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BACTERIAL KIDNEY DISEASE OF SALMONID FISHES

(Revised)

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INTRODUCTION

Kidney disease is a chronic to subacute, usually systemic, bacterial infection of salmonid fishes, and under hatchery conditions it has often been the cause of severe mortality. It is an unusual disease for a number of reasons. Virtually all records and reports have appeared since the early 1950's; secondly, recent evidence shows that kidney disease is most severe in waters which have a low mineral content; thirdly, kidney disease can occur simultaneously with such other diseases as furunculosis and visceral granuloma.

IDENTIFICATION

The disease produces light, moderate, or severe mortality among fingerling to adult salmonid fishes. Exophthalmus is often present, but macroscopically many dying fish may appear to be normal. Large external welts are often seen on affected brook trout. Tiny unbroken pimples are often associated with small crater-like lesions especially along sides of fishes; this condition is common among infected rainbow trout and chinook salmon. Welts and pimples contain red to cream-colored purulent material composed of blood cells and large numbers of the specific bacteria. Kidney is typically light and grossly swollen. Liver appears pale. Either or both organs may exhibit intact lesions filled with pus. Visceral cavity and other organs are typically hemorrhagic; ascitic fluid is often present.

CAUSE OF THE DISEASE

The causal organism of kidney disease is a tiny (0.4_{μ} X 0.8_{μ}) nonmotile gram-positive diplobacillus. The bacterium is fastidious but can usually be cultivated on a blood agar medium described by Ordal and Earp (1956). Very few of its attributes are known, but because of its morphology it has been considered a Corynebacterium.

SOURCE AND RESERVOIR OF INFECTION

Infected or carrier-type fish are considered to be likely sources of infection, and some confirming experimental results have been obtained. Insect sources have also been postulated, but critical evidence is lacking.

MODE OF TRANSMISSION

Fish to fish transmission is probably one means by which kidney disease is spread. West Coast workers have achieved 100-percent transmission to fingerling salmon by feeding infected viscera. Considerably less effective transmission was obtained with fingerling trout in the East. Under the hard-water conditions prevailing at the Eastern Fish Disease Laboratory, brook trout could not be infected by feeding cultured bacteria, and little more than half developed kidney disease after a month of daily feeding with infected fish tissues. On the other hand, when the causative bacterium was introduced by abrading or pricking the skin, more infections resulted. It seems likely, therefore, that the dermal route is the more natural portal of infection. This suggests that skin lesions such as may be made by parasites or by mechanical means may favor transmission under hatchery conditions. There is considerable circumstantial evidence for egg transmission, but conclusive evidence is still lacking.

INCUBATION PERIOD

The infection develops slowly. Experimentally from one to three months have elapsed before mortalities were produced. Incubation time following feeding was greater than that achieved with mechanical methods.

PERIOD OF COMMUNICABILITY

Unknown. Likely to be as long as infected fish or possible intermediate hosts are present in the water.

SUSCEPTIBILITY AND RESISTANCE

Disease at present unknown among non-salmonids. Propagated Pacific salmon, Atlantic salmon, and three main trouts affected--brook trout most severely, rainbow trout least severely of the three.

RANGE

Unknown.

OCCURRENCE

Kidney disease is moderately common throughout the United States. It is enzootic at some stations and infrequent or absent at others. A tendency towards seasonal periodicity has been noted, but the season varies at different stations. Warren's recent study (1963) showed that the severity of kidney disease increased with softness of water, however, the relationship may not be one of direct cause and effect.

METHODS OF CONTROL

A. Preventative measures

Until such time as the sources and modes of infection in hatcheries, especially those with very soft water are known, strict quarantine or antiseptic disposal of infected lots is recommended. Under special circumstances, release of infected lots in isolated waters may be condoned. Facilities and equipment in contact with infected fish should be sterilized before use with healthy fish.

B. Treatment

Kidney disease is perhaps the most difficult to treat bacterial infection of fishes, possibly because the bacterium can occur intracellularly and at such times is beyond the effect of some antimicrobials. Under laboratory conditions, erythromycin U.S.P. given orally at the rate of 4.5 grams per 100 pounds per day for 3 weeks gave the best, but not complete, control. Field applications have given similar results; cures were effected in some lots, but among others the disease recurred. All published accounts of treatment with sulfonamides report that mortality from the infection recurred after treatment ceased. Sulfamethazine fed at 2 grams per 100 pounds of fish per day has been successfully used for prophylaxis of Pacific salmon. The potential danger of developing sulfa-resistant makes this practice a highly questionable one.

ANNOTATED BIBLIOGRAPHY

(*Papers indicated by an asterisk are of special importance to fish culturists.)

ALLISON, LEONARD N.

*1958. Multiple sulfa therapy of kidney disease among brook trout. The Progressive Fish-Culturist, Vol. 20, No. 2, pp. 66-68.

Sulfamerazine, alone or in combination with other sulfonamides, did little to reduce mortality during a month of treatment. Post-treatment mortality among treated lots was significantly lower than nontreated controls. No cures were effected.

BELDING, DAVID L., and B. MERRILL.

1935. A preliminary report upon a hatchery disease of the salmonidae. Transactions of the American Fisheries Society, Vol. 65, pp. 76-84.

Description of symptoms of an apparently infectious disease of trout. In all probability this is the first North American report of what is now known as kidney disease. Epidemiology and etiology are discussed.

DAVIS, H.S.

