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Further study of white blindness in hatchery brook trout[1]

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[1] Contribution from the Michigan Institute for Fisheries Research

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Abstract

White blindness, a dietary disease peculiar to brook trout, was previously reported by the author as having appeared in the early spring of each year from 1946 through 1949 at certain fish hatcheries throughout Michigan. Brown and rainbow trout were not affected by the disease. White blindness is characterized by a very pale body color, and a milky opaqueness of the crystalline lens of the eyes which renders the fish blind. Analysis of the diets at hatcheries where the malady appeared, and where it was absent, strongly suggested that horse products were the cause of it, but due to the diversity of products included in the diets, it was not possible to determine whether one or all horse products were involved. The present experiments were conducted in an effort to determine which horse product was responsible for producing white blindness.

Cooked horse skeletal muscle, horse hearts and horse livers each mixed with pork melts on a 50-50 basis were tested. Brewers yeast at a 5 percent level was added to the diet of one group of fish receiving each diet.

On December 19, 1949, the first specimen with white blindness was observed in the group of brook trout on the horse liver-pork melt diet. White blindness gradually increased from 0.7 percent on January 11 to 9.9 percent on May 3 among the group receiving horse liver and pork melts, and from 0.0 percent on January 11 to 9.7 percent on May 3 among the group receiving the same diet with 5 percent brewer's yeast added. No indication of the disease was found among trout kept on any other diet in the experiment.

It was not determined whether length of time was the deciding factor, or whether low water temperature was the cause, but the evidence at hand strongly suggests that the latter may be the case. Further study is planned in an attempt to isolate the responsible factor in horse liver.

Results of this experiment indicate that horse livers may safely comprise up to 50 percent of the diet of brook trout during summer months but will cause white blindness when used at that level during prolonged periods of low water temperatures.

Introduction

White blindness, a dietary disease peculiar to brook trout and characterized by opaque crystalline lens and pale body color (Figure 1), appeared at various trout stations in Michigan in the early spring of each year from 1946 to 1949. Since trout commonly change to a dark body color when they become blind, the unusual pale body color of the blind fish in this case leads to the name of "white blindness" for the disease.

The initial study (Allison, 1949)* presented an analysis of the diets

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* Published only as abstract.

Figure 1.--Fish on left shows "white blindness." Photograph of live fish.

used at stations where the disease was present and where it was absent (Table 1). This study demonstrated that the malady was caused by a diet which included 27.2 percent, or more, of horse products fed during winter months when water temperatures dropped below 40° F., and was absent where 18.2 percent, or less, horse products were fed. Brown and rainbow trout were not affected.

Hess (1937) produced dietary blindness in rainbow trout by feeding an exclusive diet of pork spleen. However, the fish in his experiment changed to a darker body color as they became blind.

The present study was designed to determine whether any single horse product might cause the disease because, due to the great diversity of diets employed by the various trout stations, it was not possible to ascertain from the diet analyses which of several products might have been responsible. Since it was necessary to pursue the experiments at hatcheries under full production schedules, it was not feasible to make all the tests that might have been desirable. Therefore, experiments were designed to do no more than reveal the horse product responsible for the disease.

Methods

Horse products investigated were hearts, livers and cooked skeletal muscle. These products were fed at 40 percent and 50 percent levels, which were well above the critical level as determined by the initial study (1949). The experiment extended from June, 1949, to May, 1950, a period of time that encompassed both summer and winter conditions. Cooked skeletal muscle was tested at the Baldwin station (Lake County)

Table 1.--Percentage composition of total diet at Michigan Trout Hatcheries, September, 1947 to June, 1948

