish and unmarked fish might not be equally vulnerable.

The requirement of no mortality during the experiment was violated with the case of the Schnabel method, but did not appear to affect accuracy of the estimate. However, this study was preliminary in nature and a great deal more work needs to be done to test the accuracy and the effects of the violation of requirements of the methods.

The authors believe that a more dependable test of these effects could be made by intensive sampling within a few weeks of draining.

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BIOASSAY OF INDUSTRIAL POLLUTION BY USE OF MASONITE PLATE SAMPLERS POPULATED WITH CHIRONOMIDS

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ABSTRACT

Plate samplers constructed of ⅛-inch thick masonite were used in a bioassay study of water quality in the Black Warrior River near Tuscaloosa, Alabama. The samplers were placed in a fertilized pond and allowed to accumulate a dense population of larval chironomids (Chironomidae) for one month. The samplers were then placed into the river at stations above the outfall of the uppermost industry and below each outfall of four industries. Counts of chironomids on each of the samplers were made after one week and comparisons were made between the average number of organisms on the samplers at stations above the outfalls and the average number at each of the stations downstream from the outfalls.

It appeared that this inexpensive technique of bioassay can be useful in determining the effects of pollution on chironomids.

Today there are more people with more leisure time demanding more clean freshwater for recreation than ever before. There is also an increased demand for more complex industrial goods and, subsequently, more complex waste products are being discharged into our streams and lakes. There exists a great need for rapid and efficient bioassay techniques to determine the effects of these pollutants on the fish and fish food organisms living in the receiving waters.

Hester and Dendy (1962) described a multiple plate sampler constructed of ⅛-inch thick tempered hardboard ("masonite") and its use to determine the abundance of macroinvertebrate organisms in streams. The samplers were placed into streams for periods of from

one to three weeks and then examined to determine the aquatic organisms that had accumulatd on the plates of the sampler.

Dr. J. S. Dendy[1] described a bioassay technique used to determine the effects of polluted water on larval chironomids (Chironomidae). The samplers were constructed of two ⅛-inch thick plates (3 inches square) of masonite separated by a 1-inch square plate of the same thickness. The plates were bound together with a nylon rope. Samplers were placed in a fertilized pond, allowed to collect a population of larval chironomids, and then placed into a polluted portion of a stream. Samplers placed into an unpolluted tributary stream served as controls. The plates were removed after three days and examined to determine the number of chironomids on the plates. After reviewing the results of the technique used by Dendy, this author initiated a study to determine the effects of industrial pollution on the fish and fish food organisms in a portion of the Black Warrior River near Tuscaloosa, Alabama. Chironomids are abundant in non-polluted waters of Alabama and are important food items in the diets of many forage fishes (Howell, et al., 1941).

MATERIALS AND METHODS

The plate samplers used in this study were constructed of ⅛-inch thick masonite. Each sampler consisted of two 3-inch square plates separated by one 1-inch square plate. To assemble, a ⅛-inch hole was bored through the center of each 1- and 3-inch square plate. Twenty inches of number 18 nylon rope, each end bound together to form a continuous loop, was passed through the hole in the center of the plates and then looped firmly around each corner of the sampler (Figure 1). The cost of materials for each sampler, including the nylon rope, was three cents.

Samplers were suspended in a fertilized pond at a depth of about two feet and allowed to remain for about one month. It was observed that this period of time was generally required for a dense population of larval chironomids to accumulate on the samplers. Each sampler that appeared to have similar concentrations of larval chironomids attached was then removed from the pond and placed into a plastic bag filled with pond water. The bags were sealed with a rubber band and transported to the river. In one instance, one-pint polyethylene containers used for storing vegetables in home refrigerators, were used to transport the samplers from pond to river.

