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Spanish Research Report, 1957

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A. Investigations of the cod off W. Greenland during the year 1957

With the present paper Spain initiates the reporting of data from studies of the cod from Greenland. All the samples have been collected on board the vessel "ABREGO", of the PYSBE company, during the months of September and October, 1957.

Material and methods. All the samples have been arranged in two large groups, each including samples taken in about the same area and at about the same time. The two groups correspond to Subdivisions 1B (Store Hellefiske Bank) and 1D (Fylla Bank). The fishery on both banks was carried out in the central part of the banks.

The samples were taken from the catches of the commercial trawler "ABREGO", which was using a trawl having a mesh size in the codend of 160 mm. (6-3/8 inches), when new and dry. To the upper side of the codend were attached one or two covers (chafing gear). Of the 16,309 specimens measured on board in September and October in 1B, 12,256 were caught with one cover and 4,053 with two covers in use.

The specimens were measured on the deck before culling. The fishermen normally discard all specimens below about 40 cm. in length. As the averages of the lengths were calculated on the basis of all specimens caught, the resulting lengths are lower than those found by other nations using only culled material.

For the study of the length distribution 18,102 specimens were used. Of these 1,800 were used also for the study of age, sexual maturity, stomach content, etc. However, owing to the large number of otoliths which had to be read and in consideration of the time needed for the study of other samples from the ICNAF area, only 600 specimens were aged, 400 from Subdivision 1B and the rest from 1D.

The method of selecting the fish for otolithing was as follows: all fish were numbered from 1 to 10. One fish was taken at random; then all other fish with the same number were selected for aging. The perfect agreement between the two length frequencies shows that the sample provided in this way yields reliable results.

The weight in relation to the length was observed for 341 specimens. The weighings are subject to errors, owing to the influence from the movements of the boat on the scale. Once this error is eliminated, the various measurements appear to correspond well with those given by Poulsen in ICNAF Meeting Document No. 18, 1957 (Serial No. 459) obtained on the basis of data collected by other countries.

Following the procedure previously used for studying the cod on the Grand Bank, the correlations between the total length and the length of the head and the pre-dorsal length were measured using 388 specimens, as a means of studying the various races and sub-species of cod in the Northwest Atlantic. The correlation between the girth and the total length was also calculated.

All the data used in this study were taken on board by two sailors selected for this work by the PYSBE company and instructed by me during a campaign on the Grand Bank in the month of August.

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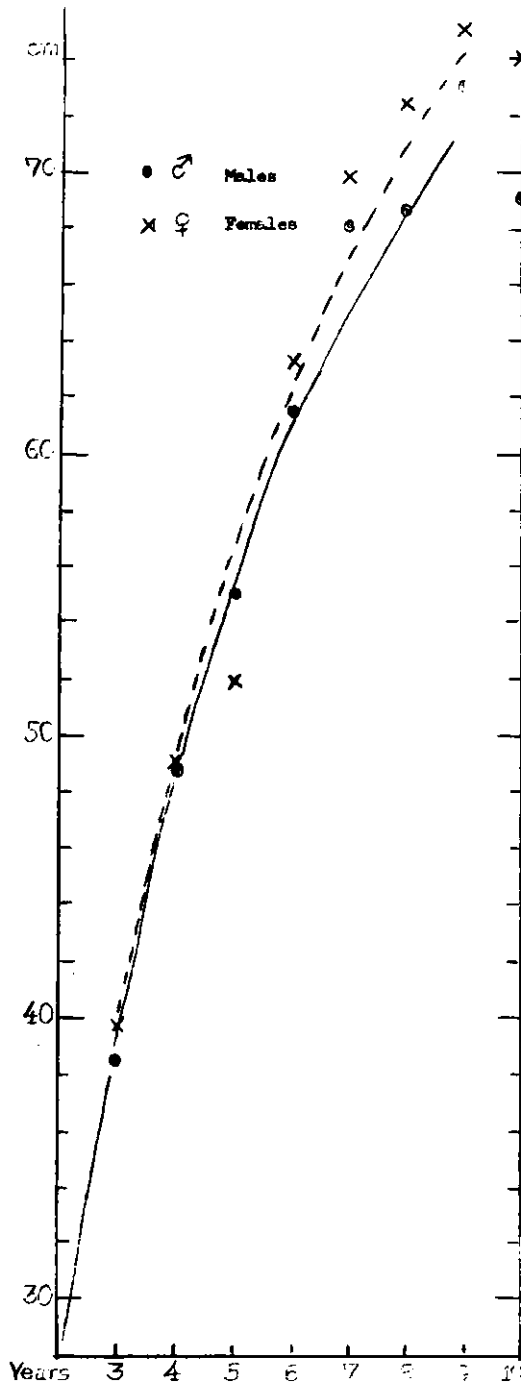


Figure 3. Cod, Subdivision 1B, Sept.-Oct. 1957. Growth curves for males (169 spec.) and females (217 spec.).

The data as to size and age referred to in this paper will be published in the ICNAF Sampling Yearbook, 1957.

Cod in Subdivision 1B

Size distribution (Fig. 1). In 1B the fishery was carried out during the whole of the months of September and October. All the samples were collected between 67° 15' and 68° 18' N and 54° 20' and 54° 25' W, i.e. on the central part of the Store Hellefiske Bank.

The peak of the length curve is in the 50 cm. group with 27%, followed by the 45 and 55 cm. groups, 17% and 16% respectively. The mean size was rather small, 54.45 cm.

Age distribution (Fig. 2). The distribution by age conforms completely with that of size, as we find a great predominance of four year-old cod (1953 year class). It must be borne in mind that the samples include specimens which would be discarded into the sea, as the measurements were made before culling.

386 otoliths were studied. There is an absolute predominance of the 1953 year class with 65%, followed by the 1952 year class with 12%. In nearly all the otoliths the growth during the summer of 1957 was noted, and it may be the case for some individuals that this marginal zone represents the fifth year. However, even in this case, the 1952 and 1953 year classes predominate.

In the following Table 1 are shown the sizes of the different age groups, separately for males and females and for both sexes together.

The two year-old specimen was not included in the calculations.

The strongest growth is found for the females, with the exception of those of age 5 (Fig.3).

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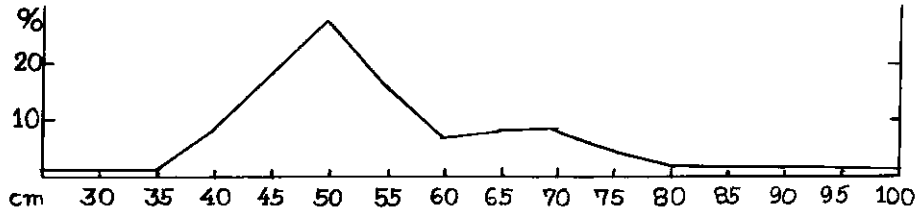


Figure 1. Cod, Subdivision 1B, Sept.-Oct. 1957. Length frequency curve, 16,309 spec.

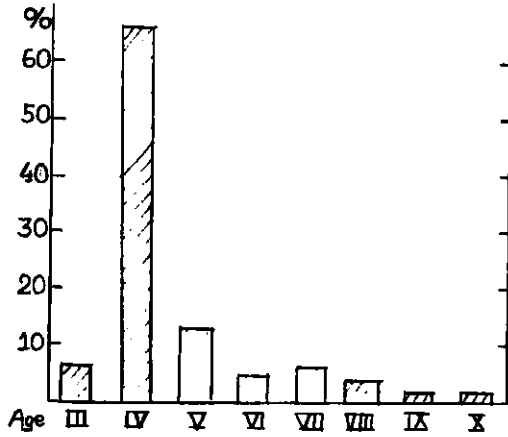


Figure 2. Cod, Subdivision 1B, Sept.-Oct. 1957. Age distribution in frequency percentages, 386 specimens.

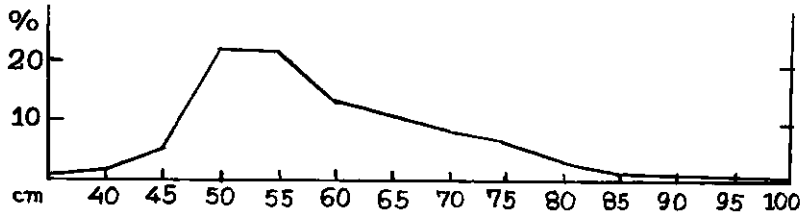


Figure 4. Cod, Subdivision 1D, Oct. 1957. Length frequency curve, 1,793 specimens.

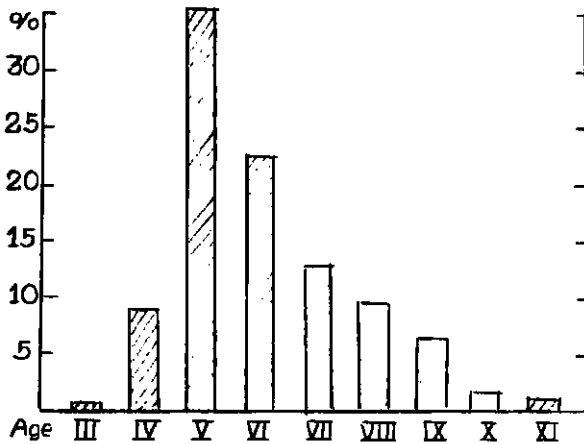


Figure 5. Cod, Subdivision 1D, Oct. 1957. Age distribution in frequency percentages, 176 specimens.

