

Northwest Atlantic



Fisheries Organization

Serial No. N1513

NAFO SCR Doc. 88/70

SCIENTIFIC COUNCIL MEETING - JUNE 1988

Comparison of Cod Samples from St. Pierre Bank, Burgeo Bank and Rose Blanche Bank from
Analysis of Meristic Characters, Average Length at Age, and Prevalence of Parasitic Nematodes

by

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Introduction

The cod stocks in NAFO Div. 3Pn4Rs and Subdivision 3Ps are reported to undergo intermingling particularly in the general area of Burgeo Bank during winter (Templeman 1978). The degree of intermingling is variable depending on the extent of migration of 3Pn4Rs cod from the Gulf of St. Lawrence. Data relative to meristic characteristics, growth and prevalence of nematodes were examined to provide further information on the extent of interrelationships of the stocks. Figure 1 shows the banks where samples were collected for various comparisons from NAFO Subdiv. 3Ps and 3Pn.

1. Meristic characters

a) Methods and Materials

Stratified-random samples of Atlantic cod (5 per 3 cm group) were collected during February-March 1987 and January-February 1988 from each of the following areas (Fig. 1):

- 1) Rose Blanche Bank - NAFO Div. 3Pn - strata 302-305 (Fig. 2)
- 2) Burgeo Bank - NAFO Div. 3Ps - strata 306-309
- 3) Northern St. Pierre Bank - NAFO Div. 3Ps - strata 310-314

The cod were examined for various biological parameters. The fillets were removed from the cod and were examined for parasites. The carcasses were then x-rayed and the meristic characters were determined from radiographs. The meristic characters obtained from the cod were as follows:

- 1) Number of rays in first dorsal fin
- 2) Number of rays in second dorsal fin
- 3) Number of rays in third dorsal fin
- 4) Number of rays in first anal fin
- 5) Number of rays in second anal fin
- 6) Number of vertebrae

The vertebral counts include the urostylor half-vertebra as a vertebra. Specimens with fused vertebrae were not included in the calculation of the averages.

b) Results

Analyses of variance performed on the samples from each of the three areas in 1987 indicated that there were no significant differences among the three areas for averages of each of the following characters:

- 1) Number of rays in first dorsal fin ($p = 0.16$)
- 2) Number of rays in second dorsal fin ($p = 0.75$)
- 3) Number of rays in third dorsal fin ($p = 0.61$)
- 4) Number of rays in first anal fin ($p = 0.57$)

There was a significant difference ($p < .01$) among the samples for the average number of rays in the second anal fin. Multiple range tests indicated that Burgeo Bank was significantly different ($p < .05$) from cod of Rose Blanche Bank and St. Pierre Bank on the basis of this meristic character. Fin rays of cod from Burgeo Bank were, on average, higher than those of the other two areas (Table 1). Vertebral averages were also significantly different ($p = .002$) among the three areas. Multiple range tests indicated that the cod of Burgeo Bank possessed significantly higher ($p < .05$) vertebral averages than those of the other two areas.

Averages of both meristic characters (rays of second anal fin and vertebrae) indicated a similar conclusion that the cod on Burgeo Bank during 1987 had higher averages for those meristic characters than those of neighbouring Rose Blanche and St. Pierre banks. Although it has been shown from results of tagging experiments that some cod of the 3Pn4Rs stock migrate to Burgeo Bank during the winter, the effect of this intermingling was not enough to mask the differences among meristic characters which are apparently characteristic of these separate groups. Similarly there were differences in the meristic characters of cod which persisted despite the intermingling of cod of Burgeo Bank and St. Pierre Bank.

Results of analyses of variance performed on the samples from each of the three areas in 1988 indicated that there were no significant differences among the three areas for averages of the size meristic characters examined (Table 2). The use of meristic characters are not helpful in distinguishing the discreteness of cod populations from the three areas during 1988, if such discreteness exists during the winter.

