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Age and Growth of Cod from the Fisheries in the Northwest Atlantic, 1960

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The present paper forms part of the work which Spain carries out, through the Direccion General de Pesca Maritima and its Junta Consultiva de Investigacion Cientifica-pesquera, as part of its cooperation with the International Commission for the Northwest Atlantic Fisheries. This work has been under way since 1952 and carried out by Margalef, O. Rodriguez, Lopez-Costa, A. Rojo and Figueras.

The material for this paper was collected by the trawler "Alisio" of PYSBE during February through May, 1960, and by the "Vendeval" in August-December of the same year.

The technique used is the same as for previous researches (Figueras, 1957). However, in order to ensure a more rapid and more accurate reading of the otoliths, otoliths from the same sample were fitted onto a plastic board with 32 hollows filled with plastilene (in previous years the otoliths were investigated singly). The present method both simplifies the work and makes possible a direct comparison of the otoliths of a sample when reading them.

For each otolith were noted: number of rings, number of "check rings", size of nucleus, aspect of edge of otolith (N - narrow, W - broad, O - opaque, and H - hyaline).

Table 1 specifies some of the characters investigated in the various samples; it shows that otoliths have been collected from 4,546 specimens, distributed over 265 samples each corresponding to a haul. Most specimens are from September, and 2J is the best represented division.

Table 1 - Summary of the Samples

Month	Feb.	Mar.	Apr.	May	Aug.	Sept.	Oct.	Nov.	Dec.	Total	
No. of samples	22	35	35	23	27	53	45	24	4	268	
No. of spec.	399	512	395	281	463	1074	821	520	81	4546	
Size range	31-134	21-85	33-88	40-100	33-91	32-101	37-92	38-86	41-72	21-134	
No. of samples by divisions-1B				13	27	4				44)	
1C				3						3)	59
1D						8				8)	
1E				4						4)	
2H						9	3			12)	101
2J				1		32	34	18	4	89)	
3K				2			2	6		10)	
3L			18				6			24)	38
3P		4								4)	
4R	6	23	9							38)	65
4V	14	8	5							27)	

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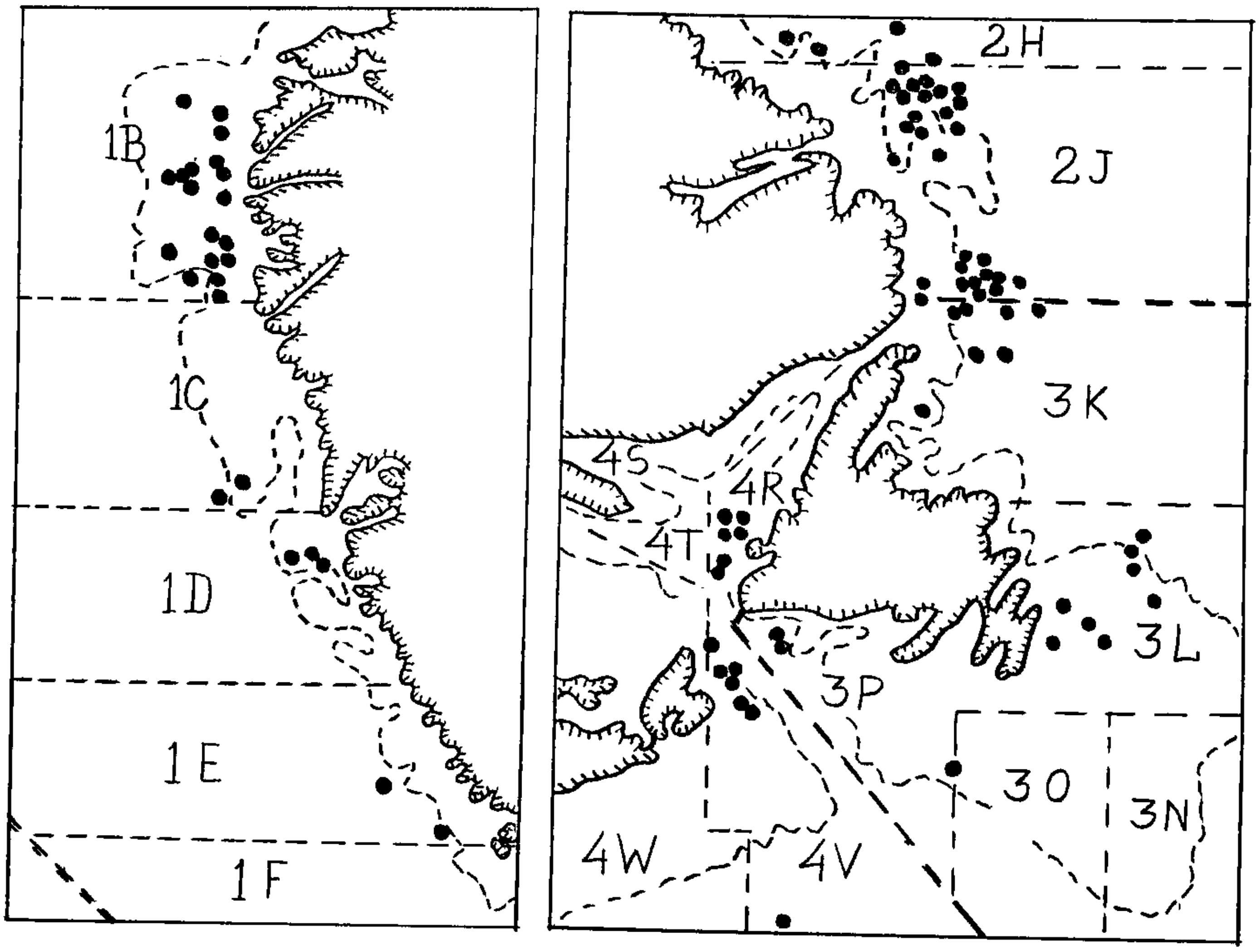

