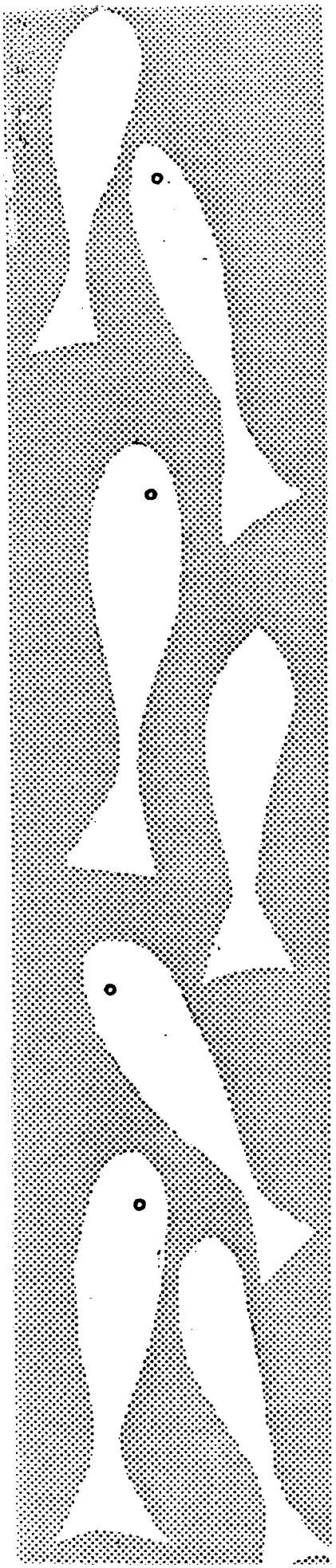

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TECHNICAL ADVISORY COMMITTEE
COLUMBIA RIVER THERMAL EFFECTS STUDY

EFFECT OF TEMPERATURE INCREASES ON JUVENILE STEELHEAD TROUT (*Salmo gairdnerii*) FROM THE COLUMBIA RIVER

George Snyder
and
Donovan R. Craddock
Fishery Biologists

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BUREAU OF COMMERCIAL FISHERIES
BIOLOGICAL LABORATORY
2725 MONTLAKE BLVD. E., SEATTLE, WASHINGTON 98102

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INTRODUCTION

The need for standards for regulation of water temperatures became acute when thermal nuclear electric plants were proposed for sites on the Columbia River. Because of apparent inconsistencies in Washington and Oregon State temperature standards for the Columbia River, a cooperative study was initiated by the Federal Water Quality Administration with participation of the Bureau of Commercial Fisheries and the Atomic Engery Commission. The objective of the study was to determine temperature requirements of anadromous species of fish found in the Columbia River. The gathered information would be applied to establish practical standards for protection of water quality.

Work plans for a 2-year study were approved by a Technical Advisory Advisory Committee of state, federal, and private agency representatives. One of the goals of participants of the Bureau of Commercial Fisheries was to determine the effect of increases in water temperature on species of anadromous fish native to the lower Columbia River.

This report describes the effect of increased water temperature on juvenile steelhead trout (*Salmo gairdnerii*) tested in water of the lower Columbia River.

WATER TEMPERATURE LABORATORY

In 1967 a floating laboratory (Snyder, Blahm, and McConnell, 1970) was established at Prescott, Oregon (fig. 1). The laboratory and water temperature control equipment has been described by Blahm and McConnell (1970).

