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Spanish Research Report, 1961.
B. Age and Growth of Cod caught by Spanish Fishing Vessels in the Northwest Atlantic Ocean in 1961.

by A. Figueras,
Inst. Fish. Inv., Vigo, Spain.

I. Material and Methods [1)]

The paper presents a summary of the results of investigations on the cod (Gadus morhua) in the ICNAF Convention Area in 1961. The summary includes growth and corresponding mean lengths by age-groups; relative abundance of year-classes by divisions of area; age at first spawning; and proportion of sexes.

The otoliths were collected on board the trawlers "Aquilon" and "Vendaval" of the company PYSBE by the observer D. Tomás García Leston in March-June and August-September, 1961 (Fig. 1). The otoliths of each individual were kept separately in envelopes with the following data: Date of capture, position, size, sex, stomach contents. The methods of reading are the same as employed in previous papers: cutting by hand of the otoliths and observation in binocular microscope with low magnification, without preceding clearing, by means of lateral light concentrated in a narrow strong band. It was observed that the gains in clearness by a strong light limited to the lateral surface leaving the upper surface of the section of the cut otolith non-lighted. A polishing of the surface diminishes its clearness; and this procedure has therefore been dropped.

The months with the most extensive sampling are (Table 1 attached): August-247 spec., September- 156 spec., April -124 spec., May - 122 spec., and October - 107 spec. Almost all samples from September, October and May are from Division 2 J, which is the best represented division. The divisions with the largest numbers of individuals sampled are: 2J-361, 3L-259, 3K-89 and 3Ps-46 (Fig. 1). The total number of individuals in the samples are 848, of which number 776 or 91.4% provided satisfactory age readings. The number of one-cm size groups are 59 between 28 and 130 cm (Fig.2).

II. Size Distribution.

The total length distribution is more close to the length distribution in August-November ("Aquilon") than to that of March-June ("Vendaval"), due to the fact that the second period includes 540 individuals, the first only 315, but perhaps also to the fact that the second period includes fish from areas very close to one another. However, both curves present very distinct peaks, corresponding to similar peaks in the age distribution curves; thus the peak at 38 cm corresponds to age 2; 47.5 cm to 3; 50-55 cm to 4; 55-60 to 5; 60-65 cm to 6 and so on (Fig. 2). As the entirety of the samples comprises cod from different divisions, and as the growth rate varies from division to division (Figs. 3 and 4), these peaks represent average sizes corresponding to an average age for each group of the total sampling. On an average for all ~~samples the most abundant~~ size group is that of 57 cm and followed by that of 59 cm.

1) Tables giving the detailed data will be published in the 1961 Sampling Yearbook.

