The Effect of Pesticides on the Bluegill (Lepomis macrochirus) In a Northern Indiana Lake

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Introduction

In an effort to control the entomological and other pest problems of the world, chemists have synthesized innumerable toxicant compounds in the twenty years since World War II. So rapid has been the production of these materials that, for many, their effects on the ecosystem in which they are used are little known.

It was the goal of this research supported in part by National Science Foundation Undergraduate Research Participation Grant GE-4070), to find readily identifiable symptoms which could be easily catalogued and used in an effort to differentiate, in a simple field identification, a particular chlorinated hydrocarbon toxicant which might be responsible for a fish kill.

Further, it was hoped that the effects of temperature on the reactions of poisoned fish could be observed. And, in a final series of experiments, the ability of a fish to recover from an exposure to one of the toxicants was tested.

The nine toxicants tested were: Aldrin (Technical Standard), Captan, Dieldrin (Technical Standard), DDT (Reference Standard), Edrin, Heptachlor, Lindane, Methoxychlor (Technical Standard), and 2-4-D.

Procedure

The tests were conducted on the bluegill sunfish *(Lepomis macrochirus)* because of its relative abundance at the David Worth Dennis Biological Station located on Dewart Lake where the research was conducted. The bluegill was also chosen because of its viability in captivity and its sensitivity to various toxicants (1). The specimens were obtained by fyke net, seines, rod and reel, and wire fish traps.

After a 72-hour period of acclimation, the specimens were transferred from 35-gallon stock tanks into 15-gallon commercial aquaria. Each aquaria contained 50 liters of water. Two fish were placed in each aquarium. The temperature of the water was maintained between 21°C. and 27°C.

The toxicants were added in acetone-toxicant solution (2) calculated to produce a concentration of toxicant to water of 1 part per million. The poisons were then thoroughly mixed with the water before the fish were introduced. Size selection of the fish was between 7 and 9 cm (Standard Length) and 90 and 155 grams.

The tanks were observed closely and symptoms of the fish were noted until death. After 100% mortality had been reached, each fish was dissected and examined for internal morphological aberrations which might have been caused by the pesticides.

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In the second series experiments, testing the effectivity of the toxicants at an increased temperature, the temperature of the water was maintained at 35°C. by standard aquarium heaters. All other procedure was the same as above.

The final series of experiments tested the ability of the bluegill to recover from the effects of poisoning once the initial symptoms of distress appeared. Two fish were added to each aquaria in the above mentioned manner. The concentration of toxicants in the tanks, however, was maintained at .1 p.p.m. rather than 1 p.p.m. At the first signs of distress, (generally a slight hypersensitivity) one of the fish was removed from the tank containing the toxicant, rinsed in the distilled water, and transferred to a tank containing 50 liters of uncontaminated water. Both of the fish were then observed until death.

Results

A definite pattern of potency was observed in all of the tests conducted. (see Graph 1). However, this potency seemed to increase as the three trials were conducted. This effect was thought to be caused by a residual toxicant remaining in the aquaria from one trial to another even though the aquaria were well scrubbed after each trial. Soaking the aquaria in a 1 molar solution of Sodium Thiosulfate after each trial seemed to correct this problem.

