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Effect of Corynebacterial kidney disease on ocean survival and return of Atlantic salmon (*Salmo salar*)

by

C. Frantsi
The Huntsman Marine Laboratory
St. Andrews, New Brunswick EOG 2XO

J. A. Ritter
Fisheries and Marine Service
Dept. of Fisheries and the Environment
Halifax, Nova Scotia

and

P. F. Elson
St. Andrews, New Brunswick EOG 2XO

ABSTRACT

Corynebacterial kidney disease (KD) has a significant effect on returns of adult Atlantic salmon to the Margaree River from smolts released from the Margaree hatchery. KD appears to have its greatest effect on smolts entering the salt water and on returning to the river with reduced effects while at sea. Reduced contributions to angling fisheries may be associated with an outbreak of KD with the onset of maturity. The degree of infection of smolts cannot be directly related to returns to angling fisheries, since mildly infected stocks are affected as much as seriously infected stocks.

Résumé

La maladie rénale corynebactérienne (KD) a un effet important sur le retour du saumon adulte de l'Atlantique à la rivière Margaree provenant des tacons libérés à la pisciculture de Margaree. KD semble avoir le plus grand effet sur l'entrée des tacons dans l'eau salée et à leur retour dans la rivière, mais l'effet diminue lorqu'ils sont en mer. Le taux inférieur de poissons exposés à la pêche à la ligne peut

être associé à une occurrence soudaine de KD au premier abord de maturité. La gravité de l'infection des tacons ne doit pas être attribuée directement au retour des poissons adultes exposés à la pêche à la ligne puisque les stocks sont affectés qu'ils soient sérieusement infectés ou non.

INTRODUCTION

This paper outlines the effects of Corynebacterial kidney disease (KD) on Atlantic salmon (*Salmo salar*) smolt survival and adult returns from stocking programs in the Margaree River, Nova Scotia. This study was initiated because smolts released from the Margaree hatchery have yielded low returns consistently for many years.

A brief outline of general knowledge pertaining to KD is given by Wolf, 1966. This disease is caused by a gram-positive diplobacillus probably *Corynebacterium* sp. The disease has been reported in natural waters (Smith 1964, Pippy 1969, MacLean and Yoder 1970, Evelyn et al. 1973 and Frantsi et al. 1975). Pippy 1969 and Frantsi et al. 1975 reported that KD was present in brook trout (*Salvelinus fontinalis*) and Atlantic salmon parr in Ingram Brook, in the waters feeding Margaree hatchery.

Pippy 1969, reported finding KD bacteria in Margaree hatchery parr from 1965, 1966 and 1967 year classes. More recently, Hyatt 1971 reported KD in 2-year smolts. In October, 1971, over 50% of the salmon yearlings at Margaree showed KD lesions; and by February, 1972, close to 90% of these same fish, now pre-smolts, showed gross lesions.

Smith 1964, estimated that two-thirds of a mortality of returning adult Atlantic salmon in the lower reaches of the Aberdeenshire Dee, Scotland, in 1958 was caused by KD. The effect of KD on Atlantic salmon returns is not known although Burrows, 1968, attributed negligible returns of Chinook salmon (*Oncorhynchus tshawytscha*) to another kidney disease caused by the protozoan *Chloromyxium majori*.

Frantsi et al. 1975, showed that the ability of Atlantic salmon smolts to acclimate to and survive in sea water was directly related to the prevalence of gross kidney lesions and thus degree of infection. Mortalities varied from a low of 3% in low KD lesion prevalence groups to a high of in excess of 40% in high KD lesion prevalence groups. All fish that survived acclimation showed a reversal in the progression of kidney disease with no gross lesions evident after one month in full strength (30 ppt) sea water. Also the growth rate of all groups in sea water was not significantly or noticeably different. Despite the apparent loss of the KD after a period in the sea, these studies indicate that a further effect may take place following return of the fish to the river.

The hypothesis formed was that KD causes mortalities on entry of salmon smolts to the sea, has a lesser effect on survivors during the period at sea but markedly reduces the ability of fish to ascend the home river and contribute to angling fisheries.

RESULTS AND DISCUSSION

Tagging data from a 13 year period were assembled for this study. Also, salmon smolts were tagged for a 2 year period specifically for this study. All salmon were tagged with Carlin tags and information was collected from commercial and sport fishermen returning tags for reward.

Table I shows the tagging data for salmon smolt releases for the period 1961 to 1973 inclusive. There are four groups in Table 1: Group 1 - Margaree River stock reared at the Margaree Hatchery - KD infected; Group 2 - Margaree River stock removed as eggs to remote kidney disease free facilities and returned for stocking to the Margaree River - KD free; Group 3 - Foreign stock reared remotely and released as smolts into the Margaree River - KD free; and Group 4 - a group of Restigouche River stock reared under low density semi-natural conditions in gravel raceways at the Margaree hatchery - KD infected but very few fish showing gross lesions.