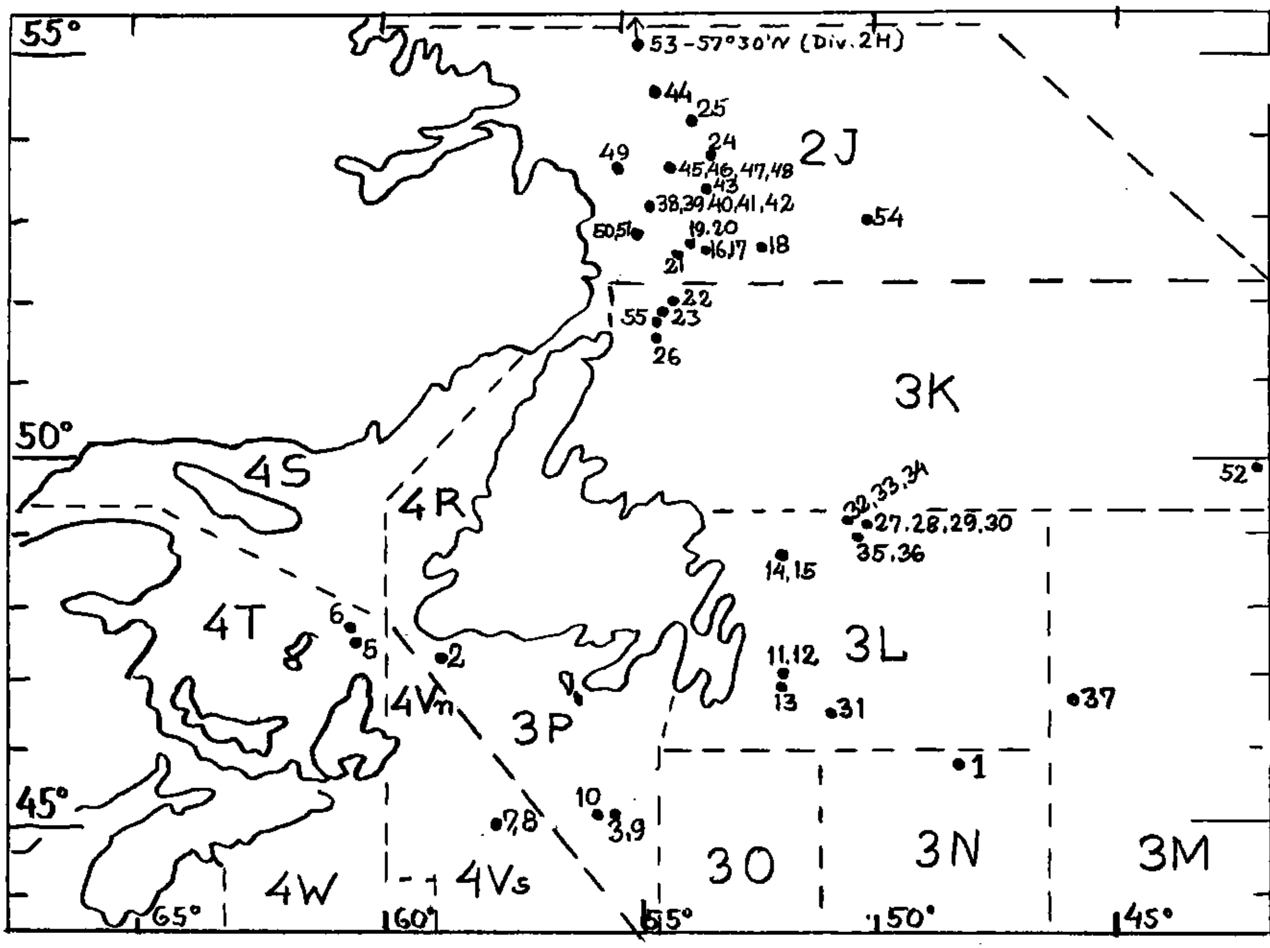

Fig. 1. Locations of samples from the fishery in 1961.

III. Growth

The numbers of individuals investigated from 2 H, 3N and 3M is rather low. When these divisions, therefore, are not considered, the samples show (Fig. 3) a general increase of growth rate from 4T (the lowest) to 3 Ps (the highest); in between and arranged from lower to higher are 2J, 4 Vs, 3K, and 3L. The growth curve coming closest the theoretical one is that of 2J which includes the highest number of specimens (see Table 2 attached). The most aberrant data based only on a low number of specimens are not considered.

A comparison with previous years can be made for Divisions 2J and 4 V (Fig. 4). For 2J the mean sizes for each of the age-groups are practically the same in 1960 and 1961. The difference in size does not exceed one centimeter. Thus the rate of growth in 2J does not vary through the period considered.

Almost the same holds good for Division 4V, apart from some of the age-groups only represented by few individuals. For age groups III, V and VI the mean lengths are so close that the conformity in growth rate for the two years can be considered as established. For both years the growth in 4V is stronger than in 2J.

IV. Age Distribution.

The age distribution is presented in Figure 5, for Divisions 4 Vs, 3 Ps, 3M, 3 L, 3 K, and 2 J; the corresponding length distributions are shown in Figure 6. When 2 H, 3 N and 4 T with only few individuals examined are not considered it appears that the highest average age (6.94) is found for 3 K; 2 J (6.67) follows closely, for 1960 a mean age of 7.3 was observed in 2 J, 3 L and 3 P s are close to one another with 5.55 and 5.54, respectively; in 1960 the mean age in 3 L was 5.7. Next come 4 Vs (4.47) and 3 M (4.48).

