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Biological characteristics of cod (*Gadus morhua* L.) caught in the  
Southern Labrador and Newfoundland fishing grounds in the winter of 1963

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Introduction

Data on the characteristics of cod, present on the fishing grounds off Southern Labrador and Newfoundland were collected on board of a factory ship (2670 BRT, engine 2400 HP). The catches were made with bottom trawl. The samples were taken in the period from 19 January to 19 March, 1963.

The catches were made on the following four fishing grounds (Fig. 1): Sundall (Division 2J); Ritu Bank (Division 3K); north-eastern slopes of Great Newfoundland Bank (Division 3L); and over the south-western slopes of Flemish Cap (Division 3M). The material, with respect to the yield and fishing periods, is presented separately for the eastern and western parts of Great Bank.

Materials and method

Catches from each of the four fishing grounds were sampled for biological information. Table 1 shows the location, date and numbers of cod collected for length measurements and for detailed analysis for age, sex, maturity and feeding. Age was determined from the cross section of the otolith. Age composition was calculated from an age/length key. The amount and kind of feeding was determined from the examination of stomach contents. Sexual maturity was determined by the eight stages of Maier's (1906) scale. Data were also collected on the yield of cod in relation to other species and depths and time of day fished.

Table 1. Cod investigated. 1963

Fishing ground	Date	Number measured	Number analysed
Sundall 2J	13-17 Feb.	3,026	328
Ritu Bank 3K	2-15 Feb. 18-26 Feb.	5,387	562
NE Slope of Great Newfoundland Bank 3L	20 Jan. -1 Feb. 27 Feb. 2-5 Mar.	2,151	308
Flemish Cap 3M	6-19 March	3,163	424

Yield of the fishery

The appearance of cod varied for different fishing grounds. The amount of cod in relation to other fish species in the areas fished varied from 12.5% in the eastern part of north-east slopes of Great Newfoundland Bank to 80.0% on Flemish Cap. The particulars regarding cod catches is given in Table 2. Data given in

Table 2 show that, on all fishing grounds except the north-east slopes of Great Bank, cod made up the major part of the catches.

Table 2. Cod. Composition and yields in the areas fished.

Fishing ground	Cod in the catches %	Cod yield (kg/h)	Fishing depth (m)		
			from	to	average
Sundall 2J	74.5	5,411	306	420	373
Ritu Bank 3K	50.5	1,326	255	450	325
NE Slope of Great Newfoundland Bank 3L	East part	212	264	480	354
	West part	241	238	385	281
Flemish Cap 3M	80.0	3,356	276	500	409

The lowest average yield of cod per hour fishing was 212 kg in the eastern part, and 241 kg in the western part of the north-east slopes of Great Bank. On the other fishing grounds the yield was considerably higher and the highest average yield was on Sundall Bank, 5.411 kg per hour.

Cod yields during the period of our observations were more uniform on the eastern part of the north-east slopes of Great Bank and Ritu Bank than on the fishing grounds of Sundall and Flemish Cap. Cod on the latter two grounds moved often from place to place as evidenced by changes in the yield.

On particular fishing grounds the yield of cod was observed to vary depending on the time of day or night that fishing was carried out (Table 3).

Table 3. Percentage of cod in all catches and the yield of cod (kg/h) in successive hours of a day

Fishing ground		Time of fishing			
		10 p.m. - 4 a.m.	4 a.m. - 10 a.m.	10 a.m. - 4 p.m.	4 p.m. - 10 p.m.
Sundall 2J	%	99.0	100.0	39.0	98.1
	kg/h	9,217	5,454	1,775	6,446
Ritu Bank 3K	%	68.0	54.8	40.0	57.5
	kg/h	1,255	1,254	1,335	1,197
NE Slope of Great Newfoundland Bank 3L	East part	%	11.1	13.2	8.0
	part	kg/h	191	335	115
	West part	%	27.0	38.8	30.6
	part	kg/h	177	364	297
Flemish Cap 3M	%	79.2	84.3		82.6
	kg/h	2,930	3,049	3,501	3,002

Highest yields of cod were obtained during the night hours on the Sundall fishing ground. With increasing daylight, yields decreased and the lowest were obtained during daytime (i. e. from 10 a. m. to 4 p. m.). On the other fishing grounds, however, yields increased slightly during the daytime (i. e. from 10 a. m. to 4 p. m.).