2) Prevalence of nematodes

a) Methods and materials

Cod samples analyzed for meristics were also examined for parasite burdens. Fish were examined using the methodology as described by Templeman et al (1957). Only skinned fillets and napes (belly flaps) were examined on a candling table with the musculature of all but the smallest fish being sliced into thin strips to reveal nematodes deeply embedded in the flesh.

b) Results

For both years the prevalence of nematodes in fillets and napes tended to increase with age in all three areas.

In 1987 the infestation rates (Table 3) were lowest in the St. Pierre Bank samples (31.3%), higher in Burgeo Bank (50.4%), and highest on Rose Blanche Bank (68.0%). In 1988 rates (Table 4) were again lowest for St. Pierre Bank (22.6%) but were similar for Burgeo (66.2%) and Rose Blanche (65.2%) banks. The decreased rate on St. Pierre Bank from 1987 to 1988 may have been caused by an increased proportion of younger fish in the sample for 1988 as well as a decreased infestation rate in the napes. The pattern of infestation by age was also similar for both years but especially so in the napes. Samples from Rose Blanche Bank showed a similar infestation pattern for the 2 years for fillets, napes, and by fish age.

An increase in infestation rate on Burgeo Bank was evident for both fillets and napes and for all age groups. The absence of nematodes in fillets of cod aged 3-6 years observed in 1987 was also evident in 1988 but only at ages 3 and 4. The pattern for ages 3-6 was similar in fillets for St. Pierre and Burgeo banks but were higher in the napes from the Burgeo Bank area.

3) Average length at age

Age and growth data from research vessel surveys conducted in 1986-88 were examined for differences in average length-at-age (Table 5) between Burgeo and St. Pierre banks and additionally between those and Rose Blanche Bank (1987-88 only). Age samples used in the comparison were collected in addition to those obtained from specimens used in the meristic and parasite study. The sample for St. Pierre Bank included those collected from the 3Ps survey area other than strata on Burgeo Bank.

The average length of cod from Rose Blanche Bank samples were lower at each age for ages older than three than those from the other areas. Average length-at-age for samples from St. Pierre Bank were highest with the exception of ages 3 and 4. There was a decline in length at age for some ages for Burgeo Bank samples from 1986-87 to 1988.

Discussion

Analysis of specimens for meristic characters suggested some differences between sampled areas based on the 1987 samples but these differences were not apparent from similar samples in 1988. A comparison of nematode burdens from the three areas indicated differences between areas in 1987 with the highest infestation rates occurring on Rose Blanche Bank and the lowest in St. Pierre Bank with younger fish being least infested in all three areas. The increase infestation rate in Burgeo Bank in 1988 may have resulted from the presence of higher proportion of cod from the 4RS3Pn stock which have higher infestation rates. This is also supported by the observed decline in average length-at-age of cod from Burgeo Bank in 1988, which could have been the result of the presence of a higher proportion of slower growing cod from 4RS3Pn.

Because cod are known to migrate from the Gulf of St. Lawrence area in early winter the timing of specimen collections could be important when comparing the three areas. The 1988 survey was conducted earlier (January 27-February 14) than that in 1987 (February 13-March 22) and 1986 (March 6-23).

The comparisons discussed suggest that there are differences in cod from the three areas and that the variation observed between years may have resulted from timing of collections or from the degree to which the bordering stocks intermingled in a particular year. The extent of the stock intermingling cannot be defined with present data and there is some evidence that there could be yearly variation.

References

- Templeman, W., H. J. Squires, and A. M. Fleming. 1957. Nematodes in fillets of cod and other fishes in Newfoundland and neighbouring areas. *J. Fish. Res. Bd. Canada*. 14: 831-897.
- Templeman, W. 1978. Migration and intermingling of stocks of Atlantic cod off the Newfoundland and adjacent areas from tagging in 1962-66. *ICNAF Res. Bull.* 14: 550.

