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# KIDNEY DISEASE AMONG MICHIGAN SALMON IN 1967[a]

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## INTRODUCTION

Pacific coast salmon are subject to heavy mortalities from outbreaks of "kidney disease." These outbreaks occur in chinook or king salmon, Oncorhynchus tshawytscha, coho or silver salmon, Oncorhynchus kisutch and blueback or kokanee salmon, Oncorhynchus nerka (Earp, Ellis and Ordal, 1953). The disease has been reported for many years from brook trout, Salvelinus fontinalis, brown trout, Salmo trutta and rainbow trout, Salmo gairdneri in coastal and inland states. Although most studies and records on kidney disease have been carried on in hatcheries, the disease has also been found in wild fingerling salmon (Rucker, Earp and Ordal, 1954).

Kidney disease was identified for the first time in Michigan in 1955 among brook trout held at two hatcheries (Allison, 1958). Since 1955 the disease has occurred at the following hatcheries: at the Oden Hatchery among brook trout, 1955 and 1956; at the Watersmeet Hatchery among brook trout, 1960 and 1962; at the Marquette Hatchery among brook trout, 1955 and 1956,and symptoms in 1966; and at the Platte River Rearing Station and the Harrietta Hatchery among lake trout in 1961 (Allison, 1967). The Platte River Station, Harrietta, Marquette and Oden hatcheries are part of the

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present system for introduction of coho and chinook salmon into Great Lakes waters. Kokanee salmon were raised at the Oden and Harrietta hatcheries and planted in Torch Lake and Higgins Lake. Prior to the actual release of coho, chinook, and kokanee salmon in Michigan waters no symptoms or evidences of kidney disease were found. This paper is a report on the 1967 finding of kidney disease and the levels of incidence in coho, chinook, and kokanee salmon.

## Description

The bacterium causing kidney disease has been considered to be a Corynebacterium because of its morphology (Wolf, 1966). This organism is a tiny (0.4 u x 0.8 u) non-motile pleomorphic rod. The straight to slightly curved rods frequently show club-shaped swellings (Breed, 1957). The rods are Gram-positive in staining reaction.

The disease is described as a generalized infection usually characterized by the presence of definite lesions of the internal organs, especially the kidney (Rucker, Earp and Ordal, 1954). Large numbers of the bacilli are found in the lesions. Frequently the kidney may appear as only slightly swollen. In advanced stages, petechiae are frequently observed and exophthalmos is present to some extent. The intestine may be filled with a yellow purulent fluid.

Not all of these symptoms occur in every outbreak or in each infected fish. Very frequently the only apparent symptom is the presence of the gray-white pustules in the kidneys (Snieszko and Griffin, 1955).

## Methods

Coho salmon found dead on beaches or floundering in off-shore waters

of Lake Michigan and Lake Superior provided the first source for autopsy. A second source was from salmon held at the Oden State Fish Hatchery and subsequently moved to the Grayling Research Station. Additional salmon came from survey netting of Lake Michigan by the Great Lakes Unit of the Fish Division. The fourth source consisted of mature salmon returning to parent streams and autopsied as part of spawn-taking operations at the Platte River Spawn-taking Station (Lake Michigan), and the Huron River Weir (Lake Superior). A fifth source was mature salmon returning in Bear Creek and held at the weir and ponds of the Bear Creek Rearing Station.

The chinook salmon autopsied were either from salmon held at the Grayling Research Station or survey netted on Lake Michigan. The kokanee salmon were from a sample also held at the Grayling Station.

Salmon were examined visually and microscopically for kidney disease at the Grayling Research Station. The microscopic identification was made on the basis of the morphology and staining characteristics of organisms in smears of the kidney and liver. The visual examination was a gross observation of the kidney and liver for swelling, lesions or pustules, and coloration. Observations were also made for other internal symptoms and external symptoms such as petechiae and exophthalmos.

## Results

The first indications of kidney disease in the Michigan coho salmon came from autopsies of adult salmon found dead or floundering in off-shore waters of Lake Michigan in July and August, 1967 (Table 1). This early indication of a possible high incidence of 20 per cent or more led to the examination of coho salmon at the Oden Hatchery. The 102 salmon examined at the Oden Hatchery had a 3.9 per cent incidence of disease. The combined total for salmon from both the Oden Hatchery and the sample transferred to

the Grayling Station was 216 examined with 34 kidney disease positive for 15.7 per cent incidence (Table 1)

Survey netting of Lake Michigan by the Great Lakes Unit of the Fish Division provided 113 coho salmon (Table 1). Netted coho salmon had a 4.4 per cent incidence.

