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Comparison of Age Distribution of Cod Samples  
from Commercially Fished Cod in the ICNAF Area, mainly Subarea 1.

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The samples from Subarea 1 reported to the Commission from the years 1952, 1953 and 1954 from the commercial fisheries by Denmark (Greenlanders' and Faroese), Iceland, Norway, Portugal and United Kingdom are considered. For comparisons are further used the large number of samples taken in Subarea 1 by hook from the Danish research vessel "Dana", as well as the - rather few - samples reported by other countries from other subareas (by Canada, France and Spain); some of these latter samples are from years before 1952. The total material comprises about 33,000 individuals of which around 27,000 are from Subarea 1. The figures used are the frequency percentages of the separate samples, and not individual numbers; this means a certain sample, be its number of individuals more or less, influences the results to the same extent.

Fig. 1 shows for Subarea 1 for the years 1952-54 and for all countries the age distribution in samples of commercially caught cod. The material comprises the following samples:

- 1952: Iceland, 3 samples, St.Hellefiske Bk., Holsteinsborg, Fylla Bk. (4,940 spec.); Norway, 3 samples, Holsteinsborg Deep, St. Hellefiske Bk. Disko Area (2,500 spec.).
- 1953: Greenlanders', 4 samples, Disko Area, Central coast, Godthåb Fj., south coast (5,482 spec.); Iceland, 1 sample, Fylla Bk. (1,950 spec.); Norway, 2 samples, Holsteinsborg Deep, Fylla Bk. (ca. 2,000 spec.); Portugal, 4 samples, Fiskenes Bk., Dana Bk., Fylla Bk., St.Hellefiske Bk. (817 spec.); United Kingdom, 1 sample, Kap Farvel (494 spec.).
- 1954: Faroes, 1 sample, Fylla Bk. (238 spec.); Greenlanders', 4 samples, Disko, Central coast, Godthåb Fj., South coast (2,762 spec.); Iceland, 1 sample, St.Hellefiske Bk. (837 spec.); Norway, 3 samples, St.Hellefiske Bk., Holsteinsborg Deep, Lille Hellefiske Bk. (2,288 spec.).

The top curve gives the age distribution of the 27 samples for all the three years together. The age ranges from 2 to 20 (22) years. There are hardly any cod of ages 2, 3 or above 20 years. The ages contributing by far the greatest bulk (83%) of the catches are ages 5-12. The age group with the highest frequency is 7 years - 18%, the next highest is 11 years - 11%. The mean age is 9.3 years. It is to be noted that the rising of the curve (ages 4 to 7) is far more steep than the decline of the curve (from age 7 and upwards). The recruiting of the marketable stock takes place during the 5th, 6th and 7th year of the cod's life. The using up of the stock by the fishery (and natural mortality) takes about 13 years.

The three lower curves of the figure give the age distribution of commercial samples by all countries for each of the years 1952, 1953 and 1954. These curves show the exceedingly great difference in the commercial value of the rich and the poor year-classes, cfr. the rich 1947, 1945 and 1942 year-classes, with the poor 1946 and 1944 year-classes. The variation of the mean age is not very great. The lowest mean age, 8.8 years, is found in 1952, when the 1947 year-class at an age of 5 years first entered the fishery. The highest mean age, 9.7 years, is in 1953 with the 1947 year-class

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has grown for another year, and while the 1942 year-class still occurs plentifully. In 1954 the mean age is lower again, 9.4 years, owing to the decline in numbers of the 1942 year-class. The rather strong decline of the 1945 year-class also is to be noted.

Fig.2 shows a comparison between the age distribution in the above-cited commercial samples and samples taken mainly by hooks and jiggs from the Danish research vessel "Dana": 1952, 7 samples (1,485 spec.); 1953, 9 samples (2,320 spec.); 1954, 12 samples (2,569 spec.). The samples from "Dana" are rather evenly spread over the fishing grounds, and not, as one must suppose the commercial samples to be, more specially from areas where larger cod - most sought by the commercial fleet - concentrate. The cod from the "Dana" samples are therefore younger (and smaller) than those from the commercial samples, 7.2 years of age instead of 9.3 years. The peak of the curve is in both cases at 7 years of age but it is considerably higher, 28% for the "Dana" samples, than for the commercial samples, 18%. The additional smaller - but still appreciable - peak of the commercial samples at age 11 is substituted by only a smaller bulge in the "Dana" samples.

The two curves thus only coincide as far as their larger features are concerned - range of age-groups and main peak. Taken together the two curves can be supposed to render a fairly true picture of the cod population on the Greenland fishing banks, at any rate as far as age-groups from 5 years and upwards are concerned. It would be of interest to have carried out experimental trawlings on the banks in order to find out if the younger age-groups are so scarce here as the samplings show.

A comparison of age composition of cod from W. Greenland, commercial samples and "Dana" samples with that of cod from two other important cod areas of the North Atlantic: Iceland and the N.E. Atlantic, (in both cases commercial samples) is shown in Fig.3.

The N.E. Atlantic samples are from German trawlings in the area between N. Norway, Bear Island and Murmansk, 1929-53 (J. Lundbeck: German Market Inv. on Cod mainly in the North Eastern Area, Rapp. et Proc. Verb. ICES Vol. 136, 1954). The Icelandic samples are from Icelandic trawling on spawning grounds round Iceland, 1950-53 (Jón Jónsson: On the Icelandic Stock of Cod during the Years 1928-53, *ibid.*).