Table 1. Meristic characters of Atlantic cod from Rose Blanche Bank, Burgeo Bank and St. Pierre Bank. (N = number in sample; \bar{X} = average; S.D. = standard deviation).

Character	Rose Blanche Bank			Burgeo Bank			St. Pierre Bank		
	N	\bar{X}	S.D.	N	\bar{X}	S.D.	N	\bar{X}	S.D.
First Dorsal fin	122	14.328	0.847	114	14.482	0.895	104	14.538	0.835
Second Dorsal fin	123	19.797	1.330	110	19.927	1.500	103	19.806	1.462
Third Dorsal fin	123	19.748	0.972	113	19.885	1.245	102	19.824	0.948
First anal fin	121	22.570	1.460	113	22.726	1.384	104	22.750	1.335
Second anal fin	122	19.492	1.159	110	19.936	1.206	102	19.628	1.052
Vertebrae	118	53.873	0.948	108	54.185	1.024	95	53.716	0.953

Table 2. Meristic characters of Atlantic cod from Rose Blanche Bank, Burgeo Bank, and St. Pierre Bank, sampled during January-February, 1988.

Character	Rose Blanche Bank			Burgeo Bank			St. Pierre Bank		
	N	\bar{X}	S.D.	N	\bar{X}	S.D.	N	\bar{X}	S.D.
First Dorsal fin	141	14.610	0.8261	142	14.542	0.9648	89	14.596	0.7495
Second Dorsal fin	141	19.979	1.4216	142	19.866	1.5123	88	19.841	1.4691
Third Dorsal fin	141	19.872	1.1139	141	19.688	1.0632	89	20.000	1.0553
First anal fin	140	22.936	1.3635	141	22.830	1.5351	86	22.570	1.4836
Second anal fin	141	19.709	1.0250	140	19.779	1.0933	86	19.919	1.2292
Vertebrae	132	54.212	0.9166	136	53.949	0.8548	83	54.060	0.9416

Table 3. Prevalence (%) of nematodes in the fillets and napes of cod from St. Pierre Bank, Burgeo Bank, and Rose Blanche Bank from research surveys in 1987.

Age	St. Pierre Bank				Burgeo Bank				Rose Blanche Bank			
	N	Fillet	Nape	Total	N	Fillet	Nape	Total	N	Fillet	Nape	Total
3	11	27.3	0	27.3	7	0	0	0	6	0	16.7	16.7
4	16	0	6.2	6.2	10	0	10.0	10.0	11	27.3	9.1	36.4
5	16	6.2	0	6.2	18	0	16.7	16.7	13	7.7	7.7	15.4
6	16	6.2	0	6.2	8	0	25.0	25.0	10	20.0	60.0	70.0
7	12	16.7	41.7	50.0	17	17.6	35.3	41.2	17	17.6	64.7	70.6
8	4	0	25.0	25.0	13	30.8	46.2	61.5	10	30.0	50.0	60.0
9	15	0	60.0	60.0	12	58.3	66.7	83.3	10	30.0	70.0	80.0
10	6	33.3	33.3	33.3	15	53.3	60.0	80.0	19	63.2	89.5	94.7
11	3	0	0	0	8	62.5	87.5	100.0	9	33.3	88.9	88.9
12	5	40.0	100.0	100.0	5	60.0	80.0	80.0	7	71.4	71.4	85.7
13	7	28.6	42.9	42.9	1	100.0	100.0	100.0	3	66.7	100.0	100.0
14	2	50.0	100.0	100.0	1	0	100.0	100.0				
15									3	66.7	100.0	100.0
16					1	0	100.0	100.0	4	75.0	100.0	100.0
17					1	0	100.0	100.0				
18	1	100.0	100.0	100.0								
19	1	100.0	100.0	100.0								
Total	115	13.9	26.1	31.3	117	26.5	42.7	50.4	122	35.2	59.8	68.0

Table 4. Prevalence (%) of Nematodes in the Fillets and Napes of cod from St. Pierre Bank, Burgeo Bank, and Rose Blanche Bank from research surveys in 1988.

