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Variability in the Number of Vertebrae in Haddock
from the Newfoundland Area

by

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Basing on data of tagging, age-composition and rate of growth of haddock from the New England, Nova Scotia and Newfoundland areas Needler (1930) came to the conclusion on the existing of great local groups of haddock in each of these areas. Then further investigations (Vladykov, 1935; Schroeder, 1942; Schuck and Arnold, 1951; Martin, 1953; Clark and Vladykov, 1960; McCracken, 1963, 1965 et al) confirmed and made more precise this division and degree of mixing of haddock from the New England and Nova Scotia.

Having examined 1230 haddock caught in 1934-1936 on the Saint Pierre Bank, Clark and Vladykov (1960) pointed out that the Newfoundland group of haddock was characterized with a small number of vertebrae (50-56, average -52.90^x). According to Marr's terminology (1957) they have described the mentioned populations as "stock". As data on haddock from the Grand Bank were not available they stated that the problem of the existence of local groups of haddock in the Newfoundland area was not decided finally.

Thompson (1939) pointed that there was a limited area on the Grand Bank where haddock with an average number of vertebrae 52.5 - 52.9 form a separate stock. Basing on the difference in the rate of growth and abundance of year-classes Templeman (1953) divided the Grand Bank haddock and haddock from the Saint Pierre

x/ Clark and Vladykov (1960), Thompson (1939) did not take into account the last vertebra with a displaced center and urostyle plate.

Bank as well into two separate stocks of haddock which had no considerable differences in the number of vertebrae. Simultaneously a very small stock of haddock with a distinctly different structure of otoliths was found out on the Flemish Cap Bank. As on the Grand Bank very big haddock which growth rate was typical of the Saint Pierre Bank haddock was caught in small numbers they concluded that in the south of the Green Bank an insignificant mixing of these stocks took place. According to several samples of vertebrae in haddock caught off the south-western coast of Newfoundland they found out a small local population of haddock differing from haddock on the Grand and Saint Pierre Banks by a smaller number of vertebrae.

Further studying of the structure of otoliths, rate of growth and abundance of year-classes (Beverton and Hodder, 1962; Hodder, 1966) proved the belonging of the Grand Bank haddock and haddock from the Saint Pierre Bank to different stocks. It was noted that haddock from these banks can mix being at a stage of egg, larvae and young fish but in all seasons this process is greatly limited by low temperature of water in deeps separating these banks. However Hodder (1966) reported that in 1949 a great amount of larvae drifted with the current from the Grand Bank to the Saint Pierre Bank.

To make clear an up-to-date structure of the population of the population of the Newfoundland haddock we have analysed the variability in the number of vertebrae.

Material and Methods

The first sample of vertebrae of the Newfoundland haddock available was taken by K.P. Yanulov (PINRO) in 1961 (Appendix I). Since 1964 they have started a regular sample gathering. The author of this paper made the analysis of fish caught directly on board research vessels of PINRO and we also, as K.P. Yanulov did, took into account the last vertebra with an urostyle plate. All the material was combined according to areas: 1/the Flemish Cap

Bank /3M/, 2/north-eastern /3L/, 3/ south-eastern /3N/ and 4/south-western /3O/ slopes of the Grand Bank, 5/ the Green Bank /3P/, 6/ south-western /3P/ and 7/ north-western /3P/ slopes of the Saint Pierre Bank (Fig.I). Total amount of 2467 specimens (Appendix I) were examined. Data collected were mathematically treated according to the method by Snedecor (1957).

Results of Investigations

In our samples the number of vertebrae in haddock varied between 50 and 57, the average number of vertebrae \bar{x} being 53.57-54.60. The value of \bar{x} obtained for haddock from area 30 (53.82) almost completely coincides with that obtained by K.P. Yanulov (53.78) and for the areas of the Saint Pierre Bank (53.86 and 53.88) - with the average number of vertebrae reported by Clark and Vladykov (1960) - 52.90. In the Grand Bank haddock \bar{x} in our samples fluctuates almost in the same limits as it was reported by Thompson (1939). Data on the number of vertebrae in haddock from various areas are presented in Table I.

Insignificant values of standard error of the sample $S\bar{x}$ indicate that a sufficient quantity of haddock was examined in each area, with the exception of the area 3L. Insignificant magnitudes and fluctuations of standard deviations S and variation coefficients C between areas indicate a slight variability in the number of vertebrae in haddock from the Newfoundland area. The greatest variation coefficient was obtained for haddock from the Green Bank where occurs mixing of stocks.

