462

MYCOBACTERIA IN ADULT SALMONID FISHES RETURNING TO NATIONAL FISH HATCHERIES IN WASHINGTON, OREGON, AND CALIFORNIA IN 1958-59

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UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

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ABSTRACT

Incidence of acid-fast bacillus infections in salmonid fishes at West Coast hatcheries was determined for 1957-59. No evidence was obtained which would indicate a definite trend towards either increased or decreased rates of infection. It is apparent that the incidence of infection is higher in hatchery-marked fish than in unmarked fish. Only one hatchery was found free of infection during the 3 years covered by the investigation. This installation had never used raw salmon products in diet.

Acid-fast bacilli belonging to the genus Mycobacterium are responsible for one of the more chronic diseases of hatchery-reared anadromous salmonid fishes. Although it is believed the disease is contracted by juvenile fish during the period of hatchery rearing, the bacteria usually are not seen until the fish return as adults. Assessment of the true significance of the disease is impossible, as any deaths occurring during the marine existence of the host would be unknown. It is difficult to believe, however, that this organism does not contribute to mortalities, as it is capable of destroying large portions of liver and kidney tissue. One obvious effect of the infection is sometimes manifested by underdeveloped sex organs which result in lowered egg takes.

A survey for the incidence of acid-fast bacilli in salmonid fish spawning at National and State fish hatcheries in Washington, Oregon, and California was started in 1957. The results of the initial study have been published (Ross, Earp, and Wood, 1959). This report is based on samples collected at national fish hatcheries during the 1958 and 1959 spawning season. In addition, a number of hatchery-reared juveniles of the 1957-58 brood year have been examined and the results recorded.

Methods

As in the previous study, livers from adult salmon were collected at the various stations and frozen prior to delivery to the Western Fish Disease Laboratory in Seattle, Wash. In juvenile samples, whole fish were frozen and transported to Seattle. Three smears from each liver were prepared on glass microslides and stained according to the Ziehl-Neelsen technique. Each slide was examined microscopically for approximately 5 minutes, and positive slides were given a numerical rating to indicate the degree of infection. The rating system is as follows:

1. 1 to 20 organisms per slide.
2. Over 20 organisms per slide.
3. 1 to 25 organisms per field.
4. 25 to 150 organisms per field.
5. Over 150 organisms per field.

Results

A summation of random sample examinations of adult livers for the years 1958 and 1959 (tables 1 and 2) showed that of the fish known or suspected to be of hatchery origin, only those from the Eagle Creek National Fish Hatchery were free from the infection. This hatchery has never fed raw salmon. It has been postulated that the disease is probably maintained in hatchery stocks by the feeding of infected salmon products to juvenile fish. The apparent lack of infection in fish returning to Eagle Creek supports this.

No acid-fast bacilli were seen in presumably wild sockeye salmon (Oncorhynchus nerka) from the Okanogan River in 1958. This is in contrast to the findings of the previous year when 36 percent of the sample fish were infected. It is possible that in 1957 a number of hatchery strays may have entered this system.

The incidence of disease in marked fish returning to the Little White Salmon and Spring Creek National Fish Hatcheries apparently was high (tables 3 and 4). Among 36 marked populations available for examination, all but 6 were positive to some degree. The numbers of fish representing the majority of groups are small, and the observed infection rates are necessarily subject to limited interpretation. There appeared to be a tendency toward higher infection rates in fish marked prior to hatchery release than in random samples. In 1958, marked fall chinook returning to the Little White Salmon Hatchery were 64 percent infected in contrast to 56 percent for a random sample of the same species. In 1959, 52 percent of the marked fall chinook salmon returning to the Spring Creek Hatchery were infected, compared with only 24 percent of the random sample. Similar results were obtained in 1957 when 55 percent of the marked fall chinooks returning to Little White Salmon were infected, while acid-fast bacilli were found in only 12 percent of the random sample.