TABLE I

Group	Stock	Reared	KD	No Smolts Released	Returns Total	%	Sea Returns Total	Distant[a]	Local[b]	Angled
1	Margaree	Margaree	+	77039	75	0.10	72	59	13	3
	Margaree	Remote	-	16491	101	0.61	83	62	21	18
	Foreign	Remote	-	26041	171	0.66	93	59	34	78
4	Restig.	[c] Margaree	+	4183	57	1.36	56	43	13	1

a - Primarily Newfoundland and Greenland fisheries.

b - Fisheries located within roughly 50 miles of the mouth of the Margaree River.

c - Semi-natural rearing - low prevalence of gross KD lesions.

A number of questions were examined as follows and submitted to Chi square testing. The comparisons were made primarily between groups 1 and 2 since they are both Margaree River stock.

A. Does KD effect total returns of Atlantic salmon?

The data indicate that KD significantly affects returns from all fisheries.

B. Does KD have an effect on salmon during entry into salt water?

The total number of smolts released versus distant fisheries catch was compared between groups 1 and 2 as well as 1 and 3. This indicated that KD infected stock returns were significantly below those of KD free returns. In addition, Frantsi et al. 1975, showed that smolts with severe kidney lesions were unable to acclimate to and survive in salt water. They also showed a reversal in the progression of KD lesions in fish surviving acclimation. It is likely, therefore, that the major reason for reduced returns from distant fisheries is that many fish are dying upon reaching the salt water.

C. Does KD effect survival at sea following successful acclimation?

In order to examine this point, we regarded distant and local commercial fisheries as two "windows" on the stock representing a time period. The *ratios* of KD infected stock between distant and local (Group 1, 59 distant: 13 local) did not vary significantly from KD free (Group 2, 62 distant: 21 local). Although the difference is not sifnificant in statistical terms, there may be a greater decrease in the KD infected stock (ratio approx. 4.5:1 compared to 3:1 indicating a possible effect at sea. This may be related to the onset of maturity as detailed later in this paper.

D. Does KD effect ability of salmon to return from the sea to the river and contribute to angling fisheries?

Looking at Groups 1 and 2, the ratio between local commercial fisheries and the river angling fishery indicates a difference significant at the 90% level with the KD infected ratio; 13 local: 3 angled and KD free 21 local: 18 angled. It appears possible, therefore, that KD infected fish do not contribute to the river angling fisheries with the frequency of KD free stocks.

It was thought that the onset of maturity may cause the KD to "break out", thus preventing the fish from surviving to maturity and contributing to the river angling fishery. The stress of re-entry to the river may also contribute to the susceptibility to KD lesion development. The effect of maturity may be occurring earlier at sea, possibly with the effects accelerating as the fish approaches the home river. In support of this, KD has been reported to cause mortalities in returning adult Atlantic (Smith 1964) and Pacific (Wood and Wallis, 1955) salmon in river estuaries. Also, KD mortalities are often closely associated with the onset of maturity in brook trout (*Salvelinus fontinalis*) held in fresh water (Frantsi and others, unpublished observations).

The extremely low returns of KD infected salmon released from the Margaree River over the thirteen year period may reflect only a small part of the kidney disease problem in the river. Group 4, Table 1, was a group of 4183 Restigouche River stock that was reared at the Margaree Hatchery at low densities of 3 fish per square foot of bottom area in gravel race-ways. They were fed at roughly one-half the "chart-rate" of fish in the hatchery proper and derived a portion of their feed from natural material in the water. These were reared under what was regarded as good semi-natural conditions, tagged and released as two-year smolts. Roughly 1% of this group showed gross KD lesions, a much reduced rate from similar groups held in the hatchery. Upon release, tags were returned from a total of 57 fish; 43 from distant fisheries, 13 local and only 1 river angling. It would appear, therefore, that fish that derive from hatcheries with even a low level of infection or exposure to KD cannot be expected to contribute substantially to angling fisheries. The most disturbing aspect of this is that natural stocks in the river exposed to the kidney disease bacteria in the effluent waters of the hatchery may be seriously affected. For many years thousands of fingerlings in excess of hatchery smolt capacity were stocked throughout the Margaree watershed in many small tributaries containing natural salmon parr. These KD infected stocks may have had a very serious effect on natural stocks. Studies by Pippy, 1969 and Frantsi et al. 1975 did not indicate high levels of infected wild stocks in either the main river or its tributaries but both authors did not have the advantage of new and more sensitive methods of detecting KD bacteria by culture or indirect fluorescent microscopy, thus their reports must be re-evaluated.

From our investigations, it would, therefore, appear that the presence of kidney disease, in even minimal numbers of fish in salmon streams, can have a very serious effect on fisheries in general and angling fisheries in particular.

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