According to the average number of vertebrae reliable but insignificant differences t (Table 2) were found between haddock from the Flemish Cap Banks and other areas and also between haddock from the area 3N and from the Saint Pierre Bank.

More essential differences were found between \bar{x} in different samples from one area (Appendix I), especially in the area 30 (t to 5.4). To find out the reasons of these differences they analysed the difference between the number of vertebrae in haddock belonging to the 1960-1968 year-classes (Table 3).

According to \bar{x} the 1968 year-class of haddock in the area 30 greatly differed from the 1961, 1962, 1964 and 1966 year-classes ($t = 5.9 - 4.9 - 5.0 - 3.9$). Actual differences according to \bar{x} were also obtained between the 1966 year-class and 1962, 1964 year-classes ($t=2.5 - 2.1$) and between the 1962 year-class and 1964, 1965 year-classes ($t = 3.2 - 2.0$) of haddock on the Green Bank. On the south-western slope of the Saint Pierre Bank the 1962 year-class differs from those of 1964, 1966, 1967 ($t=4.1 - 2.8 - 2.3$) and the 1964 year-class from that of 1966 ($t=2.2$).

Thus the greatest differences in the average number of vertebrae between year-classes were obtained for the area 30, as well as the greatest differences in the average number of the vertebrae in various samples. Apparently the prevalence of this or that year-class in the sample and condition significant fluctuations in the average number of vertebrae in samples of haddock from area. Obviously the number of vertebrae as a criterion of belonging of fish to this or that population should be considered with the allowance for variation of this character according to year-classes. It was proved that in one area fluctuation of average number of vertebrae between year-classes are due to the variations in temperature of water near the surface in the spawning period in various years (Clark and Vladykov, 1960).

Thus, the differences in the average number of vertebrae in haddock belonging to various year-classes in one area are more considerable than those in the average number of vertebrae of haddock in the areas mentioned. It make impossible to divide haddock from the Newfoundland area into stocks according to the number of vertebrae.

Conclusions

1. Number of vertebrae in haddock from the Newfoundland area fluctuates between 50 and 57 insignificantly varying between areas. Average number of vertebrae in separate samples fluctuates from 53.57 to 54.60, as to the differences between areas reliable but insignificant differences in the average number of vertebrae

were found between haddock from the Flemish Cap Bank and other areas as well as between haddock from the south-western slope of the Grand Bank (3N) and the Saint Pierre Bank.

2. Considerable differences were found in the average number of vertebrae in various samples of haddock from one area, especially on the south-western slope of the Grand Bank (30).

3. Still greater differences in the average number of vertebrae are observed in haddock from one area between year-classes. It is the prevalence of this or that year-class in the sample that condition significant fluctuations of the average number of vertebrae in samples taken in one area.

4. In haddock belonging to various year-classes in one area the differences in the average number of vertebrae are much greater than in haddock from various areas. Due to this fact it is impossible to divide haddock from the Newfoundland area into stocks according to the number of vertebrae with a reasonable reliability.

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Table 1. Number of vertebrae in haddock from the Newfoundland area

Conventional number of areas	area	number of vertebrae from - to	$\bar{x} \pm S\bar{x}$	S	C	n
1	Flemish Cap Bank /3M/	52 - 56	54,04 \pm 0,09	0,83	1,54	83
2	north-eastern slope of the Grand Bank /3L/	52 - 56	53,70 \pm 0,14	0,92	1,71	47
3	south-eastern slope of the Grand Bank /3N/	52 - 56	53,72 \pm 0,06	0,75	1,40	188
4	south-western slope of the Grand Bank /3O/	51 - 57	53,82 \pm 0,03	0,88	1,66	714
5	Green Bank /3P/	50 - 57	53,83 \pm 0,05	0,94	1,75	330
6	south-western slope of the Saint Pierre Bank /3P/	50-56	53,89 \pm 0,04	0,85	1,60	546
7	north-western slope of the Saint Pierre Bank /3P/	51 - 56	53,86 \pm 0,03	0,79	1,50	559

Table 2

Mean error of the difference in the average number of vertebrae in haddock from the Newfoundland area /t/

