

This paper not to be cited without prior reference to the authors

International Council for the
Exploration of the Sea

C.M.1975/M:5
Anadromous and Catadromous
Fish Committee

A comparison of scale analysis and serum electrophoresis as
methods of determining the stock composition of Atlantic
salmon off West Greenland in 1974

by

W. H. Lear and R. H. Payne
Department of the Environment
Fisheries and Marine Service
Newfoundland Biological Station
St. John's, Newfoundland, Canada

INTRODUCTION

The Atlantic salmon fishery off West Greenland exploits salmon originating in most of the salmon-producing areas of North America and Europe and one of the principal problems facing the ICES/ICNAF Joint Working Party on North Atlantic Salmon is estimating the relative contributions from these ampho-Atlantic breeding stocks to the West Greenland fishery: particularly, (1) the proportion of North American and European salmon and (2) the relative contributions from different regions of each continent. It is also important to know if the stock composition changes during the fishing period or from year to year; and if so, what factors determine differential recruitment.

Payne (1973) has developed a method based on serum transferrin electrophoresis to estimate the contribution from each continent, and relative contributions from different regions of North America and Europe. Lear and Sandeman (1974) applied the technique of discriminant function analysis to scale characteristics and identified individual specimens as North American native, North American hatchery and European. Both transferrin phenotype and scale analyses gave essentially the same proportions of North American and European salmon even though the analyses were not based on the same specimens.

In order to test the correspondence of the two methods when applied to the same sample, scales and blood were collected from 511 Atlantic salmon sampled off West Greenland during the 1974 fishing season.

MATERIALS AND METHODS

Blood sera and scales were collected in cooperation with the staff of the Grønlands Fiskeriundersøgelse from the Danish research vessels "Adolf Jensen" and "Tornak". Blood samples were collected as described previously (Payne 1973). The blood and scale material (N = 511) for comparison of the two methods was collected by drift net fishing off Frederickshaab Glacier (Area V) and Godthaab (Area IV) during August (Fig. 1). An additional collection of scales only (N = 316) was made from drift and set net operations at Kiglut Iluat (Area IV) during September and October. The sex of each specimen was recorded.

The proportion of North American and European salmon in the collection was estimated independently from transferrin electrophoresis and scale analysis by the methods described previously (Lear 1972; Lear and Sandeman 1974; Payne 1973).

RESULTS AND DISCUSSION

It is estimated from analysis of scale characteristics that 172 of the 511 specimens collected were of North American origin (33.7% North American). The ratio Tf1/Tf4 to Tf4 transferrin phenotypes for these specimens (Table 1) is 56/11 (=5.0909') so q_{Tf4} in the North American component is estimated as 0.28 (95% confidence interval ± 0.11). At genetic equilibrium, $q_{Tf4} = 0.28$ and Tf1/Tf4 = 56 would occur in a sample of 138 North American fish. As the electrophoretic analysis was performed on 511 blood specimens this corresponds to 27.0% North American salmon (95% confidence interval 23% to 38%; the probability density is distributed assymmetrically about the mean because of a nonlinear transformation). It is clear that within the limits of statistical error both independent methods give the same estimate of continental proportions; approximately 30% North American salmon in 1974.

Five specimens of definite North American origin (transferrin phenotypes Tf1/Tf4) were misclassified on scale characteristics as European (Table 1). If q_{Tf4} is taken as 0.28 it is estimated that a total of 12 North American specimens were misclassified by the scale analysis program. One definite European specimen (transferrin phenotype Tf2) was misclassified as North American. Since Tf2 is much rarer than Tf4 it is impossible to determine from the data available whether the misclassification by scale analysis is symmetrical.

Detailed examination of scale characteristics data indicates that the proportion of North American salmon at West Greenland in 1974 varied from 33.2% in Area V during August 2-7 to 57.8% in Area IV during October 17-31 (Table 2). Also the proportion of North American salmon in Area IV during October 17-31 was significantly higher ($P < 0.05$) than in the same area on August 13. The proportion of hatchery fish in the North American component at Area IV was 29.9% on August 13 but dropped to 9.0% over the period September 6 - October 31 ($P < 0.01$). Consideration of the complete scale collection (N = 834) indicates that for both areas IV and V over the period August 2 - October 31 the mean continental proportions were 36.1% North American native, 6.4% North American hatchery (i.e. 15% of all North American salmon in the sample) and 57.6% European.