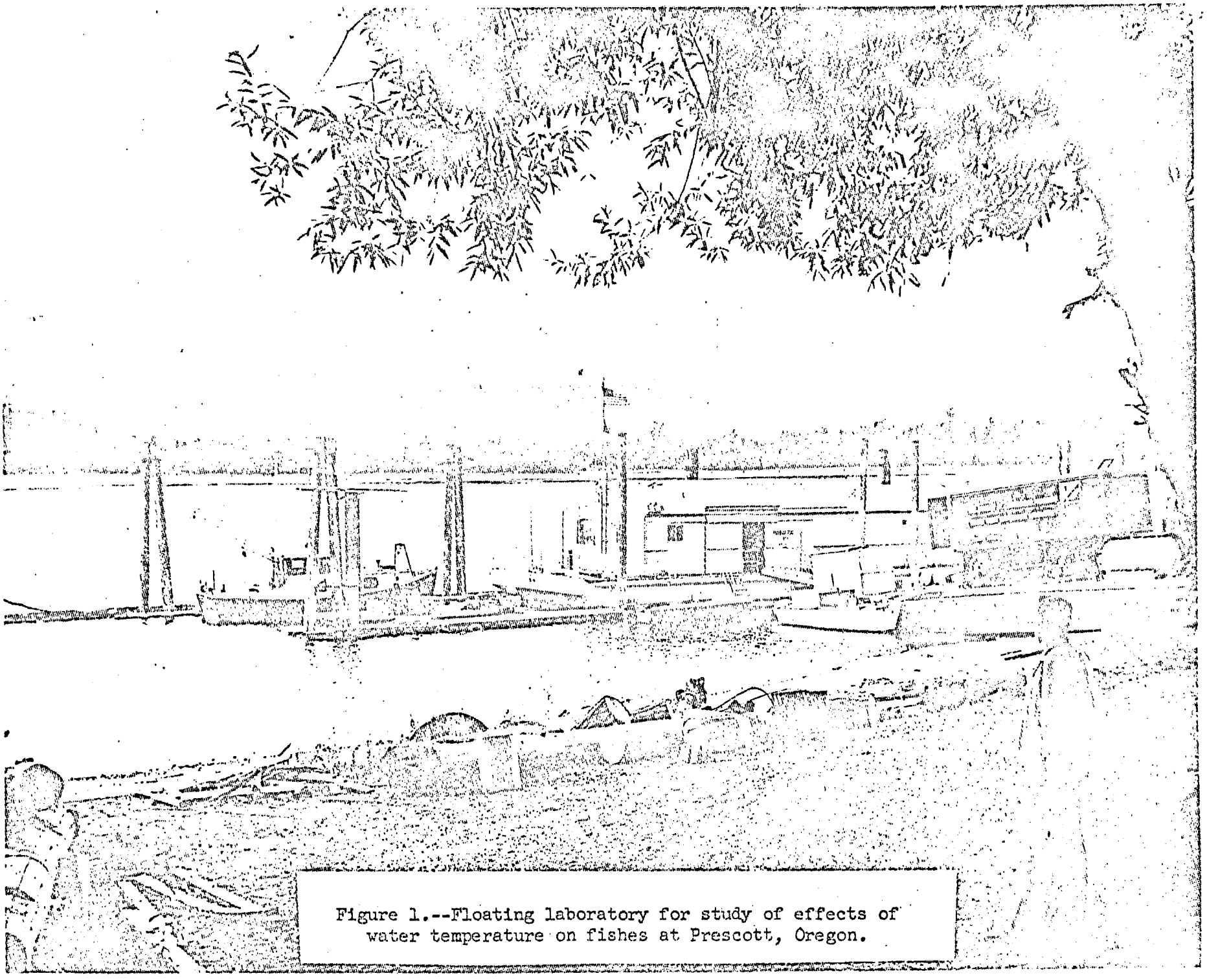

Figure 1.--Floating laboratory for study of effects of water temperature on fishes at Prescott, Oregon.

TEST STEELHEAD

Juvenile steelhead trout were obtained from the Big Creek Hatchery, near Knappa, Oregon, in April 1969 and were held prior to testing in untreated Columbia River water. These fish had a mean length of 164.5 mm. and a mean weight of 38 g. They were held in large redwood tanks supplied with a complete interchange of river water each hour. Temperatures in the holding tanks corresponded to the normal seasonal increase in river temperatures. It was assumed that during the pre-test holding period the fish would become acclimated to Columbia River water. One group, tested May 5, was held 4 weeks prior to testing and a second group, tested May 28, was held 9 weeks.