Figure 1 - Map of the Convention Area showing subareas and divisions. The dots indicate the position of the fishery from which samples were collected.

The fishery is restricted to Divisions 4R, 4V, 3P and 3L in Márch and April. From May the fishery covers the whole northern part of the Convention Area, mainly concentrated, however, in 1B, 1C, 1D, 2H, 2J and 3K (Figure 1).

The samples were grouped by divisions for the study of growth, age and length distribution, particularly. Whenever the material allowed,comparison with results from previous years was made - either for the same or for neighbouring divisions. Thus growth, age and length have been compared as follows: 3N, 3O (1955) - 3L, 3P (1960) and 1D, 1E (1958) - 1D, 1E (1960).

The appearance of rings at the margin of the otoliths was studied as to localities and seasons in order to ascertain when the annual rings are formed. Attention is drawn to a very indistinct ring (refringent), the appearance of which can be followed through the divisions.

A comparison with the results obtained by other Spanish biologists during previous cruises completes the study.

Age and Growth

Table 2 and Figures 2 and 3 reveal, firstly, a difference in growth for 1D and 1E between 1958 and 1960; however, the number of specimens investigated in the two years is very different - only 73 in 1960, compared to 1267 in 1958. Whereas the 1958 curve is very uniform with the points falling close to the theoretical curve, the 1960 results do not show such a uniformity. It is to be noted that after the fifth year all points of the 1960 curve are above those of 1958, the 1960 lengths being about 10 cm higher than those from 1958. From