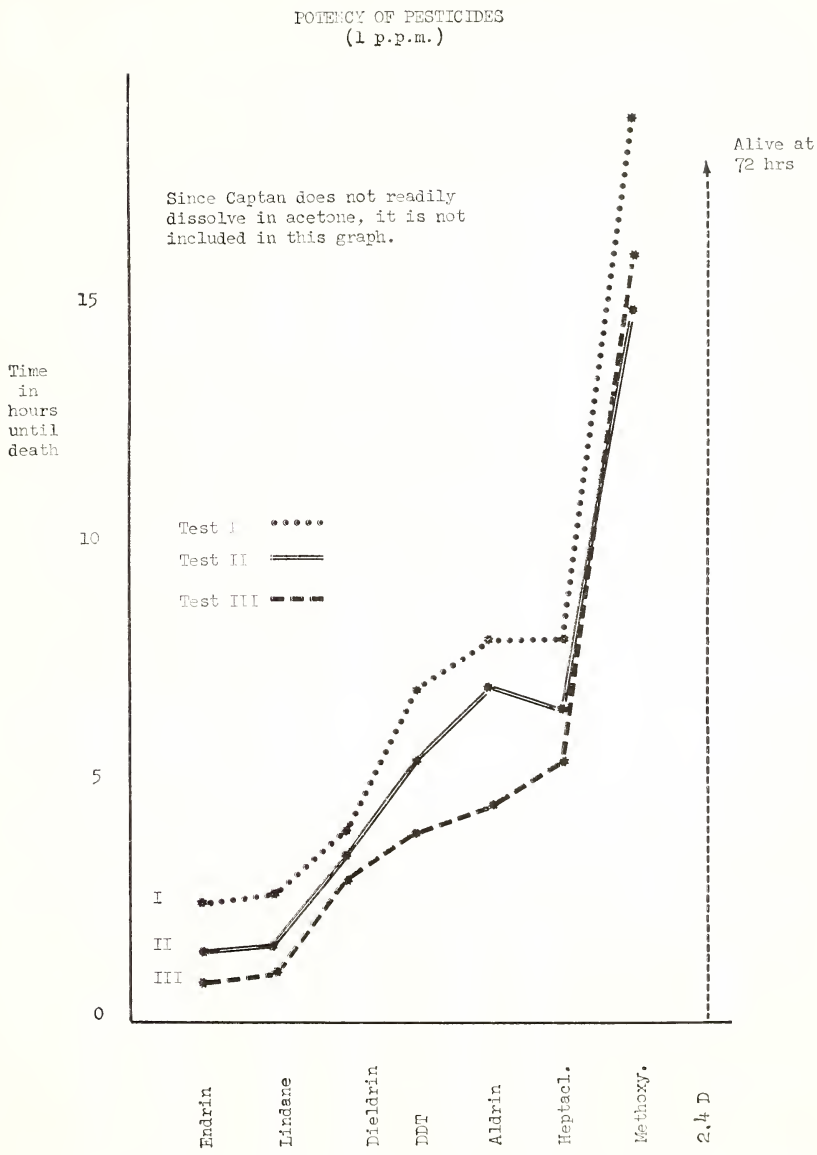
Also, the symptoms and aberrations caused by the toxicants are quite similar (See Table 1). It was observed that in a series of trials with one toxicant, the reactions varied as individual fish were affected. Ideally, to confirm the suspicion that a fish kill was caused by one of the above-mentioned chemical agents, the fish should be observed prior to death. It is in the symptoms that the effects of the chlorinated hydrocarbons are most clearly seen.

From an examination of the symptoms it would seem that these toxicants first affect the neural activity of the fish. Then, some of the agents attack specific organs of the body such as the liver and kidney where these organs can be seen to be hemorrhaged. Heptachlor, for example, causes severe hemorrhaging which is visible in the pelvic and pectoral fins. Captan, on the other hand, causes the large intestine to be partially everted through the anus.

Therefore, it appears that a person investigating a fish kill would have a difficult time identifying the specificity of a certain toxicant which might be responsible for a fish-kill merely by observing symptoms or examination of the fish after death.

