RESPONSES OF CERTAIN MARINE FISHES TO THE LOWERING OF DISSOLVED OXYGEN IN WATERS FROM THE ARTHUR KILL, THE KILL VAN KULL, AND SHARK RIVER INLET

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Marine biologists of the middle Atlantic area have long known that most of the food and game fishes of this region depend upon the estuaries during some stage, or stages, of their life cycles. The weakfish, Cynoscion regalis, for example, uses the estuaries as a spawning and nursery ground and also---to significant extent---as a forage area by the adults of the species. The bluefish, Pomatomus saltatrix, invades the estuaries shortly after hatching from the egg and grown to a length of some 10 inches in these environments before journeying to the sea at the end of its first summer of life. The winter flounder, Pseudopleuronectes americanus, enters the estuaries during Autumn and early Winter, spawns there during late Winter and early Spring, and then migrates to ocean waters. The young, in turn, use the estuaries as a nursery ground during their first year or two of life. The kingfish, Menticirrhus saxatilis, utilizes

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1962 (Exp. performed Summer 1961)

the estuaries as a nursery ground---and possibly as a spawning area---as does the Carolina sea robin, Prionotus carolinus, the blowfish, Spheroides maculatus, and a number of other species.

The forage of these predaceous fishes includes a number of invertebrate species together with such resident fishes as the spearing or silversides, Menidia menidia, the common killifish, Fundulus heteroclitus, etc.

Upper New York Bay, Lower New York Bay, Newark Bay, the Arthur Kill, the Kill Van Kull, and Raritan Bay are all parts of a very large estuarine system that is situated near the center of the nation's largest recreational and commercial fishery area. Needless to say, the nature of waste disposals and their effects upon this great marine resource are of prime concern.

PURPOSE OF RESEARCH

The purpose of the present research was a two-fold one: First, to determine whether certain marine fishes would survive in aerated waters from the Arthur Kill and Kill Van Kull; and second, whether the responses of these fishes to the lowering of dissolved oxygen would differ between the"clear blue" waters of Shark River Inlet, on the one hand, and the waters of the Arthur Kill and Kill Van Kull on the other.

PROCEDURE

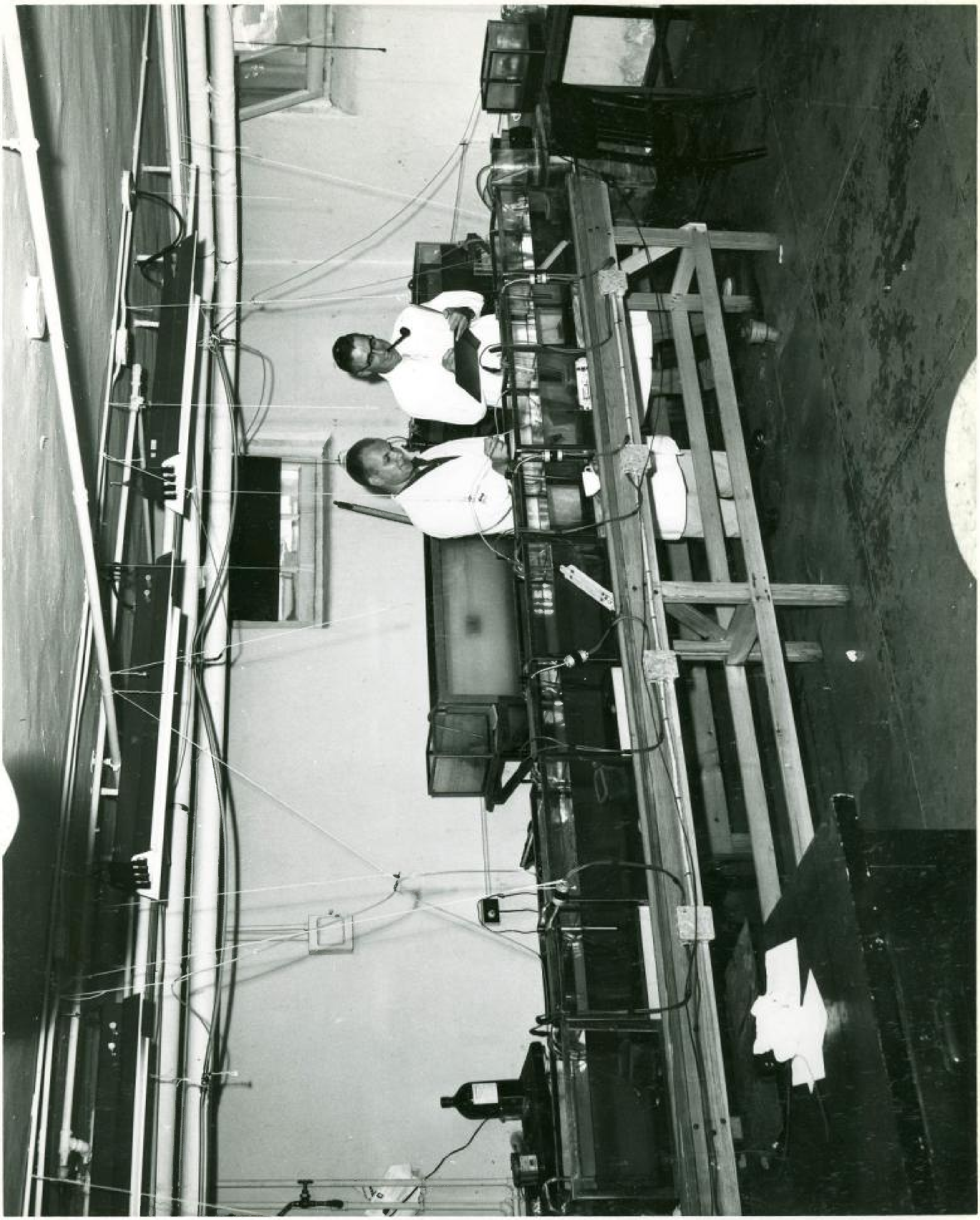
The experiments were conducted in late summer of 1961 and 1962, and four species of fish were used: (1) young-of-the-year bluefish, *Pomatomus saltatrix*, known commonly as "snappers," (2) young-of-the-year kingfish, *Menticirrhus saxatilis*, (3) young-of-the-year northern sea robin, *Prionotus carolinus*, and (4) Atlantic silverside, *Menidia menidia*, commonly called "spearing."

