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KIDNEY DISEASE INCIDENCE IN MICHIGAN SALMON, 1968-73*

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SUMMARY

Corynebacterial kidney disease continues to be found in Michigan's coho and chinook salmon. Varying levels of incidence have been reported over the years for the adult coho salmon. The Platte River data for female salmon shows a low of 0.06 percent (by gross observations) in 1971 and a high of 3.7 percent (by smear) in 1972. Accurate examinations by smear reveal a change in the disease level within year classes from the pre-release smolt to the returning adult: 0.6 to 3.5 percent, and 1.6 to 0.2 percent. Chinook salmon adults have had a low disease level, 0.1 percent in 1970. It appears that the Michigan Salmon will continue to have detectable KD in varying incidence levels.

* Work supported by Federal Anadromous Fish-Commercial funds under AF-C projects 9-1, 9-2, 9-3, and 10-1. Projects were carried out at the Grayling Research Station, Grayling, Michigan.

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INTRODUCTION

Corynebacterial kidney disease (KD) has been of significance as a fish cultural problem in the Michigan fish hatchery system for many years. Initially, brook trout (Salvelinus fontinalis) and rainbow trout (Salmo gairdneri) were periodically infected with KD at several hatcheries. The culture and introduction of coho salmon (Oncorhynchus kisutch) began in 1965. In 1966, chinook salmon (O. tshawytscha) were also imported into Michigan. The first year class of coho salmon was found to have KD in 1967 as spawning adults (28). Kidney disease had not been reported prior to release of the salmon into the Great Lakes. The initial discovery of KD in adult coho salmon in 1967 led to the development of spawning practices to avoid using spawn from infected parents, and a more or less continuous monitoring of returning coho and chinook salmon spawning populations.

Few studies on what happens to diseased salmonids after they are stocked into lakes and streams have been initiated. Allison (1) studied KD among brook trout released in various inland lakes and streams. He found that there were no instances in which the disease was transmitted from stocked fish to fish already in the waters. Nor were there any mortalities of fish from the waters stocked with the infected fish. Allison concluded: "it appears unlikely that the stocking of infected brook trout in lakes and streams can result in a widespread mortality due to kidney disease."

While Allison's study and my work involved known infected fish that were stocked in lakes and streams, Evelyn, et al (4), found a natural case of bacterial KD in a rainbow trout. The trout examined was angler caught from an inland lake in British Columbia. The trout population in the particular lake was natural with only the most remote possibility of hatchery trout introduction. This finding of KD is the first direct evidence that the bacterium also occurs in fish in natural waters.

PROCEDURES

The coho and chinook salmon used for observing the presence of KD came from 5 sources: (1) dead or dying salmon found on the beaches or in offshore waters of the Great Lakes; (2) population surveys by fisheries management crews; (3) survey netting carried on by research vessels; (4) adult salmon spawned at the spawn-taking stations; and (5) fish health inspections of fry and smolts at State fish hatcheries.

The autopsy of salmon was, in many instances, limited to gross observations for signs of KD: swelling and lesions of the kidney. Salmon were slit open from the vent to the pectoral girdle, intestines were

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displaced to 1 side and the swim bladder was pealed away for observation of the kidney. In the case of disease inspections, a sterile inoculating loop was used to sample kidney tissue for making microscope slide smears. The smears were Gram's stained prior to examination for the characteristic KD bacterium. The gram-stained smears are considered as a presumptive diagnostic method. There were no attempts made to utilize the definitive method of culturing the bacterium.

The sample sizes for the large numbers of salmon specifically examined for KD were determined according to Amend and Wedemeyer (2). This work was developed for determining the absence of Infectious Pancreatic Necrosis virus in fish. A minimum carrier incidence of 0.5 percent was assumed for kidney disease. Based on population size of 100,000 fish or more, the sample size should be 600 fish. If no disease was isolated, the results would give 95 percent confidence that the disease was not present in the population at the disease incidence tested.