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Table 1. Cod, age distribution and mean length by year classes, Subdivision 1B

<u>Year class</u>	<u>Age</u>	<u>Males (No.)</u> cm.	<u>Females (No.)</u> cm.	<u>Total (cm.)</u>	<u>%</u>
1955	2	28	°°°	28	°°°
1954	3	38.54 (11)	39.75 (12)	39.17	5.95
1953	4	48.68 (107)	48.70 (147)	48.69	65.80
1952	5	55.07 (28)	51.90 (22)	53.68	12.95
1951	6	61.42 (7)	63.09 (11)	62.44	4.66
1950	7	68.00 (10)	69.83 (12)	69.00	5.69
1949	8	68.75 (4)	72.40 (10)	71.35	3.62
1948	9	73.00 (1)	75.00 (1)	74.00	0.51
1947	10	69.00 (1)	74.00 (2)	72.33	0.77
		169	217		

Feeding. The principal food of the cod in this area during the months of September and October was the capelin (*Mallotus villosus*) and the sand eel (*Ammodytes americanus*). This is a period of great voracity for the cod, and of 387 stomachs examined no less than 68% were filled with food.

Sex ratio. The females were in the majority with 56%; this is the same percentage as that found for this area in 1956, according to the Portuguese reports.

Cod in Subdivision 1D

Size distribution. In 1D the fishery was carried out during the whole month of October in an area between 63° 35' and 64° 05' N and 52° 50' and 53° 02' W.

Measurements of 1,793 specimens were made. The mean size was 59.65 cm., a little larger than in 1B in the same months (Fig. 4).

Age distribution. The growth in 1D was slightly smaller than for the cod of Store Hellefiske Bank. The 1952 year class, five years old, is the most numerous (36%). It is followed by the six and seven year-old cod with 23% and 13% respectively (Table 2 and Fig. 5).

Table 2. Cod, age distribution and mean lengths by year classes, Subdivision 1D

<u>Year class</u>	<u>Age</u>	<u>Males (No.)</u> cm.	<u>Females (No.)</u> cm.	<u>Total (cm.)</u>	<u>%</u>
1954	3	41.00 (1)	°°°	41.00	0.56
1953	4	47.11 (9)	49.57 (7)	48.18	9.09
1952	5	52.32 (31)	53.09 (32)	52.71	35.79
1951	6	58.75 (20)	58.20 (20)	58.47	22.75
1950	7	65.81 (11)	65.83 (12)	65.82	13.06
1949	8	66.85 (7)	74.20 (17)	71.17	9.65
1948	9	71.77 (9)	63.00 (2)	70.18	6.25
1947	10	81.00 (1)	70.50 (2)	74.00	1.70
1946	11	75.00 (1)	80.00 (1)	77.50	1.13
		89	87	176	99.95

The summer and autumn growth (Fig. 6) seemed to have stopped (October); all the specimens are resting in this period, with the majority of the otoliths showing a transparent margin. This is in agreement with the considerable number of empty stomachs (55%).

The numbers of males and females are nearly equal, 50.56% and 49.43% respectively. These figures conform well with those found in the various areas of the Grand Bank of Newfoundland.

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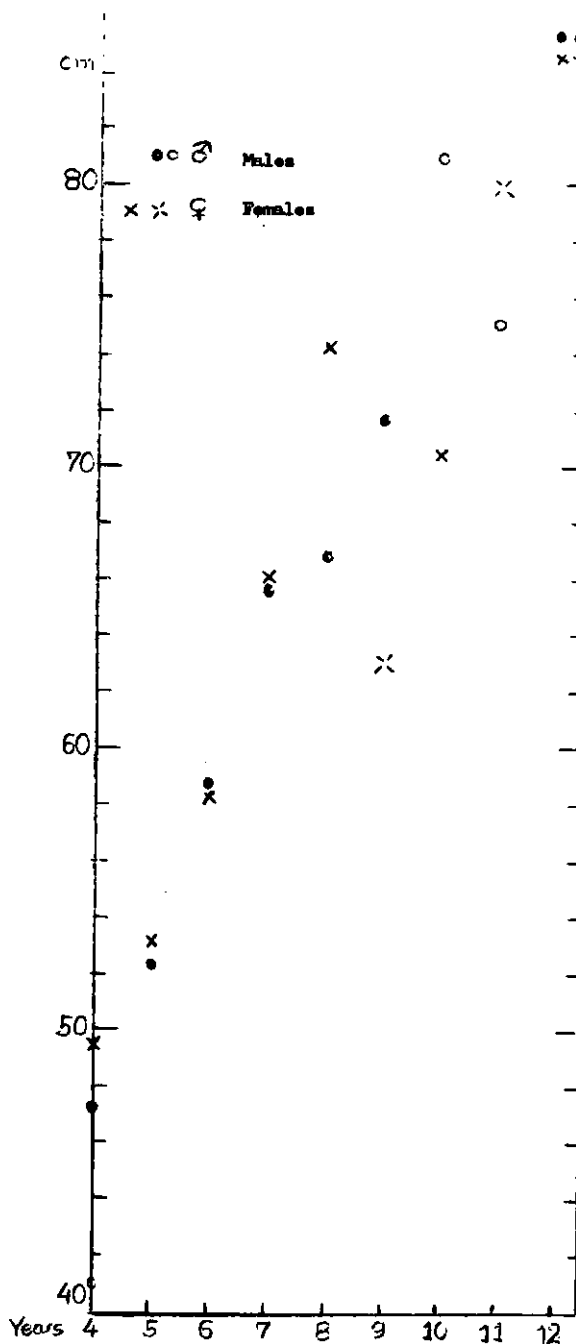


Figure 6. Cod, Subdivision 1D, October 1957. Growth curves for males (89 spec.) and females (87 spec.).

Feeding. The principal foods, as in Subdivision 1B, were the capelin and the sand eel.

Quantities discarded. Owing to the use of a net with a large mesh size (6-3/8 in. or 160 mm. new and dry), the quantity of cod discarded has been minimal. In 1B cod smaller than 40 cm., which is the lower limit accepted by the industry, made up 5.17% by number. In 1D this quantity is much smaller, only 0.79%. When taken into account that these data are based on two months' investigations, the quantities discarded can be considered as nearly negligible.

Weight. Individual weighings were carried out for 341 cod from Greenland waters (the data will appear in the Sampling Yearbook). The weighings are, as mentioned, subject to errors owing to the movements of the vessel, but when this error is eliminated and as the work was carried out on calm days, the results agree fairly well with those cited by Poulsen in Document No. 18 (ICNAF Serial No. 459 of the year 1957).

Biometric proportions (Fig. 7 and 8). Using the same methods as for the cod on the Grand Bank, the correlation between the total length, the head length and the pre-dorsal length was calculated. The corresponding equations were estimated in order to compare the various stocks of cod.

The equations found for the two regions are very much the same:

$$H \text{ (head)} = 0.219 L + 0.448$$

$$P \text{ (pred.L.)} = 0.304 L - 0.971$$

In both cases L is the total length.

Relation of total length to girth. This relation was estimated in order to compare results obtained in experimental samples with those from commercial catches, because a considerable variation of the relations occurs in both cases.

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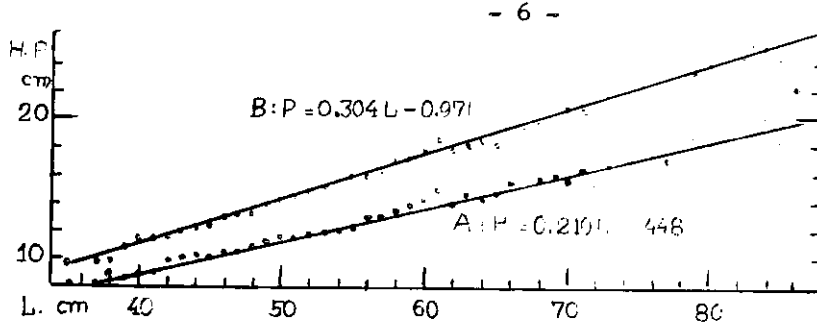


Figure 7. Cod, Subdivision 1B, Sept. 1957 (388 spec.). Line A - Correlation between total length L and head length H. Line B - Correlation between total length L and pre-dorsal length P.

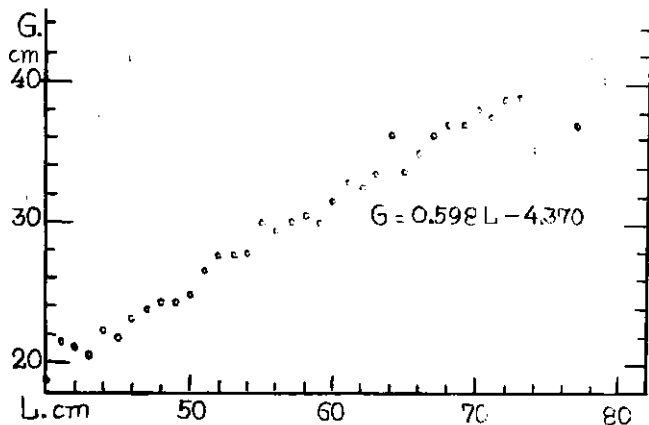


Figure 8. Cod, Greenland, 1957. Correlation between length L and girth G.