The range of ages caught is about the same in the three areas. The peak of the curve is at 7 years of age both for W. Greenland and for N.E. Atlantic waters. For Iceland the peak is at 8 years; this may well be due to the fact that the Icelandic samples are definitely from spawning areas. The mean age of the individuals only differs little:

W. Greenland	commercial samples	- 9.3 years
"	"Dana" samples	- 7.2 years
N.E. Atlantic,	commercial samples	- 7.2 years
Iceland	commercial samples	- 9.5 years

When we only consider the commercial samples, there is, however, one striking difference. The age-distribution curve for W. Greenland is more flat than that from the N.E. Atlantic and from Iceland. The highest peak reaches for W. Greenland only 18%, for the two other areas, however, 26% and 25%. In the N.E. Atlantic there is no second peak as that for 11 years in W. Greenland; in the Icelandic samples (spawning cod), there is a very small peak at 15 years of age. This comparative flatness of the curve becomes apparent from the following figures giving the sum of

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the frequencies of the 4 years making up the peak of the curves:

- W. Greenland - 48%
- Iceland - 65%
- N.E. Atlantic - 79%

This means that the bulk of the commercial catches is spread over a larger number of age-groups in W. Greenland than in Icelandic and N.E. Atlantic waters. However, this does not necessarily imply that the bulk of the cod population itself is composed of more age-groups, it might well be caused by a different mode of fishing. In W. Greenland line fishing and dory fishing (hooks) play a far greater role than in the other two areas, where trawling is so absolutely dominating.

The spreading of the fishery over more - and older - age-groups in W. Greenland waters offers a considerable protection to the cod stock, and must to that extent be considered an advantage. On the other hand it means an increase of the natural mortality compared to the fishing mortality, and thus possibly a less efficient exploitation of the stock.

Fig.4 shows a comparison of the age-distribution of commercially caught cod in Subarea 1 with age-distribution in other parts of the Convention Area (Subareas 2, 3 and 4). The material from Subareas 2, 3 and 4 is the following:

- Subarea 2: Labrador, 1931, 875 spec. (Rep. of the Newfoundland Fish. Res. Stat. Vol.1, No.4, 1932)
- " Labrador, Aug. 1952, 963 spec. (J. Ancellin: Obs. s. la Morue de Terre-Neuve et du Labrador; Rapp. et Proc. Verb.136, ICES, 1954).
- Subarea 3: S. Grand Bank, 1953, 54, 55, 508 spec. (Spanish Research Rep. to ICNAF for 1953, 54 and 55).
- " Grand Bank, 1931, 2,276 spec. (Rep. of the Newfoundland Fish. Res. Stat. Vol.1, No.4, 1932.).
- Subarea 4: Banquereau, 1945-54, 1,382 spec. (ICNAF Ann. Meet. 1955, Rep. Sc. Adv. Pan. 4. App.1 - W.R.Martin).

The mean age decreases only slightly from Subarea 1 to Subarea 3: 1 - 9.3; 2 - 8.8 and 3 - 8.7 years. From Subarea 3 to 4, there is a considerable decrease from 8.7 to 7.0 years. This is in accordance with the generally held view that the cod stock in Subarea 4 is to some degree over-exploited. The number of cod older than 15 years is much higher in Subarea 1 than in the other subareas:

- Subarea 1 - 9%
- " 2 - 2%
- " 3 - 2%
- " 4 - 1%

The catch is thus spread over a larger number of age-groups or year-classes in Subarea 1 than in the other subareas, as also the following figures giving the number of age-groups to be summed to get 4/5 of the total number:

Subarea 1, age-groups	5-13, 8	age-groups	= 82%	of total
" 2 "	7-11, 5	" "	= 81%	" "
" 3 "	6-10, 5	" "	= 80%	" "
" 4 "	5-9, 5	" "	= 79%	" "

Thus the commercially caught cod from W. Greenland waters are more evenly spread over a larger number of age-groups than are the

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catches from the more southern part of the Convention Area, as well as catches from Iceland and the North East Atlantic (Fig.3). The reasons for this may be one or all of the following:

- a. That hook fisheries play a far greater role in Subarea 1 than in the other regions (the samples from Subareas 2, 3 and 4 are all from trawl fishing);
- b. A slower growth in W. Greenland waters than in the other regions (apart from Subarea 2);
- c. A less intense fishery in Subarea 1 than in the other regions.

The material from W. Greenland is large enough to permit a comparison of the age distribution of commercial catches by the separate countries. The samples used are those reported by the countries for the years 1952-54, and include also the samples taken from the "Dana".

Fig.5 shows the age distribution curves for the separate countries. The curves for the Faroes, Portugal and United Kingdom comprise each only samples from one year, the curve for the Greenlanders' fishery 2 years, those of Germany, Iceland, Norway, as well as those from "Dana", include 3 years. The top curve is from the non-commercial samples by "Dana", three years. The following curves - apart from the "Dana" curve - are arranged after increasing mean age.

There is a considerable difference in the age-composition of the samples from one country to another. The lowest age, 7.1 years, is found in the Icelandic samples, the highest, 11.1 years, in the Norwegian samples; the difference is as high as four years. Close to the Icelandic samples are those by the Faroes and Germany, 7.3 and 7.4 years. Considerably higher are U.K., the Greenlanders' and Portuguese samples.

These differences may be due to different gears used or to different regions being fished by the separate countries. It might also be due to the defect in the material, as far as some countries only have samples from one or two of the three years concerned.