Diet	Watersmeet [1]	Thompson [1]	Harrietta [1]	Wolf Lake [1]	Grayling [1]	Cooks Run	Oden
Horse liver	27.2	45.2	41.5	90.5	34.7	18.2	8.7
Horse heart	...	22.8	17.5	...	30.8	...	...
Canned, cooked horse skeletal muscle	...	...	6.7	9.5	...	...	4.4
Horse skeletal muscle	...	...	2.7	...	...	...	...
Pork liver	24.5	...	...	...	...	30.0	...
Pork melts	34.6	25.9	...	...	30.0	39.7	36.6
Beef melts	13.3	...	...	...	...	4.4	...
Beef liver	...	...	...	...	2.0	...	...
Telang liver	...	...	6.4	...	...	...	...
Cereal	2.3	6.0	24.7	...	...	7.1	33.6
Ocean herring	...	...	0.4	...	2.5	...	...
Inedible beef liver	...	...	...	...	...	...	16.5
Total percent horse products	27.2	68.0	68.4	100.0	65.5	18.2	13.1
Total percent pork	59.1	25.9	...	...	30.0	69.7	36.6
Total percent horse and pork	86.3	93.9	...	...	95.5	87.9	49.7

[1] Blindness present

on 9,000 fingerling brook trout held in the same pond where white blindness had developed during each of the previous three winters.

At the Marquette station (Marquette County) 114,500 fingerling brook trout were divided into four groups. Group A was composed of 62,000 fish divided among eight ponds and was fed a diet consisting of equal portions of horse hearts and pork melts; Group B, with 17,000 fish in two ponds, received the same diet as Group A, plus 5 percent brewer's yeast (Strain K-2 Dried Brewer's yeast, Anheuser-Busch, Inc.); Group C, with 16,000 fish in two ponds, received a diet consisting of equal portions of horse livers and pork melts, plus 5 percent brewer's yeast; Group D, with 19,000 fish in two ponds, received the same diet as Group C, minus the yeast. The ponds (Figure 2) were approximately of equal dimmensions and were supplied individually with water from the same source.

Approximately two weeks after the first case of white blindness was observed by the hatchery superintendent at Marquette, a schedule was set up for examining the eyes of the fish every two weeks until termination of the experiment. The first check was made on 400 specimens from each group, the second check on 500 specimens, and all following checks, except the final one, were made on 600 specimens from each group. The final examination was made on 61.6 percent of groups C and D, in which white blindness had appeared. Since no affected fish were found in any of the routine examinations of Groups A and B, and none could be observed in these ponds at the time of the final check, individual examinations were not made on these fish. The pale skin of brook trout affected with white blindness renders them especially conspicuous in ponds

Figure 2.--Rearing ponds at Marquette Hatchery.

having dark colored bottoms, as is the case at the Marquette station.

Specimens for the routine examinations were collected by random sampling. At the time of collecting, all fish in a pond were confined to a small area at the lower end of the pond. They were thoroughly mixed and transferred a few at a time by scaps to 30-gallon tubs, carried into the hatchery building and distributed into troughs for examination. Each fish was held in the hands while both eyes were closely examined for any cloudiness of the crystalline lens. The degree of cloudiness, or opaqueness, varied from a thin milky color in one lens of some specimens to a dense, opaque whiteness in both lenses in other specimens. After the examinations were completed the fish were returned to their respective ponds.

At the Baldwin station, 9,000 yearling brook trout in one pond were fed from June, 1949, to April, 1950, on a diet consisting of 40 percent cooked horse skeletal muscle, 38 percent pork melts, 10 percent meat scraps, 10 percent skim milk powder and 2 percent salt (NaCl). The pond chosen for this experiment was the same pond in which white blindness had appeared in the spring of the year in 1946, 1947, and 1948. No blindness was observed among the fish in this pond from the beginning of the experiment until ice cover formed in late December. Because of the ice conditions, routine examinations could not be carried out thereafter. Five hundred fish collected by random sampling were examined on April 18, 1950, at which time the study was terminated at this station. The bottom of the pond was very dark in color, as at Marquette, and pale-colored trout are quite conspicuous.