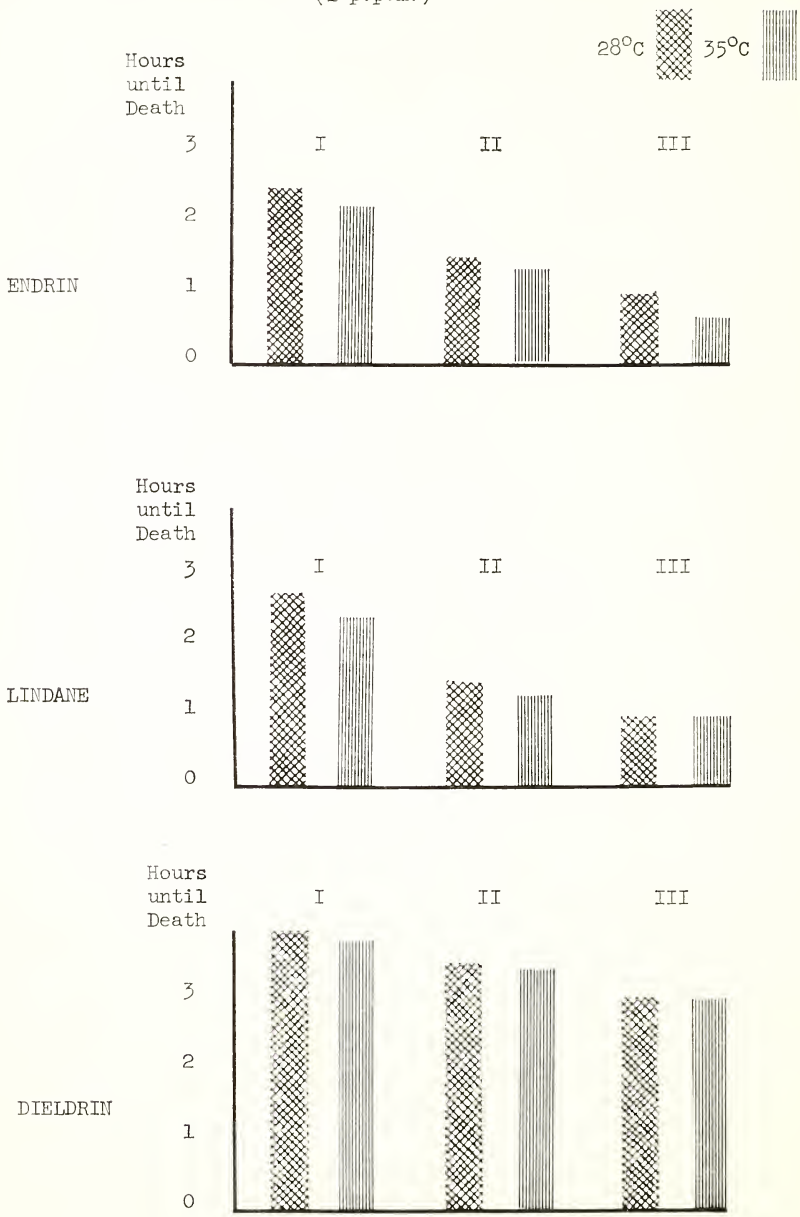
In an effort to determine the effect of temperature on the potency of pesticides, the three most toxicant compounds (Endrin, Lindane and Dieldrin) were selected. Temperature of the water was maintained at 35°C. In three trials each with Endrin, Lindane, and Dieldrin the data as shown in graph 2 indicates that the condition of the fish in warmer water deteriorated more rapidly than the condition of the fish in cooler water. It is thought that the warmer water increases the metabolism of the fish and thus, the absorption and circulation of the toxicant substances from the water is increased.

Of the four toxicants which were extensively tested in this experiment, the fish that was transferred to the uncontaminated water died