The following survey gives for each country the mean age, the mean length and the method of fishing (year of observation):

<u>Country</u>	<u>Mean Age</u>	<u>Year</u>	<u>Mean Length (cm.)</u>	<u>Year</u>	<u>Method of Fishing</u>
Norway	11.1	1952,53,54	77.1	1952,53,54	Hook & Line
Portugal	9.9	1953	70.7	1953	" " 1)
Greenlanders'	9.6	1953,54	--	--	" "
United Kingdom	8.5	1953	71.9	1953,54	Trawl
Germany	7.4	1952,53,54	70.6	1952,53,54	"
Faroes	7.3	1954	66.0	1954	"
Iceland	7.1	1952,53,54	68.8	1952,53	"

The countries showing the highest mean age of the samples are those using hook and line fishing (Norway, Portugal, and the Greenlanders), whereas the countries fishing with trawl (U.K., Germany, the Faroes, and Iceland) show a lower age. The differences within each of these two groups are probably caused by the different areas fished by the separate countries. Thus Norway (11.1 years) concentrate fishing in the Holsteinsborg Deep where large cod are supposed to concentrate. Portugal (9.9 years) spreads its fishery more evenly over the banks; the Greenlanders' fish closer to the coast and in the fjords, where in some places local stocks with a

1) The samples are all from the Portuguese demy fishing ...../5.

lower growth-rate are present. Of the trawl-fishing group, the U.K. trawlers fish off the south and south-west coast only<sup>2)</sup>, whereas Germany, Iceland, and the Faroes trawl mainly on the West Greenland Banks.

The Icelandic, German, and Faroes samples have a pronounced high peak for 7 year old cod. The U.K. have just as pronounced a peak but for 8 years age (the sample is only from one year, 1953 - the peak is due to the rich 1945 year-class). The curves for the hook and line fishing countries (Greenlanders', Norway, and Portugal) are much more flattened with rather high frequency percentages for the ages 6-12, and with quite a few older cod, 14-20 years; such old cod are hardly present in the samples by the trawl fishing countries.

The non-commercial "Dana" samples show the same picture as the curves for the trawl-fishing countries. The "Dana" samples are, as mentioned, caught on hook and jigs, but being non-commercial, the fishing has not been carried out with any preference to provide large cod.

The third column in the survey gives the mean lengths of the samples. Although the figures show that on the whole hook fishing yields older (and larger) cod than trawl fishing, the correlation between length and gear is not so pronounced as between age and gear. This is contrary to what should be expected; it may be caused by the already mentioned defects of the material.

The large number of samples reported from Subarea 1 permits a study of the variation in age composition from one subdivision to another (Fig.6), and for each subdivision from one year to another - 1952, 53, and 54 - (Fig.7)

To this purpose not only the commercial samples are used but also the "Dana" samples; a division of the material by countries is not made.

Subdivision 1B and 1C (Store and Lille Hellefiske Banke) are dealt with as one region, as a considerable fishing (and sampling) takes place just at the border between the two subdivisions (Holsteinsborg Deep). 1D and 1E are also considered as one region, partly for the same reason (Danas Bank), and partly because the number of samples from each of these two subdivisions is rather small. The region of the Godthåb Fjord and its ramifications are dealt with separately.

The extent of the material is as follows; no. of samples, in brackets no. of specimens:

	1952	1953	1954
Subdivision 1A	7 (2,300)	2 (359)	2 (284)
" 1B&C	11 (4,350)	14 (5,600)	13 (7,411)
" 1D&E	5 (1,656)	10 (3,914)	10 (2,138)
Godthåb Fj.	2 (433)	3 (753)	1 (296)
Subdivision 1F	2 (400)	2 (691)	1 (432)

The smallest numbers of specimens investigated are (apart from the small area of Godthåb Fjord) from Subarea 1A and 1F. This is quite natural as the fishery carried out in these subdivisions is smaller than in the central subdivisions B-D(E) and as the number of countries partaking in these fisheries (A and F) are fewer. However, from a biological point of view, and also where it comes

2) The U.K. sample reported is from 1F - off Cape Farvel. .... /6.

to judge the conditions of life for the cod in the central subdivisions, a comprehensive material from these regions at the borders of the area of distribution of the W. Greenland cod is of the greatest importance. For these reasons it is recommended that the countries working in subdivisions A and F make a special effort to collect, every year, a sufficiently comprehensive material.

Fig.6 shows the age-distribution curves for all samples by all countries for the years 1952-54 by subdivisions. The top figure gives the curve for the whole subarea.

There is a considerable difference from subdivision to subdivision. The oldest cod are found, or - to be cautious - caught in 1A, the northernmost part (around Disko). The mean age is here 11.5 years (mean for whole subarea 8.8 years). The peak of the curve is off 10 years of age, and there are considerable numbers of cod from 16 years and upwards. Cod from 6 years and younger are scarce.

In the region to the south of A, in B and C, (Store and Lille Hellefiske Banke), we find the youngest marketable stock; mean age only 7.9 years, peak of the curve at 6-7 years, very few old cod, and considerable numbers of ages 5 and 6.

This sudden change in the picture is no doubt due to the strong decrease in water temperature when passing from Store Hellefiske Bk. to the Disko area, a decrease in the summer temperature of the bank-water (ca. 100 m. depth) from ca. 3° to ca. 1-0°C, this causing a decrease in growth rate.

Further south, in Subareas D and E (the southern banks, Fiskenes, Fylla, and Dana), the stock is just a little older than in B and C, mean age 8.2, the peak of the curve is at 7 years, and the amount of old cod is somewhat larger.

In the southernmost subdivision, F, we have a considerably older stock, mean age 10.0, the peak is at 7-9 years, with a very steep rise through few younger years, and a more general sloping over the ages 9-17 years; the number of old cod is comparatively high.

This is in good agreement with the fact established by Danish investigators that the cod in this region is slower growing than that on the central banks.

The age distribution curve for the Godthåb Fjord also shows a high average age, 10.2 years. Danish investigations have shown this to be due to slow growth caused by over-population. The irregular form of the curve with two equally pronounced peaks at 7 and at 13 years, indicates a stock mixed of fast-growing bank cod and slow-growing fjord cod.

Fig.7 show for each of the subdivisions or regions, the age composition for each of the separate years 1952, 53 and 54. The most conspicuous feature of these curves is the great difference between the rich and poor year-classes. The moving of the rich year-classes (1947, 45 and 42) along the age scale from one year to another is clearly pronounced for all regions.