Results of the diets

The first case of white blindness was observed by the hatchery superintendent at Marquette station on December 19, 1949, seven months after initiation of the study, among fish of Group D, which received a diet consisting of 50 percent horse livers and 50 percent pork melts. Beginning on January 11, 1950, and every two weeks thereafter until May 3, 1950, routine examinations of all groups were made. The incidence of white blindness among fish in Group D gradually increased (Figure 3) during this period from 0.7 percent to 9.9 percent. In Group C, which received the same diet as Group D, plus brewer's yeast, the appearance of the disease was apparently delayed, but by May 3, 9.7 percent of the fish were affected. Thus, brewer's yeast did not prevent the appearance of the disease nor affect its intensity to any appreciable degree. There was no increase in loss among the groups of fish in which blindness developed. White blindness did not develop among the fish in either Group A or B.

At the Baldwin station, when ice cover melted and it was possible to observe the fish, no blindness was observed among the fish receiving a diet containing 40 percent cooked horse skeletal muscle. On April 18, 1950, after ten months of the same diet, 500 fish were collected at random and examined for white blindness. No symptoms of the disease were found and the experiment was terminated at this station.

Of the three horse products tested (hearts, livers, and cooked skeletal muscle) only the livers were involved in the groups of fish contracting white blindness. The affected fish were fed this diet for

