Fol. 41

International Council for the
Exploration of the Sea

Biblote

C.M. 1961
Herring Committee
No. 10

Progress Report of North Sea Herring Working Group

A. Terms of Reference and Representation

This working group was set up, following a recommendation of the Herring Committee of I.C.E.S., at its annual meeting in Moscow in 1960. Its main task was to make an appraisal of the present state of knowledge concerning (a) the stock subdivision of the North Sea herring population, and the mixing of stocks, (b) the measurement of effective fishing effort for the North Sea fisheries in pre- and post-war years, (c) the estimation of total annual mortality rates for the exploited stocks.

The solution of these important problems is an essential part of the scientific assessment of the causes of the recent disturbing changes and declines in certain of the North Sea herring fisheries, which is one of the focal points of European herring research at the present time.

The Working Group met in Copenhagen between May 24th and 29th 1961 and the representation was as follows:-

Dr. D. H. Cushing (Convenor), England
Mr. A. C. Burd, England
Dr. K. Schubert, West Germany
Dr. G. Krefft, West Germany
Dr. G. Hempel, West Germany
Mrs. E. Bohl, West Germany
Dr. A. Schumacher, West Germany
Mr. B. B. Parrish (Chairman of Herring Committee), Scotland
Mr. A. Saville, Scotland
Mr. I. G. Baxter, Scotland
Dr. J. Ancellin, France
Dr. Ch. Gilis, Belgium
Dr. Fedorov, U.S.S.R.
Dr. Birkov, U.S.S.R.
Mr. O. Østvedt, Norway
Mr. K. Popp Madsen, Denmark
Mr. J. J. Zijlstra, Netherlands

Of the countries with major herring fisheries in the North Sea, Poland and Sweden were not represented.

B. Proceedings

B.1. General

As a basis for discussion, the convener outlined the conclusions which he had reached from his investigations of the Southern Bight herring fisheries, concerning the unity of the Southern Bight stock, and the degree of mixing of these fish with members of northern spawning groups in the feeding season. These conclusions were as follows:-

(a) A common stock (in terms of recruitment and mortality) is exploited by the Southern Bight fisheries (East Anglian drift net, Sandettié and Channel trawl, and Belgian spent herring pelagic trawl fisheries), but that differences in mortality rate and recruitment are found between the Dogger and East Anglian fisheries.

(b) On the basis of mixing rates between Southern Bight and northern spawning groups in the north-western North Sea, Fladen and Dogger (determined from regressions of catch per unit efforts of different age groups in one fishery on those of another) there had been an increase in the apparent mixing rate on the Fladen and Dogger since 1950.

These conclusions were examined in the light of statistical and biological data, brought to the meeting (Appendix Table 1), and the contents of written contributions by Dr. Krefft and Professor Bückmann. For this purpose, the Group was divided into three sub-groups, to examine the following problems:-

(i) The identity of the Southern Bight stocks

Participants: Dr. Zijlstra (Chairman), Dr. Gilis, Mr. Baxter, Dr. Krefft, Dr. Burd, Dr. Ancellin

(ii) The mixing of Southern Bight fish in the northern feeding fisheries

Participants: Mr. Parrish (Chairman), Dr. Birkov, Dr. Hempel, Dr. Fedorov, Mr. K. Popp Madsen, Mrs. Bohl

(iii) The mixing of Southern Bight fish on the northern, spawning grounds (Dogger, Turbot Bank and Shetland)

Participants: Dr. Schubert (Chairman), Mr. Østvedt, Mr. Saville, Dr. Zijlstra

In addition to these topics, Mr. Popp Madsen outlined his hypothesis of the "missing ring", in explanation of the apparent increase in length for age of the young herring of the Bløden ground.

B.2. The identity of the Southern Bight stocks

The sub-group examined the biological and "population" characters of the fish caught in the East Anglian fishery and on the southern spawning grounds, with reference to their homogeneity. (The East Anglian fishery is defined as one for ripening fish in the area to the south of 53°30'N and north of the West Hinder lightvessel).

The following characters were examined:-

(i) Length for age
(ii) l_1
(iii) Otolith types
(iv) Vertebral counts
(v) Maturity stages
(vi) Mortality rates

(i) Length for age

Data were available for comparison from different fisheries from 1932-1959. The data comprised measurements of both fresh and "converted" salted herring and were made at varying times after capture when shrinkage may have been taking place. Both drift and trawl caught fish were compared (Table 1).

In the period 1952-1959 average differences from the English means of $\pm$ 3 mm were apparent in the various estimated of length for age. This is not inconsistent with their belonging to one group.

Prior to 1952 the English data gave means in the younger age groups consistently higher than in comparable data from the other fisheries. This is probably due to sampling method.

Ratios of 4 year-old to 3 year-old herring were calculated for the French, Belgian, and English data for the periods 1946-1951 and 1952-1959. Their mean values appear below:-

Mean Ratio 4/3 in catches per effort

	France	Belgium	England
1946-1951	1.04	1.14	1.58
1952-1959	0.59	0.49	0.54

These results confirm the sampling bias in the English pre-1952 data. The French and Belgian data show the same mean lengths for age; after 1952 the mean lengths for age were the same in all fisheries.