Age	St. Pierre Bank				Burgeo Bank				Rose Blanche Bank			
	N	Fillet	Nape	Total	N	Fillet	Nape	Total	N	Fillet	Nape	Total
2	14	0	0	0								
3	19	5.3	0	5.3	1	0	0	0	8	12.5	0	12.5
4	14	14.3	7.1	21.4	8	0	25.0	25.0	15	26.7	6.7	26.7
5	11	9.1	0	9.1	11	9.1	18.2	27.3	7	14.3	14.3	28.6
6	12	0	25.0	25.0	10	20.0	20.0	40.0	19	25.0	31.6	36.8
7	11	36.4	36.4	54.5	19	15.8	26.3	36.8	8	10.5	50.0	50.0
8	6	33.3	16.7	33.3	17	35.3	52.9	70.6	16	37.5	68.0	75.0
9					11	0	54.6	54.6	5	60.0	100.0	100.0
10	3	33.3	66.7	66.7	10	30.0	80.0	90.0	5	60.0	100.0	100.0
11	1	100.0	100.0	100.0	13	30.8	84.6	84.6	26	38.5	76.9	76.9
12					15	53.3	93.3	93.3	8	50.0	100.0	100.0
13					8	87.5	100.0	100.0	12	66.7	100.0	100.0
14	1	100.0	0	100.0	6	50.0	83.3	83.3	4	50.0	100.0	100.0
15					5	100.0	100.0	100.0	3	66.7	100.0	100.0
16					6	50.0	100.0	100.0	2	100.0	100.0	100.0
17					1	100.0	100.0	100.0	2	100.0	100.0	100.0
18					1	100.0	100.0	100.0	1	100.0	100.0	100.0
19												
20	1	0	100.0	100.0								
Total	93	14.0	14.0	22.6	142	33.1	59.9	66.2	141	37.6	60.3	65.2

Table 5. Average length at age of cod from research vessel surveys in NAFO Subdiv. 3Ps and 3Pn.

Age	3Pn		3Ps					
	Rose Blanche Bank		Burgeo Bank			St. Pierre Bank		
	1987	1988	1986	1987	1988	1986	1987	1988
1					7.00	10.00	10.50	10.00
2			18.14	19.00	19.00	18.88	19.81	19.85
3			27.50	31.39	30.06	26.73	29.43	28.72
4	29.01	29.44	40.57	40.61	40.51	39.90	39.76	40.27
5	35.30	36.33	48.88	49.33	46.30	48.96	48.17	47.94
6	43.45	41.49	54.52	53.18	55.54	56.71	54.15	57.10
7	48.98	49.99	61.05	58.52	60.56	64.16	62.24	63.48
8	55.55	55.85	67.88	64.74	60.57	76.21	68.73	69.63
9	56.67	57.94	70.27	75.33	71.05	82.90	79.58	75.97
10	57.18	64.72	79.72	87.64	73.81	84.43	84.56	85.13
11	72.84	74.60	84.79	79.73	77.03	94.60	82.01	79.81
12	76.55	66.25	96.45	86.00	94.59	90.73	91.61	87.05
13	64.47	65.73	96.73	112.00	105.58	97.96	96.33	96.85
14	117.00	80.38	122.80	82.00	108.01	103.83	99.78	90.41
15		102.35						
16	113.00	81.15	112.33		116.80	115.00	101.76	106.63
17	121.00	94.43			105.54	123.18	119.48	114.93
18		115.00	133.00	139.00	124.00	121.00	124.56	109.00
19	124.00	109.00			130.00		125.06	
20						127.00	118.67	121.00
							128.50	136.00
No. Aged	174	141	328	264	255	585	633	545
No. Meas.	2337	3604	795	1027	989	1830	4267	3863