Two factors, singly or in combination, may play a role in these differences. First, marked fish may be reared in the hatchery for longer periods of time than unmarked fish, thereby increasing the risk of becoming diseased through infected food. Secondly, the random sample may become diluted with wild fish, thereby lowering the infection rate. In view of the rather large differences between marked and unmarked samples returning in 1957 and 1959, it would appear that the first theory is more reasonable.

Juvenile fish were sampled only in 1958. Infections were relatively rare and were found only at the Carson and Coleman National Fish Hatcheries (table 5). It is strongly suspected that the observed absence of infection in young fish is more apparent than real and that bacilli may be present in such small numbers as to make detection virtually impossible by examination of smears. A comparison of the incidence of infection in adult random samples for the years 1957-58-59 (table 6) revealed striking differences in several instances. The most notable changes occurred in the years 1957 and 1958, when the infection rate increased at Little White Salmon Hatchery from 12 percent to 56 percent, and the Spring Creek station infection rate rose from 2 percent to 35 percent. However, no definite trend could be established towards increased numbers of infected fish in the areas studied for 3 years. It is suspected that the pronounced fluctuations were influenced by the relative amounts of infected food fed during each of the 3 brood years.

That elimination of raw salmon products as food may drastically reduce or eliminate mycobacterial infections in fishes was strongly suggested at a State-operated steelhead trout hatchery. Prior to the 1960-61 spawning season, adults returning from salt water showed a high percentage of infection. Fish returning during the 1960-61 and 1961-62 spawning seasons were from brood years in which no raw salmon products had been fed. The author was unable to find acid-fast bacilli in fish examined during these two spawning seasons.

However, other factors may be involved. Harlan E. Johnson noted (personal

communication, Branch of Fish Hatcheries, Bureau of Sport Fisheries and Wildlife, 1962) that during the 1961 and 1962 spawning seasons, a very noticeable decline occurred in the number of fall chinook adults with underdeveloped ovaries. In previous years there were many of these abnormal fish and nearly all of them were heavily infected with mycobacteria. However, this general reduction in infection occurred in the absence of any major change in diets fed at hatcheries on the Lower Columbia River.

Literature cited

Ross, A. J., B. J. Earp, and J. W. Wood. 1959. Mycobacterial infections in adult salmon and steelhead trout returning to the Columbia River Basin and other areas in 1957. U. S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 462.

Table 1:--Degree and incidence of acid-fast bacilli infections in adult male and female salmon collected at random at National Fish Hatcheries in Washington, Oregon, and California in 1958.

Hatchery or Source	Species	Sex	No. examined	No. positive	% positive	Degree of Infection 0	1	2	3	4	5
Little White Salmon	Fall Chinook	F	18	10	55	8	3	5	2	0	0
" " "	" "	M	33	19	57	14	8	6	2	3	0
" " "	Silvers	F	25	10	40	15	5	3	2	0	0
" " "	"	M	25	10	40	15	3	6	1	0	0
Spring Creek	Fall Chinook	F	24	9	37.5	15	3	4	2	0	0
" "	" "	M	25	8	32	17	5	0	3	0	0
Big White Salmon	" "	F	20	5	25	16	2	0	2	0	0
" " "	" "	M	16	5	31	11	4	0	0	1	0
(Bonneville Dam)Carson	Spring Chinook	F	39	5	12.8	34	2	1	2	0	0
" " "	" "	M	5	0	0	5	0	0	0	0	0
Entiat	Sockeye	F	22	6	26.9	16	2	3	1	0	0
"	"	M	26	3	11.5	23	0	2	0	1	0
"	Summer Chinook	F	23	3	13	20	2	1	0	0	0
"	" "	M	27	3	11.1	24	3	0	0	0	0
(Little Wenatchee R.) Leavenworth	Sockeye	F	31	9	29	22	4	1	1	1	2
" " "	"	M	17	1	5.8	16	0	1	0	0	0
Quilcene	Silvers	F	28	1	3.6	27	0	0	1	0	0
"	"	M	22	3	13.6	19	2	1	0	0	0
Eagle Creek	"	F	18	0	0	18	0	0	0	0	0
" "	"	M	32	0	0	32	0	0	0	0	0
Coleman	Spring and Summer	F	18	11	61	7	1	3	3	2	2
"	Chinook	M	15	5	33	10	1	1	2	1	0
"	Silvers	F	28	0	0	28	0	0	0	0	0
"	"	M	25	1	4	24	1	0	0	0	0
Okanogan River	Sockeye	F	12	0	0	12	0	0	0	0	0
" "	"	M	23	0	0	23	0	0	0	0	0