(ii) l_1

Using the English East Anglian l_1 distributions as standard the data from the Sandettié, Channel and spent herring fisheries have been compared (Table 2). Mean l_1 values for each year-class have been calculated and the data show the same trends in increasing size of l_1. The East Anglian data had consistently lower values than the other data. As there were no differences in the length/age data, it is felt that the differences in l_1 may be due to differences in material and technique.

From the Dutch trawl data it appears that there is no difference between the Sandettié and Channel samples.

(iii) Otolith types

There were no data for long term comparisons. Samples were available from East Anglia, Sandettié and the Channel. The percentages of narrows in the same year-class in the three fisheries were similar. The proportions of narrows varied considerably between year-classes (Table 3).

(iv) Vertebral counts

Mean vertebral counts for the East Anglian, Sandettié, Channel and Belgian spent herring fisheries were compared. Their values appear in Table 4. The data have been grouped into three periods pre-1939, 1945-1951 and 1952-1959.

No large differences could be detected between periods in any area.

A consistent difference was seen between the values obtained at Sandettié and in the Channel.

In the pre-spawning and spent fisheries intermediate values to these were obtained, with the exception of the English data. These had lower mean vertebral counts even than the Sandettié.

In the Belgian spent fishery the means in December were lower than in the following months, which could be expected from the spawning sequence at the Sandettié and Channel. This, however, no longer holds as the fishery is now more concentrated on full and spawning fish.

In the East Anglian material in the period prior to 1951, 3 year-olds had lower vertebral counts than the older age groups. Post-1951 this trend did not occur in any fishery for which data were available.

It would appear that the herring spawning in the Eastern Channel and southern North Sea are also caught in the East Anglian drift net fisheries and that of the Belgian spent herring trawl fishery.

(v) Maturity stages

Maturity stages in the English East Anglian fishery are given in Table 5. They show that about 90% of the fish are in stages IV and V with the exception of 1947 when 42% were in maturities VI, VII and II. In other years varying proportions of these latter maturity stages occur ranging from 3-16%. The East Anglian catch should exclude fish in maturity stages VI, VII and II.

(vi) Mortality rates

Mortality rates were compared for the periods 1946-1951, 1952-1959, and 1955-1959. Their values appear below:-

				Dutch		
Period	Ages	English	French	East Anglia	Sandettié	Channel
1946-1951	5-7	0.36	0.31			
1952-1959	5-7	0.90	0.73			
1955-1959	5-7	1.09	1.09	1.03	0.86	1.04

These mortalities are in reasonable agreement.

Conclusions

On the two spawning grounds of Sandettié and the Channel consistent differences were found between the mean vertebral counts of the fish. These differences were very consistent over the periods, 1932-1939 and 1946-1959. Other characters examined were length for age, l_1, otolith types, and mortality rates. Growth characters and mortality rates showed similar variations between the spawning fisheries.

Comparing the pre-spawning and spent fisheries, trends in l_1, mean length for age and mortality rates were similar to those observed in the spawning fisheries. The vertebral data in the spent fishery points to the occurrence of fish from both spawning areas. This cannot be shown with the vertebral material available for the pre-spawning fisheries. As far as characters (l_1, length for age and total mortality) used in population dynamics are concerned, the material is not inconsistent with similarity of the herring in all the fisheries in the Southern Bight area, but it must be stressed that differences in population probably exist between the Sandettié and Channel.

The Group recommends that in view of the discrepancy between the mean vertebral counts for the Southern Bight and Channel spawning herring, a more detailed statistical analysis should be made of the vertebral count data for this region.

B.3. The mixing of Southern Bight fish in the feeding fisheries

(a) Maturity

As a first step, the Group examined maturity data for herring caught in the Scottish Buchan drift net fishery in June, July and August in pre-war and post-war years, and in the German trawl fishery on the Fladen in the year 1955-1959. In the time available, it was not possible to make a thorough search of the literature for additional data from other sources.

In the absence of evidence as to the actual rates of maturation of the herring spawning in the different regions, the first assumption was made that the Downs fish in the northern North Sea in June and July are contained in the maturity stages II and III, while in August they are in stages II, III and IV. Thus, the proportions of these stages in the total stock in these months provides an upper limit to the mixing of Downs fish in the north. The data for stages II and III in the Scottish fishery are given in Table 6 and for each maturity stage separately for the German material are given in Table 7. They show that, in the Scottish fishery, the pre-war average proportions of stages II and III in June and July - about 55% - was about the same level as in the post-war years, while in August the pre-war average was higher than in the post-war years. However, the post-war material shows a marked increase again, especially of maturity stage III after 1956. The German data for the Fladen area, give values similar to those for the Scottish area, and may point to an increase in the rate of maturation during the period.

An examination of the maturity stages for each of the age groups 3-6, in the Buchan area in post-war years shows that, on average, the proportion of maturity stages II and III in June and July was higher for the three year-olds than for the older age groups. Furthermore, these proportions in the older age groups show some striking changes between June and July. Whereas, in the years up to 1959, the proportion increased from June to July, after 1951 it decreased, especially after 1954. These data are shown for 3 year-olds, 4 year-olds and 5, 6 and 7 year olds in Figures 1-3 respectively.