It is interesting to observe (Table 1) that the sex ratios of North American and European salmon at West Greenland in 1974 are significantly different ($P < 0.01$): North American salmon, 86% female; European salmon, 74% female. The sex ratio

varies with time and area (Table 3); but the observed numbers of males and females in the four samples agree closely ($0.2 > P > 0.1$) with the expected numbers calculated on the assumption that variation of the sex ratio with time and area is completely determined by variation in continental composition. Therefore, spatial and temporal variation in the sex ratio should not be interpreted as evidence that the sexes segregate independently.

Both electrophoresis and scale analysis give very similar estimates of the proportions of North American and European salmon at West Greenland. However, there are distinct operational and informational differences between the two methods:-
Scale analysis: (1) Assigns each specimen analysed to a continent or origin but at present is unable to assess regional contributions; (2) Insensitive to small sample size once discriminant functions are established; (3) Scales are easily collected and measured without specialized equipment but access to computing facilities is required for data processing.

Electrophoresis: (1) Estimates proportion of fish from each continent in the sample without assigning every specimen to a continent of origin; (2) Sensitive to variations in contribution to the West Greenland aggregate from different regions of North America and Europe; (3) Requires large samples; (4) Field and laboratory operations are fairly complex but computing facilities are not required.

The essential difference between the two methods is that scale analysis assigns individual specimens while electrophoresis can only estimate proportions indirectly, but electrophoresis permits investigation of variation in contribution from different regions of each continent while scale analysis presently does not. In view of these informational differences it is not possible to state that one method is preferable to the other, but rather that both methods provide complementary approaches to understanding the marine distribution of the Atlantic salmon.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of the Grønlands Fiskeriundersøgelse in the collection of material for this investigation; particularly P. Kanneworff, K. P. Nielsen, E. Hansen, and the masters and crews of the "Adolf Jensen" and "Tornak".

REFERENCES

- Lear, W. H. 1972. Scale characteristics of Atlantic salmon from various areas in the North Atlantic. ICES, Salmon and Trout Committee, C.M.1972/M:10, 9 p.
- Lear, W. H. and E. J. Sandeman. 1974. Use of scale characters and a discriminant function for identifying continental origin of Atlantic Salmon. Intern. Comm. Northw. Atlant. Fish. Res. Doc. 74/40, Ser. No. 3226, 12 p.
- Payne, R. H. 1973. The use of serum transferrin polymorphism to determine the stock composition of Atlantic salmon in the West Greenland Fishery. ICES, Anadromous and Catadromous Committee, C.M.1973/M:8, 7 p.