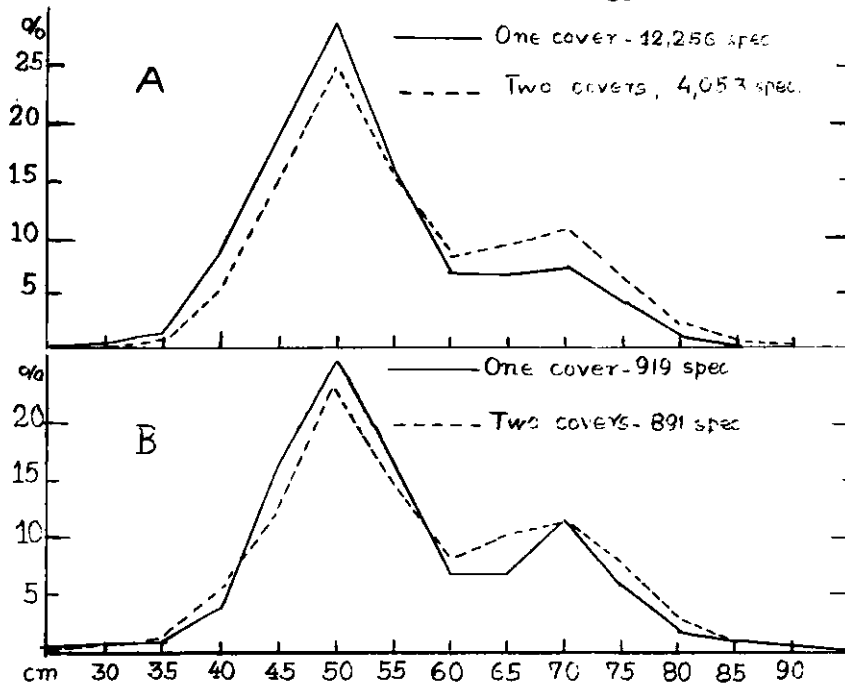


Figure 9. Cod, Greenland, 1957. Length distribution of catches made with trawls with one and two covers. A - Sept./Oct., St. Hallsfiske Bank; B - 4 days catches from one and two covers at the same locality.

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For the Greenland cod the correlation seems to be clearly lineal without any inflexion. There is, however, a considerable spread of observations for the largest individuals. The last observation (total length - 99 cm., girth - 60 cm.) is not shown in the figure.

The ratio between the mean total length and the mean girth is 1.919, slightly higher than for the cod of Labrador (1.90) and much lower than those found for cod in the Norwegian Arctic Sea. This shows that the Greenland cod grows more slowly in girth than that of Labrador.

Equation between total length L and girth G:

$$G = 0.598 L - 4.370 \text{ (Fig. 8)}$$

Comparison of catches with one and with two covers of chafing gear. During the fishery in September and October on Store Hellefiske Bank two trawls were used alternatively. One had one upper side cover, the other had two. The results (see Fig. 9) were, contrary to what one would have expected, in favour of the trawl with two covers, in so far as this gear caught the largest fish. There can be no mistake as to this observation, because it is based on a great number of hauls: with one cover - 55 hauls; with two covers - 28 hauls. The two curves showing the measurements are parallel but with a marked advantage in favour of the two covers. Also the mean size was different: 53.70 cm. for the one cover trawl and 56.70 cm. for the two covers trawl.

During four days it was possible to fish in the same place and under the same conditions with one cover and with two covers. The results obtained were identical (see the lower set of curves).

B. The Cod in the Labrador Area

Samples were collected on board the trawler "ABREGO" of the PYSBE company by special personnel instructed by me for this work in a campaign on the Grand Bank on board the same boat. With this work Spain initiates its study of the Labrador cod.

Material and methods. The material collected in 11 samples on 11 days was studied as a whole, as the various positions where the hauls were made were very close to one another and as the hauls were made on successive days.

The trawl used is that recently adopted by PYSBE, with a mesh size in the codend of 160 mm. measured dry and before use.

Measurements were carried out on 5,704 specimens and from these 10% were taken at random for the study of sexuality, age, stomach contents, etc.

The methods for the study are the same as in previous years.

Date and place of samples. The captures were made in Subdivision 2J between 53° 25' and 54° 05' N and 53° 00' and 54° 15' W, during the last days of October and the first of November.

Size distributions. The data will appear in tabular form in the Sampling Yearbook, 1957.

Fig. 10 gives curves for the size for the various days. It appears that the size decreases during the period of fishing. The mean sizes of the first and the last day were 59.87 and 53.80 cm. respectively.

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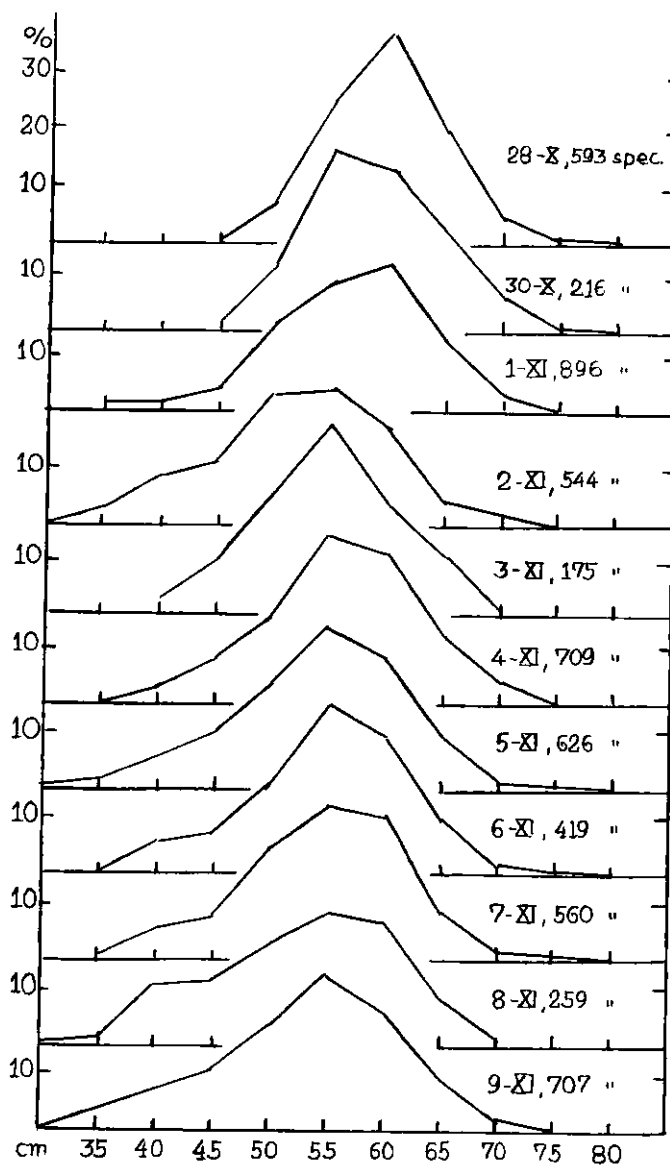


Figure 10. Cod, Labrador, 2J, 28 Oct.-9 Nov. 1957. Length frequency curves for each separate day.

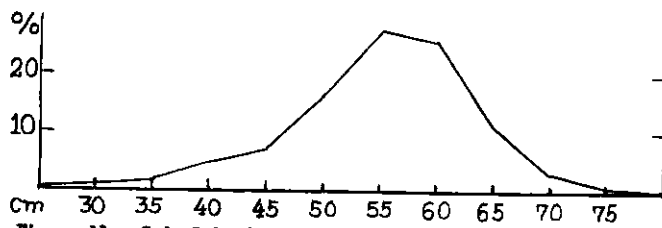


Figure 11. Cod, Labrador, 2J, Oct.-Nov. 1957. Length frequency curve for all samples (5,704 specimens).

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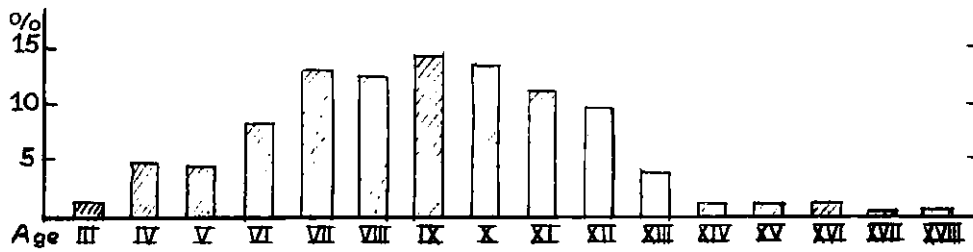


Figure 12. Cod, Labrador, 2J, Oct-Nov. 1957. Age distribution in percentage for all samples (577 specimens).