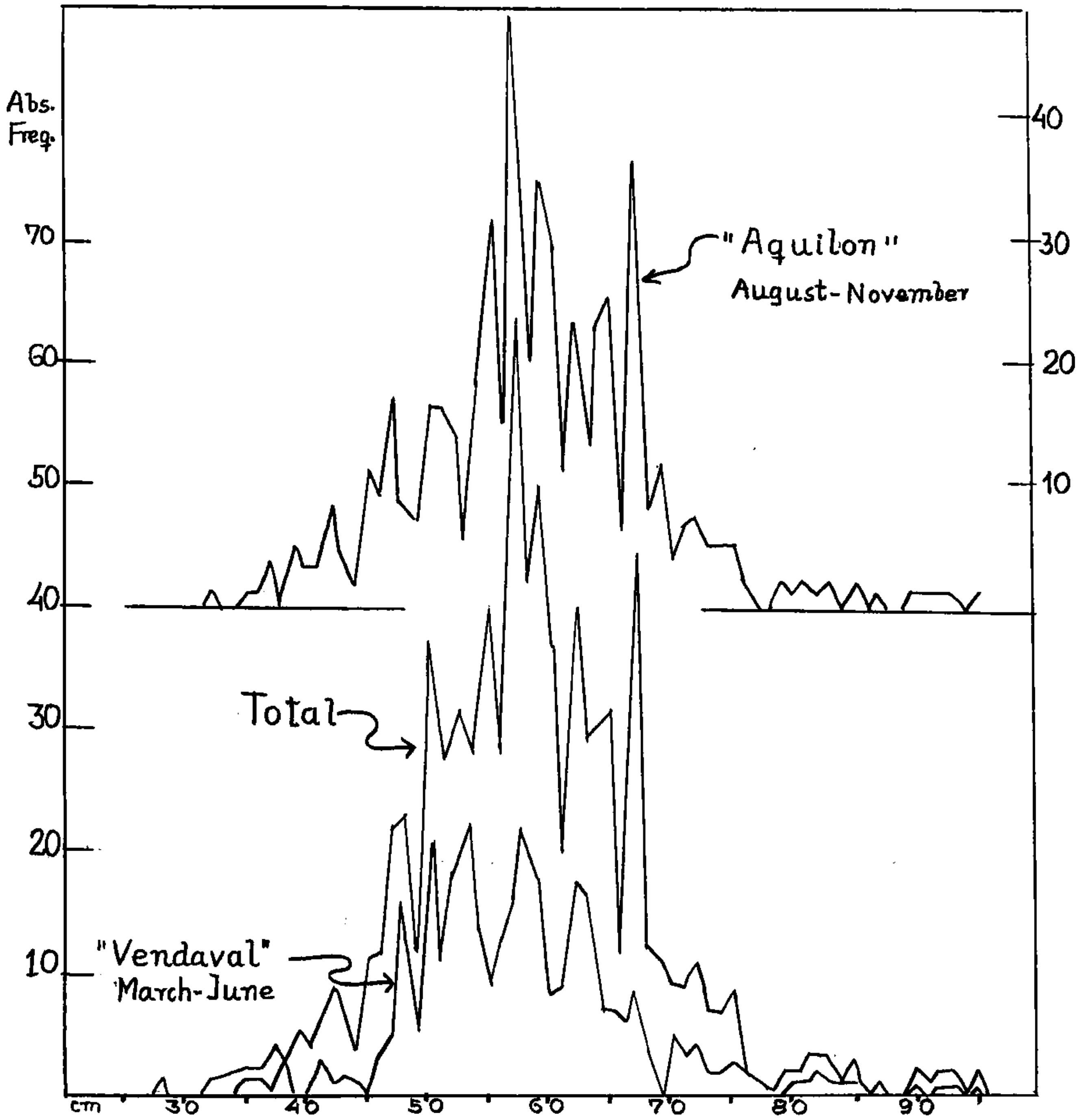

Fig. 2. Curves of absolute length frequencies by 1 cm-classes. The scale to the right applies to samples from "Aquilon" in Aug.-Nov., the scale to the left to samples from "Vendaval" in March-June and to the total of the samples.

These data are not completely comparable, as the larger number of individuals in some samples may cause the inclusion of some very small or very large specimens which could have a disturbing influence on the estimated averages. If the chances of appearance of the very young and the very old were the same the influence on the average would not be appreciable. However, it has been observed that among the young specimens of the sample, the larger ones are too strongly represented due to discard of the smaller ones. For this reason the comparison of average ages in the various divisions must be considered with some reservation.