The area where tests were made on the Black Warrior River has four industries (a chemical company that manufactures sulfuric acid, formaldehyde and resin compounds; a binder company that manufactures crude oil, refined tall oil, and an asphaltic floor tile binding compound; an asphalt company that manufactures asphalt and fuel oil products; and a pulp-paper mill that manufactures pulp paper and paper bags) located within a 2.9 mile distance along the river bank. Each of the industries empties waste products into the river within this area. A navigational lock and dam is located 1.7 miles above the uppermost industry and another lock and dam is located 4.8 miles downstream from the lowermost industry (Figure 2).

Tests were made during October, 1963; May and November, 1964; and July, 1965. Five to ten stations were used during each test period. The samplers were suspended in the river at a depth of about 18 inches. Baling wire was used to attach suspended samplers to overhanging trees. Two samplers were placed at each station. Samplers were placed above the uppermost industry during each test period. During three test periods, samplers were placed 16.5 and 21.9 miles below the lowermost outfall (Figure 2).

After one week the samplers were removed and the contents of the inside area of the plates were scraped into a vial of 80 percent ethyl alcohol. The vials were then taken to the laboratory and the number of chironomids from each station was determined. Comparisons were made between the average number of chironomids on the samplers at

[1] Auburn University, Department of Zoology and Entomology, Annual Report, 1962.

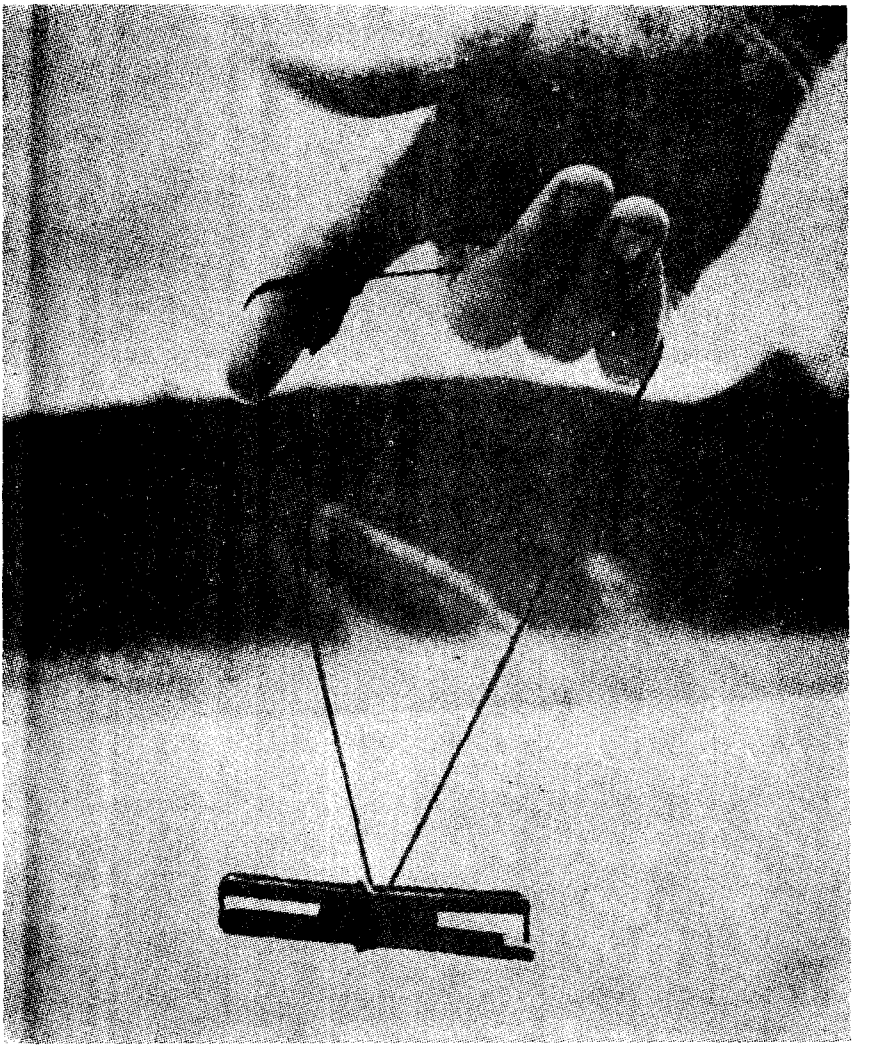

Figure 1. A masonite plate sampler attached to a nylon rope used to suspend sampler in water.

stations above the pollution outfalls and the average number of organisms on samplers at each of the stations downstream from the pollution outfalls.