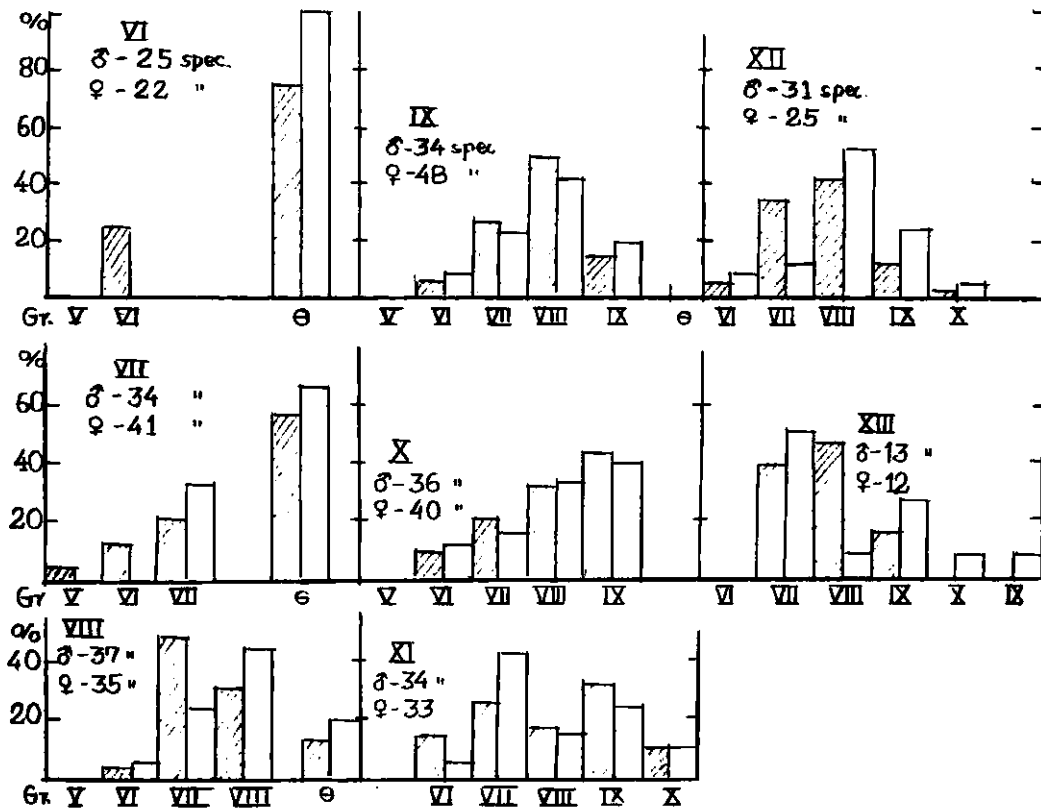


Figure 13. Cod, Labrador, 2J, Oct-Nov. 1957. Percentage numbers of males (hatched columns) and females (white columns) spawning for the first time at various ages (Gr. V-XI) estimated from otoliths of the age groups VI-XIII.

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A similar observation has been made for many campaigns of our fishing vessels in various areas: the size of the fish gets smaller and smaller during the fishing until a point when the fishery seems to fail and the boat moves to another area.

Fig. 11 shows a curve for all the samples from this area. The largest frequency is found in the 55 cm. group (28%), followed by the 60 cm. group (26%).

Quantity discarded. It is very difficult to estimate the quantities discarded. However, it appears that in this area, where the cod generally are not mixed with other species, the numbers of discards are very small.

Taking into account that the samples were measured before culling, it can be estimated that the number of cod discarded is very low. The minimal commercial size is 40 cm. In the samples from the 11 days the quantity discarded is estimated at 5.8% in number, not in weight.

Age distribution (Fig. 12). For the study of age otoliths of 577 cod were read. In general the reading of the otoliths was easy, easier than for cod from the Grand Bank and from off Bonavista.

In nearly all cases the margins of the otoliths were dark, indicating the growth of the summer and autumn of 1957.

The largest percentage is found for the nine year-old specimens (1948 year class), namely 14.38%; it is followed by the ten and seven year-olds with 13.17% and 13.00% respectively. The smaller ones, age six years, and the larger, age 12 years or more, are found in smaller proportions than 5%. (Table 3 and Fig. 12).

Table 3. Cod, age distribution and mean length of year classes, Subdivision 2½ J

Year Class	Age	Males - M.		Females - M.		Total No.	M. Lgth. cm.	%
		No.	Length cm.	No.	Length cm.			
1954	3	6	34.33	-	-	6	34.33	1.04
1953	4	13	42.23	14	41.28	27	41.74	4.68
1952	5	14	47.14	12	46.25	26	46.73	4.51
1951	6	25	48.40	22	52.50	47	50.31	8.14
1950	7	34	52.00	41	54.87	75	53.57	13.00
1949	8	37	54.24	35	56.34	72	55.26	12.48
1948	9	34	56.44	49	57.67	83	57.16	14.38
1947	10	36	57.44	40	58.42	76	57.96	13.17
1946	11	31	58.22	33	60.60	64	59.45	11.09
1945	12	31	59.06	25	61.16	56	61.07	9.71
1944	13	13	61.23	12	63.00	25	62.08	4.33
1943	14	3	67.00	3	63.33	6	65.16	1.04
1942	15	2	65.50	4	63.25	6	64.00	1.04
1941	16	1	68.00	5	70.40	6	70.00	1.04
1940	17	1	65.00	-	-	1	65.00	0.17
1939	18	-	-	1	72.00	1	72.00	0.17
		<u>281</u>		<u>296</u>		<u>577</u>		<u>99.99</u>

In Table 4 and Fig. 13 are shown the relation and percentage of age at first spawning. It is seen that spawning begins at age six years. As the fishery for cod younger than six years (three, four and five years) does not amount to more than 10% in all, the majority of the small cod are saved and with this the reproduction in the region is secured.

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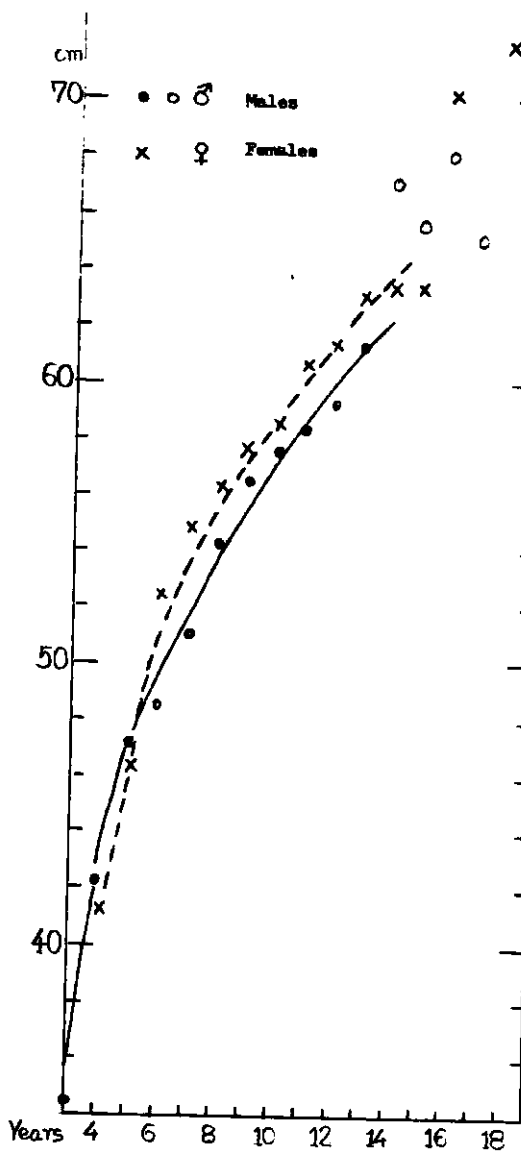


Figure 14. Cod, Labrador, 2J, Oct.-Nov. 1957. Growth curves for males (281 spec.) and females (296 spec.).

The growth curve (Fig. 14) shows that, after the sixth year, i.e. after the first spawning, the females grow more rapidly than the males. The larger specimens of 14 years or more have lengths a little higher than those to be expected from the general trend of the curve.

Stomach content. The contents of 577 stomachs were investigated; 85% were full and 15% were empty.

Capelin (*Mallotus villosus*) was the only species observed in the stomachs. The great amounts of food in the stomachs and the character of the marginal zone in the otoliths indicate that the cod in October-November are in a period of growth.

Correlation between total length (L) and girth (G). For the study of the selectivity of various mesh sizes the collection of information on the girth size of escaped and caught fish is of value. These and other similar observations have been made earlier on research vessels but not on commercial vessels, where it is difficult and uneconomic to do so when the vessel is busy fishing. Therefore, it was found advisable to compare such data which have been collected from research vessels with those from commercial trawlers. The behaviour of fish, single or in smaller or larger shoals, may no doubt differ; therefore, results from research vessels and from large trawlers may well differ considerably, due to the duration of hauls, density of stock, and the behaviour of those first caught.

The girth of the 79 cod (Figs. 15 and 16) was measured just in front of the first dorsal fin and to the half-cm., as was also the total length. The stomachs of these were not investigated, but of 577 others caught on the same day and at the same place 85% had full stomachs. However, when the girth is measured off the first dorsal fin, a full stomach will hardly influence the measurement.