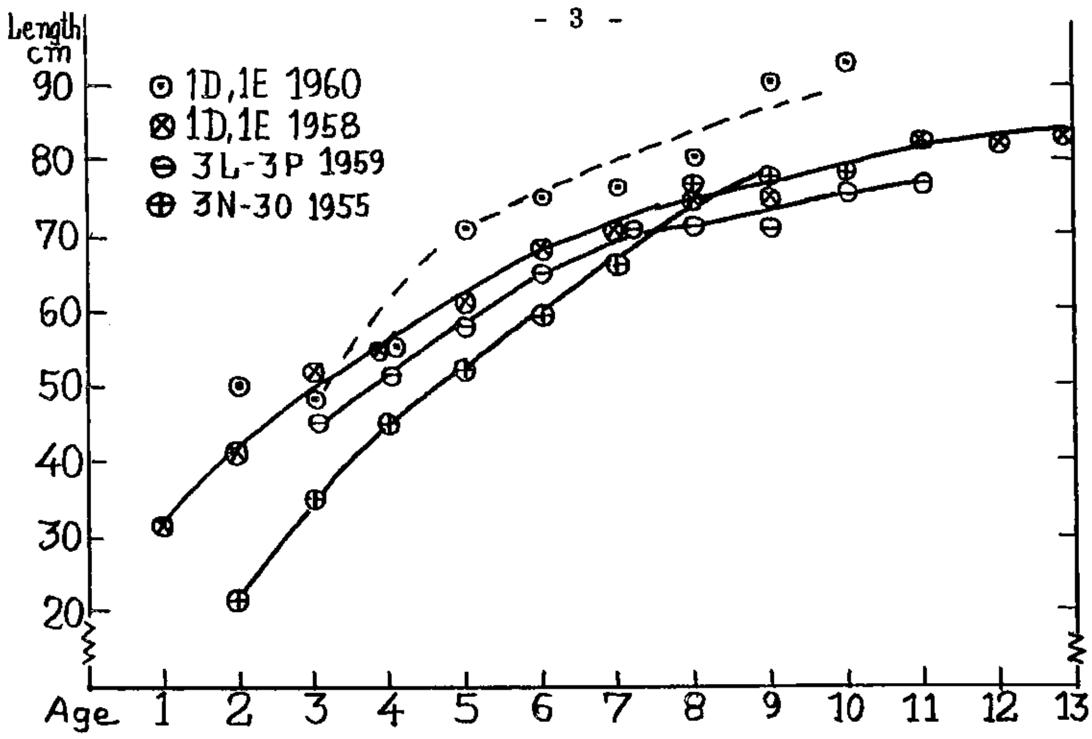

Figure 2 - Growth curves for Division 1D, 1E (data from 1960), the same (data from 1958), 3L, 3P (data from 1960) and 3N, 3O (data from 1955).

Table 2 - Frequency (number of specimens) and mean size by ages

	1960-3L		1955-3N		1960-1D		1958--1D		1960-4R		1960-4V		1960-1B		1960-2J	
Age	N°	cm	N°	cm	N°	cm	N°	cm	N°	cm	N°	cm	N°	cm	N°	cm
I							1	33.0								
II			1	22.0	2	50.5	7	42.7					15	43.4	2	43.0
III	8	44.8	25	37.3	15	48.4	96	53.4	7	43.2	9	46.0	48	48.8	4	43.6
IV	44	53.0	41	46.2	8	57.3	387	56.0	32	48.1	32	46.2	56	61.7	99	50.2
V	33	59.0	44	53.1	16	72.0	213	62.4	69	55.8	74	52.2	69	67.5	122	53.0
VI	25	65.4	54	60.6	21	75.9	138	69.1	53	57.9	57	58.2	76	72.0	132	56.4
VII	25	71.2	16	67.0	5	77.0	177	71.8	23	61.1	25	63.8	17	73.8	91	59.3
VIII	9	70.6	5	78.3	3	81.0	59	75.9	16	63.4	13	64.7	13	78.0	79	60.3
IX	3	71.3	1	79.0	1	92.0	45	76.2	9	65.4	7	65.7	12	81.5	74	61.5
X	7	76.5			1	95.0	75	79.3	7	67.8			4	84.5	69	62.7
XI	4	80.7			1	101.0	23	84.6	1	73.0	2	72.5	6	84.3	43	64.6
XII	1	92.0					17	83.1			4	79.7	10	87.6	25	65.2
XIII							6	84.1							23	65.8
XIV							12	80.5							5	63.8
XV							6	98.0							4	79.0
XVI							2	97.5					2	93.5	3	66.0
XVII							3	93.3								
	159		187		73		1267		217		223		328		775	

Figures 4 and 5 presenting age and length distribution, it appears that the average length is almost the same in the two years (1958 - 65.12 cm; 1960 - 65.84 cm) and that the 1954 year-class predominates in both years. The slight increase in size compared to 1958, and the lower mean age - close to 5 years in 1960 compared to close to 6 years in 1958, confirms the conception of an increased growth rate (as shown by the growth curves) for 1D in 1960.

When comparing specimens from 1955 (3O and 3N) with those from the neighbouring divisions 3L and 3P from 1960, the data of 1960 denote a greater growth. Here the number of specimens is about the same in the two years, and the results were therefore convincing; only the localities are somewhat different (Figueras, 1957) and therefore too bold conclusions are not permissible. The frequency-figures also show a considerable increase in average size (length) of the stock in 1960 (61.8 cm in 1960; 55.7 cm in 1955). The 1949 year-class was predominant in 1955 and the 1956 in 1960, and the mean age is a little higher in 1960 (5.7 years).

