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Summary of salmon parasite investigation, 1969

John H. C. Pippy

Fisheries Research Board of Canada

Biological Station, St. John's, Newfoundland

Introduction

Studies on the parasites of Atlantic salmon to determine which parasitic species, if any, might be useful to ascertain the continental origin of salmon caught on the high seas continued in 1969. Earlier results (Pippy, 1969a; 1969b) indicated that some marine parasites may be of value as biological tags. Pippy observed differences in the abundance of the marine nematode larva *Anisakis* in salmon from various areas and suggested that not all Canadian salmon stocks contributed equally to the Greenland salmon fishery. This knowledge, and the identification of the parasite fauna of the stocks which migrated to Greenland, was prerequisite to stock separation in Greenland.

In 1969, emphasis was placed on the geographic distribution and abundance of the following salmon parasites: (1) the larval nematode, *Anisakis* sp., the larval cestodes *Hepatoxylon trichiuri* and *Tentacularia coryphaenae*, and the adult cestode *Eubothrium crassum*. A total of 1426 adult salmon was examined during 1969. The abundance of *H. trichiuri*, *T. coryphaenae* and *E. crassum* was studied using standard observational procedures. *Anisakis* larvae were counted with the use of ultraviolet light (Pippy, 1970). This method greatly increased the efficiency of examination for *Anisakis*.

Results

Identification of Canadian and European salmon in Greenland

Past studies (Pippy, 1968) have indicated there are no morphometric differences in *Anisakis* larvae from the British Isles and Canada. Studies on apparent differences in fluorescence characteristics of Canadian and European *Anisakis* were continued. Specimens from the west coast of Scotland were received from John Smith of Aberdeen and others from the North Sea were received from P. van Banning and M. Kat of Ijmuiden. These specimens exhibited the brightly fluorescent band, previously attributed only to American specimens. None of the *Anisakis* from salmon collected in Greenland in 1969 exhibited the fluorescent band. This was true for those from both American and European salmon in Greenland (identified by Nyman, 1970) in 1969. Evidently, the presence or absence of the fluorescent band is not dependent upon geographic origin of the parasites. Differences may have resulted from different feeding habits of the hosts involved, or differences in preservation techniques. That

Anisakis larvae in salmon from both sides of the Atlantic belong to the same species has since been demonstrated by Nyman and Pippy (1970). Their studies indicate that, not only do salmon from both sides of the Atlantic harbour the same species of larval *Anisakis*, but the *Anisakis* in salmon from both areas probably belong to the same breeding populations. Therefore, it is very unlikely that qualitative differences in *Anisakis* larvae from both areas exist. Hence, this technique cannot be used to determine the continental origin of individual salmon in Greenland.

In 1969, West Greenland salmon, identified (Nyman, 1970) as being either of American or European origin, were studied in West Greenland. The mean number of *Anisakis* in European salmon (7.16) was higher (P = .01) than that in American salmon (4.50). The mean number of *Anisakis* in 28 salmon tagged in Canada and caught in Greenland (4.93) was the same (P = .71) as for those identified by Nyman as being of American origin (Table 1).

Previous ICNAF reports (Templeman, 1967, Pippy, 1968) have suggested that the incidence of the tapeworm *Eubothrium crassum* is higher in American than European salmon in Greenland. Data collected in Greenland in 1968 and 1969 support this hypothesis: (1) in 1968, 10 of 16 salmon (63%) tagged in Canada and caught in Greenland were infested with *E. crassum*, compared with only 89 of 169 (54%) infested fish of a random sample taken at the same time; (2) in 1969, 6 of 28 (21%) tagged Canadian salmon were infested compared with only 33 of 196 (17%) salmon selected at random. Furthermore, in 1969, the incidence of infestation in salmon identified as being of North American origin (24%) by Nyman (1970) was higher (.01 < P < .05) than in those of European origin (13%) (Table 2), but the same (P > .05) as in tagged Canadian salmon in West Greenland.

The incidence of infestation by the tapeworm larvae, *H. trichiuri* and *T. coryphaenae* was too low for consideration of usage in separating North American from European stocks of salmon.

Characterization of Canadian stocks by body cavity parasites

Studies in 1968 indicated that the abundance of *T. coryphaenae* and *H. trichiuri* could be used to distinguish different stocks of Canadian salmon. Too few of these parasites were found in 1969 to support the 1968 findings. Apparently, annual variation in abundance of these worms is very great and comparisons of results from year to year are not feasible.