The relation between the averages of the total length and the pre-dorsal girth is 1.90, much lower than what has been found for the Arcto-Norwegian cod, for which the following values were estimated:

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1st girth	3rd girth
2.41	2.17
2.51	2.23
2.36	1.97
2.44	2.43

If both stocks (Labrador and the Northeast Atlantic) showed the same ratio, the body development would have been the same. The smaller proportion found for the Labrador cod indicates that this is a stouter stock.

The relationship between total length and girth corresponds fairly well with a straight line, for which the following equation was elaborated:

$$G = 0.644 L - 6.763$$

In this case an inflexion at 65 cm., as that found for the Grand Bank cod, was not observed. This may be due to the small number of specimens.

The ratio of total length to girth was larger than that found for the Grand Bank. However, the girth of the Grand Bank cod was measured near the operculum.

Table 4. Cod, Subdivision 2¹, age at first maturity estimated from the rich age groups VI-XII

		V	VI	VII	VIII	IX	X	XI	?	θ	Total
VI	♂	No	6	-	-	-	-	-	-	19	25
		%	24	-	-	-	-	-	-	76	
	♀	No	-	-	-	-	-	-	-	22	22
		%	-	-	-	-	-	-	-	100	
VII	♂	No	4	7	-	-	-	-	3	19	24
		%	2.9	11.8	20.6	-	-	-	8.8	55.9	
	♀	No	-	13	-	-	-	-	1	27	41
		%	-	31.7	-	-	-	-	2.4	65.9	
VIII	♂	No	1	18	11	-	-	-	2	5	37
		%	-	2.7	48.7	29.7	-	-	5.4	13.5	
	♀	No	1	8	16	-	-	-	4	6	35
		%	-	2.9	22.9	45.7	-	-	11.4	17.1	
IX	♂	No	2	9	17	5	-	-	1	-	34
		%	-	5.9	26.5	50.0	14.7	-	2.9	-	
	♀	No	4	11	21	10	-	-	1	2	48
		%	-	8.3	22.9	43.8	20.8	-	2.1	4.1	
X	♂	No	3	7	11	15	-	-	-	-	36
		%	-	8.3	19.4	30.6	41.7	-	-	-	
	♀	No	4	6	13	15	-	-	2	-	40
		%	-	10.0	15.0	32.5	37.5	-	5.0	-	
XI	♂	No	4	8	5	10	3	-	1	-	31
		%	-	12.9	25.8	16.1	32.3	9.7	3.2	-	
	♀	No	1	14	5	8	3	-	2	-	33
		%	-	3.0	42.4	15.2	24.2	9.1	6.1	-	
XII	♂	No	2	11	13	4	1	-	-	-	31
		%	-	6.5	35.5	41.9	12.9	3.2	-	-	
	♀	No	2	3	13	6	1	-	-	-	25
		%	-	8.0	12.0	52.0	24.0	4.0	-	-	

? - doubtful.

θ - immature.

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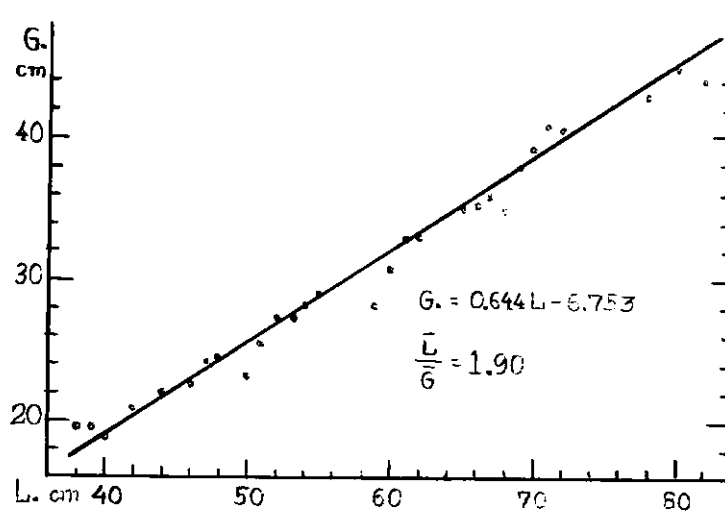


Figure 15. Cod, Labrador, 2J, Oct.-Nov. 1957. Correlation between total length L and girth G.

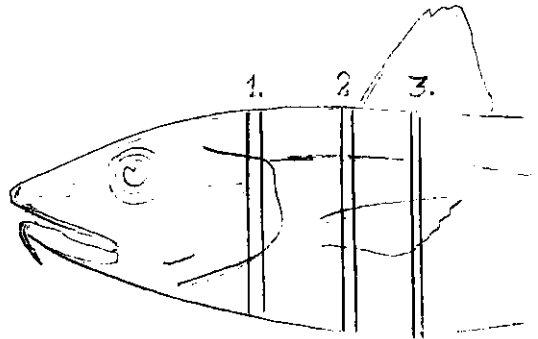


Figure 16. Position on body of the 3 girth measurements.

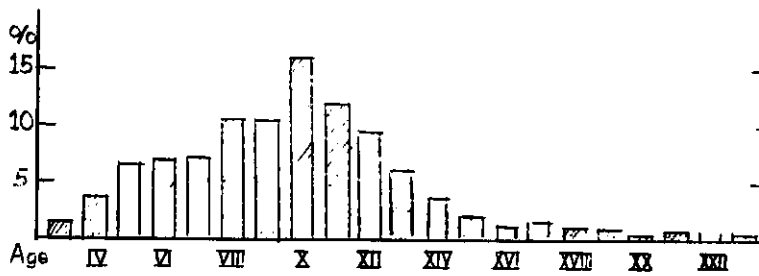


Figure 18. Cod, age distribution, Subdivision 3L, August 1957, 645 spec.

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Observations on Spanish Trawler Catches in Subarea 3 in 1957

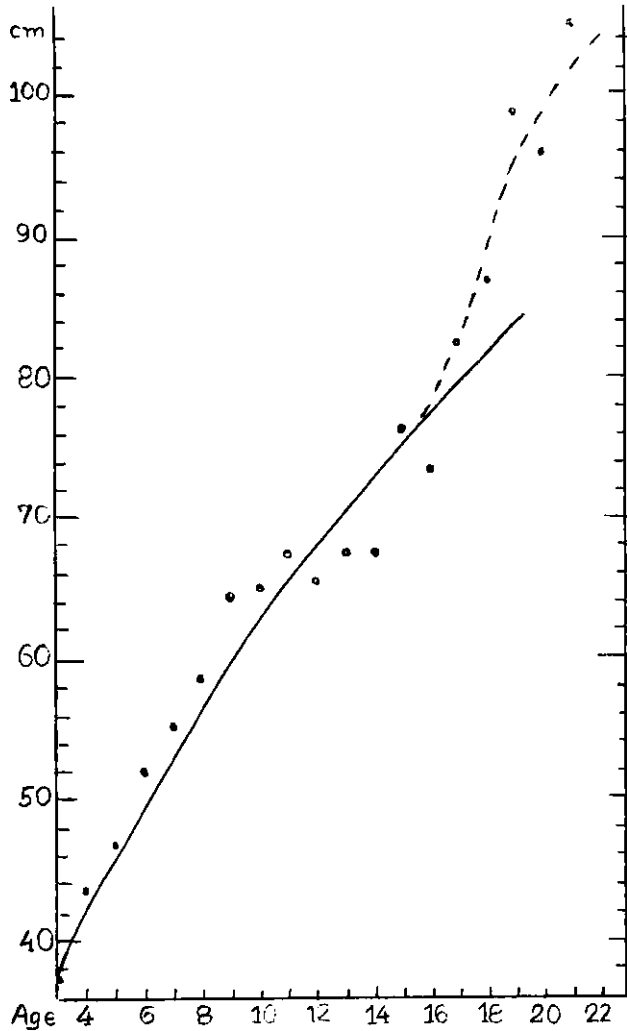


Figure 17. Growth curve for cod, Subdivision 3L, August 1957. 645 specimens.

A large amount of material was collected in 1957 in the various subdivisions of Subarea 3 on board the trawlers "ABREGO" and "SANTA EUGENIA" as well as in port from various vessels; but as they often were caught in the same region and at the same time the results are comparable. The investigations on the selectivity of the trawls are very difficult to make on board vessels intended for commercial fishery for economic reasons, loss of time, etc., but samples collected in that manner offer direct evidence of the variation in selectivity of trawls with meshes of different size.

The material and the results of the investigations are given separately for each of the subdivisions of Subarea 3.

The species considered are: cod (*Gadus callarias* L.), haddock (*Melanogrammus aeglefinus* L.), and pollock (*Pollachius virens* L.). A part of the material collected has not been worked up owing to lack of the necessary manpower and time. All samples were collected and investigated by the author.

C O D

Subdivision 3K

It was only possible to collect a small sample from the vessel "ABREGO", 50° 58' N and 54° 35' W, August 1957, fishing with a trawl with meshes of 160 mm. (new, dry).