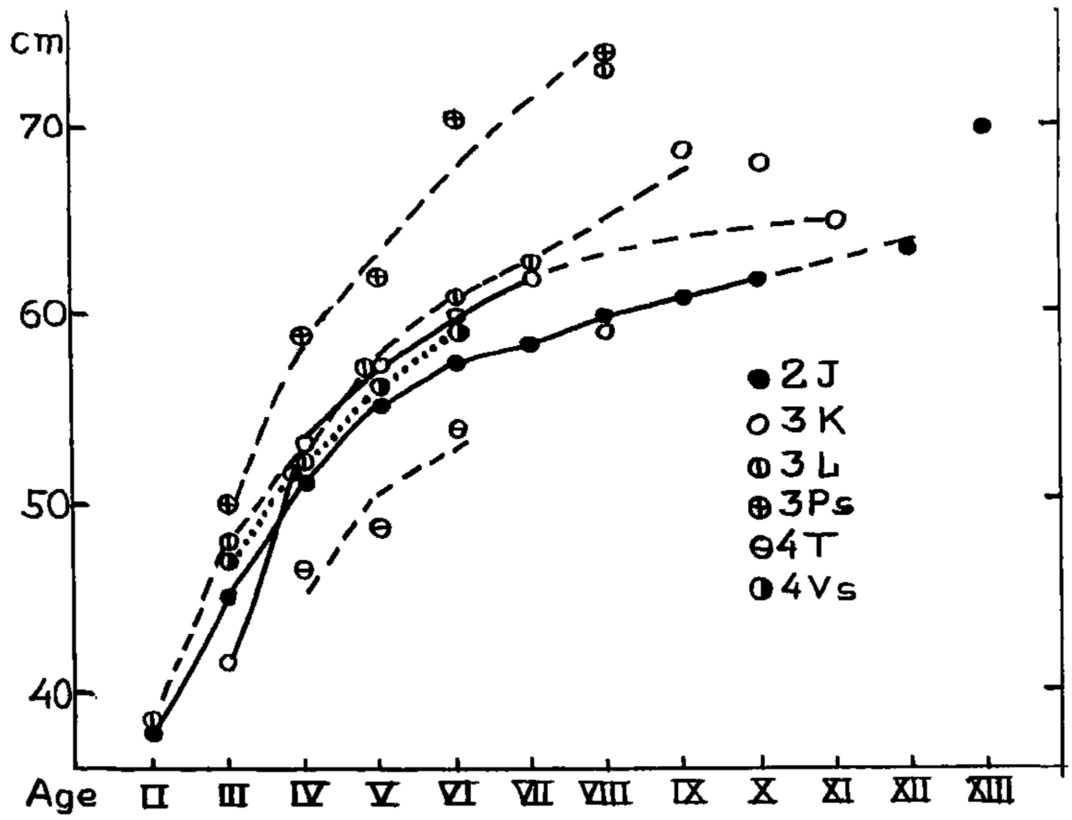

Fig. 3. Growth curves for divisions 2J, 3K, 3L, 3P, 4T and 4 Vs for 1961. The full lines unite points representing the mean size for each age. The broken lines indicate approximate growth rates estimated from the data at hand.

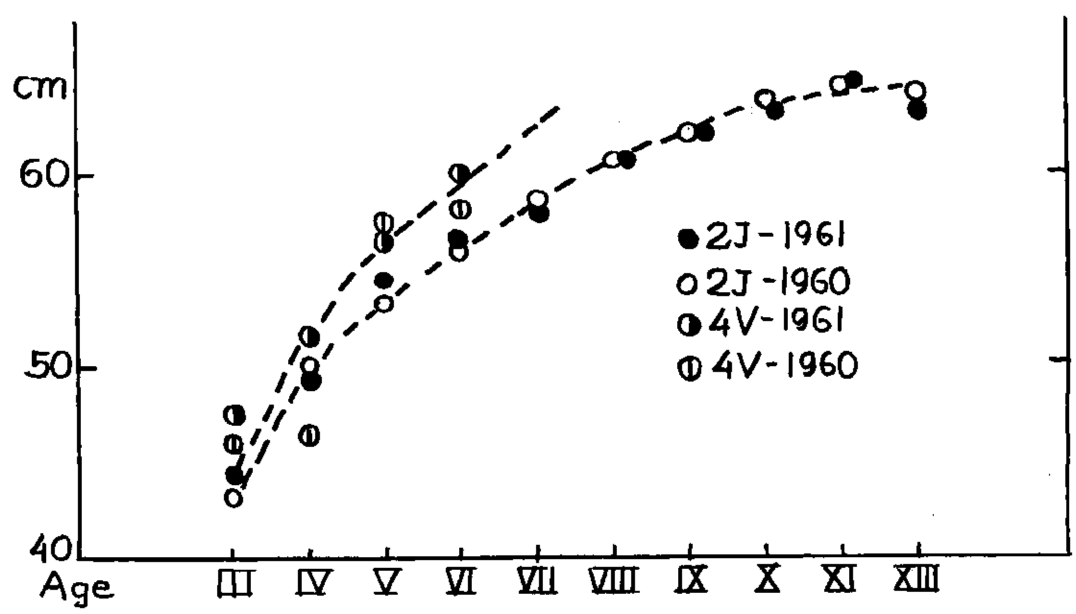

Fig. 4. Growth curves for divisions 2J and 4 Vs for 1960 and 1961.

