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Differentiation of effects of two pesticides upon Urosalpinx cinerea Say from the Eastern Shore of Virginia

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DIFFERENTIATION OF EFFECTS OF TWO PESTICIDES UPON *UROSALPINX CINEREA* SAY FROM THE EASTERN SHORE OF VIRGINIA

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ABSTRACT

Adult *Urosalpinx* were exposed to various combinations of two pesticides ("Sevin", a methyl carbamate, and "Polystream", a mixture of chlorinated benzenes) recommended for oyster predator control by the Milford Biological Laboratory of the U. S. Fish and Wildlife Service. Concentrations used were within the recommended range, and the field procedure suggested was modified by us for application in laboratory trays. Under controlled laboratory conditions, Polystream used alone killed half the animals within a period of 5.5 to 6.8 days. The use of Sevin, which is highly toxic in crustaceans, is therefore questionable.

INTRODUCTION

Several recent publications (Loosanoff, MacKenzie and Davis, 1960; Loosanoff, MacKenzie and Shearer, 1960; Loosanoff, 1960, and MacKenzie and Gnewuch, 1962) have reported the effectiveness of toxic chemicals on oyster predators, particularly *Urosalpinx*. The chemical agents recommended by these writers are "Polystream" and "Sevin." The former is an aggregate of chlorinated benzenes produced by the Hooker Chemical Company; "Sevin" is the trademark of an established insecticide manufactured by the Union Carbide Corporation.

It has been suggested that these two agents be mixed with sand and broadcast over oyster grounds, and considerable success has been reported (Davis et al., 1961) with this procedure in field tests in Long Island Sound. In light of this it seemed necessary to obtain additional basic information on these toxic chemicals and their possible effects upon the marine habitat.

Two immediate questions were proposed. First, we wanted to know something about the specific effects of the recommended dosage of the two agents upon the large, Eastern Shore *Urosalpinx*. For instance, does the mixture kill them directly, or does it simply cause

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them to swell so that they are easy prey for some roving larger animal which is itself unaffected by the poison? The second question grew out of the report (Loosanoff et al., 1959) that "Sevin" killed crabs. Since we were considering using "Sevin" in an area that supports a blue crab fishery, it seemed vitally necessary to establish the relative effectiveness of the Polystream-sand treatment with and without "Sevin."

MATERIALS AND METHODS

All experimental animals were adult Urosalpinx cinerea Say of the large variety, collected near Wachapreague, Virginia, during the summer of 1962. They were maintained in running seawater aquaria or in a recirculating aquarium until 23 January 1963. Then they were transported to the Virginia Institute of Marine Science at Gloucester Point, Virginia, where they were placed in running York River water aquaria at ambient temperature and salinity for several days or longer. Three animal samples were used in these experiments. For two months prior to the experiment, the first group (Run A) was supplied with food and maintained at a controlled temperature of ca. 20 C. The two groups of animals used in Runs B and C were maintained without food and at incoming salinity and temperature prior to the experiments.

Seven enamel trays served as the experimental containers, each containing 50 animals. Treatments were applied to each of the trays as follows:

Tray Number	Treatment
1,5	Polystream-Sevin
2,6	Polystream
3,7	Sevin
4	Control

The concentrations of Polystream and Sevin were within or near the range of treatment suggested by the United States Fish and Wildlife Service Biological Laboratory at Milford, Connecticut (Table 1). In Runs A and C concentrations of chemicals were computed assuming uniform coverage over the whole tray bottom. In Run B approximately 2/3 of the bottom of each tray was covered and concentrations were based upon this area.

After the animals were placed in the trays, the treated and untreated sand was spread over the tray bottoms.

Table 1. Concentration of chemicals

Run	Polystream	Sevin
A	3-4 $\mu l/cm^2$	100 $\mu g/cm^2$
B	7-9 $\mu l/cm^2$	200-250 $\mu g/cm^2$
C	3-4 $\mu l/cm^2$	100 $\mu g/cm^2$

Several observations were made the first day, with daily observations throughout each run. Run A was terminated at 380 hours, Run B at 168 hours, and Run C at 143 hours.