Table 2:--Degree of incidence of acid-fast bacilli infections in adult male and female salmon collected at random at National Fish Hatcheries in Washington, Oregon, and California in 1959.

Hatchery or Source	Species	Sex	No. examined	No. positive	% positive	Degree of Infection 0	1	2	3	4	5
Little White Salmon	Silvers	F	10	3	30	7	0	1	2	0	0
" " "	"	M	15	3	20	12	0	1	2	0	0
Spring Creek	Fall Chinook	F	24	4	16.6	20	2	0	0	1	1
" "	" "	M	22	7	31.8	15	0	1	2	3	1
Big White Salmon River	Fall Chinook	F	27	11	40.7	16	3	2	4	2	0
" " " "	" "	M	23	8	34.8	15	1	0	1	1	5
Coleman	Spring and Summer	F	173	29	16.8	144	9	4	4	5	7
"	Chinook	M	56	8	14.3	48	5	1	1	1	0
Keswick Dam	Spring and Summer	F	80	1	1.2	79	1	0	0	0	0
" "	Chinook	M	41	2	4.6	41	0	1	1	0	0
Eagle Creek	Steelhead	F	19	0	0						
" "	"	M	5	0	0						
" "	Silvers	F	3	0	0						
" "	"	M	4	0	0						
" "	Fall Chinook	F	0	0	0						
" "	" "	M	5	0	0						

Table 3:--Degree and incidence of acid-fast bacilli infections in marked Fall Chinook salmon returning to the Little White Salmon and Spring Creek National Fish Hatcheries in 1958

Hatchery	Brood Year	Date Released	No. examined	No. positive	% positive	Degree of Infection 0	1	2	3	4	5
LITTLE WHITE SALMON											
Little White	1956	5/9/57	1	1	100	0	1	0	0	0	0
Little White	1956	7/2/57	1	0	0	1	0	0	0	0	0
Spring Creek	1956	5/7/57	5	3	60	2	0	0	0	1	2
Willard	1954	7/5/55	1	1	100	0	1	0	0	0	0
Willard	1953	6/21/54	2	2	100	0	1	0	0	1	0
Willard	1953	3/7/55	14	11	78.5	3	2	2	5	1	1
Carson	----	--	6	1	16.6	0	1	0	0	0	0
Carson	1954	9/21/55	1	1	100	0	0	0	0	0	1
Gnat Creek	1955	6/20/56	1	1	100	0	1	0	0	0	0
Gnat Creek	1955	4/3/57	1	0	0	1	0	0	0	0	0
Klickitat	----	--	10	5	50	5	2	2	1	0	0
Bonneville	----	--	5	5	100	0	0	0	2	2	1
SPRING CREEK											
Spring Creek	1953	6/20/54	1	1	100	0	0	0	0	1	0
Spring Creek	1956	5/7/57	1	0	0	1	0	0	0	0	0

Table 4:--Degree and incidence of acid-fast bacilli infections in marked Fall Chinook salmon returning to the Little White Salmon and Spring Creek National Fish Hatcheries in 1959