THERMAL EFFECTS TESTS

Techniques for thermal tolerance tests conducted at the laboratory have been outlined by Blahm and McConnell (1970a, 1970b). The methods are essentially the same as those recommended by Fry (1947) and used by Brett (1952). Samples of 20 fish each were placed in test tanks containing 188 liters of water at the test temperature. The fish remained in the test temperature for 2 weeks and time to death of each individual fish was recorded.

The tests were conducted during May 1969 coincident with the peak migration of juvenile steelhead (McConnell and Snyder, 1970). On May 5 when the river temperature was 10 C, a test series was initiated using test temperatures of 10, 17, 20, 21, 22, 23, 24, 25, 26, and 29 C. This was repeated on May 28 when the river temperature was 14 C.

EFFECT OF IMPOSED THERMAL INCREASES

The results of the tests are summarized in figures 2 and 3. In the May 5 test group (fig. 2) 50% of the fish died at 17 C. The lowest temperature level at which 100% mortality occurred was 22 C. Temperatures of 20 and 21 C caused 95% mortality. All fish tested at 25, 26, and 29 C died in less than 1 day.

In the test series beginning May 28 (fig. 3) a 50% mortality occurred at 17 C and above, as in the first tests, and 100% at 22, 25, 26, and 29 C.

A comparison of survival time in the two tests is shown in figure 4. In the May 28 tests, mortality was less at 22 C and below than in the May 5 tests. In both series at least 65% of the fish died within 2 weeks at all test levels above the control temperature. Apparently the higher base temperature (14 C) of the May 28 test group increased the survival time at test temperatures of 17 to 22 C, but not at temperatures above 22 C.