The percentage of cod in the catches did not change greatly during twenty-four hours on the same fishing grounds except on the Sundall fishing ground where the percentage ranged from 39.0% to 98-100%.

The depth at which fishing was carried out had an influence on the yield and percentage of cod in the catches. On Ritu Bank and on the eastern part of the north-east slopes of Great Bank and Flemish Cap the percentage of cod in the catches decreased while the number of redfish increased with the depth at which fishing was carried out. On Flemish Cap, cod appeared to be present in quantity even at 500 m, while on other fishing grounds, they were not present in quantity deeper than 350-400 m.

#### Length composition

Length composition of cod taken from the various fishing grounds is shown in Fig. 2.

Fish taken on Sundall and Ritu Bank was similar in length and were mainly from 42 to 62 cm in length. However, on Sundall 44.4% of the cod were 48 to 53 cm in length with an average length of 53.6 cm and, on Ritu Bank, 48.1% were 45 to 53 cm in length, with an average length of 51.7 cm.

Cod captured on Flemish Cap were larger, ranging from 48 to 65 cm in length with 32.4% of the individuals from 51 to 56 cm and an average length of 56.9 cm.

The length of cod from the eastern part of north-eastern slopes of Great Bank was considerably different to the length of cod from other fishing grounds. The fish were much smaller, ranging mainly from 30 to 50 cm in length with 29.9% from 39 to 44 cm.

On Flemish Cap smaller cod were observed in shallower waters. This was observed previously by E. M. Mankevich and V. S. Prokhorov (1962).

#### Age composition

Age composition of cod taken on the various fishing grounds is given in Fig. 2.

On Sundall the most important year-classes were the 1957 (6 year olds), 1956 (7 year olds) and 1958 (5 year olds), in that order. They made up 74.6% of the fish in the catches. The 1957 year-class (6 year olds) was the most abundant (36.6%).

On Ritu Bank the 6, 5 and 7 year old cod (year-classes 1957, 1958 and 1956) were dominant and made up 76.7% of the catches.

On the eastern part of north-eastern slopes of Great Bank, 66.9% of the fish caught were 4 and 5 year olds belonging to the year-classes 1959 and 1958. A considerable percentage (19.4%) were 2 and 3 year old fish (year-classes 1961 and 1960).

Catches from Flemish Cap were 61.1% 5 and 6 year olds (year-classes 1958 and 1957). A considerable proportion were 7, 8 and 9 year olds (year-classes 1956, 1955 and 1954) whereas cod 4 years old were very scarce (1.4%). No fish

2 and 3 years old were taken.

Rate of growth

The rate of growth of cod has been given on the basis of average length measurements in particular years of life (Table 4). The highest rate of growth was found for cod from the Flemish Cap fishing ground, the least for cod from the eastern part of the north-eastern slopes of Great Bank.

Table 4. Rate of growth of cod from fishing grounds, 1963.

Fishing ground	Years										
	2	3	4	5	6	7	8	9	10	11	12
Sundall 2J			46.9	50.7	52.1	55.3	60.5	60.9	66.7	69.5	70.6
Ritu Bank 3K		34.5	44.0	48.8	51.8	56.8	60.6	62.8	73.5		
NE Slope of Great Newfoundland Bank East part	31.4	36.8	41.5	47.2	51.9	63.5	75.5				
Flemish Cap 3M			47.7	50.7	55.9	60.6	64.4	64.3	65.0	67.7	

Sexual maturity

The state of sexual maturity of cod varied on different fishing grounds (Table 5).

Table 5. Sexual maturity of cod according to Maier's scale

Fishing ground	Sex	% of fish in particular stages of sexual maturity							Total %
		I-II	III	IV	V	VI	VII	VIII	
Sundall 2J	♂	5.8	2.4	6.4	19.5	8.5	-	-	42.6
	♀	24.6	1.2	31.6	-	-	-	-	57.4
	♂♀	30.4	3.6	38.0	19.5	8.5	-	-	100.0
Ritu Bank 3K	♂	19.8	3.0	5.3	12.3	5.7	0.7	-	46.8
	♀	39.7	-	13.3	-	0.2	-	-	53.2
	♂♀	59.5	3.0	18.6	12.3	5.9	0.7	-	100.0
NE slope of Great Newfoundland Bank East part 3L	♂	36.7	1.0	3.2	1.9	-	0.3	-	43.1
	♀	52.4	1.9	2.6	-	-	-	-	56.9
	♂♀	89.1	2.9	5.8	1.9	-	0.3	-	100.0
Flemish Cap 3M	♂	1.1	3.7	0.6	6.4	51.3	6.6	1.5	71.2
	♀	4.3	-	3.7	12.2	5.6	1.3	1.7	28.8
	♂♀	5.4	3.7	4.3	18.6	56.9	7.9	3.2	100.0

On Sundall fishing ground (in February) cod in the I-II (30.4%), IV (38.4%) and V (19.6%) stages of maturity were predominant. Of the 8.5% fish in the running stage (VI), all were male.