Conventional number of areas	2	3	4	5	6	7
1	2,0	2,9	2,2	1,9	1,5	2,1
2	-	0,1	0,9	0,9	1,3	1,1
3	-	-	1,4	1,4	2,4	2,0
4	-	-	-	0,2	1,4	1,0
5	-	-	-	-	0,9	0,5
6	-	-	-	-	-	0,6

Table 3

Average number of vertebrae in haddock of the 1960-1968 year-classes in the Newfoundland area according to the data of analyses made in 1961,

1964 - 1969

Year-class	south-eastern slope of the Grand Bank /3N/		south-western slope of the Grand Bank /3O/		Green Bank /3P/		south-western slope of the Saint Pierre Bank /3P/		north-western slope of the Saint Pierre Bank /3P/		Total	
	n	\bar{x}	n	\bar{x}	n	\bar{x}	n	\bar{x}	n	\bar{x}		
I960	5	53,74	13	53,69	3	54,00	8	53,75	8	54,37	37	53,95
I961	33	53,57	80	53,71	11	53,18	32	53,88	26	53,81	182	53,70
I962	105	53,77	292	53,72	44	54,25	70	53,89	32	54,22	543	53,82
I963	9	53,89	26	53,85	20	53,70	77	53,87	16	53,81	148	53,84
I964	26	53,73	38	53,66	153	53,79	132	53,76	113	53,66	462	53,73
I965	1	54,00	10	54,10	32	53,69	5	53,00	17	53,65	65	53,69
I966			95	54,02	61	53,95	162	54,10	215	53,81	533	53,95
I967			8	53,75	2	54,50	27	53,63	71	53,85	108	53,80
I968			31	54,65	3	54,00	4	55,75	3	54,67	41	54,71
Total	179	53,74	593	53,81	329	53,85	517	53,91	501	53,82	2119	53,84