The sample included 245 specimens. 25 (or 10%) were aged. The ten year-old fish, 1947 year class, predominated.

The size distribution of the sample is shown in Fig. 19, curve 1a. The mean length is 61.85 cm. (Size and age data considered in this paper will be presented in tabular form in the 1957 Sampling Yearbook. Owing to the scarcity of material other data are not reported.)

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Subdivision 3L

Several samples were collected in August 1957. As all these samples were caught in nearly the same position, between 47° 53' - 48° 47' N and 50° 50' - 52° 45' W, they have here been considered only in their entirety. All samples were taken by 160 mm. (6-3/8 in.) meshes, new.

Size distribution. The size distribution of 6643 cod measured on board before culling is shown in Fig. 19, curve 2a; the mean size is 61.40 cm.

Age and growth. Otoliths of 645 specimens (10% of the sample) were studied. Until the 11th year the growth rhythm is regular, but after that age the size values lie above the curve, similar to what was found for Greenland cod the previous year (Fig. 17).

From the sixth year (i.e. principal year of first spawning) the females grow more rapidly than the males, similar to the case with the Labrador cod.

The 1947 year class predominated in the samples with 15.66%, followed by the 1946 year class with 11.94%, the 1948 year class with 10.85% and the 1949 year class with 10.54% (Fig. 18).

The proportion of males and females was 49.9% and 50.1% respectively.

Stomach contents. The stomach contents were studied on 649 specimens; 74% had full stomachs.

Weight (Fig. 20). On some of the quietest days 402 specimens were measured to the centimetre and weighed. Fig. 4 gives for each cm. group the number of specimens weighed and the mean individual weight.

Subdivision 3N

The Spanish trawl fishery in 3N is carried out mainly in summer. As in previous years, a large number of samples was taken. They are here grouped in two main samples, one for August, the other for September.

The first sample-group, caught on 5th August at 44° 45' N and 50° 34' W, includes 416 specimens. The mesh size of the codend used was 160 mm., measured when new. The average length of the specimens is 48.35 cm.

Age determinations were carried out on 51 cod. Owing to this small number the results are not considered here.

The second sample-group is from catches made during September at 44° 50' N and 50° 20' W and in nearby places by the trawler "SANTA EUGENIA" using a mesh size of 130 mm. (new, dry). The fishery was better in September than in August, as has been the case in the last three years. This good cod fishery lasts until the beginning of October.

Although the meshes differ considerably for these two sample-groups, the vessels, the fishing and the handling of the fish were very much the same. Further, as the region was the same and the time difference only about one month, there appears to be no very appreciable difference in the number of small fish passing through the net.

The length distribution curves, 4a and 5a, of Fig. 19 are very similar, and the quantity of discarded cod is 22.34% for the

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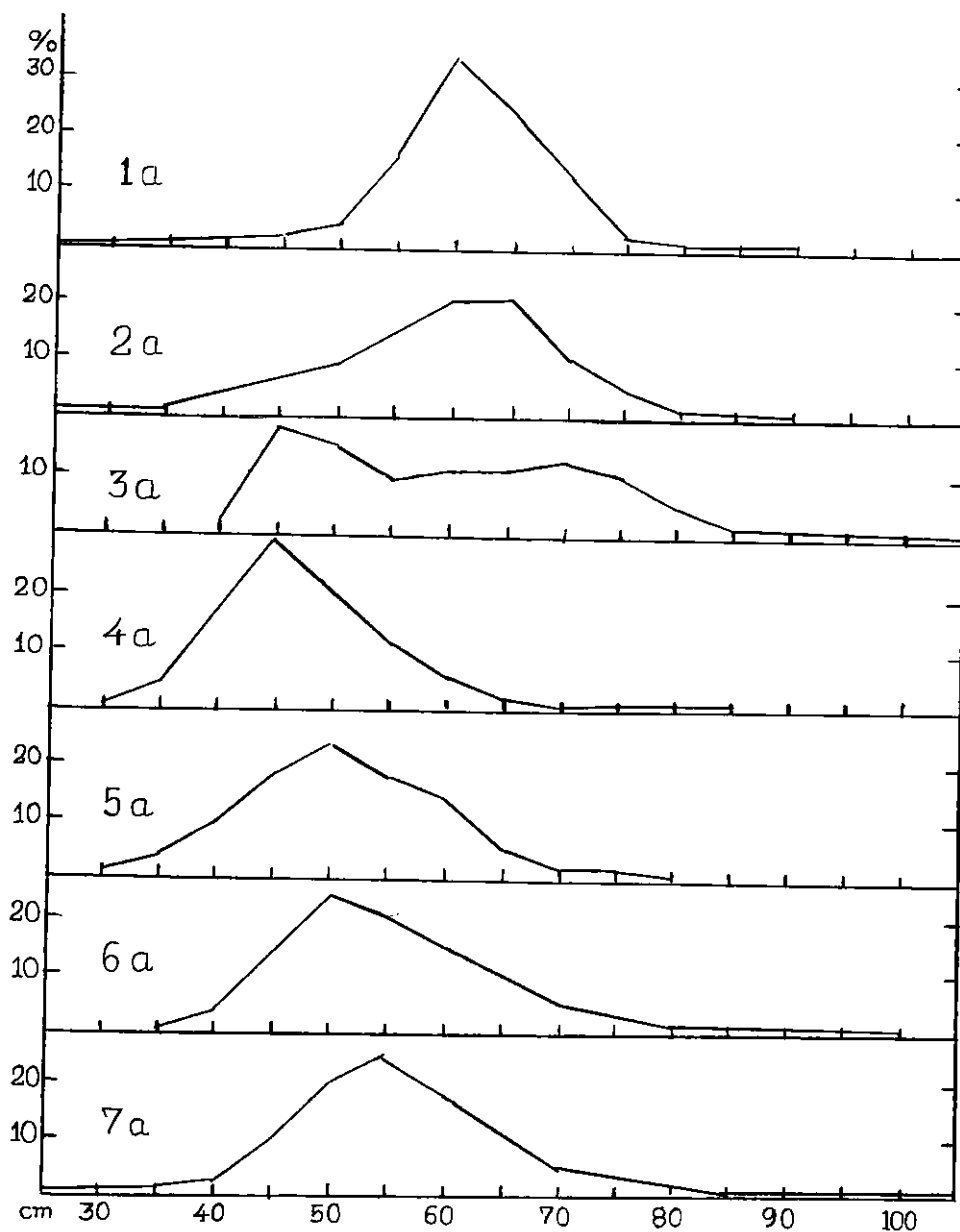


Figure 19. Cod, length distribution, Subarea 3, Year 1957.

- | | |
|---|-------------------------------------|
| 1a - "Abrego", 20 Aug. 3K, 245 spec. | 2a - "Abrego", Aug. 3L, 6,643 spec. |
| 3a - "Abrego", 25 Aug. 3P, 436 spec. | 4a - "Abrego", 5 Aug. 3M, 416 spec. |
| 5a - "Santa Eugenia", Sept. 3W, 1,526 sp. | 6a - "Abrego", Nov. 3P, 2,787 spec. |
| 7a - "Abrego", Nov. 3O, 3,531 spec. | |

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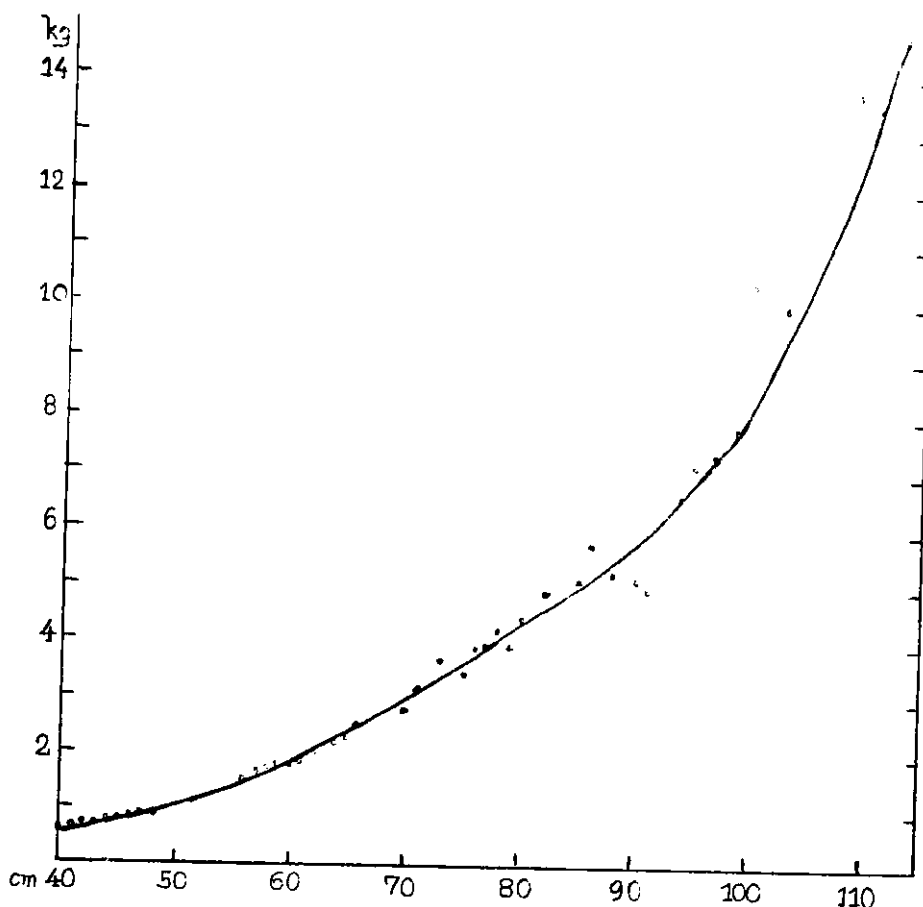


Figure 20. Length-weight curve, mean weight for each cm. group for 402 cod caught in Subdivision 3L in August 1957.

first group and 11.74% for the second. In comparison with other years it appears that no appreciable difference occurs in the improvement of the selection as far as cod is concerned.