RESULTS

It appeared that the method used can be a very useful and inexpensive way of determining the toxicity of polluted waters to chironomids. In most instances, there was a significant difference in the number of test organisms on the samplers at stations located downstream from polluted outfalls as compared to control stations (Table 1). Samplers were lost in several instances.

During the first sample period the average number of chironomids on samplers was 36 to 98 per cent less at five stations below the pollution outfalls as compared to the numbers on samplers at the station 0.5 miles above the uppermost polluted area.

The average number of chironomids per sampler during the sec-

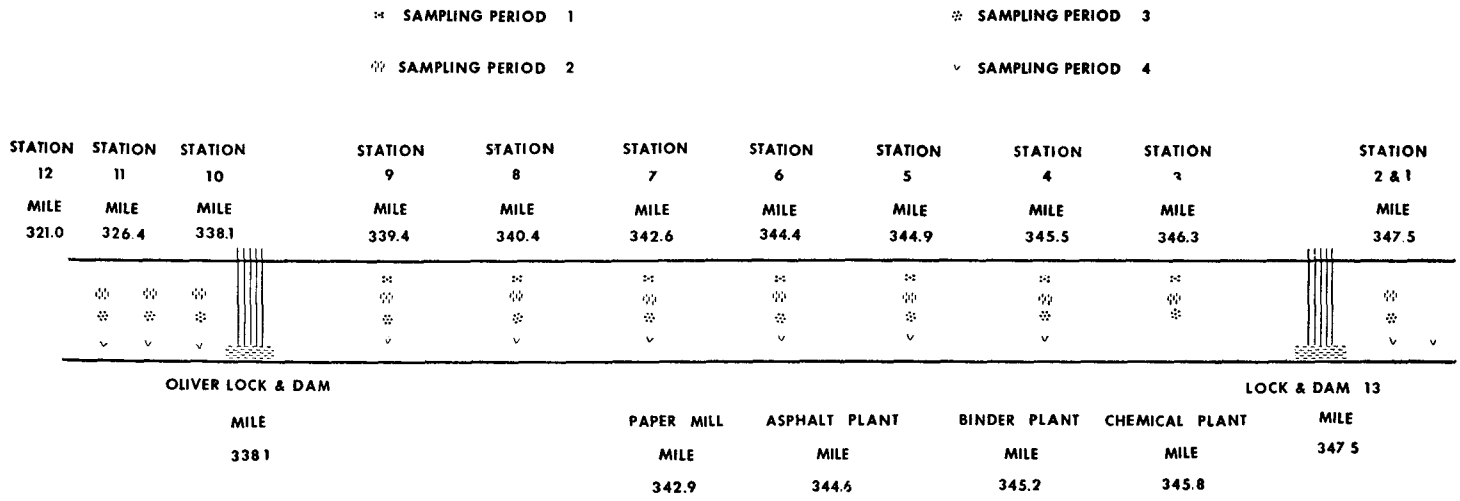

Figure 2 A schematic diagram of a portion of the Black Warrior River near Tuscaloosa, Alabama showing the relative location of five industries and bioassay sampling stations (stream flow is from right to left)

ond test period at four stations below the industry outfalls ranged from 47 to 79 per cent lower than the average number on samplers at the control stations 1.7 miles above the uppermost industry. The station that served as a control during the second period was 1.7 miles above the uppermost pollution outfall and 100 yards above the upstream navigational lock (Figure 2). Conditions appeared to be more favorable for chironomids in this area. The average number on the samplers was 44 per cent greater than the average number located below the lock and dam (0.5 mile above uppermost industry). Samplers were placed at Stations located 5, 16 and 21.9 miles below the lowermost industry outfall during this test period but were lost.