*1953. Culture and diseases of game fishes. Univ. Calif. Press, Berkeley and Los Angeles. 332 pp., illus.

Under descriptions of "popeye" the author gives a short discussion of what is now recognized as kidney disease. (last paragraph on p. 287 and 288).

EARP, B.J., C.H. ELLIS, and E.J. ORDAL.

*1953. Kidney disease in young salmon. State of Washington Dept. of Fisheries, Special Report Series, No. 1, 74 pp., illus.

A lengthy report of kidney disease among young salmon in West Coast hatcheries. Symptoms are described. Epizootiological data from seven hatcheries for from 1 to 3 years are presented. Results of hatchery therapy and of therapy of experimentally infected fish are also given. Some work lacked controls, other work inadequately controlled.

ORDAL, E.J., and B.J. EARP.

1956. Cultivation and transmission of etiological agent of kidney disease in salmonid fishes. Proceedings Society of Experimental Biology and Medicine, Vol. 92, pp. 85-88, illus.

This paper gives the composition of the first semisynthetic medium upon which the causative organism of kidney disease could be consistently grown. Results of transmission experiments demonstrate the fulfillment of the generally accepted Koch's postulates for establishing an organism as the cause of a disease.

PIPER, ROBERT G.

*1961. Toxic effects of erythromycin thiocyanate on rainbow trout. The Progressive Fish-Culturist. Vol. 23, No. 3, pp. 134-135.

Rainbow trout brood stock with diagnosed kidney disease were treated with erythromycin thiocyanate. Extreme nervousness and other abnormal behavior was interpreted as drug toxicity and forced temporary cessation of therapy. Final results indicated control of the infection.

RUCKER, R.R., A.F. BERNIER, W.J. WHIPPLE, and R.E. BURROWS.

*1951. Sulfadiazine for kidney disease. The Progressive Fish-Culturist, Vol. 13, No. 3, pp. 135-137.

Kidney disease occurrence among fingerling salmon. Infected fish given 2 extended courses of sulfadiazine showed less mortality than untreated fish.

RUCKER, ROBERT R., B.J. EARP, and E.J. ORDAL.

*1954. Infectious diseases of Pacific salmon. (Symposium. Research on Fish Diseases: A review of progress during the past 10 years). Transactions of the American Fisheries Society, Vol. 83, pp. 279-312.

Summary type discussion of knowledge of kidney disease especially as it occurs

among various species of Pacific salmon is included in a larger work on the diseases of these fishes.

SNIESZKO, S.F.

*1954. Therapy of bacterial fish diseases. (Symposium. Research on Fish Diseases: A review of progress during the past 10 years). Transactions of the American Fisheries Society, Vol. 83, pp. 313-330.

A brief resume of the status of knowledge on therapy of kidney disease is included in this comprehensive paper.

SNIESZKO, S.F., and P.J. GRIFFIN.

*1955. Kidney disease in brook trout and its treatment. The Progressive Fish-Culturist, Vol. 17, No. 1, pp. 3-13, illus.

Detailed description of kidney disease symptoms (there is reason to believe that the granuloma also described is a confounding condition independent of kidney disease). Results of therapy (two sulfonamides on naturally infected trout) (five sulfonamides and three antibiotics on experimentally infected trout) are given. Recommendations for therapy are best available.

WARREN, JAMES W.

*1963. Toxicity tests of erythromycinate in rainbow trout. The Progressive Fish-Culturist, Vol. 25, No. 2, pp. 88-92.

Healthy rainbow trout of different ages were fed erythromycin thiocyanate at different dosage levels. Five times the recommended dosage level evoked diarrhea, convulsions, and other symptoms of toxicity among force fed adult fish. Yearling fish reacted less violently, but some mortality occurred. In elective feeding, rejection of treated food was noted at all levels of administration, but recommended dosage produced no obvious toxicity.

*1963. Kidney disease of salmonid fishes and the analysis of hatchery waters. The Progressive Fish-Culturist, Vol. 25, No. 3, pp. 121-131.

Water analyses were compared with the incidence and severity of kidney disease at 37 National Fish Hatcheries. A highly significant relation was found; kidney disease was most severe at stations having water low in dissolved materials, and either absent or of little concern at hardwater stations. Detailed findings are presented.

WOLF, KEN, and C.E. DUNBAR.

1959. Methods of infecting trout with kidney disease and some effects of temperature on experimental infections. U.S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 286, 8 pp.

Transmission of kidney disease to trout was attempted with two strains of the bacterium; five different methods were employed, but only the mechanical metho were effective. Mortality was greater ar more rapid at low temperature.

*1959. Test of 34 therapeutic agents for control of kidney disease in trout. Transactions of the American Fisher Society, Vol. 88, pp 117-124.

Sixteen strains of the bacterium were tes in vitro for their sensitivity to 34 chemotherapeutic agents. The results aided in selecting 11 agents for in vivo trials. Results and recommendations for therapy are given.

WOOD, JAMES W., and J. WALLIS.

1955. Kidney disease in adult chinook salm and its transmission by feeding to you chinook salmon. Research Briefs, Fis Commission of Oregon, Vol. 6, No. pp. 32-40.

First report of kidney disease among adu spring chinook salmon. Young salmon infected (100%) by feeding infected adult carcasses. Dosage of sulfamethazine 2 gms/100 lbs. fish, effectively blocked infection of fish receiving infected carcasses. Experiment was not replicat and period of observation not stated.

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