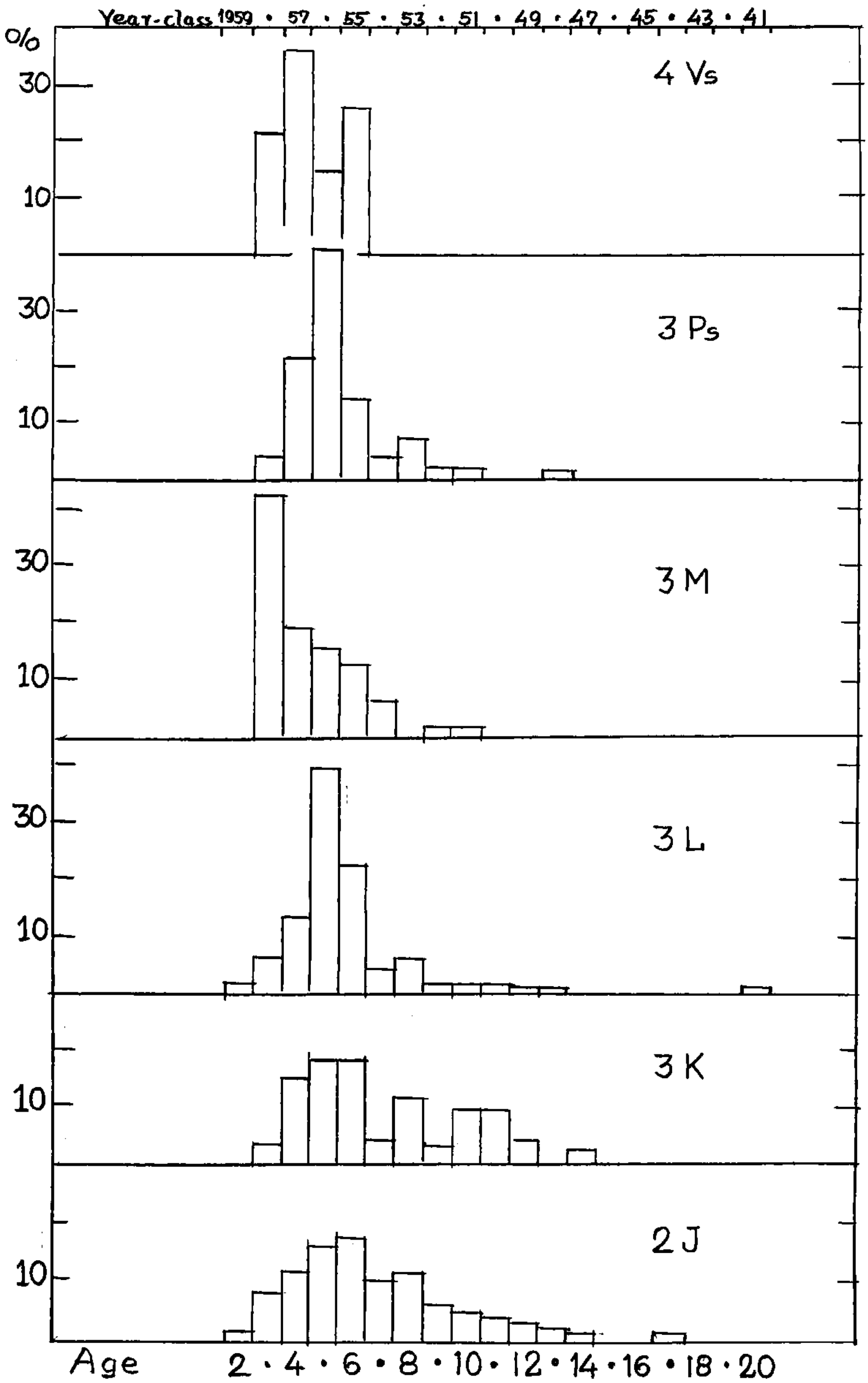

Fig. 5. Histograms presenting relative frequencies of ages and year-classes in Divisions 4 Vs, 3 Ps, 3M, 3L, 3K and 2J in 1961.

