Sensitivity to Pesticides in Three Generations of Sheepshead Minnows

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The increasing use of pesticides to control pests that live in or near the aquatic environment creates a need for more information concerning the effects of these chemicals on fishes. Recent investigations indicate that some pesticides affect reproduction in fishes. For example, mortality of fry of lake trout (Salvelinus namaycush) is positively correlated with the amount of DDT present in the eggs (1). Chronic exposure to dieldrin alters the age structure of confined populations of guppies so that proportionately more fry and immature fish appear in the population (2). Sheepshead minnows (Cyprinodon variegatus) whose parents had survived toxic concentrations of DDT are more sensitive to DDT and endrin than are offspring of "control" fish whose parents had not been exposed to DDT (3).

The purpose of this study was to determine whether succeeding generations of sheepshead minnows exposed to DDT can develop resistance to DDT, and whether "cross-resistance" to endrin, a related insecticide, can develop.

Methods and Materials

Three lines of fish, each consisting of a parental group and their descendants, are represented in these tests. Fish from which these lines were derived were collected from marsh ditches on Santa Rosa Island, Escambia County, Florida in July 1964, March-April 1965, and July 1965. Salinity in the ditches ranged from 1 to 10 p.p.t. (parts per thousand); water temperature, from 18° to 25° C. Fish were acclimated to laboratory conditions for 24 hours before testing. The fish were subjected to bioassay tests in the laboratory to determine their sensitivity to the pesticides.

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Tests were conducted in acrylic plastic aquaria that contained 20 liters of tap water adjusted to 4 p.p.t. salinity with artificial sea salt. The water was aerated to near saturation and its temperature was maintained at 21 ± 1°C. Stock solutions of pesticide in acetone were added at the rate of 0.5 ml acetone per liter of water to give the desired concentration of toxicant. Final concentration of DDT ranged from 15 to 40 p.p.b. (parts per billion, μg/L); that of acetone was 0.05%. From 50 to 100 experimental fish and a similar number of control fish of the same size range were used in each test. After each test, aquaria were washed with detergent and water, and rinsed with a 50% solution of acetone in water.

Since all lines were treated similarly (Figure 1), the treatment is described for only one line.

A sample of wild fish collected the same day was separated into two groups, designated "experimental" and "control". Sixty to 75 fish (50 to 70 mm total length), distributed 5 per aquarium, were exposed for 24 hours to a concentration of DDT that killed 95% or more of the fish (Table 1). Control fish of similar size and number were exposed to acetone-water solution alone. Survivors of the DDT challenge, placed in a brackish-water breeding pond on Santa Rosa Island to reproduce, produced the F1 generation of the experimental line of fish. Offspring of the control fish, spawned and reared in an adjacent pond, represent the F1 control generation (normal population).

### TABLE 1

Survival of wild sheepshead minnows subjected to concentrations of DDT that killed 95% or more of the fish. Survivors provided breeding stock for the three test lines used in this study.

<table>
<thead>
<tr>
<th>Date</th>
<th>Number tested</th>
<th>Survivors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>July 1964</td>
<td>195</td>
<td>2</td>
</tr>
<tr>
<td>March-April 1965</td>
<td>1050</td>
<td>15</td>
</tr>
<tr>
<td>July 1965</td>
<td>555</td>
<td>4</td>
</tr>
</tbody>
</table>

Breeding ponds were adjacent rectangular excavations 15 m. long, 5 m. wide, and 1.25 m. deep. Sea water was periodically pumped into the ponds to maintain salinity levels from 1 to 10 p.p.t. and depths from 0.5 to 1 m. Environmental conditions were similar