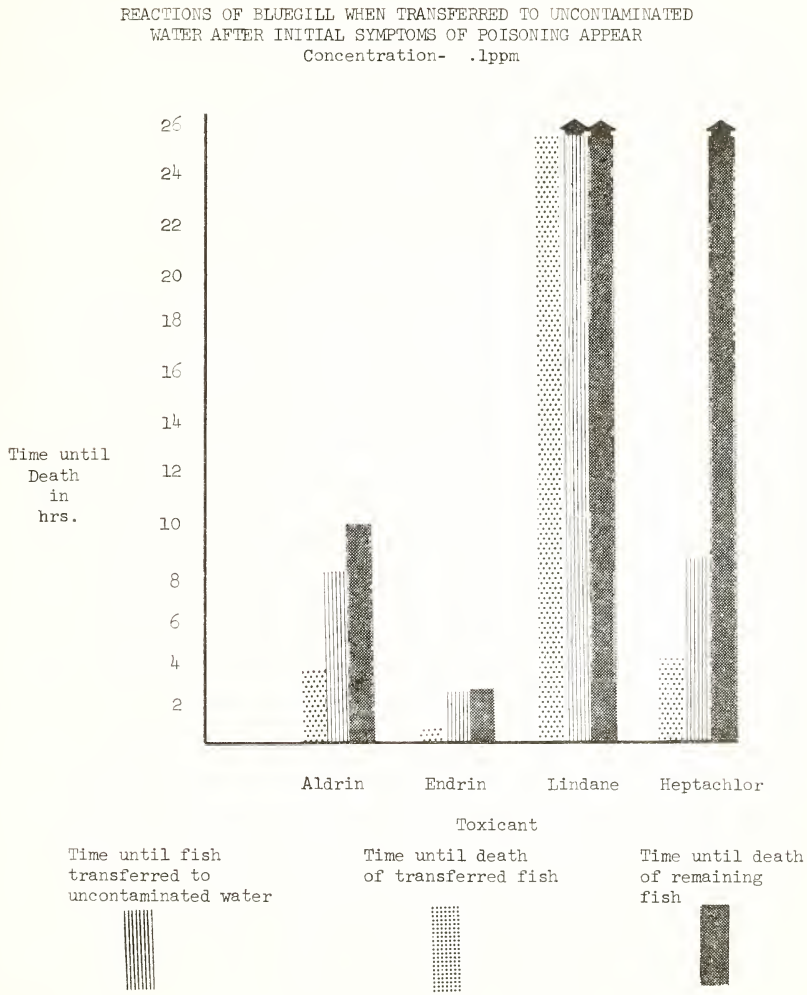

POTENCY OF PESTICIDES
(1 p.p.m.)
Since Captan does not readily dissolve in acetone, it is not included in this graph.
Alive at 72 hrs
Time in hours until death
15
10
5
0
Test I
Test II
Test III
I
II
III
Endrin
Lindane
Dieldrin
DDT
Aldrin
Heptacl.
Methoxy.
2,4 D

Graph 1

THE EFFECT OF HEAT ON THE POTENCY OF PESTICIDES
(1 p.p.m.)



Graph 2



Graph 3

sooner than the fish which remained in the poison. This indicates that, at least for these four compounds, death is inevitable once the initial symptoms have appeared (Graph 3.)

TABLE 1. Morphological abnormalities associated with short-term exposure to insecticides.

Toxicant	Before Death	After Death
Aldrin	Loss of equilibrium	Gills ruptured and bleeding Liver darker than normal and bleeding
Captan	Activity retarded during early stages of poisoning Respiration increase Spastic motions; loss of equilibrium Evidence of hemorrhaging in pelvic and pectoral areas	Kidney bloated and ruptured Intestine pushed through anus
Dieldrin	Loss of vertical equilibrium Irregular respiration Loss of color	No obvious defects
DDT	Hypersensitivity Loss of equilibrium Irregular respiration	No obvious defects
Endrin	Loss of color Fins rigid and erect Increased sensitivity Loss of equilibrium	Brain region watery Intestinal swelling Gills expanded
Heptachlor	Loss of equilibrium Hemorrhaging in pelvic area	Internal bleeding Liver bleeding
Lindane	Hypersensitivity Loss of equilibrium Coloration changes: fins darker at border, body lighter, top of head darker, pupil darker surrounded by light coloration	Brain damage Internal bleeding Intestine pushed through anus Liver damage
Methoxychlor	Loss of equilibrium	Gills slightly hemorrhaging
2, 4D	Signs of impaired respiration	No apparent defects

Summary

1. From a simple examination of symptoms or examination after death of a bluegill, it is difficult, if not almost impossible, to specify the toxicant responsible, in a simple field assay.

2. When bluegill are placed in water containing toxicant material, as the temperature of the water increases the time that it takes the fish to be affected by the toxicant decreases. This is thought to occur because increased temperature increases the metabolism of the fish causing more rapid absorption of the toxicant.

3. Once bluegill show the initial symptoms of poisoning, deterioration of the individual's health continues even though the subject is placed in uncontaminated water.

Literature Cited

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