In contrast, the difference and improvement is great as regards the small haddock, the large mesh net saving more than the other.

The reason for this difference between the two species may be that the small cod do not shoal so strongly on the bank as the grown-up ones, and on account of this they have a better opportunity to escape the trawl. This would not be the case for the dense shoals of haddock. This fact was also mentioned for Greenland cod, where large shoals diminish the selectivity.

From this fact it appears that the experiments on selectivity carried out by research vessels need some revision, in so far as the selection is less pronounced for the big trawlers.

During September otoliths were collected, but time has not yet permitted a study of them. They are expected to be read during next year.

A total of 4081 cod were measured from "SANTA EUGENIA" in September; their average size was 53.0 cm. A size distribution for 1526 of these cod is shown in Fig. 19, curve 5a.

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Subdivision 3P

From this subdivision (St. Pierre Bank) a series of samples of split cod were collected through the year in port from various trawlers fishing in the same region and at about the same period. The cod were measured on board, as split and salted, about two or three days after capture. The measurements were converted to fresh fish using the equation determined last year for cod from the Grand Bank. Thus the results of these measurements become comparable with measurements of fresh cod. For the total length the mean and the standard deviation were calculated.

At the same time and for the same vessels the codend meshes were measured. These vessels in 1957 used two upper covers for the codend, and the trawls differ somewhat for trawlers belonging to the various companies.

The size distribution of these samples is shown in Fig. 21. All the curves are given in the same figure in order to facilitate comparison. It is apparent that the size of the cod becomes larger with increasing size of codend meshes, owing to the different selectivity. Especially telling is the comparison between samples 3a and 4a, collected on the same day and at the same place, but from vessels using a slightly different mesh size. Two year classes appear in the samples, and the boat using the smaller mesh caught the larger proportion of small cod.

From the curves shown in Fig. 21 it is apparent that the mean size is decreasing from the beginning of March to the beginning of April. This fact has already been observed several times on the Grand Bank.

Through all the samples the percentages of large cod increase with increasing mesh size, it can even be said in proportion to the mesh sizes in the five cases examined (Fig. 5).

As the fish were split and salted, material for aging could not be collected.

In August another sample of 436 specimens was taken in Subdivision 3P from "ABREGO" (mesh size - 160 mm., new, dry). The average length was 60.70 cm.; the predominating size groups were 45, 50 and 70 cm. The dispersion of sizes is large, the standard deviation being 12.85. Otoliths were collected from only 45 specimens; they have not yet been read.

Another sample of 12,787 specimens was taken at the border of Subdivision 30 in November. Its mean length was 53.90 cm., i.e. considerably below the sizes observed in August.

Subdivision 30

One sample was taken in November, just at the border of 3P. The trawl used had codend meshes of 160 mm. (new) and one upper cover on the codend. The mean size of the 3531 specimens was 52.70 cm.

H A D D O C K

During the fishing campaign of the summer of 1957 (August-September) a smaller amount of data on the haddock were collected.

Material and methods. The samples were taken from the same vessels and the same gears as the cod samples. The Spanish trawlers do not give special attention to fishing for haddock; this species is only considered as a by-product of the cod fishery. Therefore, during

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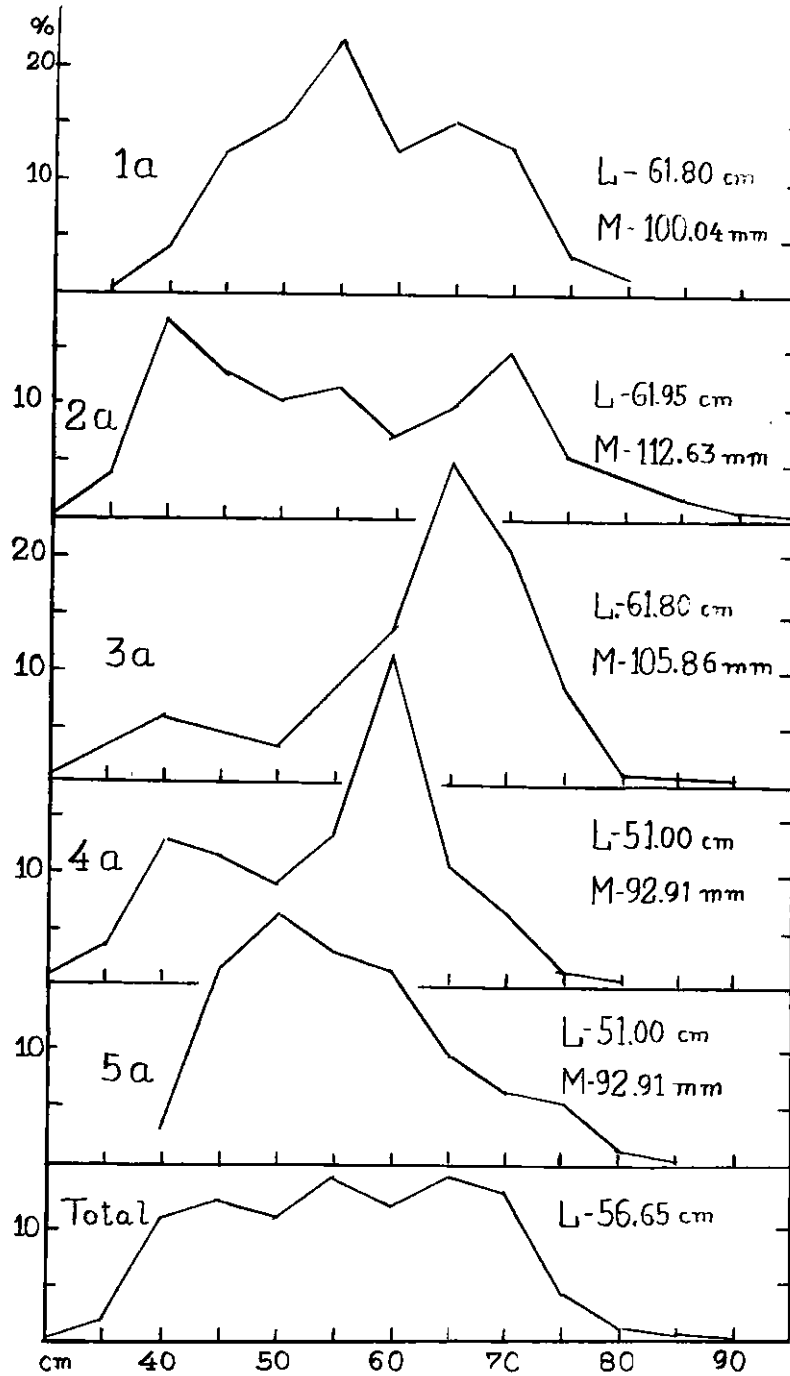


Figure 21. Length distribution of cod, Subdivision 3P, March-April 1957.

1a - "Puerto de Navacerrada", 3 March, 403 spec. 2a - "Puerto de Dondefria", 1 April, 488 spec. 3a - "Santa Ines", 9 April, 406 spec. 4a - "Santa Elvira", 9 April, 133 spec. 5a - "Galerna", 12 April, 351 spec.

L. Mean Length of sample in cm.

M. Codend mesh size in mm.

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some years the Spanish haddock catch has decreased considerably (the low Spanish catches of haddock in recent years are thus not due to a scarcity of this species). The Spanish captains leave areas with large concentrations of haddock, searching for cod concentrations.

Size distribution. Two samples were collected in the summer of 1957 in 3N, one in August from the "ABREGO" using a mesh size of 160 mm. (6-3/8 in.), new, another in September from the "SANTA EUGENIA", mesh size 130 mm. (5-1/8 in.), new.

The lengths of the fish were grouped in 3 cm. groups. The mean length of the "ABREGO" sample was 40.22 cm. (standard deviation +3.90), that of the "SANTA EUGENIA" 39.59 cm. (standard deviation +6.12). The size difference is negligible in spite of the considerable difference in mesh size used. However, a study of the two last curves of Fig. 22 shows that the trawl with the larger mesh size (the August sample) allowed the haddock below 30 cm. to escape. These small haddock belong to the 1954 and 1955 year classes (two and three years old).

The standard deviation is considerably smaller for the August sample than for the September sample. This is due to the fact that the former sample represents only a single day's fishing and, it might well be, just a single shoal of small haddock. The September sample, however, is from a period with rich fishery. However, the quantities discarded are in both cases very large.