Each observation included salinity, temperature, and number of animals dead, retracted, attached or swollen. The criterion used to determine death in a gastropod was the presence of a "rotting" odor. Retracted animals included all animals that were not attached, swollen or dead and had partially or completely withdrawn into their shells. A gastropod was considered attached when the foot was extended and attached to a surface or when the animal was mobile. If the body was distended and white, and the gastropod was unable to withdraw it completely, the animal was counted as swollen. There were many cases in which one animal was included in both of the categories, "swollen" and "attached."

RESULTS

In Run A the first mortality count was made six days after the application of treatments (Table 2). In this run the number of animals killed by the Polystream-Sevin treatment was similar to the number killed by Polystream alone throughout the course of the run (Fig. 1). At the termination of Run A, 16 days, the total mortality of the Polystream-Sevin group was 77% and that of the Polystream group was 78%. In Runs B and C the total mortality was greater for those animals treated with Polystream-Sevin than for those treated with Polystream alone. There was a total mortality of 11% observed among the animals treated with Sevin alone in Run B.

The observed LD_{50} (time required to kill half the animals in a sample) of the Polystream-Sevin and Polystream groups in Run B, 3.8

and 5.4 days respectively, was less than the LD_{50}'s in Runs A and C (Fig. 1). There was a difference of 1-2 days in the LD_{50}'s of the Polystream-Sevin group and the Polystream group in Runs B and C, while the LD_{50}'s of these two groups in Run A were almost identical.

In both the Polystream-Sevin and Polystream treatments the percentage of animals retracted was high in each of the three runs (Fig. 2). This high incidence of retraction was usually first observed shortly after the application of treatments and continued throughout each run.

Most swelling occurred in the Sevin-treated groups in each of the three runs (Fig. 3). The maximum number of animals was found swollen in the Sevin-treated groups at the end of 6 or 7 hours; swollen gastropods were not found after 2 or 3 days. Swelling was also noted in the Polystream-Sevin and Polystream treatments in each of the runs and was usually still evident in both of these treatments at the termination of each run. There was a higher percentage of swelling found in the Polystream-Sevin treatments than in the Polystream treatments.

The fraction of animals attached in the Polystream-Sevin and Polystream treatments was low throughout each run. In both of these treatments in Run A and in the Polystream-Sevin treatment in Run B, the proportion of animals increased gradually until approximately one third of the surviving animals was attached.

DISCUSSION

General

The conditions under which these experiments were run, as contrasted with those obtaining in most field situations, tended to favor the pesticides against the drills. That is, the flow of dilution water through the trays was rather low compared to the large volumes moving across most natural oyster beds, and contact with the drills by the poisoned sand was maximized by the method of administration and the lack of topographic relief of the tray bottoms. Despite these facts, the treatments described here never resulted in the catastrophic mortality rates reported for field trials by Loosanoff (1962a, 1962b).

The mean terminal kill for all our "Polystream" treatments was only 72.2%; this differs from previous field studies in which 90 to "more than 99%" (Loosanoff, 1962a) were reported as "eliminated."

Table 2. Cumulative mortality

Cumulative Days	Percentage dead											
	Polystream and Sevin			Polystream			Sevin			Controls		
	Run A	Run B	Run C	Run A	Run B	Run C	Run A	Run B	Run C	Run A	Run B	Run C
0	0	0	0	0	0	0	0	0	0	0	0	0
1	-	0	0	-	0	0	-	0	0	-	0	0
2	-	0	0	-	0	2	-	0	0	-	0	0
3	-	18	27	-	17	15	-	6	0	-	0	0
4	-	54	40	-	30	31	-	8	0	-	0	0
5	-	76	59	-	45	41	-	9	0	-	0	0
6	30	85	66	30	58	50	0	10	0	0	2	0
7	56	88	-	52	74	-	0	11	-	0	2	-
8	67	-	-	66	-	-	0	-	-	0	-	-
9	69	-	-	70	-	-	0	-	-	0	-	-
10	72	-	-	74	-	-	0	-	-	0	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	77	-	-	77	-	-	2	-	-	0	-	-
14	77	-	-	77	-	-	2	-	-	0	-	-
15	77	-	-	77	-	-	2	-	-	0	-	-
16	77	-	-	78	-	-	2	-	-	0	-	-