On Ritu Bank (in February) cod gonads were mostly in I-II stages of maturity (59.5%). There were only 6.6% in the running stage (VI and VII).

In the eastern part of the north-eastern slopes of Great Bank (in January) 89.1% of the cod had gonads in the I-II stages of maturity. Only 0.3% of the fish had gonads in VI and VII stages of maturity.

On Flemish Cap (in March) 64.8% of cod had gonads in VI and VII stages of maturity. These were mostly males. Since the males predominated on the spawning grounds, it may be assumed that it was the beginning of spawning season there.

The slight development of gonads of cod on all fishing grounds except Flemish Cap indicates a later spawning. According to V. I. Travin and L. N. Pechenik (1962) the spawning of cod in Divisions 2J, 3K and 3L takes place in May and June.

Feeding

Investigations on the feeding of cod show that a high percentage of fish had empty stomachs (Table 6).

Table 6. Feeding of cod on the four fishing grounds

Fishing ground	Sex	% of fish with various amounts of stomach contents					Total
		empty	trace	small amount	large amount	full	
Sundall 2J	♂	73.6	20.7	4.3	1.4	-	100.0
	♀	57.1	30.7	10.6	1.6	-	100.0
	♂♀	64.2	26.4	7.9	1.5	-	100.0
Ritu Bank 3K	♂	47.9	32.7	16.0	3.4	-	100.0
	♀	43.5	34.8	19.4	2.0	0.3	100.0
	♂♀	45.5	33.8	17.8	2.7	0.2	100.0
NE slope of Great New- foundland Bank East 3L part	♂	70.1	15.7	11.2	3.0	-	100.0
	♀	64.4	14.7	14.7	4.5	1.7	100.0
	♂♀	66.8	15.2	13.1	3.9	1.0	100.0
Flemish Cap 3M	♂	81.1	4.2	6.3	4.2	4.2	100.0
	♀	72.1	1.9	6.5	7.8	11.7	100.0
	♂♀	78.4	3.6	6.4	5.2	6.4	100.0

Particularly large numbers of cod with empty stomachs were found on the Flemish Cap fishing ground (78.4%). On the other hand, there were greater numbers of individuals with large amounts of stomach contents and full stomachs (5.2%) than on the other fishing grounds. However, the food of 90% of feeding cod consisted of offal discarded from the eviscerating and filleting process. Such items must be considered occasional food. Only 10% of fish from Flemish Cap had invertebrates in their stomach contents.

The numbers of fish with empty stomachs was similar on Sundall (64.2%) and on the eastern part of the north-eastern slopes of Great Bank (66.8%). The fewest empty stomachs were found on Ritu Bank (45.5%). Except for Flemish Cap, there were few fish with large amounts of food in their stomachs. Cod with full stomachs were scarce or absent.

On Sundall, Ritu Bank and eastern part of the north-eastern slopes of Great Bank, cod fed mainly on invertebrates (Crustacea, Echinodermata, Molluscs, Coelenterata).

An average of 20% of cod stomachs contained fish, often capelin.

In general more males than females were found with empty stomachs or with traces of food in them. Of the fish with food in the stomachs females had more. The greater number of non-eating males then may have been due to more advanced gonads development.

### Conclusions

Very good yields of cod were obtained in Sundall and Flemish Cap in the winter of 1963. Gonads of cod from these fishing grounds were in a more advanced stage of development. Cod of the Sundall fishing grounds are in prespawning shoals at the same time as the cod of Flemish Cap are in spawning concentrations.

No important changes were noted in 1963 in the length of cod in Divisions 2J and 3K from 1962 (J. Messtorff 1963, A. Figueras 1963), whereas in 1963 in Division 3L there was a decrease, and in Division 3M an increase in the length of cod.