In Subdivision A, the dominating year-class in all the 3 years is 1942, followed, however, by considerable numbers of 2 (3) older rich year-classes, 1936, 34 (and 40). The younger rich - 1945 - year-class shows a gradual but only slow increase during the three years. Only in 1954 is the rich 1947 year-class present in large

...../7.

numbers. The old rich 1940, 1930, and 1934 year-classes are still well represented.

In B and C the 1947 year-class is dominating in the three years, followed, but far behind, by the 1945 and 1942 year-classes; of the older year-classes hardly any are present. In 1954 a new rich year-class (1950) appears.

In D and E again the picture changes. In 1952 and 1953 the 1945 year-class dominates; only in 1954 does the 1947 year-class attain the dominance. The striking difference between the two regions is the great role that the 1945 year-class plays in D and E compared to what is the case in B and C. However, another striking feature is the considerable decrease in number of the 1945 year-class (in D and E) from 1953 to 1954. This decrease is noted in the Icelandic Research Report for 1954, and it is indicated that the decrease might be due to a southward migration or to a migration to deeper water. Also the Danish Research Report for that year stresses this strong decrease in strength of the 1945 year-class in the southern subdivisions and attributes it to either high fishing mortality (mainly caused by English trawlers), or to migrations to other areas.

The present comparison where all countries are regarded as a whole shows that from 1953 to 1954 there was no decrease of the 1945 year-class in Subdivision A; hardly any in B and C, a considerable decrease in D and E (and in the Godthåb Fjord); however, a pronounced increase is found for the southernmost Subdivision F. This irregularity between the subdivisions makes it difficult to attribute the decrease to a general emigration from the subarea, it would sooner indicate migrations within the subarea. The fact that the decrease is strongest in D and E where the United Kingdom catch only amounts to ca. 1/6 of the catch, and not present, as far as the only sample shows, in F, where the main U.K. fishery takes place (U.K. lands from F 24,000 tons out of the total of ca. 30,000 tons from the subdivision) does not indicate that the cause is just the U.K. fishery.

In F, the most southern region, the 1945 year-class dominates in all three years, followed closely in 1952 and 53 by the 1942 year-class, and in 1954 by the 1947 year-class. It is of interest to note that the 1949 year-class appears suddenly as a rich one in 1954 contrary to what is the case in any other of the regions (immigration from Iceland or East Greenland?). The most striking feature is, however, the sudden and nearly complete disappearance of the 1942 and older year-classes from 1953 to 1954. Where one should have expected a gradual and slow decrease, one is faced with elimination. The decrease is so strong that it can hardly be attributed to the fishing activities, but sooner to emigrations to Iceland or to other parts of Subarea 1. The fact that the decrease only occurs from 1953 to 54 and not from 1952 to 1953 might indicate that such an emigration is not a general feature, but caused by special conditions in the period 1953 to 1954.

The samples dealt with here include the ages from 5 years and upwards, comprising a few specimens of only 4 years and hardly any younger. We know from Danish researches - cfr. Res. Rep. for 1955 - that such young cod occur in abundance in near-coastal waters and especially in the fjords; and as the Res. Rep. says "It seems that the stock of cod on the banks is recruited to a high degree from cod grown up in the coastal waters and the fjords". However,

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there might be stocks of these young age-group in the bank area, stocks which have been overlooked, the special areas where they live not being fished, or special gears suitable for the capture not being used. Here obviously is a field for wider research.

Also in another field of our study of the recruitment there may well be a gap. The fishing for larvae, carried out only from the "Dana", shows that only small amounts of larvae are found; in the years 1952-55, the following numbers per 30 minutes with 2 m. stramin bag: 1.6, 4.1, 1.3 and 1.3. These numbers are exceedingly small compared to other rich cod areas, and it seems hardly possible, that the dense W. Greenland cod stock can be recruited solely from them. It might be that the larvae researches are carried out so late in the season (July) that only the late comers are caught. An extension of larvae researches to a period closer to the spawning season is desirable.

These possible gaps in our knowledge of distribution of larvae or quite young age-groups leads to the problem of possible recruitment through immigration of young cod (say I to III groups) to the subarea. The study of this problem could be approached through taggings of quantities of quite young cod in W. Iceland waters.

The material of cod from Subarea 1 collected by the member countries and reported to the Commission for the years 1952-54 (also for 1955, not considered in this compilation) is a vast one, giving good coverage not only to the subarea as a whole, but also to its various subdivisions, and to the separate years.

When it is taken into account that considerable samplings have been carried out - mainly by Denmark - right back to the middle of the 'twenties, we are in this case in the unique position to have carefully studied the life history of a cod population right from its birth in the late 'twenties when the amelioration of the climate commenced, through its years of steady growth to its present height, where it equals, or even surpasses, in size that of any of the other large cod populations of the world.

It is of the utmost importance that this study is continued. Therefore it is most gratifying that new countries during the latest years have initiated researches on Greenland cod. This study now ranges as one of the largest international co-operations in fisheries research work.

One of the aims of this compilation has been to show the extent of this work, and of its various branches as well as its distribution over the separate subdivisions. Thus, this compilation could be of some help in forming a basis for the planning of this work so as to avoid repetitions and to fill in gaps.

Minor repetitions might occur, possibly in the large samplings by several countries in Subdivisions B and C. No doubt gaps occur in the material.

The question of further studies of larvae distribution and of increased researches in the problem of migrations and immigration of young cod have been mentioned.

As far as the samplings themselves are concerned, the following suggestions can be offered:

1. More extensive sampling in Subdivision A, where the cod lives under extreme conditions at its northern limit.

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2. More extensive sampling from Subdivision F, where migrations to and from other cod areas will be most strongly felt.
3. A special study of the possible occurrence and abundance of young cod on the banks.