In 1968 the larger (3-sea-year) salmon from the Miramichi and Chaleur Bay areas had less *Anisakis* than the smaller salmon (2-sea-year). This was contrary to what one might expect if *Anisakis* larvae accumulate with years spent at sea by the salmon. Again, in 1969, the larger salmon in the Miramichi area had less larvae than the smaller ones. However, those from the Port aux Basques and Chaleur Bay areas had a greater abundance. This is evidence for variation in the relative abundance of *Anisakis* larvae in the small and large salmon from different Canadian waters.

Atlantic salmon in Canadian waters may be divided into several parasitologically distinct groups. In 1968 *Anisakis* was less abundant in salmon from the Bay of Fundy than in those from Miramichi and Chaleur bays (Pippy, 1969a). This is also true for the 1969 data (Bay of Fundy = 3.26 per fish, Miramichi and Chaleur Bay 4.59 per fish). In 1969, the mean for salmon sampled in Newfoundland (3.66) was close to that of the Bay of Fundy sample.

Similarities between Canadian stocks and Greenland salmon

Pippy (1968) observed that *Anisakis* larvae were more abundant in some salmon stocks in Canadian waters than in those from West Greenland and concluded that some stocks of Canadian salmon do not migrate to Greenland. This conclusion was based on the assumption that the abundance of the larvae was the same in both Canadian and European salmon in Greenland. In the light of present studies, this assumption is no longer tenable. In 1969 *Anisakis* was found to be more abundant in European salmon than in North American stocks. The same appears to be true for the Greenland salmon in 1968 (all Canadian stocks of comparable size have less *Anisakis* than the mixed European-American sample in Greenland the previous fall (Table 3)). The relatively low abundance of *Anisakis* in salmon in Greenland in 1967 (4.4 per host; Pippy, 1968) and the relatively high abundance in Greenland the following year (5.96 per host, Table 3) suggest an annual variation in the abundance of *Anisakis* in salmon in Greenland. However, the abundance of *Anisakis* in Greenland salmon in 1969 (5.97 per host) was practically identical to that observed in 1968. The apparent discrepancy between the 1967 and later studies may, at least in part, be the result of more efficient methods (Pippy, 1970) employed in the 1969 studies. The use of ultraviolet light to help find *Anisakis* is very efficient with Greenland salmon which contain much obscuring fat in the body cavity. Contrary

to earlier conclusions, which were based on small samples from few localities, the data collected in 1969 suggest that there may not be any appreciable increase in abundance of *Anisakis* larvae during the time of migration from Greenland to home waters.

Despite the possibility that the abundance of *Anisakis* in salmon in Greenland may be constant from year to year, salmon collected in Canadian waters in 1968 (Pippy, 1969a) had many more *Anisakis* than did those collected in 1969 (Table 3). This variation, when considered with the apparently constant abundance of *Anisakis* in salmon in Greenland, could mean that either: (1) the overall abundance of *Anisakis* in Atlantic salmon in the North Atlantic is constant from year to year or (2) the proportion of Greenland salmon represented by Canadian stocks varies from year to year. More comparable information similar to that obtained in 1969 is necessary before the apparent variation in abundance of *Anisakis* can be explained.

The abundance of *Anisakis* in salmon from the Bay of Fundy and Newfoundland in 1969 (3.26 and 3.66 per fish, respectively) is considerably lower than the 1968 mean for salmon in Greenland (5.96). However, the 1969 mean for salmon caught in the Miramichi and Chaleur Bay areas (4.59) is closer to the 1968 Greenland mean. Perhaps the Miramichi and Chaleur Bay salmon are representative of Canadian salmon in Greenland, a suggestion already made by Pippy (1969a, b). It is not yet known if the similarity of the 1969 mean for the Miramichi and Chaleur Bay salmon to the 1969 mean for North American fish in Greenland (4.57) is relevant to the 1968-69 data presented in Table 3. Annual variations may exist which preclude such a comparison. If further studies show an almost insignificant increase in abundance of *Anisakis* in salmon during the period of the migration from Greenland to home waters, the identification of salmon stocks which are represented in the Greenland fishery may be much simpler and more accurate than the data examined by Pippy (1969b) suggested.

Summary

1. Studies in 1969 were confined to documentation of abundance of the larval nematode *Anisakis* sp., the larval cestodes *Hepatoxylon trichiuri* and *Tentacularia coryphaenae* and the adult cestode *Eubothrium crassum*.