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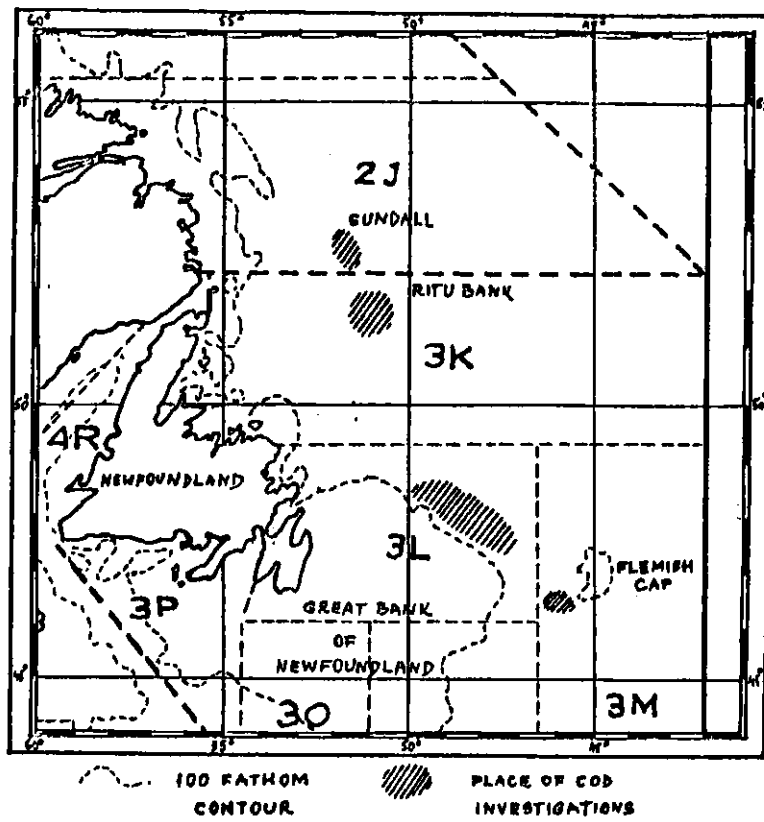


Fig. 1. Areas of cod investigations during the winter of 1963.

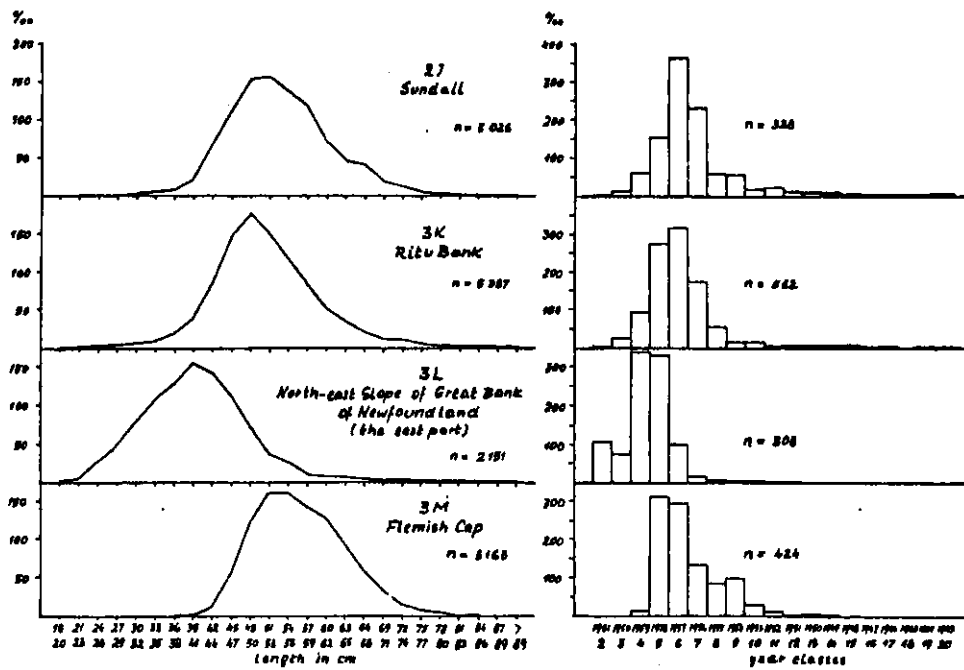


Fig. 2. Age and length composition of cod.