Further, it is suggested that all countries report age-distribution as well as size-distribution, and that the reporting is done not only in graphic form but also by numbers (original numbers or frequency %/•), this in order to make compilation of data possible.

Finally, it is suggested that the large material of tagging data procured during recent years by several of the countries, be compiled and compared. This is not only to draw the results from them, but also that possible gaps in the taggings and defects in reporting of recaptures may be discovered and duly rectified.

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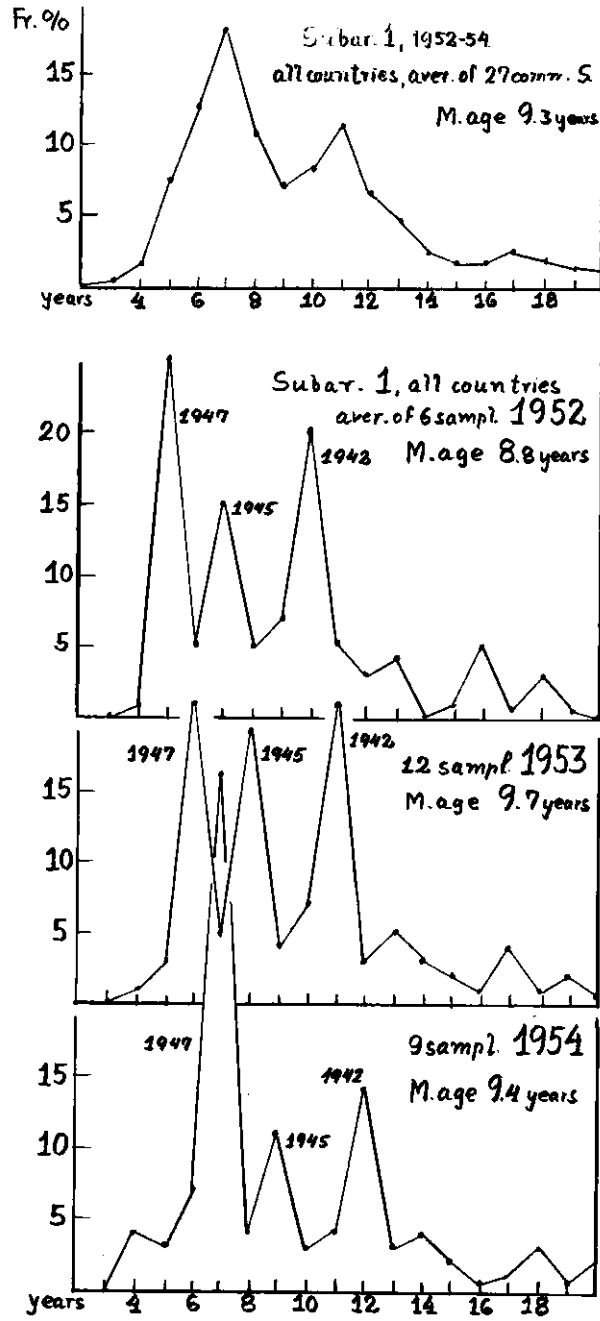


Fig. 1 - Cod, Subarea 1. Age-distribution in Commercial samples by all countries for the years 1952-54 together and for the separate years. No. of samples, mean age of all samples, and rich year-classes indicated.

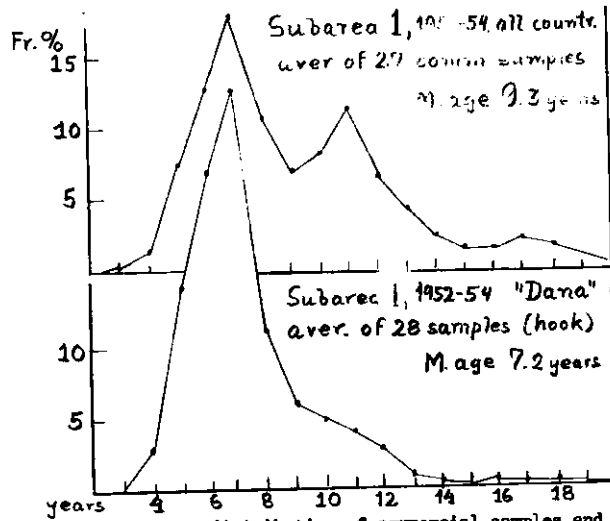


Fig.2 - Age distribution of commercial samples and hook samples from the Danish research vessel "Dana". No. of samples and mean age indicated.

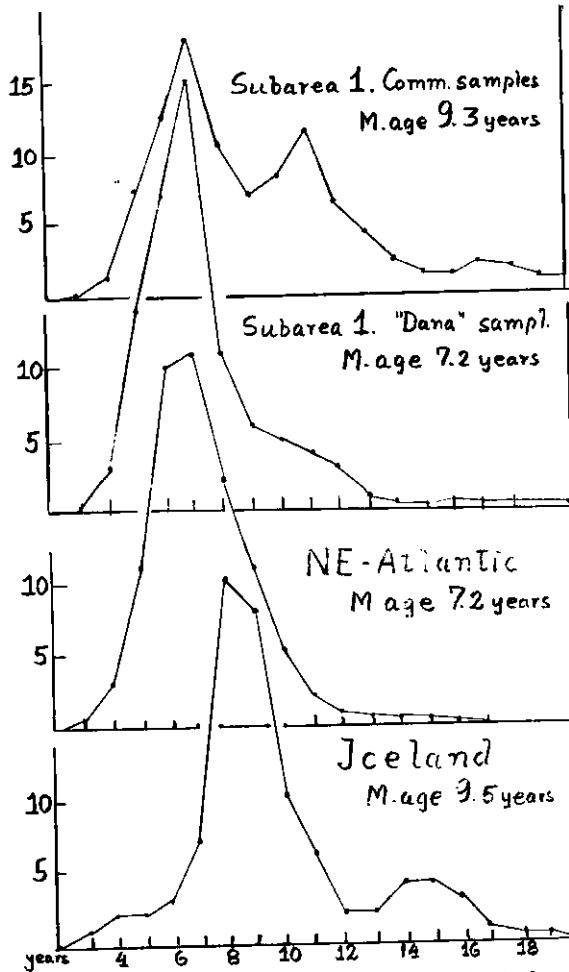


Fig.3 - Comparison of age distribution of cod from commercial and "Dana" samples from W.Greenland waters with commercial samples from the N.E. Atlantic and from Iceland.