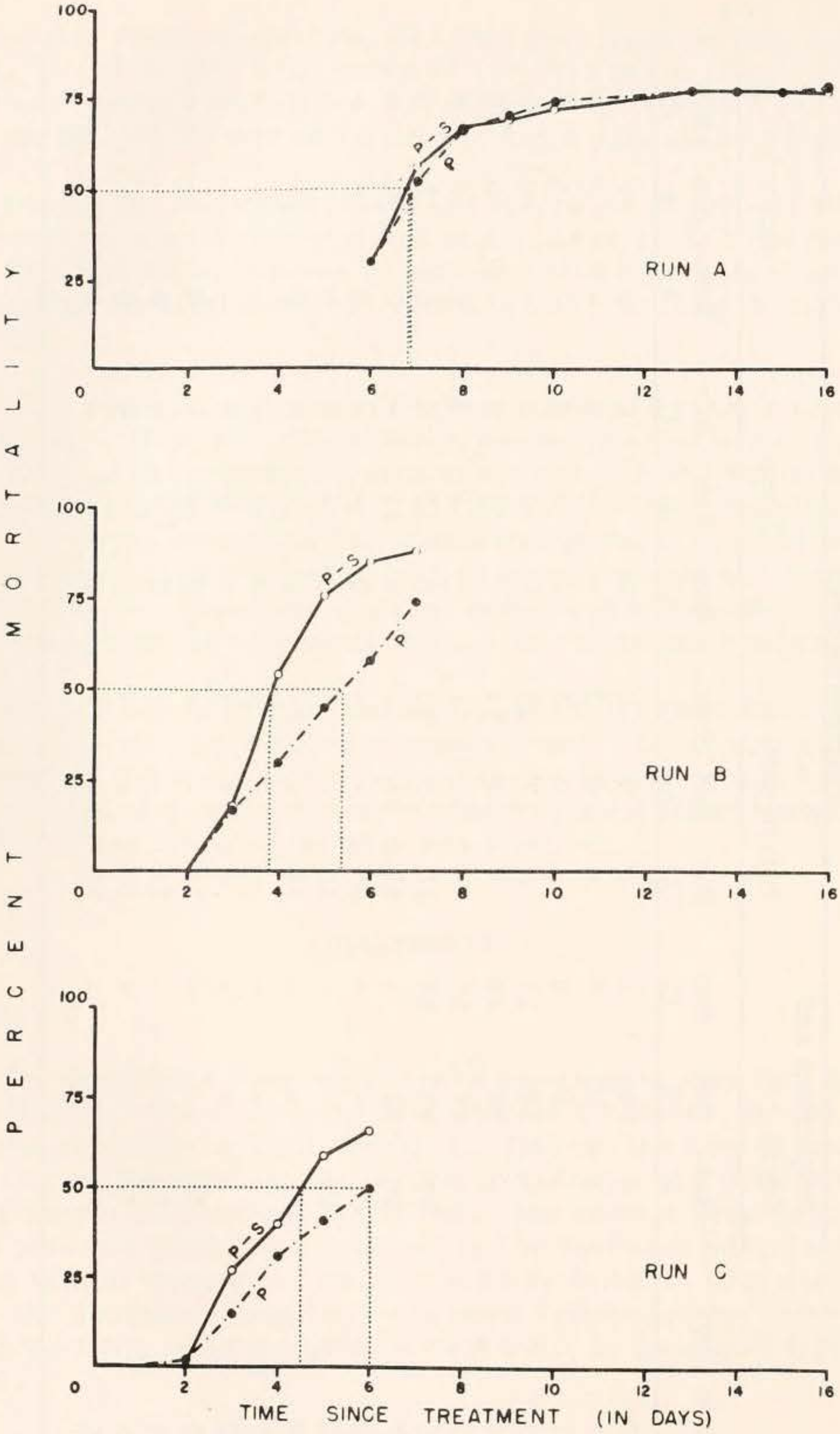

Figure 1

Cumulative mortality of *Urosalpinx cinereo* treated with Polystream and Polystream - Sevin