RESULTS AND DISCUSSION

The information available on KD occurrence in salmon is difficult to follow for a variety of reasons, chief among them is that the "newness" of salmon success in the Great Lakes has worn off and KD is considered no longer as a disease of consequence on the salmon program as it was in 1967-68. Also, field observations were either not made, not forwarded to the Disease Unit or were not made a part of any written report. In 1967, there were 22 reports, totaling 44 dead or floundering adult coho salmon (28). With fishing interest even higher in 1968, there was only 1 report of a floundering salmon (30). This shift to fewer observations and no recorded information is evident even more so after 1970 (Table 1).

The limitations of depending solely upon gross observations by non-disease or even disease trained personnel are obvious to anyone who has worked with kidney diseased fish: the method is less than 100 percent correct and differences between observers also exist. Schorfhaar (29) reported a 1.6 percent incidence in 308 coho salmon from Thompson Creek in 1970 (Table 1). Hnath (19) examined 60 female salmon from the same creek, year class, and by the same method of gross observations, but found no KD. In most cases, it was impossible for the Disease Unit to handle and autopsy the large number of salmon that were available. Smears could not be prepared from these fish by already burdened field biologists.

The results of autopsying the 1969 year class of Platte River adult coho salmon (Table 2) are of interest when one compares the gross observation method to stained kidney smears. By gross observation, 6 of 300 male salmon "had" KD for 2.0 percent incidence. Similarly, there was a 4 percent KD incidence (12 of 300) in the female salmon. The combined percentage for males and females was 3.0 percent positive under gross observation. The data on kidney smears from the same salmon reveals little change in compiled percentages. Male salmon, including 7 jack salmon, were 3.7 percent diseased (11 of 300). The female salmon were 3 percent diseased (9 of 300). Overall, the 600 salmon had an incidence of 3.5 percent (21 of 600), based on kidney smears. The total percentage for the 2 KD diagnostic methods are

Table 1. Coho Salmon Examined For Kidney Disease

Source	Exam Year	No. Fish Examined	Sex[1]	Diagnosis Gross obs.[2]	Smear	Positive Percent	Reference
Lake Michigan							
Dead or floundering	1967	44	M		X	22.7	28
	1968	1	U		X	0	29
Netted	1967	113	M	X		4.4	18
	1968	278	M	X		5.7	19
River spawning runs							
Little Manistee	1968	329	♀	X		1.2	30
Bear Creek	1968	317	M	X		1.6	28
Platte River	1967	3884	M	X		0.4	28
	1968	8700	M	X		0.6	28
	1969	5046	♀	X		0.8	*
	1970	5230	♀	X		0.5	*
	1971**	5453	♀	X		0.06	*
Big Cedar River	1970	59	U	X		1.5	29
Manistique R.	1970	90	U	X		0	29
Thompson Creek	1970	308	U	X		1.6	29
Whitefish River	1970	195	U	X		0	29
Lake Superior							
Dead or floundering	1967	2	U	X		100	28
River spawning runs							
Huron River	1967	231	M	X		13.4	28
	1968	139	M	X		2.8	30
Anna River	1970	135	U	X		16.5	29
Chocolay River	1970	51	U	X		0	29
Falls River	1970	10	U	X		0	29
Lake Huron							
River spawning run							
Carp River	1970	80	U	X		0	29

1. M: female and male salmon examined, data grouped for total.
U: unknown, records provide no information on sex of fish examined.

2. Gross obs.: visual examination of kidney for lesion(s) and swelling.
Smear: microscope slide smear, gram-stained.

* W. C. Houghton, Platte River State Fish Hatchery, Honor, Michigan (personal communication).