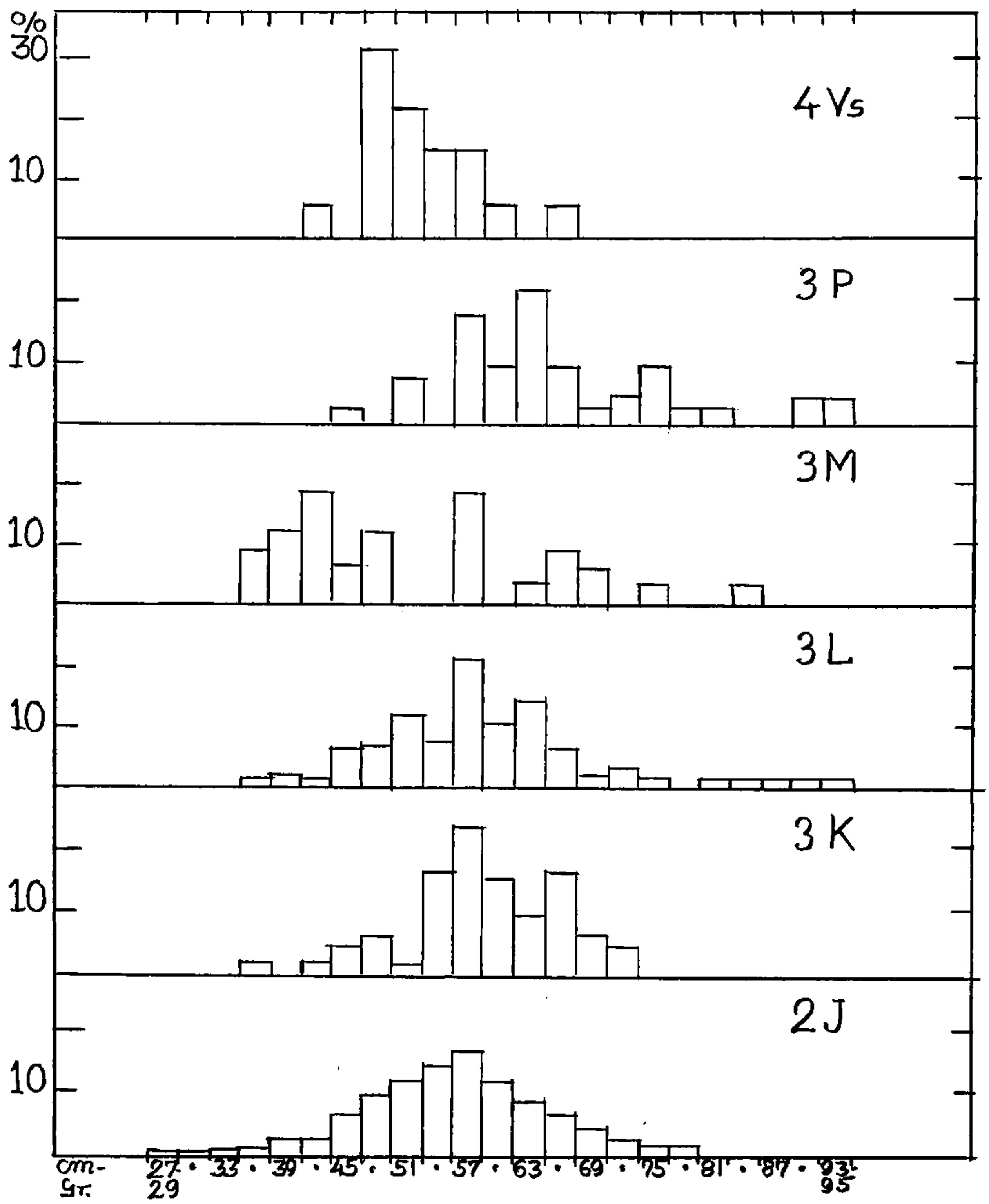

Fig. 6. Histograms presenting relative size frequencies for the separate divisions in 1961.

The following observations can be made from the length distributions in the separate divisions:

a. The presence of small individuals in 2 J although the mean length (57.39 cm) is higher than in 3 M (51.06 cm).

b. The presence of larger individuals in 3 Ps and 3L, where the mean lengths are 68.14 and 60.19 cm. As figure 6 shows, the difference in mean length between 3L and 2 J is only 3 cm (3L is the highest).

c. The mean lengths in 3 K (59.56 cm) and 3 L (60.19 cm) are almost the same; this is also the case for 4 Vs (53.42 cm) and 3 M (51.06 cm).

d. The highest mean length is observed for 3 Ps (68.44 cm) which also presents the strongest growth rate (see Fig. 3). The lowest mean length appears in 4 T (50.92 cm), wh. also presents the weakest growth (Fig.3).