Table 1. The number of chironomids on masonite plate samplers after samplers remained in the Black Warrior River for one week.

Station number	Number of chironomids per sampler							
	Sample period 1		Sample period 2		Sample period 3		Sample period 4	
	Total	Average	Total	Average	Total	Average	Total	Average
1	—	—	—	—	—	—	44	50.5
	—		—		—		57	
2	—	—	123	117	310	294.0	24	27.5
	—		111		278		31	
3	76	66.0	51	66	219	226.0	*	
	56		81		234		19	
4	34	30.5	71	62	231	190.0	31	44.5
	27		53		149		58	
5	*	*	*	*	*	*	*	*
	*		*		*		*	
6	51	42.5	26	34	225	193.0	19	21.0
	34		42		161		23	
7	2	4.0	40	26	167	191.0	*	
	6		11		215		9	
8	6	7.5	31	25	114	101.5	29	27.0
	9		19		89		25	
9	2	1.5	*	*	*	*	8	9.5
	—		*		*		11	
10	—	—	*	*	91	69.0	*	*
	—		*		47		*	
11	—	—	*	*	84	81.5	64	
	—		*		79		*	
12	—	—	*	*	211	199.5	44	56.5
	—		*		188		69	

* Sampler lost and not recovered.

During the third sampling period a total of nine stations was used. The average number of chironomids ranged from 32 to 77 per cent less on samplers at seven stations located below pollution outfalls as compared to the average number on samplers located 1.7 miles above the uppermost industry outfall.

An additional control station was included during the fourth sampling period. It was also located 1.7 miles above the uppermost pollution outfall. Polyethylene vegetable containers were used to transport the samplers from pond to river during this period. The samplers used as controls were the last to be placed into the river after an unavoid-

able delay of five hours. Prior to placing the samplers in the river at Stations 1 and 2, it was noted that numerous larval chironomids were floating on the water in the containers. It was likely that these samplers contained fewer test organisms than the samplers placed at the other stations earlier. However, the average number of chironomids on the samplers below five of the pollution outfalls was noticeably lower than the average number on the samplers at the uppermost stations. One sampler was lost at each of Stations 3, 7 and 11. Both samplers were lost at Station 5 during each of the test periods.

DISCUSSION

It appears that this inexpensive technique of bioassay can be useful in determining the effects of pollution on chironomids.

The results of the preliminary tests offer supporting evidence that waste materials emptied into the Black Warrior River by the complex of industries near Tuscaloosa, Alabama adversely affects fish food organisms in more than nine miles of the stream.

It is recommended that the following practices be followed to help reduce biased results when this bioassay method is attempted.

1. Locate a pond containing a dense population of chironomids, or other non-burrowing insect larvae, as close as possible to the area to be tested.
2. Insure that each sampler is submersed in the transporting container and if the container is sealed, allow sufficient air space in the container to provide adequate oxygen for the organisms.
3. Do not permit excessive jolting or excessive temperature changes while transporting samplers from pond to test area.
4. Avoid unnecessary delay while transporting samplers.
5. Use adequate number of samplers at each sampling station. Loss of some samplers appears inevitable.

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A TAG COMPARISON STUDY OF LARGEMOUTH BASS IN THEIR NATURAL ENVIRONMENT

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ABSTRACT

One thousand three hundred and forty-six largemouth bass were captured, tagged, and released in nineteen bodies of water throughout the State of Florida. Spaghetti, Petersen disc, and Monel metal strap tags were the principal tags employed. All fish caught by anglers were returned to the Game and Fresh Water Fish Commission for information regarding growth rates of which negative data was obtained. Comparisons were made of the percent returns of each of the three tags represented, plus the Spaghetti tag was compared in two different locations on the fish. The external effects on the recaptured fish showed