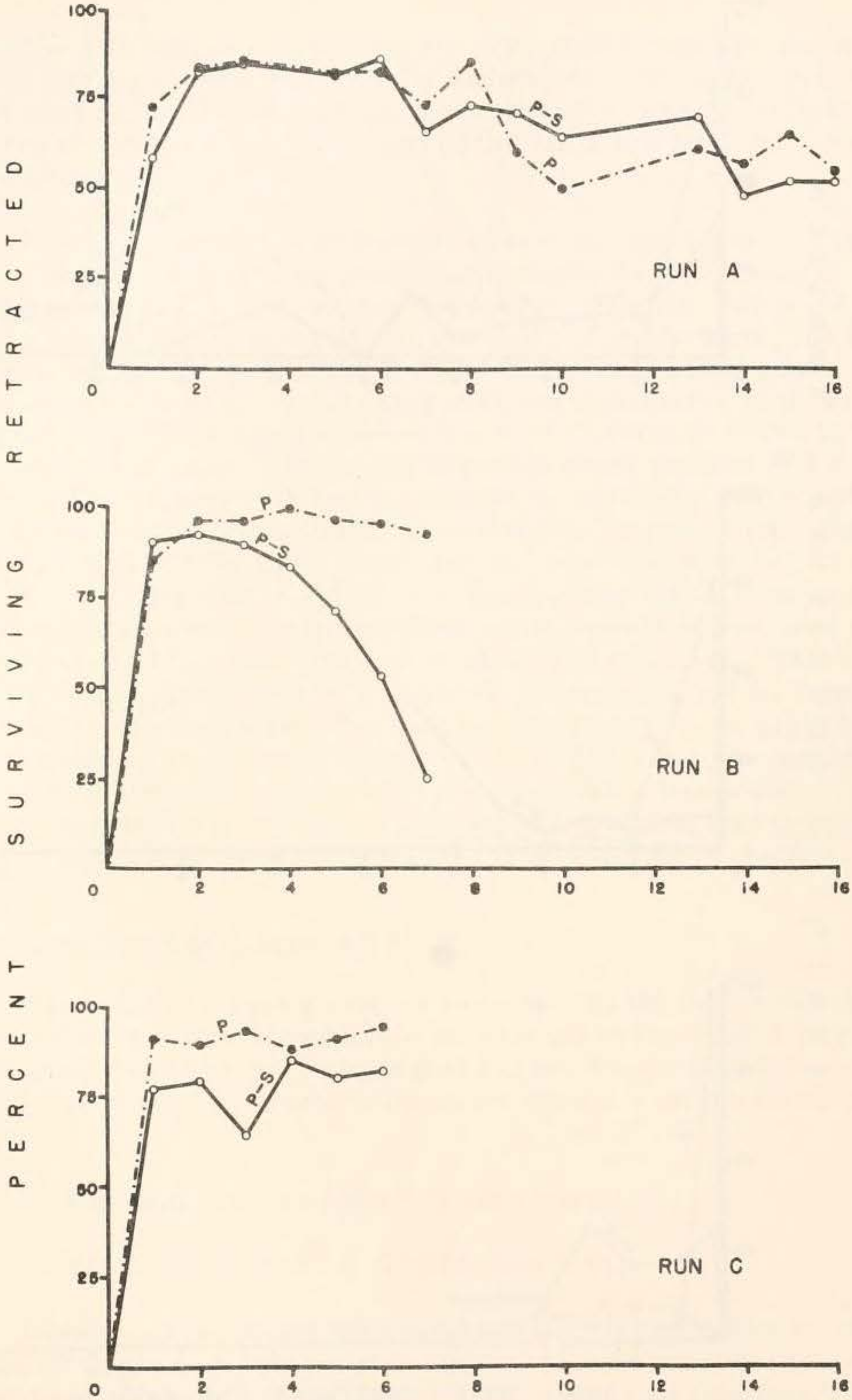

Figure 2

Retraction induced by various treatments

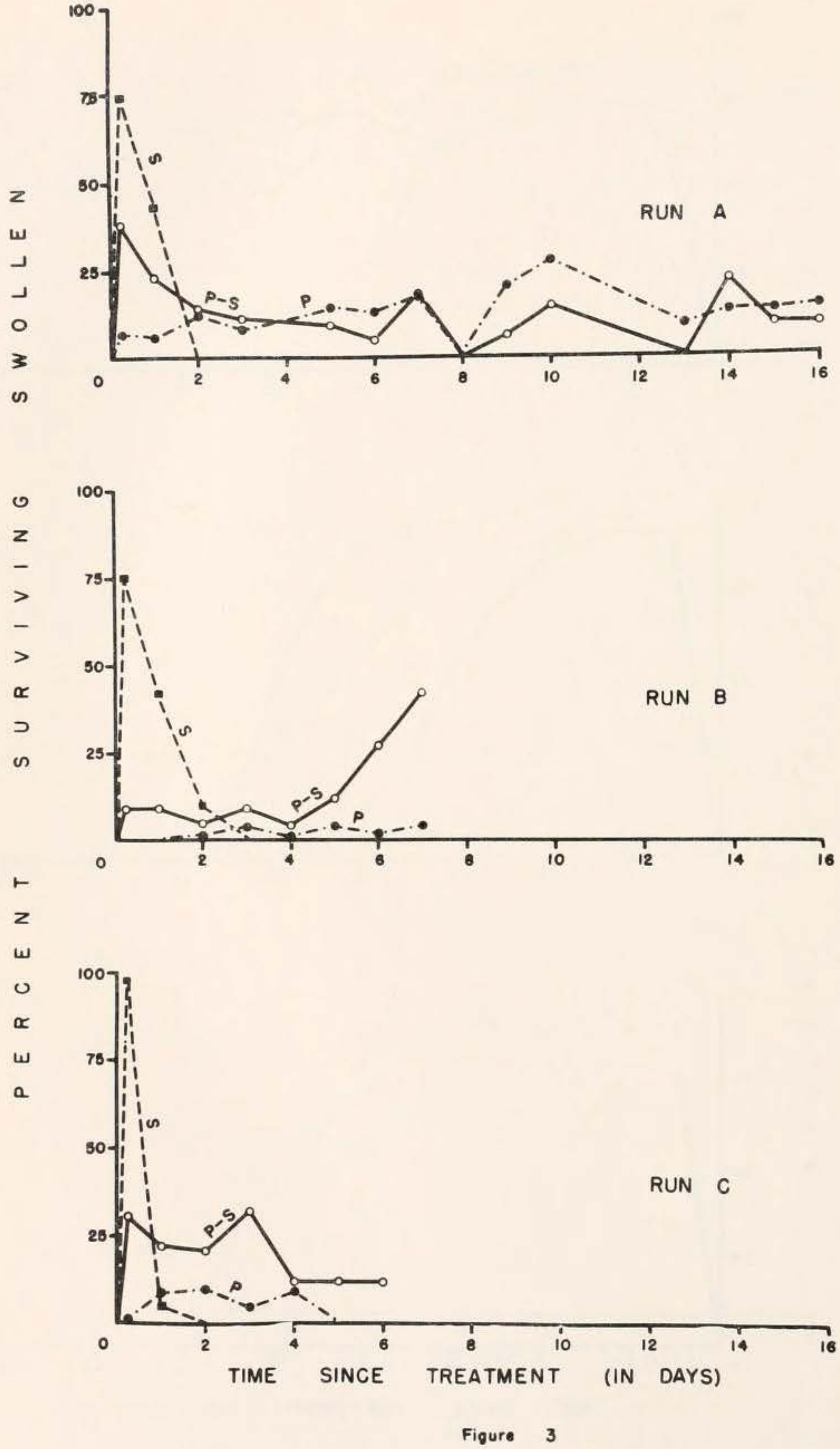

Figure 3

Swelling induced by various treatments

The differences in the mortality rates shown amongst the three runs of this experiment are not fully understood. However, it is reasonably safe to conclude that they may be the result of interaction between two factors: the condition of the drills and the concentrations of the chemicals.

It will be recalled that the test sample for Run A was conditioned and fed for two months prior to treatment; those for Runs B and C were not. Runs A and C employed the lower concentrations, Run B the higher, by a factor of about 2. On the basis of these facts, the interpretation would proceed as follows: In Run A, animals in good condition were exposed to initial concentrations comparable to those expected in the field application of the Milford Formula. The LD_{50} was obtained in about 7 days, and mortality never reached 80% even by the end of 16 days. In Run B, animals in relatively poor condition were treated with a concentration about double that of Run A. The LD_{50} was obtained in 4 to 5 days, and the maximum mortality of greater than 80% was obtained in 7 days. In Run C, animals in perhaps even poorer condition were treated with the same concentrations used in Run A, and the LD_{50} was obtained in about 