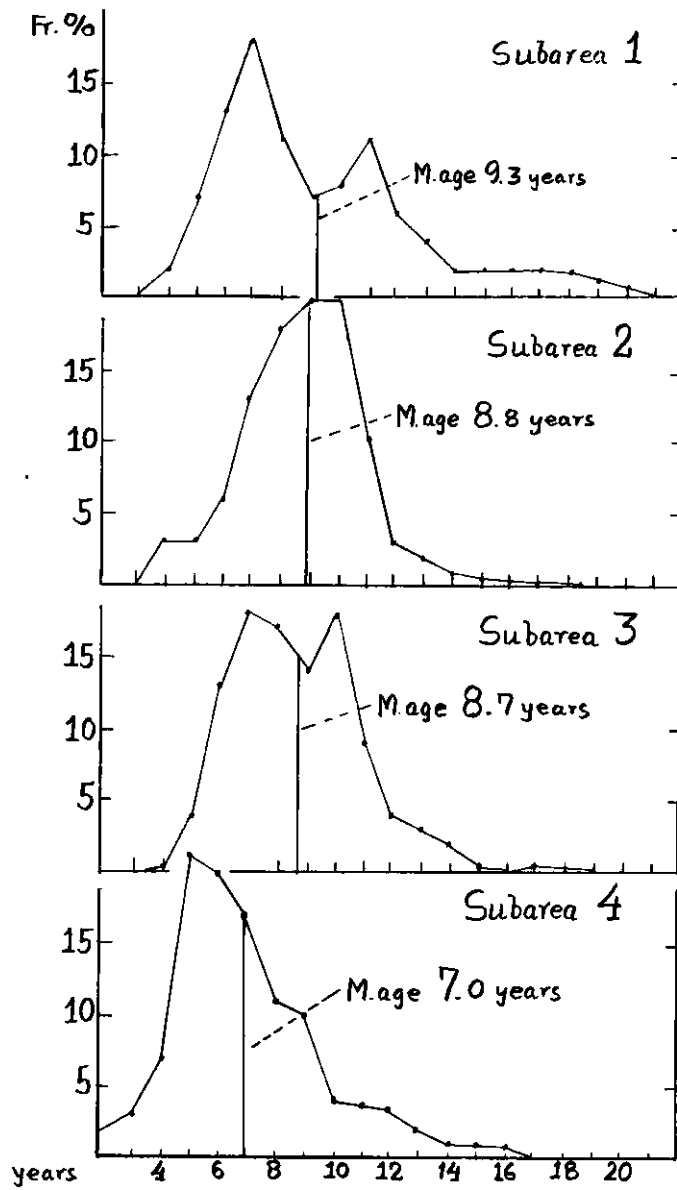


Fig.4 - Age distribution of commercially fished cod in Subareas 1-4. The vertical lines indicate mean age.

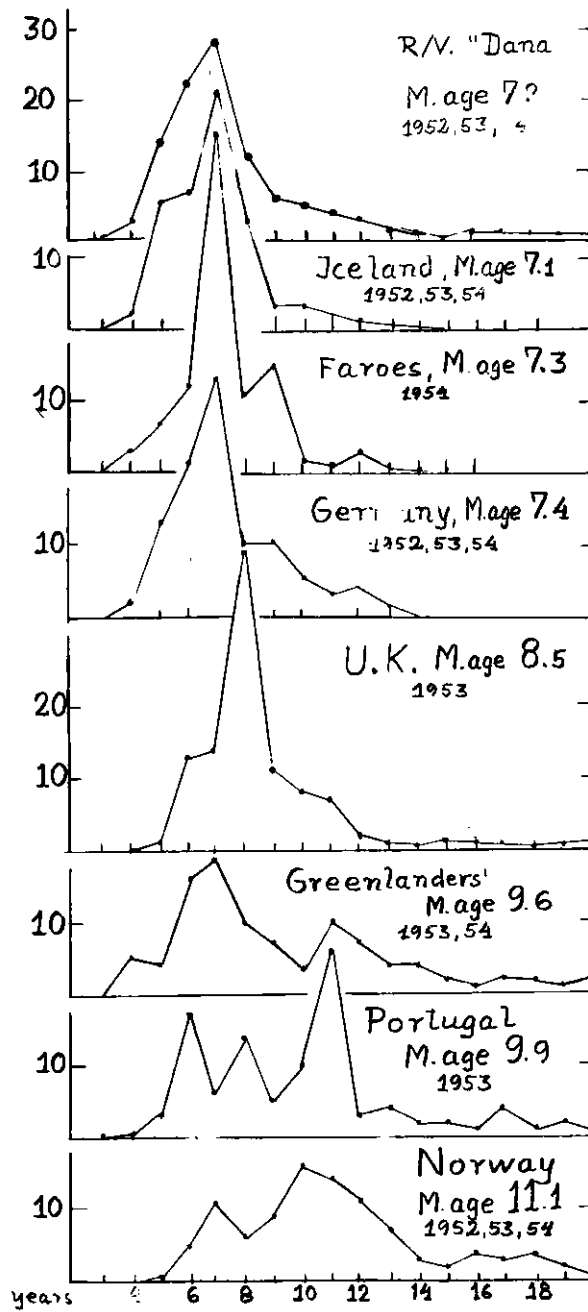


Fig.5 - Subarea 1, Cod. Age-distribution in commercial samples by countries (years 1952-54). Mean age and years sampled shown for each country.