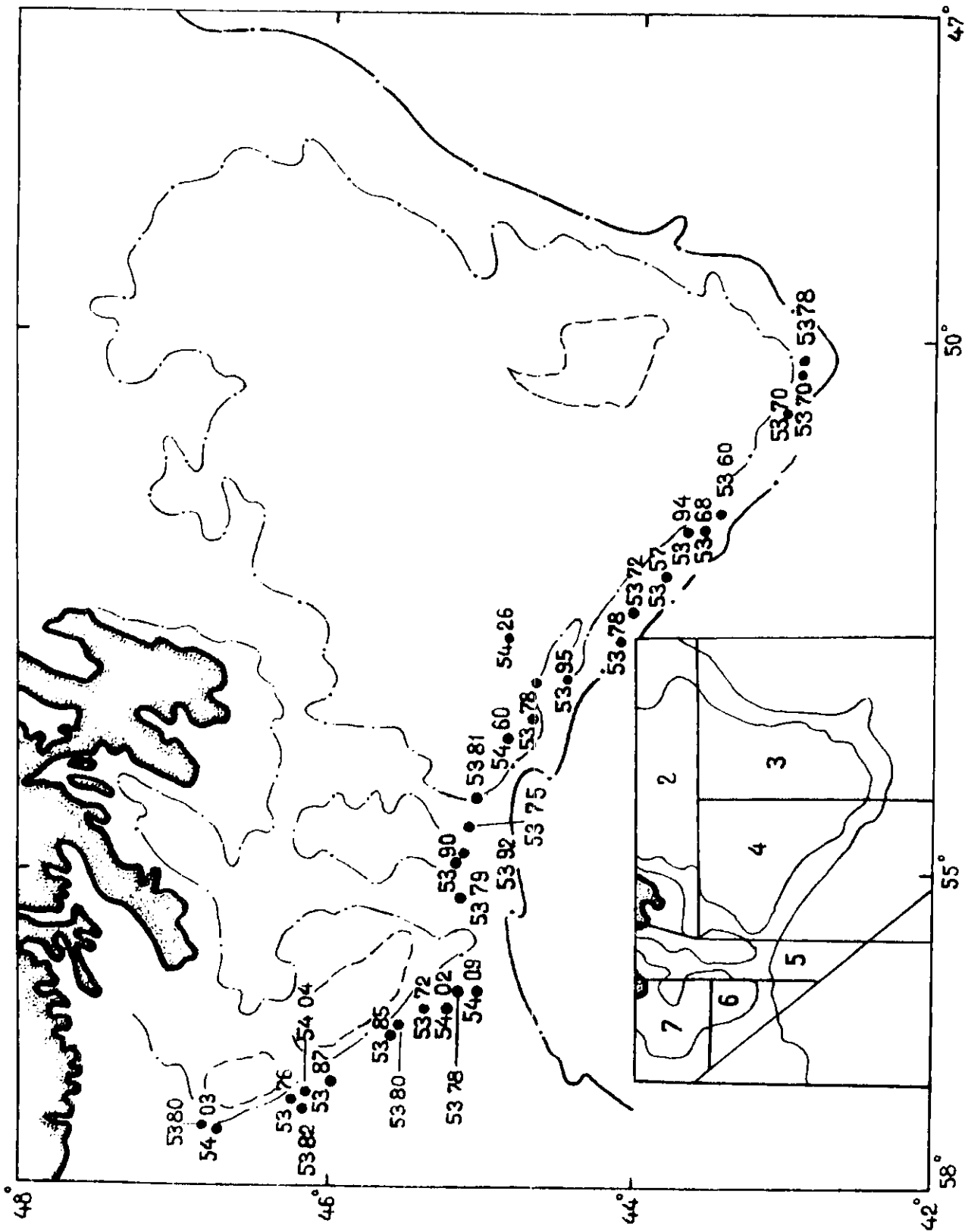


Fig. 1. Average number of vertebrae in haddock from the Newfoundland area according to results of analyses made in 1961, 1964-1969.

Description of numbered areas on insert map:

2. Northeast slope of Grand Bank (Div.3L);
3. Southeast slope of Grand Bank (Div.3N);
4. Southwest slope of Grand Bank (Div.3O);
5. Green Bank (Div.3P);
6. Southwest slope of Saint Pierre Bank (Div.3P);
7. Northwest slope of Saint Pierre Bank (Div.3P).

Area and date	number of fish with total amount of vertebrae							total number of fish	average number of vertebrae
	50	51	52	53	54	55	56		
3M, Flemish Cap Bank									
April 1967		1	5	8	2	1	1	17	53,82
April 1968		1	4	10	5	1	1	21	54,05
April 1969			9	23	12	1		45	54,11
total by the area		2	18	41	19	3		83	54,04
Grand Bank									
3L, north-eastern slope		2	22	12	10	1		47	53,70
3N, south-eastern slope									
February 1966		1	14	30	5			50	53,78
April 1967		4	9	18	6			37	53,70
April 1967		5	32	53	10	1		101	53,70
total by the area		10	55	101	21	1		188	53,72
3O south-western slope									
May 1961 ^{x/}									
December 1964			39	36	17	4		100	53,78
October 1965			38	40	15		1	100	53,68
February 1966	1	2	21	19	7			50	53,57
February 1966		2	21	15	10	2		50	53,78
May 1966	1	2	20	20	7			50	53,60
April 1967		1	30	53	14	1		100	53,81
May 1967			9	16	7			32	53,94
May 1968	1	3	26	29	13	1		73	53,72
May 1969		2	31	43	19	4	1	100	53,95
May 1969			4	17	13			34	54,26
May 1969			1	10	12	2		25	54,60
total by the area	4	22	240	298	134	14	2	714	53,82

x/ The analysis was made by Yanulov K.P.

Area and date	number of fish with total amount of vertebrae					total number of fish	average number of vertebrae			
	50	51	52	53	54			55	56	57
3P Green Bank										
1967	I		11	24	45	14	4	I	100	53,75
April 1967			4	30	51	13	2		100	53,79
April 1968		2	2	26	44	22	3		99	53,92
May 1969		I	I	4	19	6			31	53,90
June 1969										
total by the area	I	3	18	84	159	55	9	I	330	53,82
3P. Saint Pierre Bank										
a/ south-western slope	I		3	14	20	9	2		50	53,72
October 1965			2	32	51	14	I		100	53,80
October 1966		I	I	32	51	11	2		98	53,78
May 1967			4	30	45	15	4		98	53,85
April 1967			5	19	53	21	2		100	54,02
April 1968			4	15	54	22	5		100	54,09
June 1969										
total by the area	I	2	19	142	274	92	16		546	53,88
b/ north-western slope										
May 1966			2	24	44	28	2		100	54,04
April 1967			5	30	50	14	I		100	53,76
June 1968			5	31	51	13			100	53,72
June 1968			6	24	52	18			100	53,80
June 1969			4	24	57	16			101	53,87
June 1969		I	I	9	32	14	I		58	54,03
total by the area	I	I	23	142	286	103	4		559	53,86