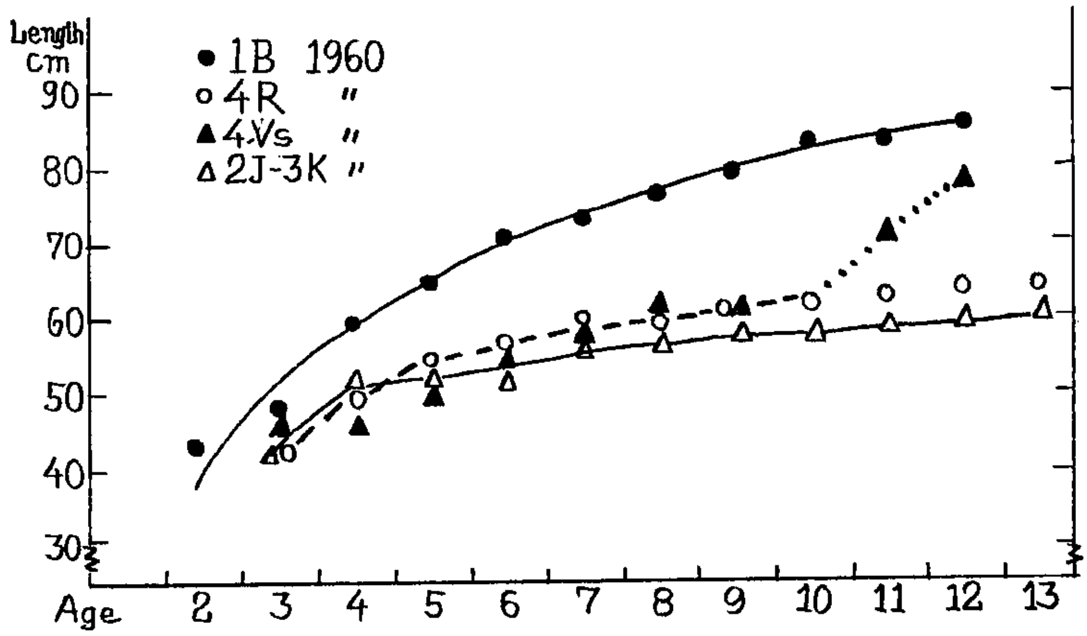

Figure 3 - Growth curves for Divisions 1B, 4R, 4V and 2J (data from 1960).

From comparison of the samples from 1960 from the different areas in which "Alisio" and "Vendeval" have operated, the following results are gained:

a. The average length increases gradually from south to north, from 55.8 in 4V to 66.0 in 1B (Figure 4).

b. However, the average age (Figure 5) does not show the same grading; the highest age, 7.3 years, is observed in 2J; in the other divisions the average age varies between 5 and 6. The high age of 7 years in 2J in 1960 is remarkable; from the length distribution data a contrast is observed between the relative abundance of old individuals and the scarcity of cod over 75 cm in 2J and the low number of old individuals and the numerous cod over 75 cm in 1B and 1D (1960).

c. In 2J we find the highest average age together with the lowest growth rate (see Figure 3); the difference in size between the younger and older cod (age groups 3 and 13) is only slightly more than 20 cm.

d. The growth curves for 4R and 4V are almost the same. The mean length is, however, 2 cm greater in 4R (57.8 cm) than in 4V (55.7 cm). The 1955 year-class predominates in both divisions, and the average age is about the same (5.8 and 5.7 years).

e. The 1957 year-class is rather predominant in 1D in 1960, and also relatively abundant in 1B. Probably this abundance of year-classes conforms with the statement of Corlett (1958), who found, in comparing the quantity of available food during the pelagic phase of the young cod with the year-class strength, that the dry weight of plankton per volume of water in a certain year, in March-April to September (the pelagic phase of the cod), is strongly related to the strength of the year-class of that year. Thus, according to the abundance of plankton, the 1950 year-class (not known from our material) must be considered as very rich, and the 1949 and 1954 year-classes - which indeed were predominant in the area - as good. As mentioned earlier, the next rich year-class in Subarea 1 will be that of 1957; this will coincide with Corlett's prediction. Following Corlett's theory, it is probable that the 1953 and 1955 year-classes must be classified as medium, and those of 1951 and 1952 as poor. However, it remains to be investigated whether the year-class strength prediction method found valid by Corlett for the Northeast Atlantic is also valid for the Convention Area.