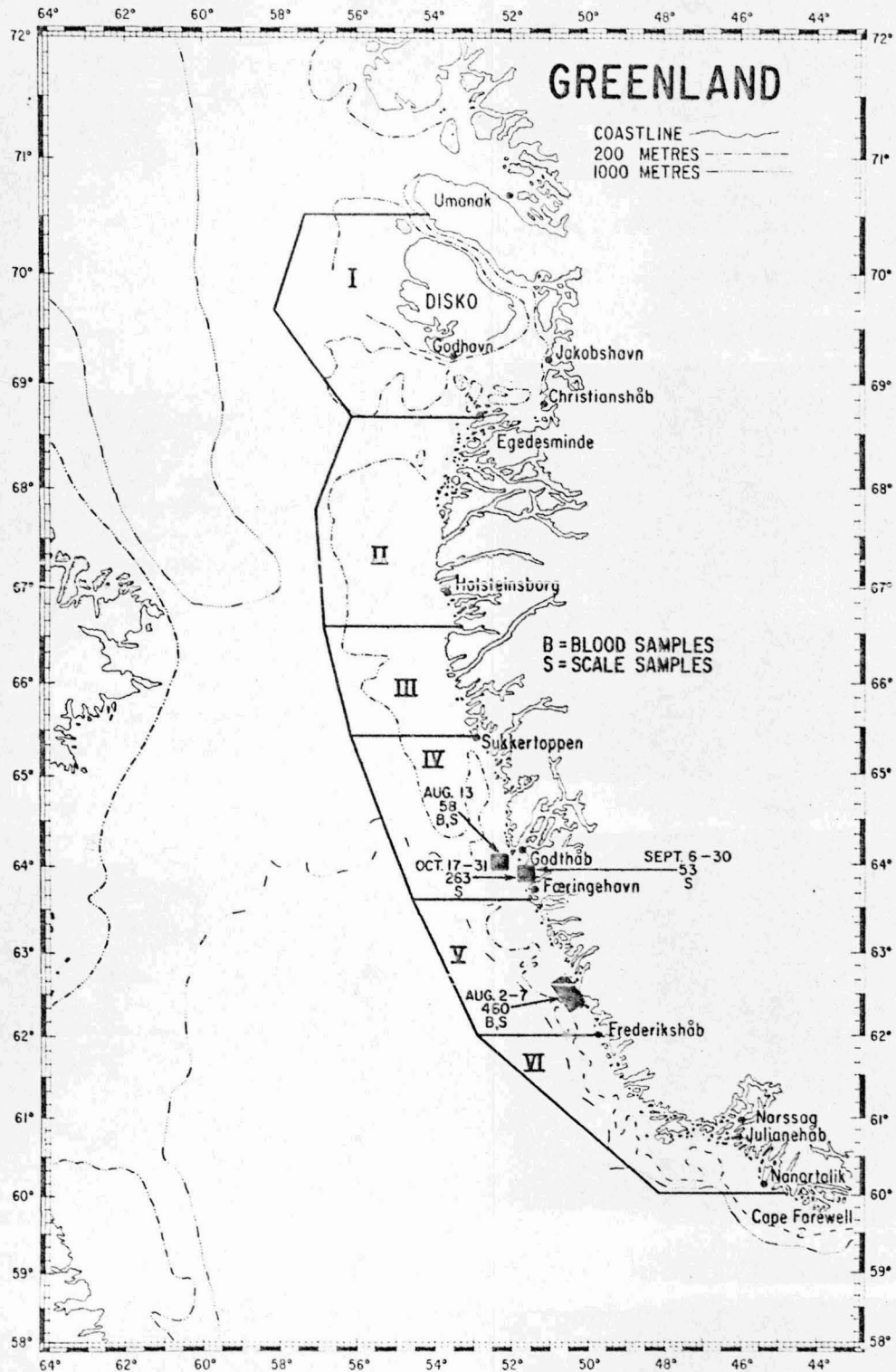


Fig. 1. Area map of West Greenland showing sampling locations, dates, fishing areas and place names mentioned in the text.

Table 1. Transferrin phenotypes of salmon identified as European or North American by discriminant function analysis of scale characteristics.

SCALE TYPE	SEX	TRANSFERRIN PHENOTYPE					ROW TOTALS
		Tf1	Tf1/Tf4	Tf4	Tf1/Tf2	Tf2	
European	M	87	1	0	0	0	88
	F	245	4	0	2	0	251
North American	M	17	7	0	0	0	24
	F	92	44	11	0	1	148
Column Totals		441	56	11	2	1	511

Table 2. Continental proportions of Atlantic salmon at West Greenland during 1974 estimated from scale characters by discriminant function analysis.

Area	Date	Number				Per cent			
		NAN	NAH	E	Total	NAN	NAH	E	Total
V	Aug 2-7	123	30	307	460	26.7	6.5	66.7	99.9
IV	Aug 13	17	7	34	58	29.3	12.1	58.6	100.0
IV	Sept 6-30	24	1	28	53	45.3	1.9	52.8	100.0
IV	Oct 17-31	137	15	111	263	52.1	5.7	42.2	100.0
					834				

NAN = North American native
 NAH = North American hatchery
 E == European

Table 3. Sex ratios by sea age of Atlantic salmon sampled at various areas off West Greenland during 1974. (PS = Previous spawners).

Area	Date	Sea age	% males	% females	Number
V	Aug 2-7	1	22.3	77.7	440
		2	14.3	85.7	7
		PS	0.0	100.0	1
		1, 2, PS	22.1	77.9	448
IV	Aug 13	1	20.8	79.2	53
		2	0.0	100.0	3
		1, 2	19.6	80.4	56
IV	Sept 6-30	1	14.0	86.0	50
		PS	0.0	100.0	1
		1, PS	13.7	86.3	51
IV	Oct 17-31	1	13.8	86.2	253
		2	50.0	50.0	4
		PS	66.7	33.3	3
		1, 2, PS	15.0	85.0	260