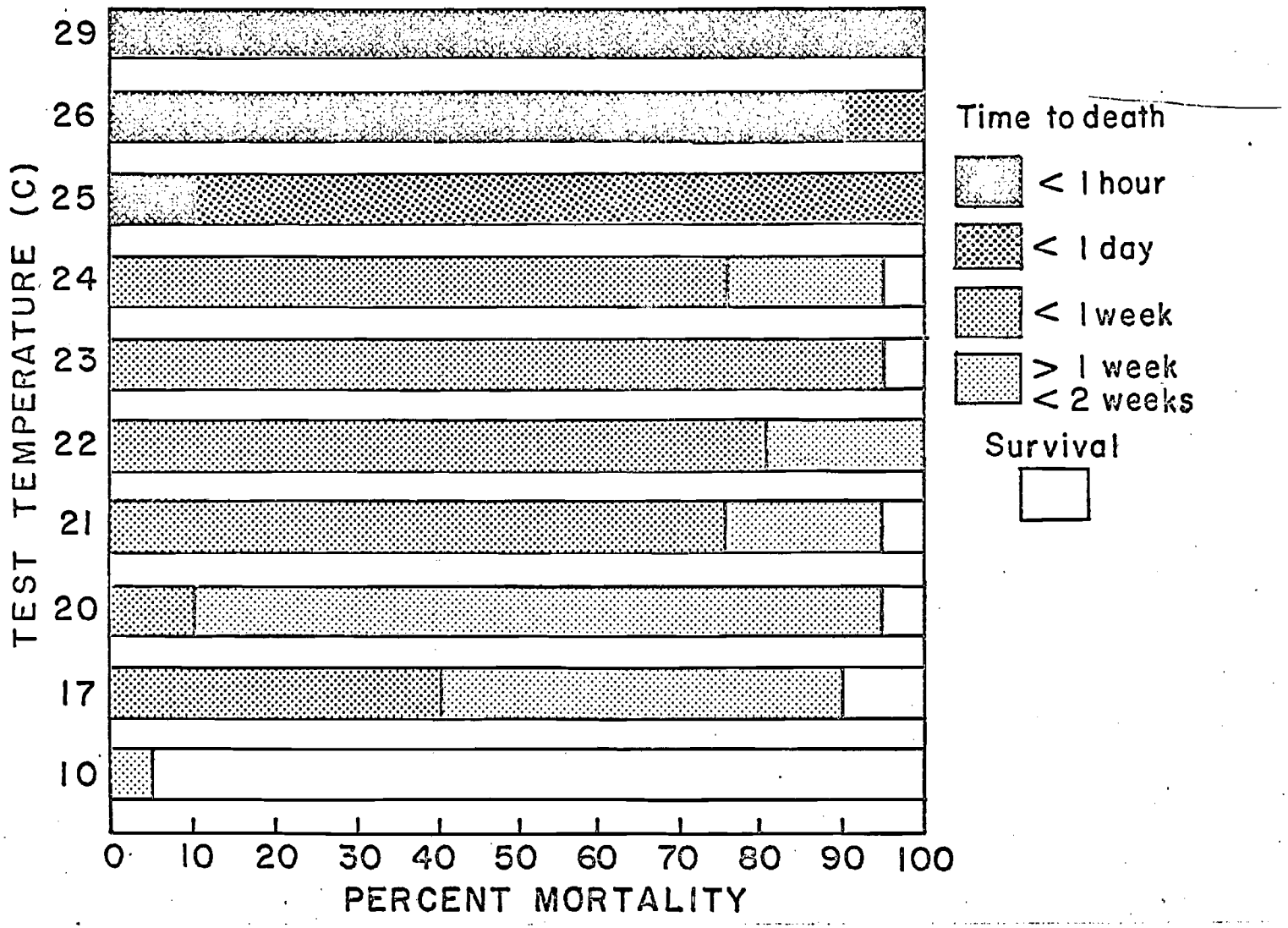

Figure 2.--Percent mortality of juvenile steelhead trout acclimated to 10 C and subjected to various water temperatures. Tests conducted May 5 - May 19, 1969, at Prescott, Oregon, on the lower Columbia River.