Water for the experiments was obtained at (1) Shark River Inlet during high tide, (2) Kill Van Kull at Buoy No. 5 near the end of ebb tide, and (3) the Arthur Kill at Outerbridge Crossing at low tide. The water was transported in plastic containers to the laboratory where it was first placed in a 50-gallon or 65-gallon stock aquarium equipped with recirculation by air lift, and with fiberglass filters. The water was always used within a 36 hour period. Fish used in the experiments were obtained from Raritan Bay at Leonardo, or at Sandy Hook.

Five ten-gallon aquaria were used in the first series of D.O. experiments, which were conducted in 1961. One was used as a control and four as replications of treatment (see Plate 1.) Two bluefish, one to three spearing, one or two sea robins, and two kingfish were

PLATE 1.

EQUIPMENT USED IN EXPERIMENTS



used in each aquarium, and the dissolved oxygen was lowered by the introduction of sodium sulfite as described by Westman and Hunter (3). Preliminary trials revealed that an initial dose of 28 p.p.m. of sodium sulfite, followed by a second dose of 7 p.p.m. some three hours later, gave the desired rate of lowering of the dissolved oxygen. Measurements of D.O. were made by the polarographic method as described by Rand and Heukelekian (1). Water temperatures were maintained between 74 deg. F. and 78 deg. F., which were the same as existed in the field situations. The pH of these waters was between 7.8 and 8.4 as measured colorimetrically.

The first symptoms of distress were considered to be (1) gulping at the surface, or (2) loss of equilibrium. In some instances gulping would precede loss of equilibrium, and in others no gulping took place. It was quickly discovered that spearing could survive by gulping, even when the D.O. had fallen to less than 1 p.p.m.

Survival experiments were conducted in the 10 gallon control aquarium, with aeration.

RESULTS AND COMMENTS

The responses to the lowering of dissolved oxygen are graphically portrayed in Figs. 1, 2 and 3. It will be noted that the fish in the Kill Van Kull experiment were affected more quickly than the fish in the other experiments. Further, that the fish in the Kill Van Kull water required a greater amount of dissolved oxygen in order to survive.