Season of Formation of Rings

From the studies of the percentage of cod with a ring at the margin of the otolith during the year and through the divisions, it appears that the majority are formed in August in Subarea 1 (Table 6). During August, samples from 1B only, 24% of the cod, had a recently formed ring at the margin. Contrary to this, in Subarea 4 (4R and 4V) the highest percentage (13.6%) of cod with a marginal ring was found in February. For want of data, this phenomenon cannot be related to temperature, but compared with latitude it could be concluded that the ring is formed in winter in the southern subareas and in summer in the northern. This,

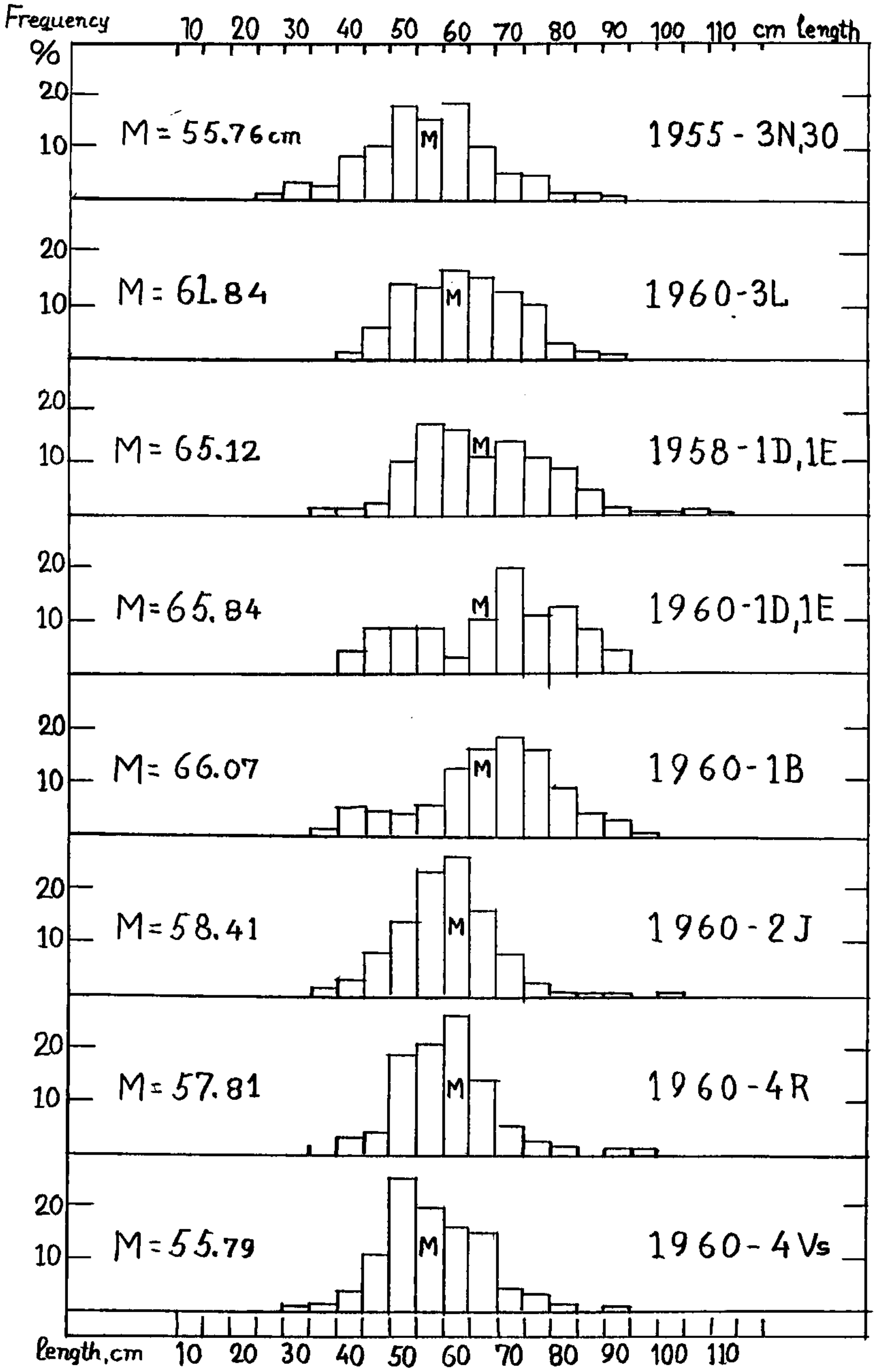

Figure 4 - Size frequency by divisions. M = mean size.

