

Original: Prog. Fish. Cult.
cc: Fish Division
Educ.-Game
Inst. for Fish. Res.
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Marquette Hatchery
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Report No. 1583

December 22, 1959

"SUNBURNING" FINGERLING LAKE TROUT WITH ULTRA-VIOLET LIGHT
AND THE EFFECT OF A NIACIN FORTIFIED DIET

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For a number of years an abnormality has been observed among fingerling lake trout at the State Fish Hatchery, Marquette, Michigan. Each year, beginning in early June, a "bald" spot begins to appear on the top of the head of fish in their second summer of life. The fish are held indoors in troughs during their first year of life and are transferred to outdoor raceways when they are about one year old. The "bald" appearance is caused by partial or complete erosion of the skin, exposing the light-colored bones of the skull. By the end of July approximately twenty percent of the fish are affected, but in August the condition begins to disappear and the lesions are completely healed by the end of September. Mortality is above normal, although not high, and growth is retarded to some extent. Similar lesions have never been observed among older fish at this station.

Lesions similar to those in the lake trout fingerlings at Marquette were described by DeLong et al. (1958) among chinook salmon in Idaho, and by Dunbar (1959) who used a sun lamp to produce the symptoms among fingerling rainbow trout fed a standard diet at the U. S. Fish-Cultural Station (Leetown) at Kearneysville, West Virginia. In both reports, the condition was termed "sunburn."

To induce sunburn, DeLong et al. exposed the fish to natural sunlight for 30 days and fed a diet deficient in niacin. The fish were then divided into equal

groups: one group received the niacin-deficient diet and the other received a complete diet. Mortality within 14 days after the fish were divided was 15 of 83 fish on the deficient diet and 5 of 82 on the complete diet. There was no subsequent mortality in either group. According to our experience with lake trout fingerlings at Marquette, the condition clears up naturally during the late summer and fall months when there is less sunlight. DeLong et al. did not report the time of year their observations were made, but shorter days may explain the arrested mortalities in their study.

To determine whether the "baldness" in lake trout at Marquette may have been caused by sunlight, fingerlings one year old were brought to the Pathologist's laboratory in Grayling and exposed for varying periods of time to light from a sun lamp positioned at various distances above the aquarium. Since DeLong et al. found that mortality among fish fed a diet deficient in niacin was higher than those fed a complete diet, up to eight times the normal daily requirement of niacin was added to the diet of one group of fish to determine if sunburning could be prevented in this manner.

Materials and Methods

Two groups of fingerling lake trout one year old were held in separate aquaria (29-gallon) as stock supplies for experimentation. One group was fed a diet of beef liver and the other group the same diet, plus niacin. For exposure to ultra-violet light fish were transferred into a smaller aquarium (5-gallon) set up in a water bath with a constant temperature of 50° F. Since fish fed different diets were exposed to the light at the same time in the same aquarium they were fin-clipped for identification. Because the tests extended about ten days and the fish refused food while held in the test aquarium, both groups were transferred to separate larger aquaria when not being exposed to the light.

Over the test aquarium one Westinghouse 275-watt RS sun lamp was suspended on a cord which permitted up-and-down adjustment of the bulb. The lamp was connected to a timing device so that it would turn on and off automatically at the same times each day.

The first test was made between April 15 and 19, 1959, to determine whether or not the sun lamp would induce symptoms of sunburn on the fish. The lamp was positioned 16.5 inches above the aquarium which was filled with water to a depth of 4.5 inches. Daily periods of exposure to the light varied from 9 to 12 hours. After a total of 25 hours of exposure to ultra-violet light all fish had developed sunburn symptoms, but four of the five fish died. In the second test, May 8 to 13, 1959, the lamp was raised to 18 inches above the aquarium and water depth increased to 6 inches. Daily exposure to light was adjusted to 8 hours and after a total of 26 hours of exposure all fish exhibited symptoms of sunburn, but two of the three test fish died. Niacin was not employed in either of these tests. Tests three and four were made between May 13 and June 8, 1959, with the lamp 19.5 inches above the aquarium filled with water to a depth of 6 inches. Daily exposure was 4 hours and total exposure was 28 hours. Symptoms of sunburn developed and there was no mortality. Both tests included two groups of three fish each, and one group in each test received the normal daily requirement of niacin added to the diet. Phillips and Brockway established the daily requirement of niacin for trout to be 3.0 to 4.1 milligrams per kilogram of fish. The greater amount was employed here.