Based upon "t" tests, the difference between survival time was significant at the 5% level (20:1 probability), and the difference between dissolved oxygen requirement was highly significant at the 1% level (100:1 probability). It can be concluded, therefore, that some factor other than chance was responsible for these differences and that this factor was probably present in the water from the Kill Van Kull. This was further indicated by the fact that two bluefish died within five days in the survival tests in Kill Van Kull water, as contrasted to no deaths in any of the other survival tests.

That certain pollutants in water can affect the oxygen requirements of fish is not a new discovery. Tagatz (1961), for example, has demonstrated that certain petroleum products such as gasoline and Diesel fuel oil become more toxic to young shad at low oxygen levels, or vice versa,

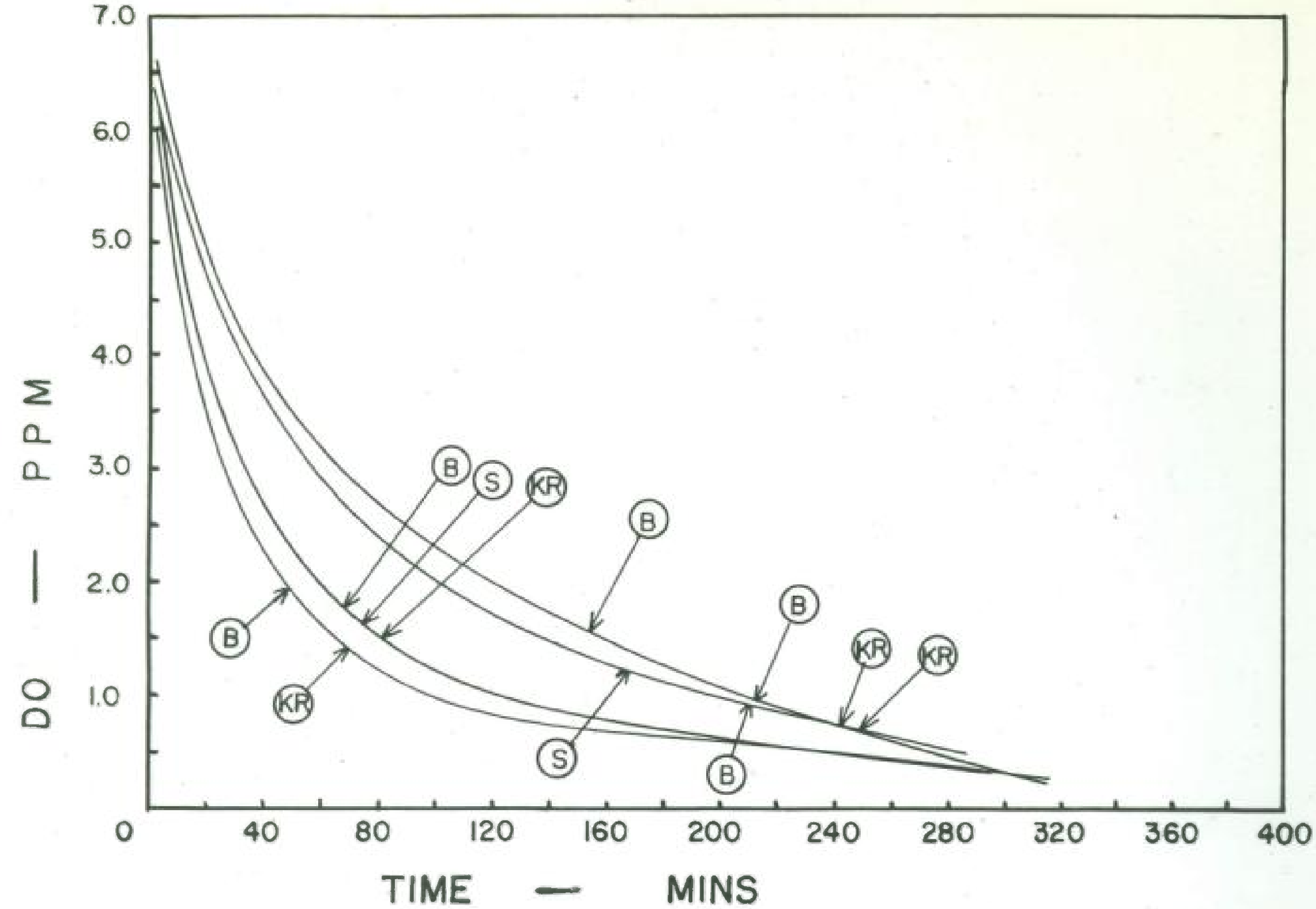
Fig. 1.