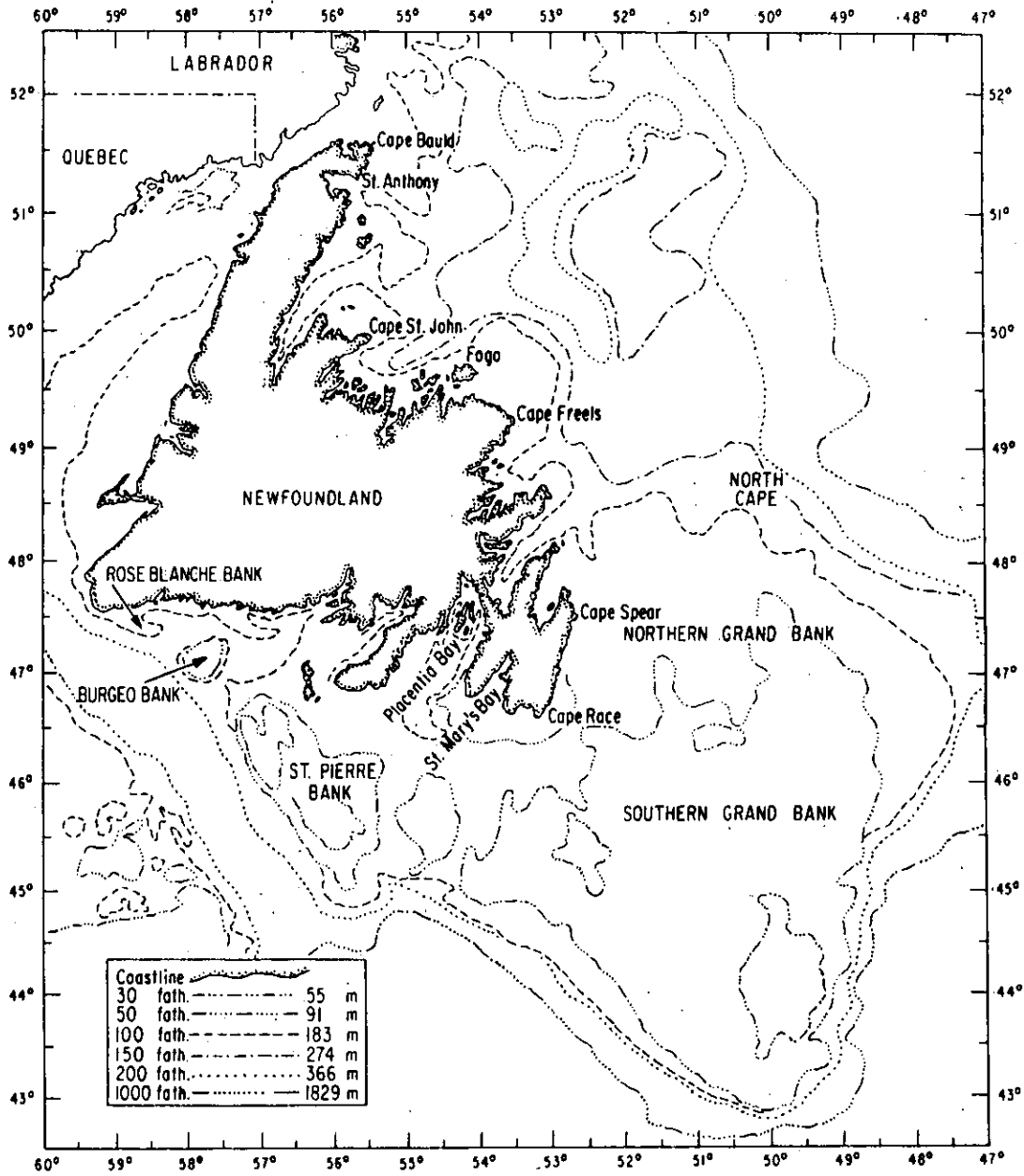


Fig. 1. Map showing the three banks where samples were collected from NAFO Subdiv. 3Ps and 3Pn.