The larger mesh size (160 mm.) has caused some improvement in the selectivity, but not one sufficient to ensure the escape of a large part of the fish not used for salting. The explanation of this is either that the two codend covers greatly diminish the escape or that the haddock concentration is so large that the large quantities in the codend hinder the escape.

Size curves for earlier years are included for comparison. In some years two peaks are observed, indicating two year classes whose growth can be followed through the years. The year class which predominated in 1956 continues to predominate in 1957, and in this year another appears with a modal size of around 29 cm., which, according to the growth rate calculated for this region of the Grand Bank is two years old (1955 year class). These data seem to confirm the three-year cycle for haddock abundance, demonstrated earlier.

It is to be noted that the abundance of small haddock increases from year to year. The stippled line in Fig. 22 indicates the minimum size accepted by the Spanish fishing industry. The quantities to the left of this line are those discarded, increasing considerably from year to year. But, although this quantity increases in the sample, the total yearly catch does not increase, due to the fact that the Spanish trawlers, as mentioned, do not give much attention to haddock, the demand for this species being small.

What is the reason for the increase in the abundance of small haddock? Firstly, it could be caused by a decrease in the size of haddock over the years. Secondly, also to a better adaption of this species owing to improved conditions for the young, i.e. to larger year classes. I am in favour of this second explanation because a comparison of Thompson's figures for 1939 and mine for 1954-1956 shows an increase in size for haddock of the same age. Finally, it could be noted that the mean temperature of the Grand Bank has increased during recent years which is beneficial for the haddock, which prefer warmer water than the cod.

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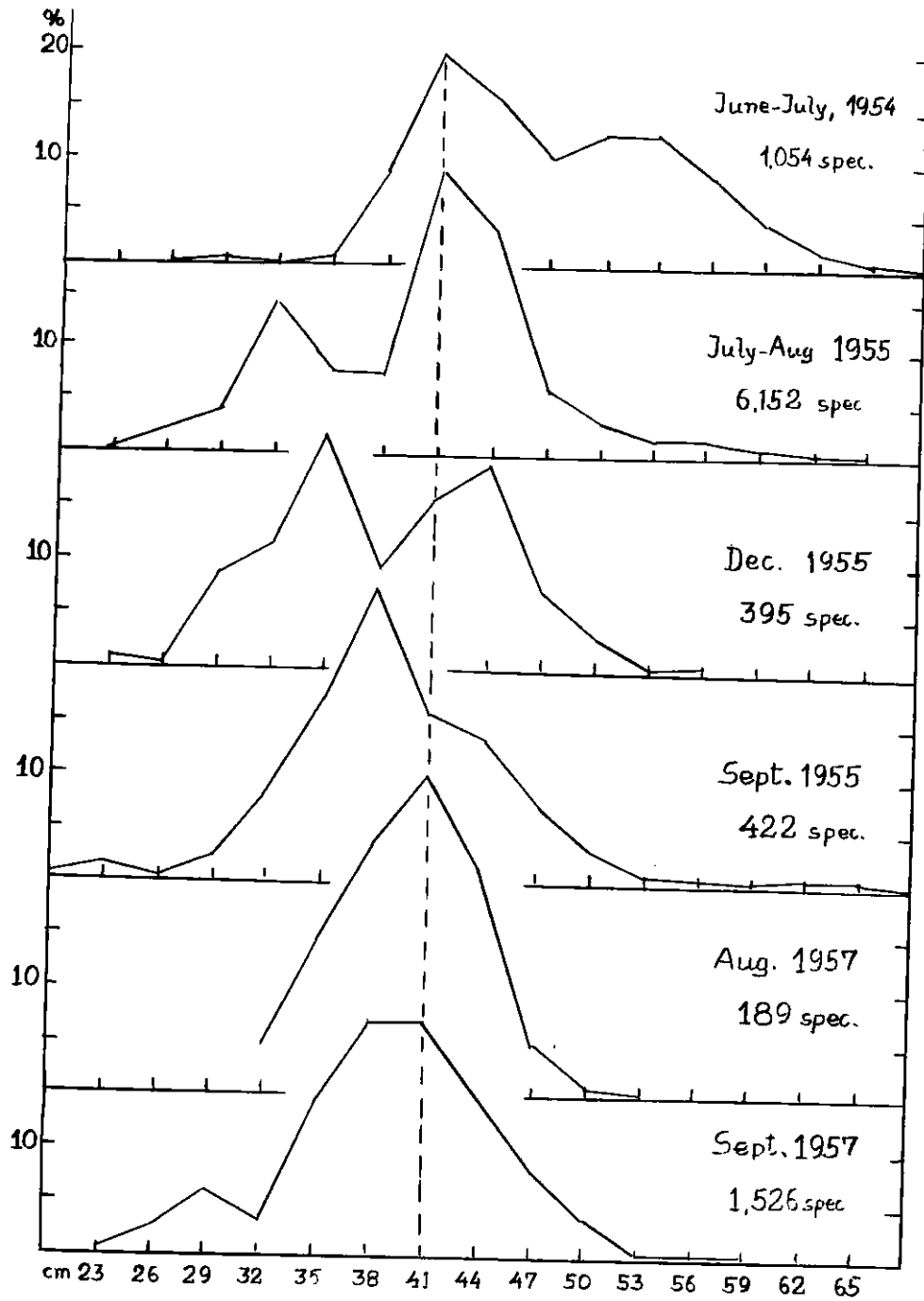


Figure 22. Length distribution of haddock, Subdivision 3B, 1954-57.

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P O L L O C K

No special attention has been attached to the pollock, but some material has been collected on days when it appeared in abundance in the catches in Subdivision 3P (45° 05' N and 55° 15' W).

The measurements were made on board "ABREGO" on fish caught in a 160 mm. codend (new). The length measured is, as for the cod, the fork length, to the nearest centimetre. In the last days of August 1054 pollock were measured and grouped in 5 cm. groups, with multiples of 5 as the group center (as for the cod).

The modal size (Fig. 23) is in the 45 cm. group (fresh fish length) and the mean size is 56.55 cm. Otoliths were collected but not read.

The yield of the fishery varies through the 24 hours, being highest early in the morning, decreasing towards noon, and being negligible in the afternoon and at night (Fig. 23). The quantity fished (from 2½ days fishing) is expressed in "cestos" of 80 kg. split fish.

The food of the pollock in this region was almost exclusively Myctophum punctatum Raff. and Ceratocopelus maderensis, i.e. luciferus fishes.

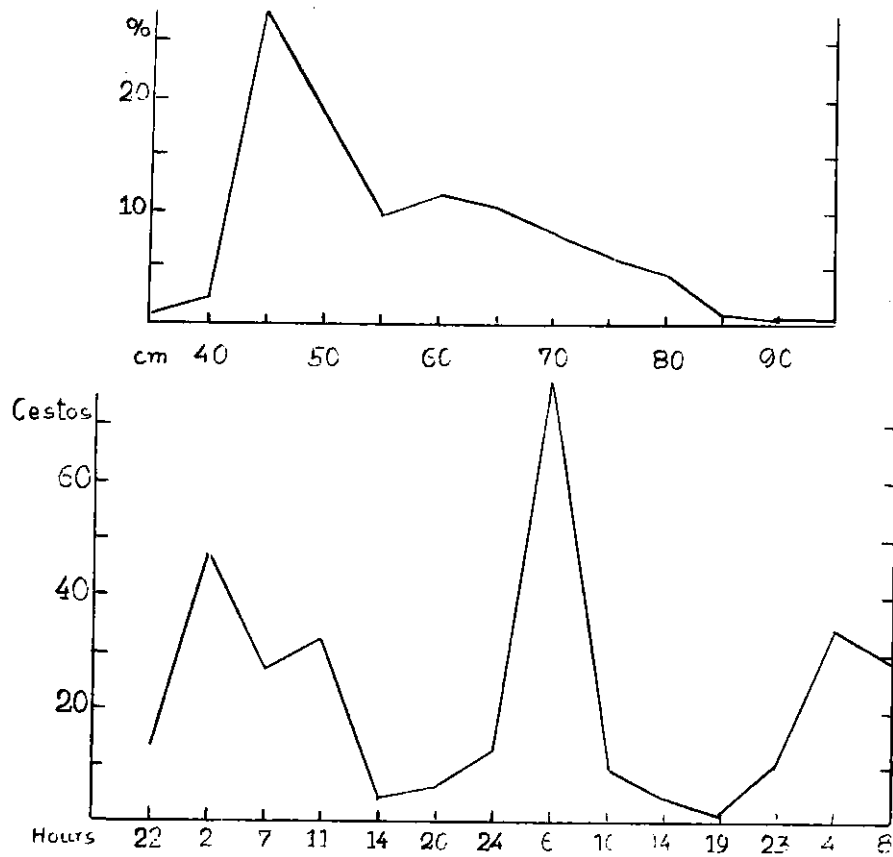


Figure 23. Above - length distribution of pollock, Subdivision 3P, August 1957, 1,054 specimens.
Below - catch of pollock at different hours of the 24 hours. 1 cesto = 80 kgs. split fish.