V. Age-Classes.

The relative predominance of the separate year-classes is presented in Figure 5. The 1956 year-class is the one which predominates in the highest number of divisions:

Year-classes:	1958	1957	1956	1955
Divisions:	3 M	4 Vs	3P,3L,3K	3K,2J

A greater abundance of the 1957 and 1955 year-classes was noted in 4 Vs. The 1956 and 1955 year-classes are almost equally abundant in 2J and 3K; this confirms the prediction that the 1956 year-class would predominate in 2J, although also the 1955 year-class is fairly predominant. In 3 Ps, 3M, and 3L the predominance of the 1956 year-class is clear and undisputed.

As data from Subarea 1 are not available for the present paper, it cannot be established whether the prediction of the dominance in that subarea of the 1955 and 1957 year-classes is coming true.

VI. Age at First Maturity.

The age at first maturity was determined from the spawning rings in the otoliths of the various year-classes in samples from the divisions studied (Table 3 attached). with the following results.

a. The large majority of cod spawned for the first time at age 6.

b. The scanty data available do not show any difference in age at first maturity for males and females, with the exeption that for the 1948 year-class in 2 J the females appear to have their first spawning later than the males, however, the scarcity of the material must be borne in mind.

c. The number of cod becoming mature for the first time at age 7 (11 spec.) and at age 8 (7 spec.) is very low compared to the majority of 51 specimen at age 6.

d. One male of the 1953 year-class in 2 J appeared to have spawned for the first time at age 5. Once more it must, however, be stressed that the material is rather small, and that certain difficulties in estimating the spawning rings make it necessary to consider the results with some reservation.

VII. Sex Ratio.

The study of the sex ratio reveals a considerable predominance of females (Table 4 attached). Only in 2 J and 3 K the percentages of males are above 25 (viz. 29 and 33% respectively), in the other divisions the male percentages are even lower. Here, as the Table 4 shows, the numbers of specimens in the samples do not appear to have influence on the proportion of the sexes as the following arrangement of the percentages of males according to numbers of specimens in the samples shows:

Division	2J	3L	3K	3Ps	3M	4Vs	4T	2H	3N
No. of spec.	326	240	81	42	33	19	15	12	7
% males	29	19	33	14	18	11	13	25	0

The data from 3 K and 2 H especially support the assertion that the number of specimen does not influence the sex ratio figures.

For all samples together the percentage of males is 24.

VIII. Summary and Conclusions.

The main conclusions are:

a. The most common length group in the samples is the 57 cm group, and the mean length is 58 cm. The samples from the preceding year, 1960, showed a mean length of 60.79 cm.

b. The growth curves for the various divisions show that the growth rate is higher in Subarea 3 than in 2 and 4; the stock in 3 Ps shows by far the highest growth rate.

c. A comparison of the years 1960 and 1961 show a marked agreement of the growth rates for these two years in 2 J and 4 Vs.

d. The dominating year-classes are: Subarea 4-1957, Subarea 3-1956 and Subarea 2-1955.

e. The majority (74%) of all year-classes become mature for the first time at age 6; only 15.9 % at age 7 and 10.1 % at age 8.

f. The percentage of males in the samples is very low, only 24% as an average for all samples.

TABLE 1. Serial no., date, locality, no. of specimens, and subarea for each sample with otoli

No.	Date	Locality	No. of spec.	Subarea
"Vendaval"				
	March			
1	25	45,5ON-48,20W	7	3N
2	26	47,20-59,06	14	3Ps
			21	
	April			
3	4	45,05N-55,20W	5	3 Ps
4	16	- - - - -	4	-
5	16	47,30-60,30	5	4 T
6	17	47,40-60,35	12	4 T
7	19	45,00-57,45	7	4 Vs
8	21	idem.	13	4 Vs
9	23	45,05-55,16	12	3 Ps
10	24	45,05-55,45	14	3 Ps
11	26	47,00-51,40	16	3 L
12	29	47,00-51,50	12	3 L
13	30	46,55-51,45	23	3 L
			124	
	May			
14	8	48,45N-51,55W	18	3 L
15	8	idem.	14	3 L
16	18	52,35-53,20	17	2 J
17	19	52,40-53,15	15	2 J
18	20	52,30-52,20	18	2 J
19	24	52,40-53,40	14	2 J
20	30	52,40-53,20	11	2 J
21	31	52,30-54,00	15	2 J
			122	
	June			
22	2	52,00N-54,00W	11	3 K
23	3	51,55-54,10	12	3 K
24	6	53,50-53,20	12	2 J
25	13	54,10-53,40	13	2 J
			48	

TABLE 1 continued.