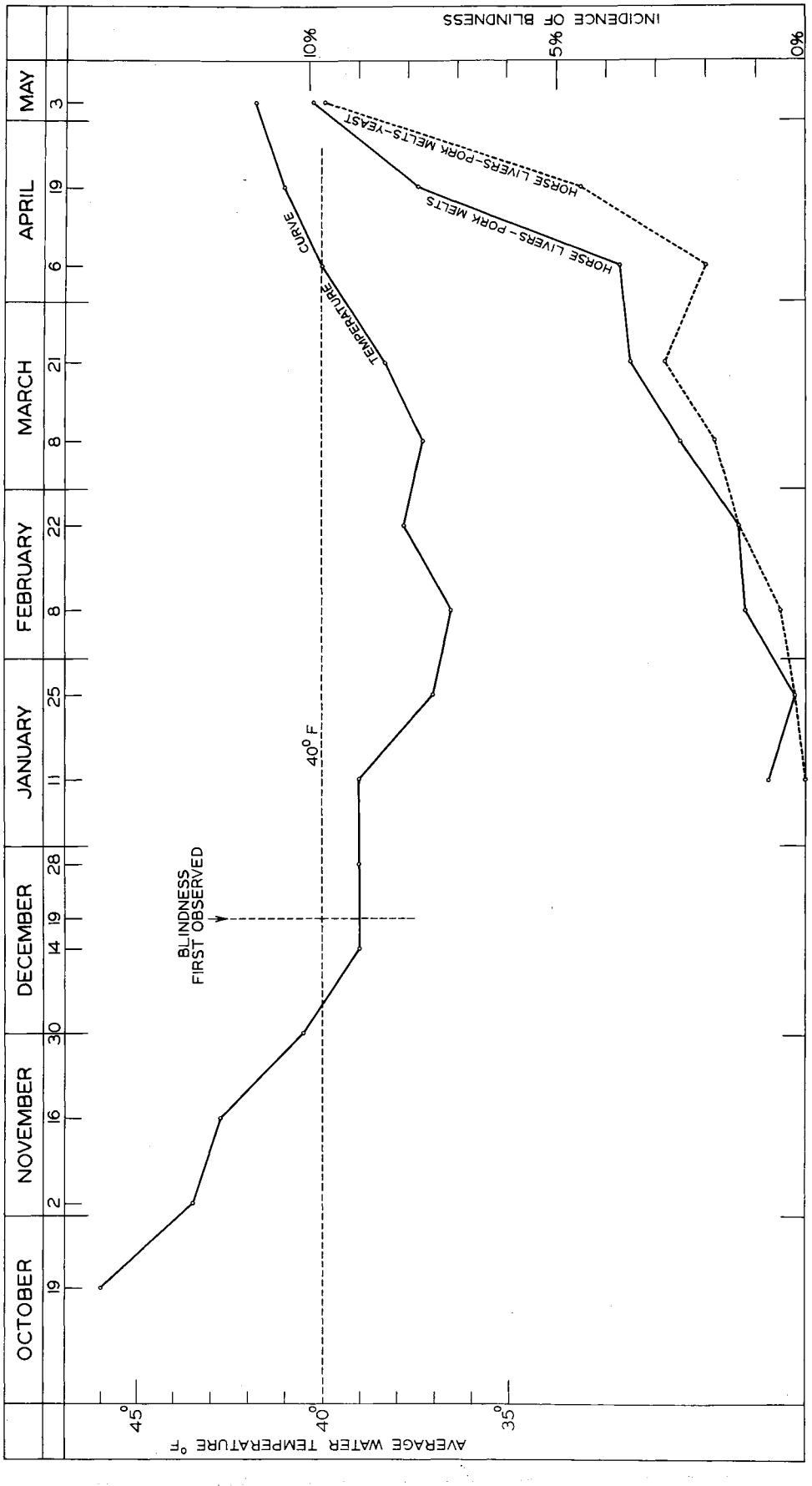

Figure 3.-- Comparison of incidence of white blindness with water temperatures at Marquette Hatchery.

seven months before the disease appeared. It is beyond the scope of this study to point out the specific agent responsible, whether length of time on the diet is important or whether low water temperatures are significant. However, the fact that white blindness develops in brook trout during periods of low water temperatures suggests some correlation. Average water temperatures for the Marquette station (Figure 3) were plotted from the routine hatchery records taken daily at 6:00 a.m., noon, and 6:00 p.m. The average was derived from the daily maximum and minimum readings. Comparing the graphs of temperature and incidence of the disease it can be seen that the disease did not appear before the water temperature dropped below about 40° F. It is not possible to determine the exact critical degree of temperature from the data at hand. During the period when water temperatures remained below 40° F., incidence of the disease gradually increased, and climbed rapidly when water temperatures increased and passed 40° F. It is possible that horse liver is deficient in some essential vitamin and that during periods of low temperatures, when metabolism of fish is slowed down, this vitamin is not stored in sufficient quantities by the fish. Consequently, when water temperatures and metabolism increase, the deficiency becomes more pronounced. It is also possible that length of time on the diet is responsible, regardless of variation in temperature.

Although brown and rainbow trout are not affected with white blindness, there is some evidence that other species of fish are affected. Lake trout fingerlings held over winter at stations feeding horse liver became blind and pale in color. The following year at the same stations, fish of the same species and age were normal when horse liver was omitted

from the diet. In a personal communication Mr. Harold Wasko, Aquarist at the Toledo Zoological Park, Toledo, Ohio, informed the writer that he had observed white blindness among orangespotted sunfish, longear sunfish, green sunfish, smallmouth and largemouth bass, spotted bass, and yellow perch. The fish were fed twice each week, horse liver on Monday and fish on Friday. He noted that some groups gorged themselves on horse liver and ate sparingly of the fish, and pointed out that such fish were subject to white blindness. Since water temperatures varied between 70° F. and 80° F. throughout the year it would appear that length of time on the diet is important in this case and not low temperatures.

Conclusions

White blindness can be a serious hatchery disease because affected fish are blinded permanently and thus are of little value for stocking purposes.

Fingerling brook trout may be safely fed a diet containing up to 50 percent horse liver for six months when water temperatures exceed 40° F. There are some indications that water temperatures below 40° F. are correlated with the onset of the disease in brook trout.

Lake trout also appear to be affected similar to brook trout. Brown and rainbow trout are not affected by white blindness.

Acknowledgments

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