2. Fluorescence characteristics of *Anisakis* larvae cannot be used to identify continental origin of salmon in Greenland. No qualitative differences in the *Anisakis* larvae of European and North American salmon have been found. Very likely these larvae belong to the same species and same breeding population.

3. The intensity of infestation of *Anisakis* in European salmon (7.16 per host) in Greenland was higher than in North American fish (4.61) from the same area during 1969.

4. The incidence of *E. crassum* was higher in Canadian salmon (23%) than in European salmon (13%) in Greenland in 1969. A similar trend was observed in samples from 1968.

5. There is considerable variation in the abundance of *Anisakis* in different Canadian stocks of salmon. High intensity of infestation by *Anisakis* may be indicative of migration to Greenland. Low intensity may indicate resident Canadian populations.

6. *H. trichiuri* and *T. coryphaenae* were not abundant enough in the samples studied to show differences in abundance in salmon from different areas. Also, there is evidence for significant annual variation in their abundance in salmon populations.

7. In 1969, additional evidence was found to support the suggestion that not all Canadian stocks are equally represented in Greenland.

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Table 1. Incidence and intensity of infestation of *Anisakis* sp. in the body cavity of Atlantic salmon of known continental origin in West Greenland, 1969.

Sample	No. hosts examined	Per cent infested	Mean per host	Standard deviation
General West Greenland sample	196	98	5.97	6.76
"European" salmon (according to Nyman, 1970)	112	95	7.16	7.40
"North American" salmon (according to Nyman, 1970)	84	83	4.50	4.45
Canadian tagged salmon	28	93	4.93	3.93

Table 2. Incidence and intensity of infestation of *E. crassum*, *T. coryphaenae* and *H. trichiuri* in salmon examined in 1969.

Sample	Salmon size*	No. hosts examined	*E. crassum*	*T. coryphaenae*		*H. trichiuri*	
			Per cent infested	Per cent infested	Mean per host	Per cent infested	Mean per host
West Greenland (1968)	S	165	54	0	0	4	.04
Pack's Harbour	S	13	85	0	0	23	.31
St. Anthony	S	50	66	0	0	2	.02
Bonavista	S	125	78	1	.01	0	0
St. John's	S	106	73	1	.01	2	.02
Port aux Basques	S	77	75	1	.03	1	.01
	L	9	78	0	0	0	0
Miramichi area	S	99	53	1	.01	7	.07
	L	8	75	0	0	12	.12
Chaleur Bay	S	78	51	3	.03	1	.01
	L	80	51	1	.01	3	.03
East Shore, Bay of Fundy	S	114	70	3	.04	1	.01
Saint John area	S	72	92	1	.03	0	0
General West Greenland (1969)	S	196	17	0	0	4	.04
"European" salmon (Nyman, 1970)	S	112	13	0	0	4	.04
"North American" salmon (Nyman, 1970)	S	86	24	0	0	3	.03
Canadian tagged salmon in Greenland	S	28	21	0	0	4	.04

* S = less than 15 lb, L = 15 lb or over (ages not yet determined).

Table 3. Incidence and intensity of infestation of *Anisakis* sp. in the body cavity of Atlantic salmon from various areas of the North Atlantic, 1968-69.

Area sampled	Salmon size*	Date	No. hosts examined	Per cent infested	Mean per host	Standard deviation
West Greenland	S	Sept. 1968	165	93	5.96	4.67
Pack's Harbour, Labrador	S	8 July 1969	13	85	5.00	5.15
St. Anthony, Nfld.	S	25-27 June 1969	50	90	3.36	2.60
Bonavista, Nfld.	S	12-14 June 1969	125	86	3.04	2.76
St. John's, Nfld.	S	8-14 June 1969	106	90	4.88	4.50
Port aux Basques, Nfld.	S	2 May-10 June 1969	77	84	3.18	3.33
	L	2 May-10 June 1969	9	100	4.88	3.59
Miramichi area, N.B.	S	25-27 June 1969	99	90	4.40	4.15
	L	27 June 1969	8	100	3.75	-
Chaleur Bay	S	23 June 1969	78	96	4.83	3.85
	L	24 June 1969	80	99	7.75	9.82
East Shore, Bay of Fundy	S	5-10 July 1969	114	73	2.75	3.45
Saint John area, Bay of Fundy	S	2-3 July 1969	72	83	4.06	4.91

* S = less than 15 lb, L = 15 lb or over (ages not yet determined).