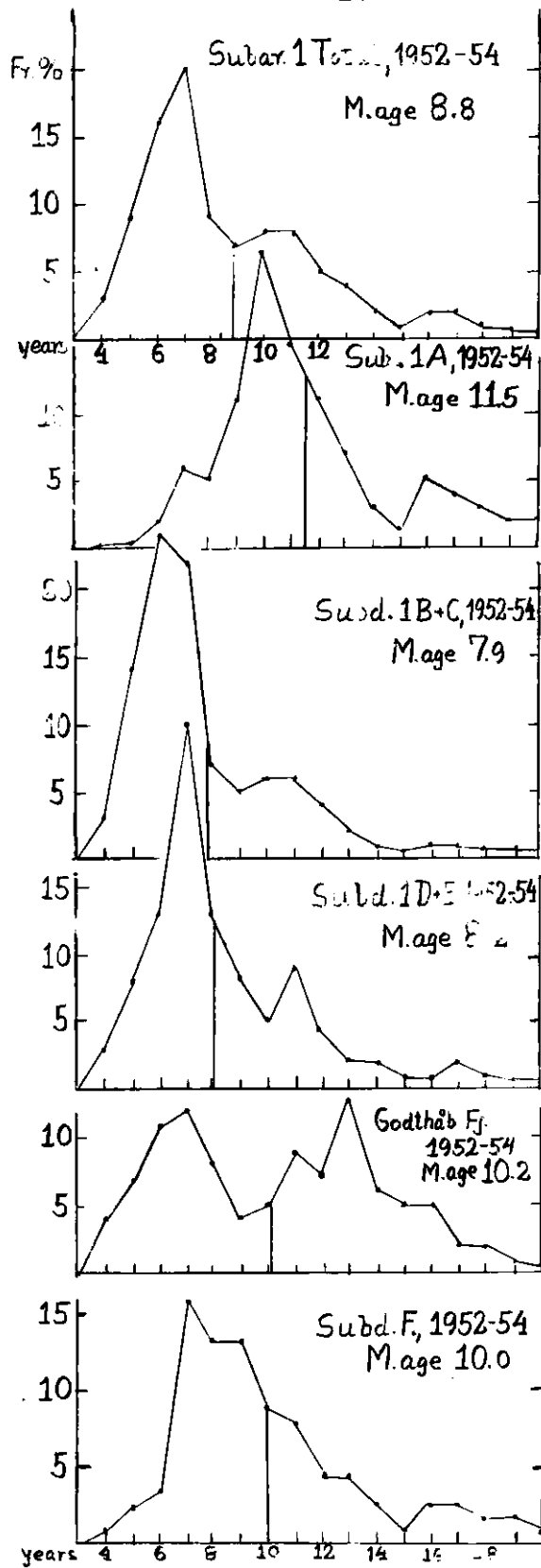


Fig. 6 - Age distribution of cod, Subarea 1, by subdivisions.

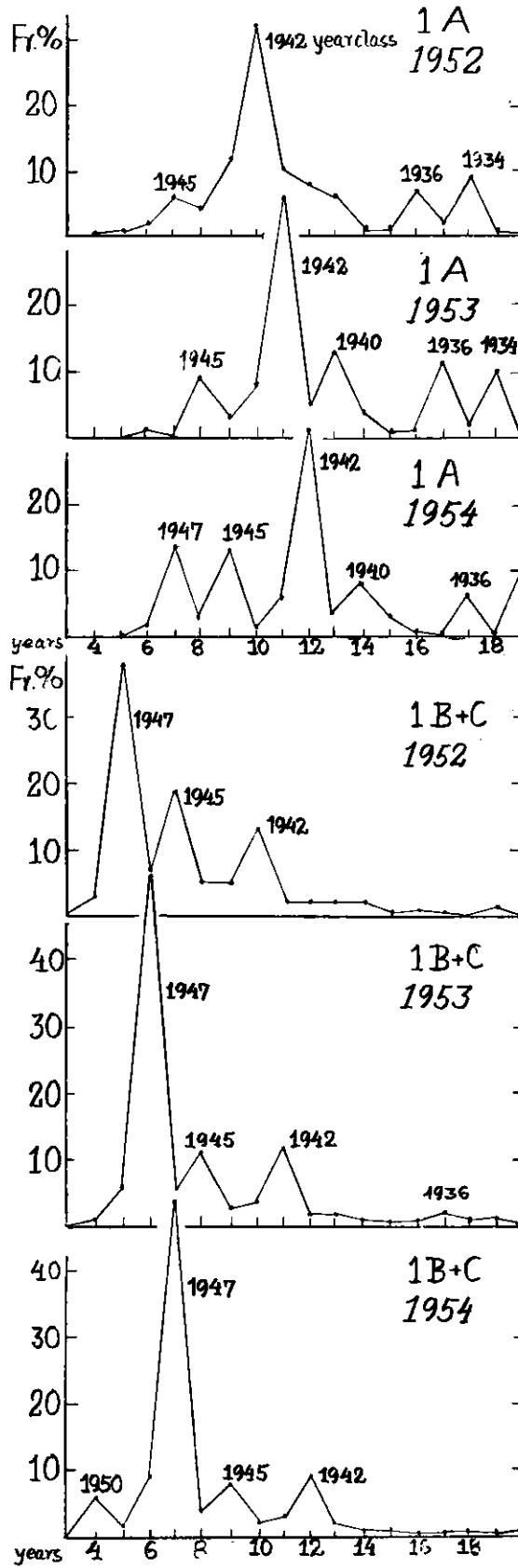


Fig. 7 - Age-distribution of cod in the various subdivisions and for each of the years 1952, 1953 and 1954.