The fifth and sixth tests were made between June 8 and July 30, 1959, under the same conditions as the previous two tests, except that total light was increased to 60 hours without causing a mortality. The amount of niacin was increased to four times the daily requirement in the fifth test and to eight times the daily requirement in the sixth test.

Niacin was added to the diet from one to three weeks prior to, during, and for at least two weeks following each test.

Results

Definite symptoms of sunburn were produced in all groups of fish by exposure to ultra-violet light from the sun lamp. The addition of niacin to the diet did not prevent symptoms of sunburn, although the symptoms did not appear as quickly even among those fed the single daily requirement. Among fish fed eight times the normal daily requirement of niacin, symptoms did not appear until about 18 hours after they were noted among the control fish, and the symptoms disappeared more quickly than among the control fish.

Discussion

Since fish were actually killed (apparently by over-exposure to the sun lamp) before sunburn symptoms developed into typical skin erosion, it is assumed that the light from the sun lamp was more intense than that of natural sunlight. It might also be assumed, then, that under normal daylight conditions a niacin-rich diet might prevent sunburn in lake trout. However, this was tested in a limited experiment conducted during July, 1958, at the State Fish Hatchery at Marquette. Three raceways containing equal numbers of lake trout fingerlings in their second summer of life were involved in the experiment. About two-thirds of one raceway was shaded with specially constructed covers as a protection from sunlight and the fish were fed the usual diet. Fish in the second raceway received food enriched by niacin at the rate of 5.8 milligrams per kilogram of fish. Fish in the third raceway were used as the control group, with no shade and fed a standard diet. Mr. Robertson, superintendent of the station, made observations reported here of the fish. Mortality during the three-week period was 122 among fish fed niacin, 77 among fish in the shaded

raceway and 37 among the control group of fish. During this period Mr. Robertson reported that the sunburn lesions appeared to become gradually less conspicuous among all three groups. The test is not conclusive in that no replicas are available for comparison and the actual number of fish with lesions was not recorded before and after the test. Daily observations revealed that these fish hid under the covers when disturbed but did not seek the cover when not disturbed. Older lake trout appear to utilize covers to escape bright sunlight as well as for protection. This may be the reason that the cover employed was not effective in reducing sunburn lesions among the younger fish. In the year of 1959, several groups of fingerling lake trout were held throughout the summer in cement tanks in the hatchery building at Marquette, where they were completely protected from direct sunlight. None of these fish developed sunburn symptoms. Fish of the same age held in out-door raceways during the same period developed the symptoms.

Conclusions

These tests demonstrated that among fingerling lake trout fed a diet of beef liver sunburn can be induced by ultra-violet light and that the addition of niacin up to eight times the normal daily requirement will not prevent it.

Suitable covers for the raceways that would completely shade the fish from direct sunlight should prevent sunburn. Since the condition appears early in the year and regresses after the first of August, shade should be required only from May 15th to July 31st. Water depth is 24 inches in the raceways where fingerling lake trout are held at Marquette. It is possible that deeper water would also be effective in preventing sunburn.

Acknowledgments

The assistance of Mr. Russell Robertson and the crew at the Marquette hatchery for observations and handling of fish at that station, and of Mrs. Arleen Barker for feeding and manipulation of fish in the aquaria at the Fish Pathology laboratory is gratefully acknowledged.

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Typed by M. S. McClure