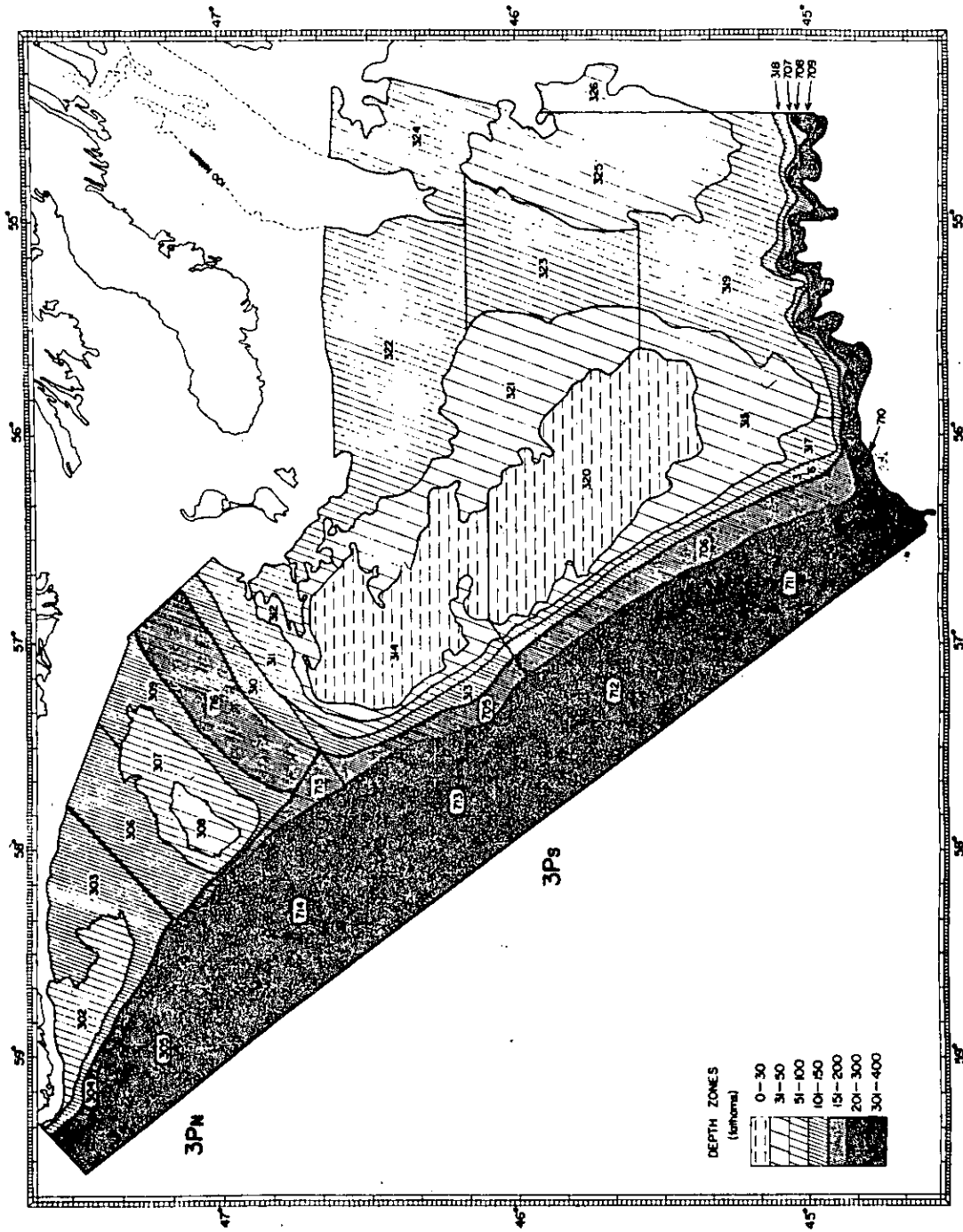


Fig. 2. Stratification scheme used for random-stratified research vessel surveys in Subdivision 3Ps.