The mature salmon returning to their parent streams formed the largest group, in numbers, of all salmon examined. The Lake Michigan coho salmon were examined at the Platte River and Bear Creek Stations (Table 1). Total coho salmon examined at Platte River were 3,884 with 15 positive for a 0.4 per cent incidence. Bear Creek salmon had a 1.6 per cent incidence with 5 positive salmon among 317 examined. The Lake Superior coho salmon were examined at the Huron River site and from 231 salmon examined, 31 were positive for 13.4 per cent incidence (Table 1).

The total incidence of kidney disease is summarized in Table 2. Briefly, Lake Michigan coho salmon had a 1.5 per cent incidence while Lake Superior salmon had a 14.2 per cent incidence. The total for all coho salmon was 2.1 per cent incidence among 4,807 examined. This total is separated by sex (Table 3) as follows: 1,610 males, 3,075 females, and 122 with no record. This last group consists of salmon for which no record of sex was kept and immature salmon with no determination of sex made. By sex, males had a higher incidence with 3.2 per cent, whereas females had a 1.3 per cent incidence.

A total of 34 chinook salmon examined had a 29.4 per cent incidence of kidney disease (Table 4). Chinook salmon held at the Grayling Research Station had a 45.4 per cent incidence, 10 of 22 were positive. The Lake Michigan record is incomplete with only 12 chinook salmon examined and no

positive records. A total of 60 kokanee salmon were autopsied (Table 5) with 1 positive for a 1.7 per cent incidence.

## Discussion

The primary concern of our survey was to exclude from state fish hatcheries the reproductive products from any coho salmon with kidney disease symptoms. Transmission of the disease by eggs was suspected as a means of introducing and spreading the disease.

Very few of the salmon which had no gross internal lesions were positive for kidney disease when stained smears of liver and kidney were examined microscopically. Also, few of the fish which had kidney disease exhibited gross external symptoms. With these points in mind and in order to provide a smooth spawn-taking operation, only the visual examination of internal organs was made during these operations. Our examinations had 2 purposes: (1) remove from production the spawn from kidney diseased coho salmon to prevent possible transmission of the disease to hatcheries and salmon offspring; and (2) to determine the extent of kidney disease in the newly introduced salmon in Michigan.

A sample of coho salmon was withheld from planting in Lake Michigan and was retained at the Oden Hatchery. From this number, a sample of 500 was transferred to the Grayling Research Station for observation. Kidney disease among these fish appeared to increase the longer they were held. This occurrence was possibly due to either a reduction in disease resistance or a breakdown of body tissues as the salmon fed inconsistently and sexually matured.

The incidence of kidney disease and internal parasites was higher in

Lake Superior coho salmon than in Lake Michigan coho salmon. The Lake Superior salmon were heavily infested with Acanthocephala in the large intestine and the nematode, Cystidicola sp., in the swim bladder. The Lake Michigan salmon were infested in low numbers with Acanthocephala but no Cystidicola were observed. We have no definite information about a correlation between parasitism and kidney disease. The variation in the kidney disease incidence between coho salmon in the two Great Lakes will be further studied as salmon year classes mature.

We have not separated coho salmon by year class, noting only that salmon were mature when examined. The vast majority of coho salmon autopsied were from the 1965 year class which matured and spawned in 1967. A number of coho salmon of the 1966 year class, maturing in 1968, were taken in gill nets, found dead, or returned to spawn as jacks in 1967. Partial records indicated positive observance of kidney disease in these early maturing salmon. Therefore, fish of this 1966 year class may be expected to further exhibit symptoms of kidney disease as they age, mature, and return to spawning streams. Chinook and kokanee salmon may also have kidney disease evident by the time they mature.

Our survey revealed a higher incidence of kidney disease among male coho salmon than among female by nearly 3:1. No factual reason can be given for this occurrence.

We have found kidney disease in both chinook and kokanee salmon. However, our survey was incomplete with low numbers and only immature fish examined. Completion of this study must necessarily wait for the return of mature salmon during future spawning runs. A high incidence of kidney

disease among the chinook salmon held in aquaria was noted when compared with a low incidence among those held in the raceway. Oxygen in aquaria water was approximately 6 ppm.. Therefore, a continuous oxygen stress may have reduced resistance to the disease.

The limited survey of kokanee salmon revealed a low incidence. The one positive case was demonstrated in a salmon held in a small aquaria. No mortalities attributed to kidney disease have occurred among kokanee salmon held in the raceway. The stress of continuous exposure to low oxygen may have assisted development of the disease as in the chinook salmon.