** CO 68 PR WL CH

Table 2. Inspections of Adult Salmon

Source	Species	Exam Year	Lot Designation	No. Fish Examined	Sex[1]	Diagnosis Gross Obs.[2]	Smear	Positive Percent	Reference
Little Manistee Station	Chinook	1971		103	M	X	X (15)	0	5
	Chinook	1972		25	U		X	0	6
	Coho	1972		15	U		X	0	7
	Chinook	1973		20	M		X	0	8
	Coho	1973		20	M		X	0	9
Platte River Hatchery	Coho	1971	Co68PR WL CH	111	M	X		0	12
	"	1971	"	15	U		X	0	12
	"	1972	Co 69 PR	15	U		X	0	13
	"	1972	"	300	♀		X	3.0	
	"	1972	"	300	♂ 3.		X	3.7	
	"	1973	Co70 PR	300	♀		X	0.3	
	"	1973	"	300	♂		X	0	
	"	1973	"	20	M		X	0	15
Thompson Hatchery	Coho	1970		60	♀	X		0	19
	"	1972	Co69 TH(Mi)	15	U		X	0	22
	"	1973	Co70 TH	20	M		X	0	24

1. M: female and male salmon examined, data grouped for total.
   U: unknown, records provide no information on sex of fish examined.

2. Gross obs.: visual examination of kidney for lesion(s) and swelling.
   Smear: microscope slide smear, gram-stained.

3. Seven "jack" salmon of Co71PR year class inadvertently included, 1 of which was positive for KD.

quite close (3.0 versus 3.5); however, results on individual fish were not comparable. Of the 18 salmon appearing to have gross signs of KD, only 1 of these salmon was confirmed as positive by examination of the kidney smear. The other 17 kidney smears were negative for the KD bacterium. The gross signs, mainly swelling of the kidney, were due to unknown cause or causes.

Similar autopsy results were obtained when the 1970 year class of coho salmon were examined as adults in 1973. The gross observation data indicated that 1.3 percent of the female salmon and 5.0 percent of the male salmon were infected with KD. The overall percentage was 3.2. The gram-stained smears presented quite different results with 0.3 percent of the females and 0 percent of the male salmon infected. The total percentage calculates to 0.2 percent. Examination of the 19 smears from grossly positive fish revealed that only 1 fish was actually infected with KD. This particular female fish was also the only 1 of the 600 salmon which had a definite pustule in the kidney.

As seen in Tables 1,2 and 3, coho salmon continue to have KD, although at low levels. The reports have been scattered over many streams with the most consistent reports coming from the Platte River. Here, efforts have been made each fall to grossly observe the female adult coho salmon for KD. Specific inspections have also been made on fry and pre-released smolts (Table 3), and adult coho salmon (Table 2). Statistical samples of smolts for 2 successive year classes were checked by gram-stained kidney smears. The 1969 year class (Co 69 PR) had an incidence of 0.6 percent. This same year class was again checked (Table 2) by gram-stained smear and large sample size as returning adults in the Platte River. This second check revealed that the level of disease had increased to 3.5 percent. The female coho parent of the 69 year class had a 0.8 percent KD incidence by gross observations (Table 1). The 1970 year class (Co 70 PR) was similarly monitored. The smolts had 1.6 percent incidence in the spring of 1972 while as adult salmon in the fall of 1973, the incidence decreased to 0.2 percent.

The Thompson Hatchery coho salmon have also been inspected as both adults and smolts (Tables 2 and 3). The 1970 and 1971 year classes of the Alaska strain coho salmon have been positive for KD. One lot of salmon (Co71ALTh) was inspected as both fingerlings and smolts with 20 and 0 percent incidence respectively. No logical explanation can be given for this occurrence although it is possible that all of the diseased fish died before the second (smolt) inspection without spreading the disease to other fish in the lot. Hnath's 1972 inspection (22) of the returning 1969 year class (Co69Th(Mi) found no KD, the same result as he reported in 1971 (20) when the salmon were smolts in the hatchery.