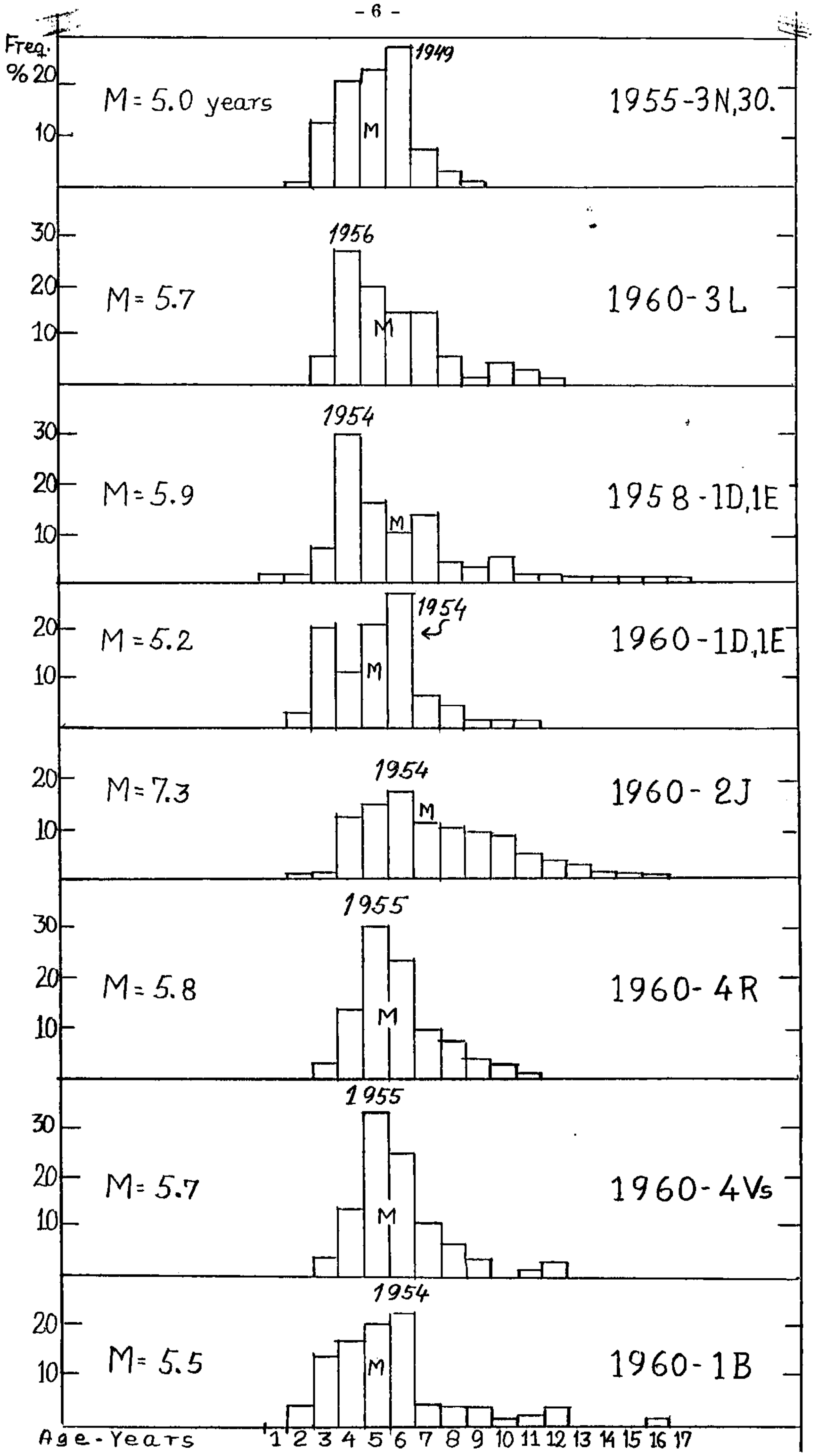

Figure 5 - Age frequencies and age-classes. M = mean age. The predominating year-class is indicated in each case. The age scales indicated above and below refer to all years and divisions.

