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VARIATION IN STRENGTH OF PYRIDYLMERCURIC ACETATE TECHNICAL AND ITS EFFECT ON RAINBOW TROUT (SALMO GAIRDNERI)

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The use of pyridylmercuric acetate technical (PMA) for treatment of various external diseases of fish, as suggested by Van Horn and Katz (1946) and tested first by Rucker (1948), has given excellent results in the past several years. It has been especially efficacious in the treatment of gill trouble among trout, although experiments by Rodgers, et al. (1951) and experience of others have proven its toxicity to rainbow trout. It would be of considerable advantage to the fish-culturist if it were possible to use this chemical without danger of mortality among rainbow trout.

History of the Problem

In Michigan, PMA was employed successfully in controlling gill disease among brook trout in dilutions up to 1:250,000, and among rainbow trout at a dilution of 1:500,000, despite experiences in other states that indicated this chemical could be lethal to rainbow trout. After using PMA for about two years in treatments of gill disease among rainbow trout, two incidents occurred in which a high mortality followed treatments. The fact that PMA from two sources was involved suggested that the chemical from only one of the sources might be lethal to the fish.

The first incident occurred at Oden hatchery where raceways are constructed in two parallel series of five ponds each. The upper four ponds of each series contained brook trout and the lowermost pond of each series

held legal-sized rainbow trout. During the morning of October 11, 1954, brook trout in the upper pond of each series were treated with PMA and the treated water was flushed through the lower four ponds as usual. By chance, the chemicals used in the two ponds were from different chemical companies. On October 11 and 12 a 7-percent mortality occurred among the 8,000 rainbow trout in one of the lowermost ponds; rainbow trout in the comparable pond of the other series were not adversely affected. Since fish were killed in one pond and not the other, there were two possible causes for the mortality--either there had been an error in making the stock solution for treating one pond or the PMA from one of the sources was at fault. Later tests proved that error in making the stock solution was not responsible for the loss.

The second incident happened at Harrietta hatchery on March 3, 1955, when rainbow trout fry were given the usual prophylactic treatment with PMA. Several hours later a mortality began which extended throughout the following day and resulted in the loss of about 600,000 fry. The PMA employed for this treatment was from a different source than the PMA previously used at Harrietta and was identical to that presumed to have caused the loss of legal-sized rainbow trout at the Oden hatchery. On March 4, in an attempt to establish the cause of the previous day's loss of fry, Mr. J. Southwick, the hatchery superintendent, treated one group of rainbow trout fry with PMA from one source and another group with PMA from the second source. Fish exposed to the PMA previously employed at Harrietta (here termed No.1) remained normal, but all fish died in the group treated with PMA from the new source (No. 2).

In view of the above incidents, experiments were conducted in aquaria to test chemicals from the two sources under controlled conditions.

Effect of PMA from two sources on brook trout and rainbow trout

For each of several tests ten fish were placed in an aerated aquarium and exposed for one hour to a dilution of PMA. Tests with each of several dilutions were made in duplicate. At the end of the hour, treated water was replaced by fresh water and the fish were observed for 16 hours. Water temperature was 55° F. The results were as follows:

PMA No. 1:

Rainbow trout

1:500,000. No mortality in 16 hours.

Brook trout

1:500,000. No mortality in 16 hours.

PMA No. 2:

Rainbow trout

1:500,000. All 20 fish died in 16 hours.

1:1,000,000. Twelve of 20 fish died in 16 hours.

Brook trout

1:500,000. No mortality in 16 hours.

1:250,000. No mortality in 16 hours.

Mortality occurred between two and eight hours after transfer of the fish from treated to fresh water.

The results of this experiment were reported to the Mallinckrodt Chemical Works, St. Louis, Missouri, and a sample of PMA from each source was sent to them for analysis. They reported that sample No. 1 assayed 81.4 percent PMA and sample No. 2 assayed 87.0 percent. They also indicated that the composition of Pyridylmercuric Acetate Technical varies to some extent. Because it is used principally as a fungicide for industrial

applications a pure product is not required, nor for the intended applications is it necessary to identify or closely regulate the percentages of various impurities contained in the compound. The assay values reported for this product do not necessarily represent the pyridylmercuric acetate content as such. They actually include all other organic mercury compounds present, such as polymercurated pyridine compounds and these would be reported as an equivalent amount of pyridylmercuric acetate. Also, the product is reported to contain varying proportions of alkali acetate which could cause significant differences in assay from lot to lot.

The effect of PMA of different composition on rainbow trout fingerlings

The Mallinckrodt Chemical Works kindly furnished upon request four samples of PMA which assayed 81.8 percent, 84.4 percent, 84.8 percent and 87.3 percent. Each of these four samples was tested on fish in dilutions of 1:400,000; 1:500,000 and 1:600,000, and each dilution was tested on three lots of ten fish each. Only rainbow trout fingerlings were subjected to the tests because earlier results demonstrated that brook trout were not adversely affected by PMA from either source.

Among the lots of fish exposed to samples of PMA assaying 81.8 percent, 84.4 percent and 84.8 percent, there was no mortality in 24 hours post-treatment. Among the lots exposed to the 87.3-percent sample, post-treatment mortality within 24 hours was as follows: 1:400,000 dilution, 24 of 30 fish died; 1:500,000 dilution, 20 of 30 fish died; 1:600,000 dilution, 11 of 30 fish died.

Discussion

Because of the variations in impurities contained in Pyridylmercuric Acetate Technical the results of the experiments are not clear cut. For instance, there was no mortality when the 81.8 percent sample was tested in

a dilution of 1:400,000 with a relative mercury concentration of 2.04. However, 11 of 30 fish died when the 87.3 percent sample was tested in a dilution of 1:600,000 with a relative mercury concentration of only 1.46. Obviously the 87.3 percent sample contained an impurity that was toxic to rainbow trout.

Since the impurities in PMA are said to vary from one batch to another, it is reasonable to assume that a toxic substance might also be found at times in the product assaying 81 percent. Therefore aquarium tests should be made on each new batch of PMA before large numbers of rainbow trout are treated.

At the present time this information is of little value for practical application in treatment of rainbow trout because there is not sufficient demand to make it profitable for any company to produce pyridylmercuric acetate within the percentage and composition limits that are safe for rainbow trout. However, there is always a possibility that such a demand may develop in the future.

The fact that, in all cases, mortality did not begin until about two hours post-treatment suggests that an antidote might be given immediately following treatment. Since no substitute for PMA has been found that is as efficient in controlling gill disease, a search for an antidote should be profitable. Microscopical study of sections of gills taken at intervals up to five hours post-treatment demonstrated progressive deterioration of the tissue (Figs. 1 and 2), and in some stages fusion occurred as it appears in gill disease. An antidote given soon after exposure to PMA might arrest this action on the gills and prevent mortality.

In conducting experiments with PMA on rainbow trout, fish that have never been exposed to this chemical should be used for each test because of the possibility that a tolerance may be developed. This possibility

Figure 1.--Section of gill of rainbow trout 30 minutes following one-hour treatment in PMA at 1:400,000. Note slight thickening at tip.

Figure 2.--Section of gill of rainbow trout five hours following one-hour immersion in PMA at 1:400,000. Note that filament is affected for entire length.

is suggested by the method formerly used at Harrietta for weekly prophylactic treatment of rainbow fingerlings. Personnel at Harrietta found that mortality could be avoided if the first few treatments were made at a dilution of 1:600,000. Thereafter the dilution was gradually reduced until it reached about 1:400,000.

Acknowledgments

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