No.	Date	Locality	No. of spec.	Subarea
"Aquilon"				
	August			
26	6	51,50N-54,10W	35	3K
27	10	49,05-50,15	13	3K
28	11	49,00-50,15	23	3L
29	12	49,10-50,15	17	3L
30	13	49,05-50,20	20	3L
31	16	46,42-50,45	18	3L
32	19	49,06-50,15	19	3L
33	20	49,06-50,15	16	3L
34	22	49,05-50,20	27	3L
35	23	48,55-50,10	11	3L
36	24	48,50-50,10	25	3L
37	28	46,50-45,50	23	3M
			247	
	September			
38	10	53,21N-54,35W	23	2J
39	13	53,35-54,00	7	2J
40	16	53,50-54,40	13	2J
41	17	53,50-54,40	15	2J
42	18	53,50-54,55	13	2J
43	21	53,30-53,10	28	2J
44	22	54,25-54,06	19	2J
45	23	53,40-54,00	24	2J
46	24	idem.	14	2J
			156	
	October			
47	8	53,50N-54,35W	18	2J
48	8	idem.	22	2J
49	9	53,30-55,20	13	2J
50	14	52,45-54,45	16	2J
51	14	idem.	12	2J
52	22	49,50-40,10	13	--
53	25	57,30-54,55	13	2H
			107	
	November			
54	1	53,00N,-50,20W	12	2J
55	9	51,45-54,20	18	3K

TABLE 2. Distribution of samples by Subareas and dates, with no. of spec. investigated.

Subarea	Sample	Date	No. of spec.	Total
2 H	53	October 25	13	13
2J	16-21	May 18,19,20,24,30,31	90	
	24-25	June 6,13	25	
	38-46	September 10,13,16,17,18,21 22,23,24	156	
	47-51	October 8,9,14	78	
	54	November 1	12	361
3 K	22,23	June 2,3	23	
	26,27	August 6,10	48	
	55	November 9	18	89
3 L	11-13	April 26,29,30	51	
	14,15	May 8	32	
	28-36	August 11,12,13,16,19,20,22, 23,24	176	259
3 M	37	August 28	23	
	52 ?	October 22	13	36
3 N	1	March 25	7	7
3 Ps	2	March 26	14	
	3,9,10	April 4,23,24	32	46
4 T	5,6	April 16,17	17	17
4 Vs	7,8	April 19,21	20	20
				848

TABLE 3. Age at first maturity by year-classes and Subareas.

Ages	♂ 1947	♀ 1947	♂ 1948	♀ 1948	♂ 1949	♀ 1949
6.....	3K(1)		2J(1)	2J(1)		2J(4) 3K(2)
7.....		2J(1)				2J(1) 3K(1)
8.....			2J(1)	2J(3)		2J(1)

Ages	♂ 1950	♀ 1950	♂ 1951	♀ 1951	♂ 1952	♀ 1952	♂ 1953	♀ 1953
5....							2J(1)	
6....	2J(6) 3K(1)	2J(3) 3K(1)	3K(1) 2J(4)	2J(1) 3K(2)	2J(3) 3M(1)	2J(4) 2H(1) 3K(2)	2J(1) 3K(2)	2J(5) 3K(1)
7....			2J(2) 2H(1) 3M(1)	2J(1) 3K(1)	2J(1)	2J(1)		
8....	2J(1)	3K(1)						

Ages	♂ 1954	♀ 1954
6....	2J(1)	2H(1)

TABLE 4. Frequencies, numbers and percentages, of males and females by divisions.

	♂ 2H		♀	♂ 2J		♀	♂ 3K		♀	♂ 3L		♀	♂ 3M		♀
N....	3		9	95		231	27		54	45		195	6		27
Total.		12			326			81			240			33	
%....	25		75	29		71	33		67	19		81	18		82

	♂ 3N		♀	♂ 3P		♀	♂ 4 T		♀	♂ 4 Vs		♀
N...	0		7	6		36	2		13	2		17
Total.		7			42			15			19	
%..	0		100	14		86	13		87	11		89

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