Table 3 - Length distribution

Length Group cm		25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	
1955-3N	N°	2	8	5	25	30	52	47	55	32	16	14	5	5	1			2		299
	%	0.6	2.6	1.6	8.3	10	17	15	18	10	5	4	1.7	1.7	0.3			0.7		
1958-1D	N°			3	11	21	127	214	218	139	183	142	114	56	13	5	3	6	2	1257
	%			0.2	0.8	1.6	10	17	17	11	14	11	9	4	1	0.3	0.3	0.4	0.2	
1960-3L	N°				1	10	23	23	27	26	21	17	5	2	2					157
	%				0.6	6	14	14	17	16	13	10	3	1.3	1.3					
1960-1D	N°				3	6	6	6	2	7	14	8	9	6	3		1			71
	%				4	8	8	8	3	10	20	11	12	8	4		1.4			
1960-4R	N°			3	7	11	44	49	61	34	11	5	2		1	1			2	231
	%			1.3	3	4	19	21	26	14	4	2	0.9		0.4	0.4			0.9	
1960-4V	N°		1	1	8	27	56	44	36	33	9	7	3		1					226
	%		0.4	0.4	3	11	24	19	15	14	4	3	1.3		0.4					
1960-1B	N°			4	16	16	14	16	41	53	58	52	30	12	9	1				325
	%			1.2	4	4	4	4	12	16	17	16	9	3	2	0.3				
1960-2J	N°			3	21	64	114	193	212	135	57	17	4	1	1		1	1		813
	%			0.4	2	7	14	23	26	16	7	2	0.5	0.1	0.1		0.1	0.1		

however, cannot be confirmed before we have data from the summer for the southern, and from the winter for the northern subareas. For the solution of the problem, it is desirable to collect samples from both regions through all seasons of the year.

The Occurrence of a Particular, Very Indistinct Ring

In rather many specimens a particular, very indistinct ring was observed; in almost all cases this ring was the second ring, occasionally the first, third or fourth, and in these cases almost always also the second. This ring cannot be considered as a spawning ring, as first spawning only occurs at age 6 in Division 2J. It must therefore be attributed to other causes, e.g. an ecological change in the environment. The distribution by months and divisions of this ring, or rings, is shown in Table 5. The ring occurs in the highest percentage of cod in 3K, and with decreasing percentages to the north as well as to the south. The most probable explanation is perhaps the previously mentioned possibility of a change in environmental conditions, perhaps as to currents, although the authors note the larger confluence only more to the south. It can further be noted that this indistinct ring is much more common in the females than in the males.

Comparison with Results obtained in previous Years by Spanish Authors

The Spanish research cruises in the Convention Area began in 1953 when O. Rodriguez and Lopez-Costa investigated Subarea 3 in February-April on board the trawler "Vendeval". The second cruise was carried out by O. Rodriguez and A. Rojo on board the "Mistral" in June-July, 1954. According to data published in ICNAF Annual Proceedings Vol.5, the mean length of the cod in Subarea 3 was 51-55 cm (10 cm more than in 1953), and the richest year-class was that of 1949 (5 years old); it was followed by the 1948 year-class. From Figures 4 and 5, it appears that the mean length for this subarea is 60 cm and that the 1956 year-class predominates. Thus, a certain increase in growth rate has occurred for this subarea.

The third cruise was carried out in June-July 1955 on board the trawler "Cierzo" by O. Rodriguez. The mean length was 56-60 cm in Subarea 3 and the 1949 year-class was still predominant, followed by the 1950 year-class.

The fourth cruise was made by A. Rojo on board "Santa Ines" and "Santa Celia" in September 1956 and mainly in Division 3N. The mean length was 50 cm and the 1951 year-class predominated. The growth rate was about the same as that found for this division in 1955, but somewhat lower than in 1960 for 3L. From the figure showing year-class strength since 1953, it appears that the predominant year-classes in Subarea 3 have been: 1946, 1949, 1951 and 1956; however, corresponding data for the years 1957, 1958 and 1959 are missing.