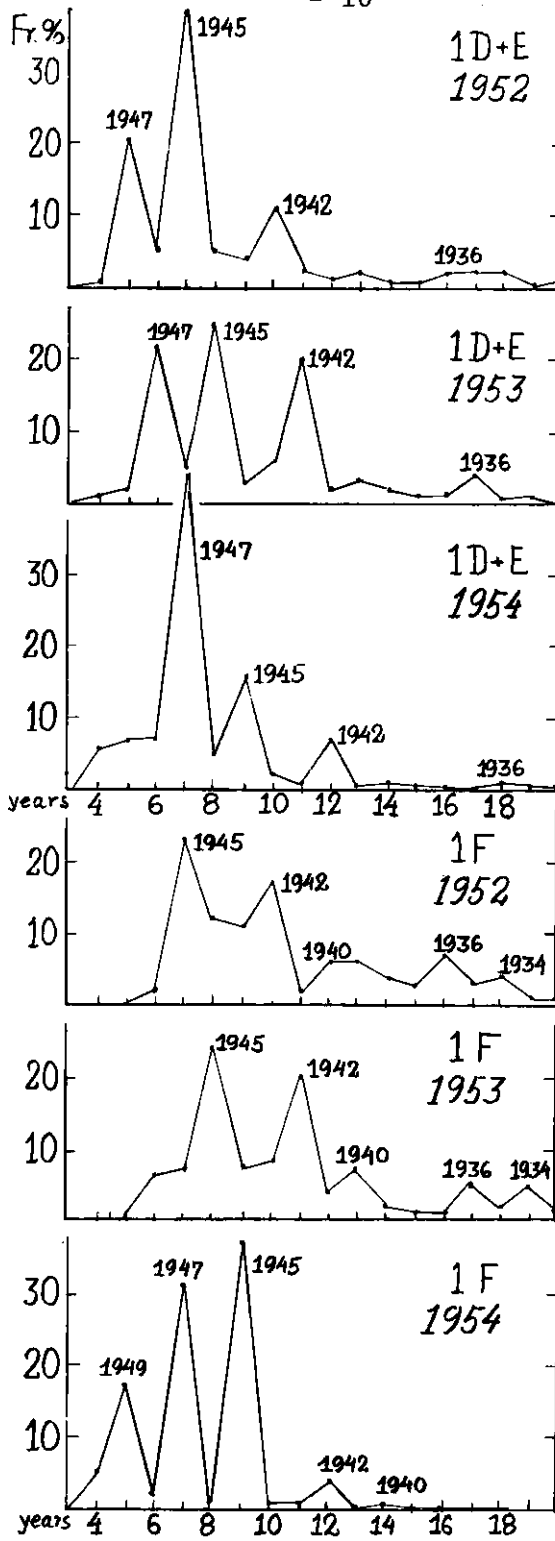


Fig. 7 (cont'd) - Age distribution of cod in the various subdivisions and for each of the years 1952, 1953 and 1954.



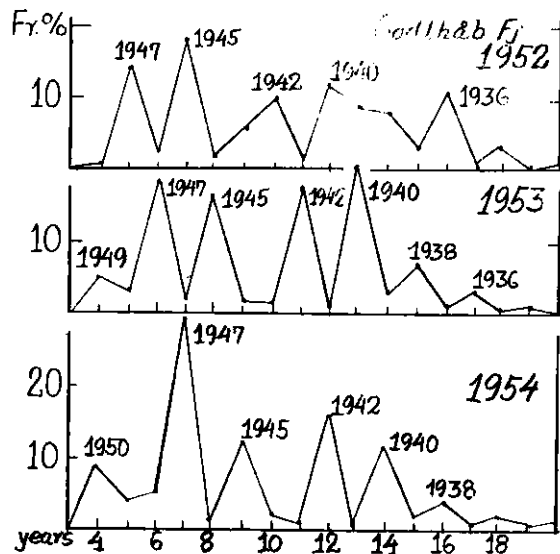


Fig.7 (cont'd) - Age distribution of cod in the various subdivisions and for each of the years 1952, 1953 and 1954.

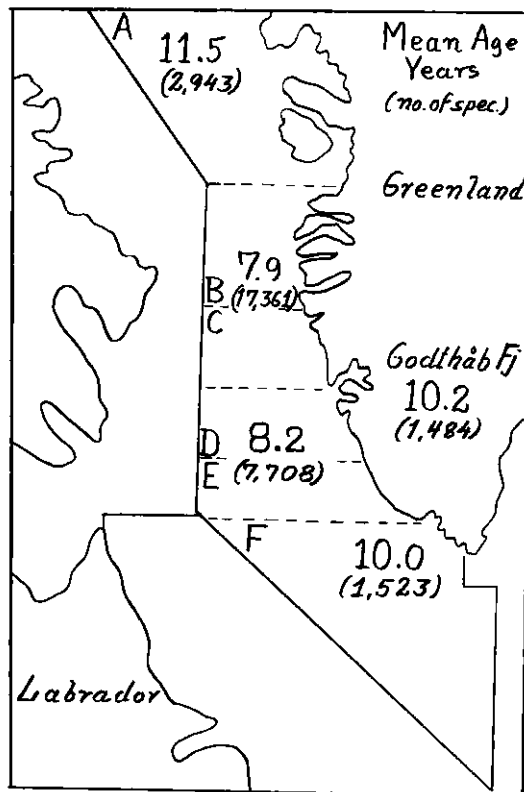


Fig.8 - Map of Subarea 1 with mean age of cod for the subdivisions A, B + C, D + E, F, and for Godthåb Fj. in ( ) no. of spec. All years, all countries.