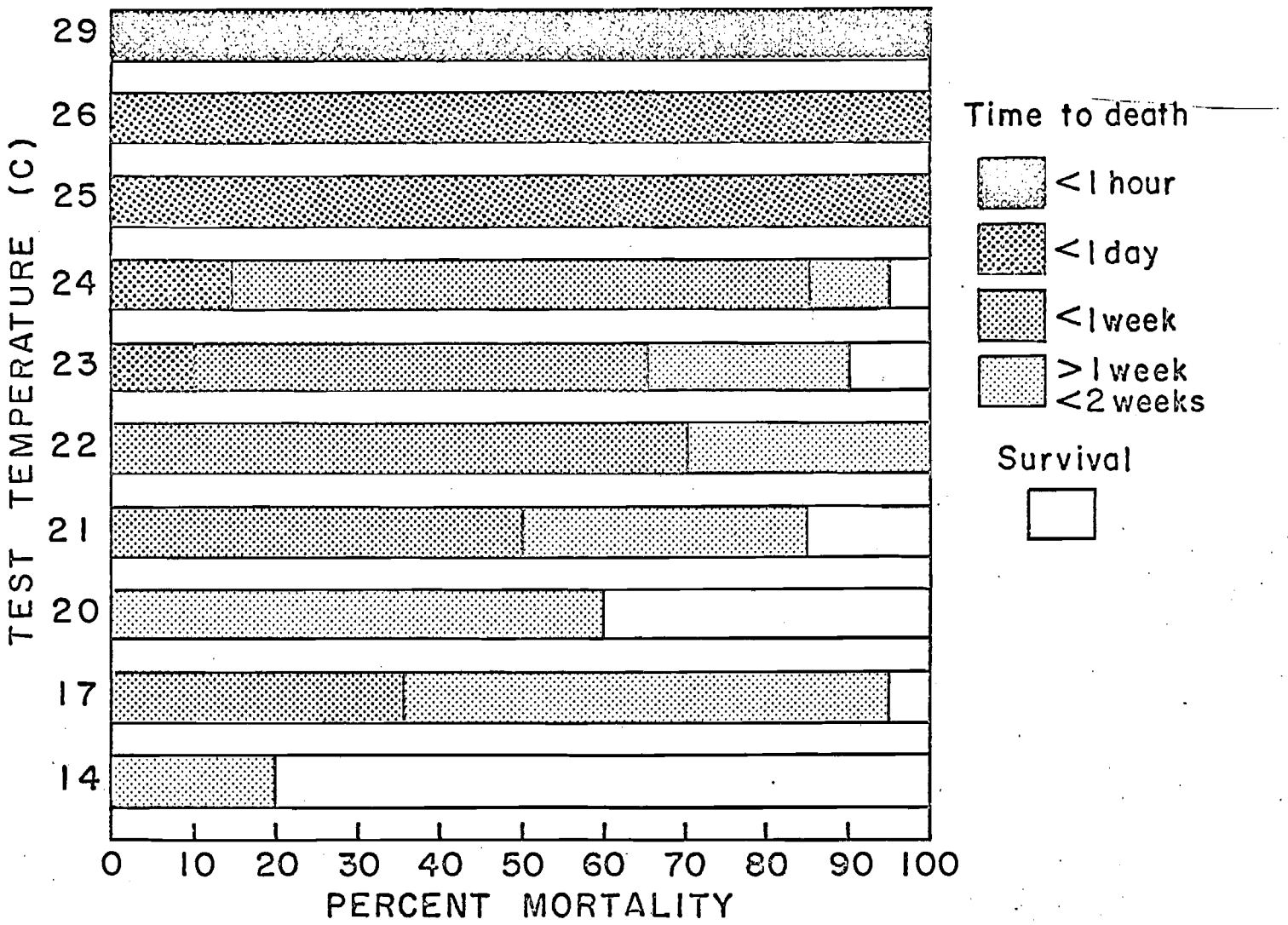

Figure 3.--Percent mortality of juvenile steelhead trout acclimated to 14 C and subjected to various water temperatures. Tests conducted May 28 - June 12, 1969, at Prescott, Oregon, on the lower Columbia River.