UPPER: Arthur Kill, August 30, 1961
Chlorides 12,000 p.p.m.

LOWER: Shark River Inlet, August 25, 1961
Chlorides 14,500 p.p.m.

LEGEND: B - bluefish; K - kingfish; R - sea robin;
S - spearing.

Points indicate first symptoms of distress as defined in text.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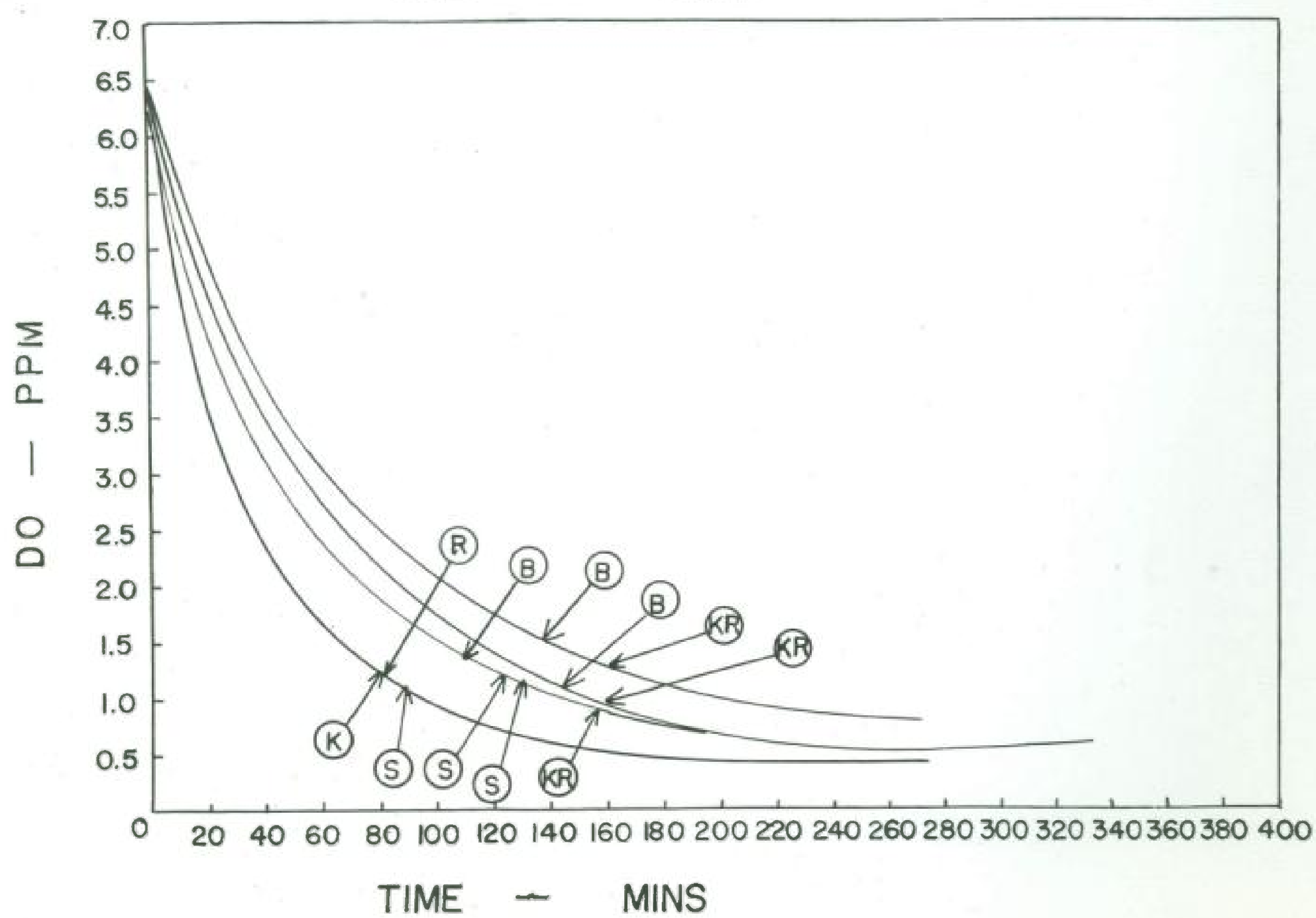
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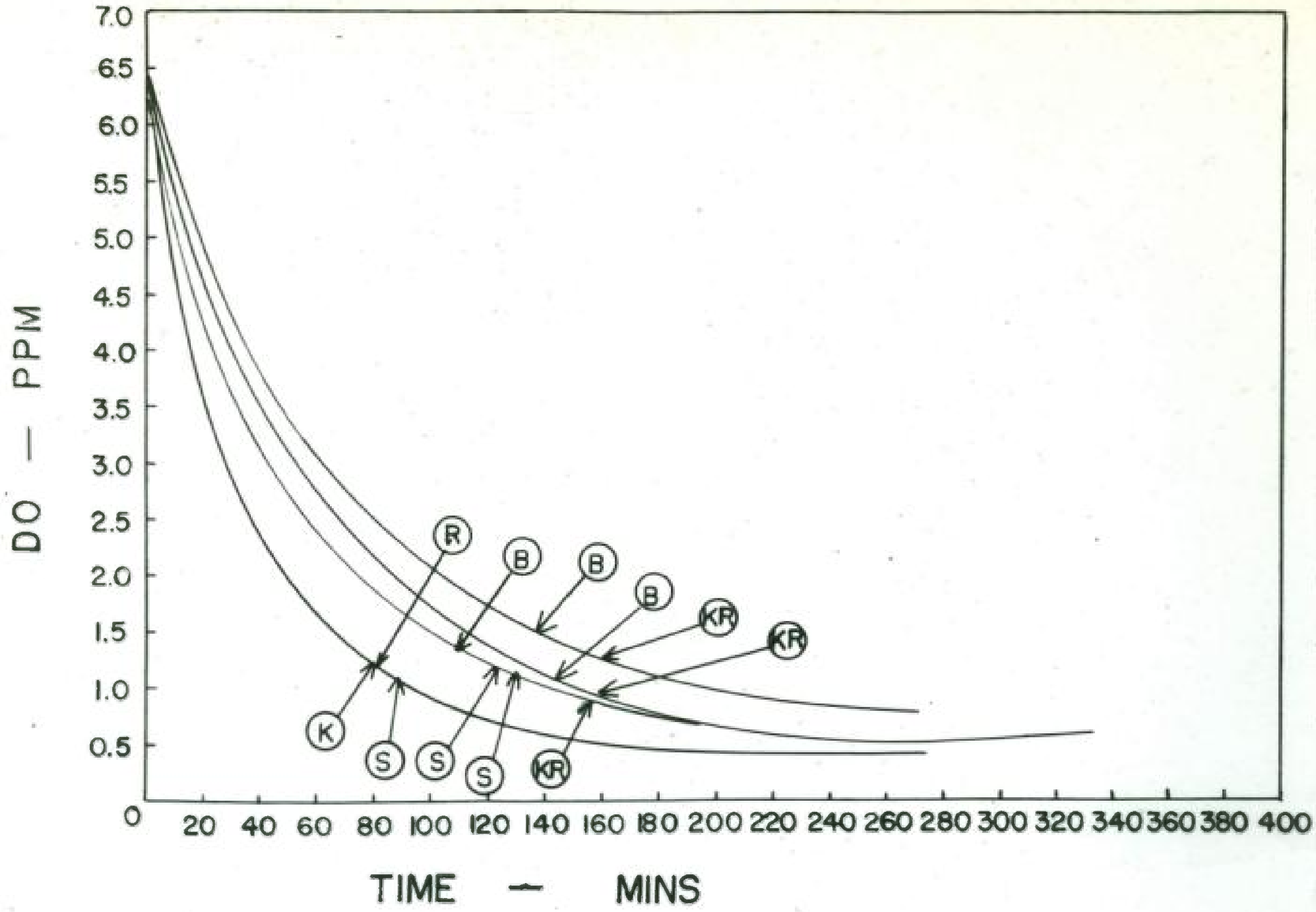
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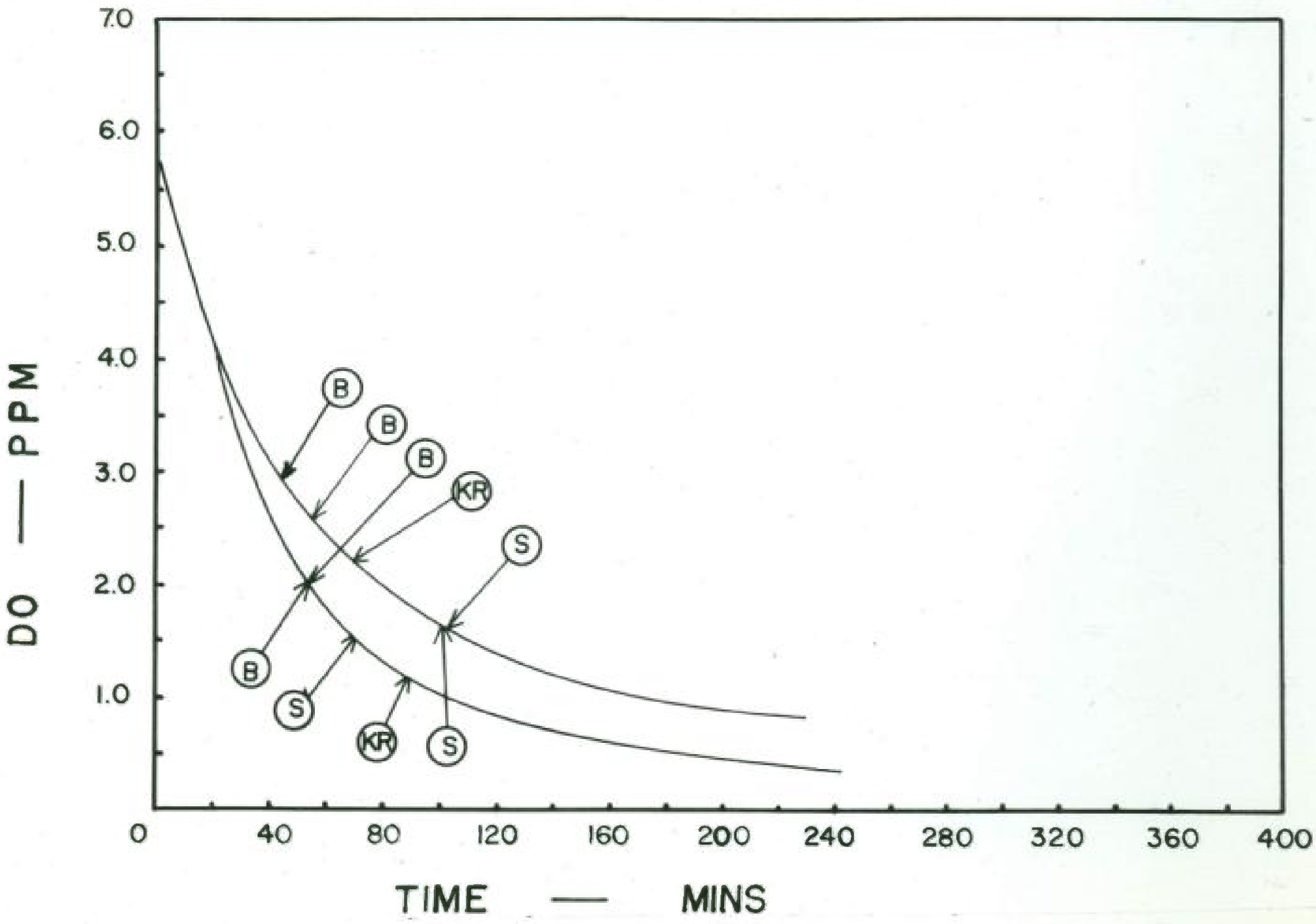
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Fig. 2.

UPPER: Shark River Inlet, August 25, 1961
Chlorides: 14,500 p.p.m.

LOWER: Kill Van Kull, September 13, 1961
Chlorides: 12,500 p.p.m.

(Due to closeness of rate of O_2 decrease in some of the aquaria, only two curves have been drawn).

LEGEND: B - bluefish; K - kingfishl R - sea robin; S - spearing.

Points indicate first symptoms of distress as defined in text.

that the minimum oxygen requirements of these young fish increases in the presence of these pollutants when the pollutants have reached particular concentrations.

During the late summer of 1962, the water of the Kill Van Kull was again subjected to a similar comparative experiment with water from Shark River Inlet. On this occasion there was no significant difference between survival time or oxygen requirement. Nor were there any significant differences between years for the waters of Shark River Inlet. It can be concluded, therefore, that the condition of the Kill Van Kull water differs significantly between occasions.

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