Hatchery	Brood Year	Date Released	No. examined	No. positive	% positive	Degree of Infection 0	1	2	3	4	5
LITTLE WHITE SALMON											
Little White	1956	2/5/57	2	0	0	2	0	0	0	0	0
	1956	2/13/57	1	1	100	0	0	0	1	0	0
	1956	5/7/57	6	1	16.6	5	0	0	0	1	0
	1956	5/9/57	11	8	72.7	3	0	1	2	1	4
	1956	5/28/57	1	1	100	0	0	0	0	0	1
	1956	7/2/57	16	12	75	4	2	0	4	2	4
	1956	9/2/57	1	1	100	0	0	0	0	1	0
	1956	10/15/57	1	1	100	0	1	0	0	0	0
	1956	2/13/58	51	41	80.3	10	7	6	13	8	7
	1957	2/13/58	1	1	100	0	0	0	0	1	0
	1957	5/8/58	2	1	50	1	0	0	0	0	1
	1957	7/1/58	1	0	0	1	0	0	0	0	0
	1957	9/4/58	3	3	100	0	1	0	2	0	0
	1957	10/15/58	5	4	80	1	2	1	0	1	0
	1956 or 1957	7/1/?	14	9	64.3	5	1	0	1	0	7
	1956 or 1957	10/15/?	21	18	85.7	3	4	4	3	5	2
SPRING CREEK											
Spring Creek	1956	2/5/57	3	0	0	3	0	0	0	0	0
	1956	4/29/57	1	1	100	0	0	0	0	0	1
	1956	5/7/57	103	58	56.3	46	7	10	13	9	18
	1956	5/9/57	3	2	66.6	1	0	0	1	0	1
	1956	10/15/57	1	1	100	0	1	0	0	0	0
	1957	5/7/58	6	4	66.6	2	0	0	0	1	3

Table 5:-- Incidence of acid-fast bacilli in juvenile fish reared at selected National Fish Hatcheries

Hatchery	Species	Brood Year	Date Sampled	No. Examined	No. of positives with degree of infection	Diet
Entiat	Summer Chinook	1958	10/8/58	50	0	--------
Carson	Spring Chinook	1957	4/9/59	25	0	Wet
Carson	" "	1957	4/9/59	25	3 (5,2, 1)	Dry pellets since 2/1/58
Carson (Spring Creek stock)	Fall Chinook	1958	5/5/59	45	0	Wet
Spring Creek	Fall Chinook	1958	5/5/59	50	0	Wet
Little White	Fall Chinook	1958	5/5/59	45	0	Wet
Little White	Silvers	1957	2/12/59	36	0	Dry pellets
Big White	Fall Chinook	1958	5/5/59	50	0	Wet
Willard	Fall Chinook	1958	5/6/59	30	0	Wet
Eagle Creek	Spring Chinook	1957	2/13/59	50	0	Wet
Coleman	Fall and Spring Chinook		10/7/58	24	6 (3,3,2,2,2,2)	Wet

Table 6:--A Comparison of mycobacterial infections in adult salmon at National Fish Hatcheries, in 1957 - 1958 - 1959

		1957		1958		1959	
Hatchery	Species	No. of fish in sample	Percent Infection	No. of fish in sample	Percent Infection	No. of fish in sample	Percent Infection
Little White Salmon	Fall Chinook	364	11.8	51	56		
Spring Creek	Fall Chinook	300	2.3	49	34.7	46	23.9
Carson	Spring Chinook	387	13.4	44	6.4		
Entiat	Sockeye	105	12.3	48	19.2		
Entiat	Summer Chinook	95	10.5	50	12		
Leavenworth	Sockeye	117	0	48	17.4		
Quilcene	Silvers	85	1.1	50	8.6		
Coleman	Spring and Summer Chinook	93	21.5	33	47	229	16.2
Eagle Creek	Spring Chinook					5	0
Eagle Creek	Silvers			50	0	7	0
Eagle Creek	Steelhead	22	0			24	0
Big White Salmon (River)	Fall Chinook			36	27.8	50	38