Table 4 - Age distribution and year-classes (N)

Age	1960-3L		1955-3N		1960-1D		1958-1D		1960-4R		1960-4V		1960-1B		1960-2J	
	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm
I							57	0.1								
II			53	0.5	58	2.7	56	0.5					58	4.5	58	0.3
III	57	5.0	52	13.2	57	20.4	55	7.5	57	3.2	57	4.0	57	14.4	57	0.5
IV	56	27.6	51	21.7	56	10.8	54	30.5	56	14.7	56	14.4	56	16.8	56	12.8
V	55	20.7	50	23.3	55	21.7	53	16.8	55	31.7	55	33.3	55	20.7	55	15.7
VI	54	15.7	49	28.6	54	28.5	52	10.9	54	24.3	54	25.6	54	22.8	54	17.0
VII	53	15.7	48	8.4	53	6.8	51	13.9	53	10.5	53	11.2	53	5.1	53	11.7
VIII	52	5.6	47	2.6	52	4.0	50	4.6	52	7.3	52	5.8	52	3.9	52	10.2
IX	51	1.8	46	0.5	51	1.3	49	3.5	51	4.1	51	3.1	51	3.6	51	9.5
X	50	4.4			50	1.3	48	5.9	50	3.2	50		50	1.2	50	8.9
XI	49	2.5			49	1.3	47	1.8	49	0.4	49	0.9	49	1.8	49	5.5
XII	48	0.6					46	1.3			48	1.8	48	3.0	48	3.2
XIII							45	0.4							47	3.0
XIV							44	0.9							46	0.6
XV							43	0.4							45	0.5
XVI							42	0.1					44	0.6	44	[illegible]
XVII							41	0.2								

Table 5 - Frequency of the 2nd, Indistinct Ring

By months:	March	April	May	August	September	October	November	Dec.
% monthly	3.8	15.2	2.7	0.8	6.5	10.2	12.7	2.4
% of males	27.2	13.3	20.0	0.0	40.0	30.9	35.2	0.0

By divisions:	1B	1E	2H	2J	3K	3L	3P	4R	4V
No. of spec.	3	3	10	84	15	16	2	14	10
%	0.4	3.7	5.1	5	7.5	3	2	1.8	1.8

Table 6 - Frequency of rings at the margin

Month	Division	No. of Specimens	%
February	4R, 4V	36	13.5
March	4R, 4V, 3P	32	11.0
April	4R, 4V, 3L	16	8.1
May	1B, 1C, 1D, 2J, 3K	18	10.0
August	1B	55	24.2
September	1B, 1D, 2J	9	1.6
October	2J	3	0.7
November	2J	3	1.1
December	2J	0	0.0

The fifth cruise took place with "Abrego" in September-October 1957. A. Rojo (1958) gives the mean length for 1B as 50 cm, in 1960 the mean length had increased to 70 cm; the predominant year-class was the 1953 (4 years old) in 1957, and 1954 (6 years old) in 1960. Thus, the growth curve of 1957 is below that of 1960. The growth rate has increased. For 1D and for the same year, 1957, A. Rojo gives the mean length as 59.6 cm and the 1952 year-class as predominant, and he notes that the majority of otoliths had transparent margins. An inflection was observed in the growth curves between the ages of 7 and 8. Such an inflection is also observed in 1960 in 1D between ages 5 and 7 and in 3L between 7 and 9.

The sixth cruise was made in 1958 by "Aliseo" in May-July. The results obtained by O. Rodriguez have already been compared with those from 1960.

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From the foregoing, it can be concluded that a tendency of increase in growth rate exists in certain divisions (1B, 1D). It can further be concluded that the year-classes which will form the basis for the fisheries in 1961 will be as follows: Subarea 1 - 1955 and 1957 year-classes; in Subareas 2 and 4 - the 1956 year-class.

Bibliography

Corlett, John 1958. J. du Conseil, 23(3):354-356
Figueras, A. 1957. Inv. Pesq. VIII:3-14
Rodriguez, O. 1956. ICNAF Annual Proceedings Vol.6 : 55
Rodriguez, O. 1959. ICNAF Annual Proceedings Vol.9 : 80
Rodriguez, O. and A. Rojo 1955. ICNAF Annual Proceedings Vol.5: 51
Rojo, A. 1957. ICNAF Annual Proceedings Vol.7: 58
Rojo, A. 1958. ICNAF Annual Proceedings Vol.8: 61