4.5 to 6 days. This interpretation of our data leads to a tentative recommendation for field workers: If Polystream is to be used on an oyster bed, it might best be administered in the early spring when the drills are just emerging from their winter "hibernation" and are presumably weakened. Another investigation (Wood, unpublished) has shown that Urosalpinx is less resistant to osmotic stress in the spring than in the fall.

Polystream-Sevin or Polystream Alone?

Using the chi-square test we have determined that in Run A of our experiment it was not possible to distinguish the effects of the two treatments; however, in Runs B and C the Polystream-Sevin mixture produced slightly greater cumulative mortality on the following days:

Run B: Days 4 through 7 (P less than 0.01)

Run C: Days 5 and 6 (P less than 0.01)

Several investigators have reported (Carriker and Blake, 1959; Loosanoff et al., 1959) the effect of Sevin in causing drills to swell; it has been claimed further (Davis et al., 1961) that this swelling renders the gastropods easy prey to other species such as fish and sea stars. Since a primary object of most pesticides is to kill only the selected pest, and that as quickly as possible, it is, in our

opinion, a poor pesticide whose effectiveness depends upon the presence of an unaffected second party. We have also been unable to find many reports of direct observations of predation upon disabled and swollen gastropods. To the extent that this question applies to the waters of the Eastern Shore of Virginia, it would appear that the chief candidate for the job of cleaning up disabled Urosalpinx would be the blue crab, and the possibility exists that this organism would itself be rendered inoperative by the inclusion of Sevin in the treatment, at least in the early days.

Therefore it is our conclusion that in light of the failure of our experiments to indicate the absolute necessity of Sevin in this treatment, the lack of such evidence from other quarters, and finally the possibility that its inclusion might do harm to another valuable fishery (blue crab), we cannot justify the employment of Sevin in Virginia's Seaside waters. We have shown that Polystream alone kills Urosalpinx directly, in the laboratory; other investigations at the Virginia Institute of Marine Science have disclosed (Haven et al., 1964) that the Polystream-Sevin combination killed up to 85% of the benthic associates of the oyster when applied in field tests near Wachapreague, Virginia. Should it be shown, however, that Polystream does not permanently damage the bottom communities of which commercial oyster grounds are a part, this pesticide might prove to be a valuable adjunct to other modern ostreicultural practices.

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