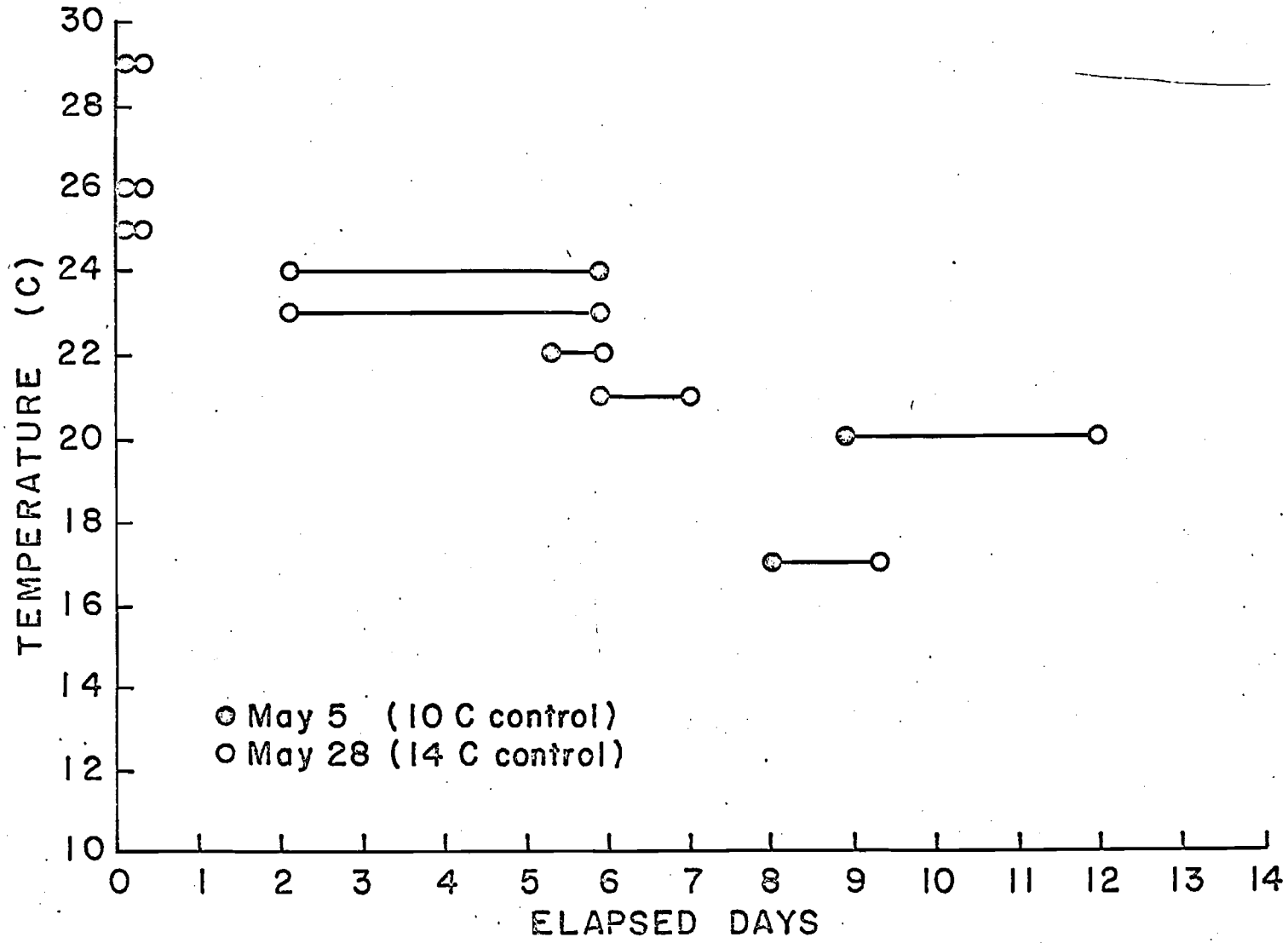

Figure 4.--Time until death of 50% of the sample (TD-50) of juvenile steelhead trout at various water temperatures.

Mortalities in both control groups during the second week of each test period suggested the presence of harmful factors other than temperature. Water quality in the test tank was monitored. Oxygen (O_2) and ammonia (NH_3) were at acceptable levels. The fish then were examined anatomically to attempt an explanation of the unexpected mortalities. During the testing the saturation levels of nitrogen gas in the lower Columbia River were between 112 and 130%. Supersaturation of river water with atmospheric nitrogen has been described in the Columbia River by Ebel (1970) and Beiningen and Ebel (1970). Our inspections determined that some of the fish used in these tests showed the external symptons described for nitrogen "gas bubble disease." These were in the form of the typical tiny subcutaneous bubbles on body and fins. These may have escaped notice on other of the fish tested, because such bubbles often disappear after death.

CONCLUSIONS

The steelhead trout used in these two test series displayed little resistance to increases in water temperature. Mortalities in both control groups suggested that all fish were stressed by some common factor. This probably was due in part to the effect of supersaturation of the river water with atmospheric nitrogen gas, and the tendency of the gas to come out of solution in the seasonally increasing temperature of the river. Since 17 C was the first temperature increase where mortalities occurred in both tests, it is likely that higher mortalities would have occurred at much lower temperatures than those described in the literature.

Angelovic, Sigler, and Newhold (1961) found the optimum temperature for rainbow trout was 18.4 C and the upper lethal temperature about 24 C. Our tests showed that in the present river environment, a mortality of 50% of the fish tested could occur at temperatures of 17 C, and possibly lower, due to synergistic effects of environmental factors other than temperature. Such effects might have escaped notice within a shorter interval of testing.

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