## Summary

The first report of kidney disease in recently introduced coho, chinook, and kokanee salmon is made. The following points are of significance:

1. Adult coho salmon during the lake phase of their life cycle exhibited kidney disease symptoms.
2. Coho salmon had a low incidence of disease.
3. Lake Superior coho salmon had a greater incidence of kidney disease than Lake Michigan coho salmon.
4. Male coho salmon had a higher incidence of kidney disease than did female salmon.
5. Kidney disease is reported from chinook and kokanee salmon held at the Grayling Station with no positive records from either Lake Michigan chinook salmon or the kokanee salmon planted in Torch Lake and Higgins Lake.

6. Coho salmon of the 1966 year class, returning in 1968, may be expected to have kidney disease. Chinook and kokanee salmon may also exhibit disease symptoms as adults.
7. To the best of our knowledge and with just regard for our gross method of observation, spawn from coho salmon infected with kidney disease were eliminated from hatchery production.

Further study of the incidence of kidney disease in coho, chinook, and kokanee salmon is planned. A study of the possible transmission of kidney disease by egg and/or sperm is in progress at present.

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TABLE 1

INCIDENCE OF KIDNEY DISEASE IN COHO SALMON BY SOURCE

| SOURCE | FISH EXAMINED | POSITIVE | POSITIVE PERCENTAGE |
|---|---|---|---|
| 1. Lake Michigan* | 44 | 10 | 22.7 |
| 2. Oden Hatchery | 102 | 4 | 3.9 |
| 3. Grayling Station | 114 | 30 | 26.3 |
| 4. Lake Michigan-netted | 113 | 5 | 4.4 |
| 5. Platte River | 3,884 | 15 | 0.4 |
| 6. Bear Creek | 317 | 5 | 1.6 |
| 7. Lake Superior* | 2 | 2 | ---- |
| 8. Huron River (Lake Superior) | 231 | 31 | 13.4 |

*These fish were found dead or floundering along the beaches or in off-shore waters.

TABLE 2

SUMMARY OF KIDNEY DISEASE IN COHO SALMON BY GREAT LAKES

| SOURCE | FISH EXAMINED | POSITIVE | POSITIVE PERCENTAGE |
|---|---|---|---|
| Lake Michigan | 4,574 | 69 | 1.50 |
| Lake Superior | 233 | 33 | 14.2 |
| TOTAL | 4,807 | 102 | 2.12 |

TABLE 3

KIDNEY DISEASE INCIDENCE BY SEX OF COHO SALMON

| SOURCE | FISH EXAMINED | POSITIVE | POSITIVE PERCENTAGE |
|---|---|---|---|
| 1. Lake Michigan* | | | |
| Male | 32 | 5 | 15.6 |
| Female | 8 | 3 | 37.5 |
| No record** | 4 | 2 | 50.0 |
| 2. Oden Hatchery | | | |
| No record** | 102 | 4 | 3.9 |
| 3. Grayling Station | | | |
| Male | 43 | 13 | 30.2 |
| Female | 63 | 14 | 22.2 |
| No record** | 8 | 3 | 37.5 |
| 4. Lake Michigan-netted | | | |
| Male | 92 | 4 | 4.34 |
| Female | 13 | 1 | 7.7 |
| No record** | 8 | 0 | 0.0 |
| 5. Platte River | | | |
| Male | 1198 | 4 | 0.3 |
| Female | 2686 | 11 | 0.4 |
| 6. Bear Creek | | | |
| Male | 104 | 4 | 3.8 |
| Female | 213 | 1 | 0.5 |
| 7 Lake Superior* | | | |
| Male | 1 | 1 | --- |
| Female | 1 | 1 | --- |
| 8. Huron River | | | |
| Male | 140 | 21 | 15.0 |
| Female | 91 | 10 | 11.0 |
| TOTAL | | | |
| Male | 1610 | 52 | 3.2 |
| Female | 3075 | 41 | 1.3 |
| No record** | 122 | 9 | 7.4 |
| | 4807 | 102 | 2.12 |

* These fish were found dead or floundering along the beaches or in off-shore waters.

**No record made of sex or immature with no determination of sex made.

TABLE 4

CHINOOK SALMON KIDNEY DISEASE INCIDENCE

| SOURCE | FISH EXAMINED | POSITIVE |
|---|---|---|
| Grayling Station | | |
| Aquarium | 10 | 10 |
| Raceway | 12 | 0 |
| Lake Michigan | | |
| Netted | 12 | 0 |
| TOTAL | 34 | 10 |

TABLE 5

KOKANEE SALMON KIDNEY DISEASE INCIDENCE

| GRAYLING RESEARCH STATION | FISH EXAMINED | POSITIVE |
|---|---|---|
| Fish Held in Raceway | 59 | 0 |
| Fish Held in Aquarium | 1 | 1 |
| TOTAL | 60 | 1 |