Returning adult chinook salmon have been checked for KD, mainly at the Little Manistee River spawn-taking station (Tables 2 and 4). The 1970 report was of 0.1 percent disease incidence. The 1971, 1972, and 1973 inspection reports (5,6,8) state that no KD was found. No detection of KD has been made in the chinook salmon prior to their

TABLE 3. Coho Salmon Fry And Smolt Inspection

Source	Exam Year	Lot Designation	No. Fish Examined	Diagnosis[1]. Gross Obs.	Diagnosis[1]. Smear	Positive Percent	Reference
Oden Hatchery	1971	Co69 PR OD	30		X	0	10
Platte River Hatchery	1971	Co69 PR	15		X	26.6	11
	1971	Co69 PR	499		X	0.6	
	1972	Co70 PR	500		X	1.6	
	1973	Co71 PR	20		X	0	14
	1973	Co71WA WL PR	20		X	0	14
Sturgeon River Station	1972	Co71 PR SR	15		X	0	16
	1972	Co72(Wa)WL SR	31		X	3.2	16
	1973	Co71 PR SR Co72(Wa)WL SR	20		X	0	17
Thompson Hatchery	1971	Co69 TH (Mi)	12		X	0	20
	1972	Co70 AL TH	30		X	10.0	21
	1972	Co71 AL TH	15		X	20.0	21
	1973	Co71 AL TH	15		X	0	23
Wolf Lake Hatchery	1973	Co72 WC WL	30		X	0	25
	1973	Co72 PR WL	30		X	0	26

1. Gross obs.: visual examination of kidney for lesion(s) and swelling.
Smear: microscope slide smear, gram-stained.

TABLE 4. Chinook Salmon Examined For Kidney Disease

Source	Exam Year	No. Fish Examined	Sex[1]	Diagnosis[2] Gross Obs.	Diagnosis[2] Smear	Positive Percent	Reference
Grayling Research Station	1971 (Ch69)	100	M		X	0	
Lake Mich.							
Netted	1967	12	U	X		0	28
	1968	50	U	X		0	30
River spawning runs							
Little Manistee	1970	1112	♀	X		0.1	*
Lake Superior							
River spawning runs							
Chocolay R.	1970	103	U	X		6.8	29
Big Huron R.	1970	4	U	X		4.8	29

1. M: female and male salmon examined, data grouped for total.
   U: unknown, records provide no information on sex of fish examined.

2. Gross obs.: visual examination of kidney for lesion(s) and swelling.
   Smear: microscope slide smear, gram-stained.

* W. C. Houghton, Platte River State Fish Hatchery, Honor, Michigan (personal communication).

stocking in tributary streams of the Great Lakes. The relatively young age of these salmon at stocking time, 6 months or so, may preclude development of the disease to a detectable or problem stage in the hatchery as well as prevent them from contacting the disease from diseased fish in the hatchery.

CONCLUSIONS

The data for salmon returns in different rivers is not necessarily related to each other. Our salmon eggs originated from west coast sources until a complete Michigan year class was accomplished at both the Platte River and Thompson spawn-taking facilities. The Thompson coho salmon was of an Alaskan strain, whereas an Oregon strain was used for the original Lake Michigan and Lake Superior stockings. The disease reports reveal that Lake Superior coho and chinook salmon have had incidence rates higher than for salmon of the same egg source and year class from Lake Michigan. I can only speculate as to the reason or reasons for such a difference: source of eggs; water chemistry; observer variance; and so on.

The Michigan salmon stocks appear to be surviving in harmony with kidney disease. Salmon losses in the hatcheries due to KD have not been significant. Similarly, the disease has had no observed impact on the adult populations in the Great Lakes since 1967. Comparing the salmon information with the work of Allison (1) on brook trout, I feel that no widespread mortality will occur due to KD in the stocked salmon.

Within the present hatchery system, disease awareness must be maintained to insure that the KD does not increase causing significant production fish losses. Hopefully, disinfection of salmon eggs with a suitable compound prior to setting-up the eggs in the incubator system will soon be feasible.

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