These results and an accompanying increase in the proportion of maturity stage IV in July agree with the German data. One explanation of this increase is an increase in the rate of maturation of post-recruit herring in the north-western North Sea since 1951.

In view of the presence of the major spawning on the Dogger in September and October, it is expected that some of the fish in maturity stages II and III in June and July will not belong to the Downs group, but will spawn on the Dogger (perhaps some will also spawn on the northern grounds in August-September). Therefore, the estimates of mixing, from the maturity data above, are likely to be overestimates. Attempts were therefore made to determine the Downs component amongst these maturity groups.

The characters examined were l_1s, vertebral counts, length for age and otolith types from the Scottish north-western North Sea fishery.

(b) l_1s

Data were available for age groups 3, 4, 5 and 6 in the Scottish Buchan fishery for the years 1948-1955 and 1958. Similar to observations of the East Anglian data, an increase in l_1 has been observed in the post-war period in maturity stages II and III of three year-old fish. In the time available, it was not possible to work up the data in all years, but for 1948, 1953, 1954 and 1958, the l_1 distributions (percentage) of the 3 year-olds, and for 1949 and 1953 also for the 4 year-olds, were compared with those of the same age groups in the East Anglian fishery in the sam year (from the data supplied by the Lowestoft laboratory). Examples of these are given in Figures 4 and 5. Rough estimates of the size of Downs component in the northern samples were then obtained by taking the ratio of half the area of overlap between the two distributions to the area of the northern one. These estimates for June were as follows:-

	3 year-olds	4 year-olds
1948	23.2%	33.3%
1953	14.6%	22.7%
1954	18.3%	-
1958	17.4%	-

Having in mind that the Bank stock is presumably larger than the Downs stock these estimates are probably too large.

These estimates can therefore be taken as upper limits of the proportion of the Downs fish amongst the maturity stage II and III fish in the northern North Sea in June. Since the July l_1 distributions were very similar to the June ones, these estimates can be taken to apply to both months. Thus, the l_1 data suggest that not more than about 20% of the 3 year-olds and 30% of the 4 year-olds in the maturity stages II and III fish in the north-western North Sea in June and July in the post-war years were Downs fish. The data also suggest that the proportion has decreased since 1950.

(c) Vertebral counts

Again vertebral counts for maturity stage II and III fish of age groups 3, 4, 5 and 6 are available for the Scottish north-western sea fishery in the years 1952-1960. The means for each age group in each month for all years, except 1956 and 1958, are given in Table 8. The most striking difference between these figures and those for the East Anglian fishery in the same year, is amongst the 3 year-olds. In most years, the northern value in July was considerably lower than the East Anglian one. Furthermore, the value dropped substantially between June and July in all years, suggesting that most of the maturity stage II and III fish in July were Banks fish.

(d) Length for age

The mean lengths of age groups 3-6 for maturity stages II and III in the post-war Scottish material are given in Table 9.

In all years except 1955, the means for the 3 year-olds in the Buchan area in June and July are slightly greater than those in the East Anglian fishery in October and November. For the older age groups the data are more variable; in some age groups and years, the mean lengths are greater than those in the East Anglian area, but in others the East Anglian values are greater.

In the time available it was not possible to examine the length data in more detail, especially with respect to the total length distributions. The Group considers that further attention should be given to this.

(e) Otolith types

Data submitted to recent meetings of the Herring Committee show that in the north-western North Sea most of the otoliths of 3 year-old herring in all maturity stages in June and July have been the "Narrow" type. Estimates of the proportions of the "Narrow" and "Wide" types for maturity stage II and III year-olds in June and July in 1958 and 1959, obtained from Scottish data were as follows:-

	"Narrow"	"Wide"
1958	(99.4)	0.6
1959	(96.9)	3.1

German data from the northern area (including the Fladen ground) are also available for all maturity stages combined for the northern area in July 1959 and 1960. These give the following proportions of "Narrows" and "Wides" amongst all maturity stages of the 3 year-olds:-

	"Narrow"	"Wide"
1959	74	18
1960	35	51

The difference between the Scottish and German data for 1959 is due to two German samples from statistical squares 11E and 14C, which gave 21% and 29% "Wides" respectively. In all other areas the percentages of "Wides" in the German data were less than 5% as in the Scottish data The corresponding figures for 3 year-olds in the East Anglian and Sandettié and Channel spawning areas were as follows:-

	East Anglia		Sandettie		Channel	
	Narrow	Wide	% Narrow	Wide	% Narrow	Wide
1958	88	(12)	77	(23)	68	(32)
1959	-	-	26	(74)	25	(75)
1960	-	-	26	(74)	28	(72)

For 1958 the data do not preclude the possibility of a substantial degree of mixing of Downs three year-old fish in the northern North Sea. In 1959 and 1960 they point to a much smaller degree of mixing. In the older age groups the proportion of "Wides" in the north-western North Sea is generally greater than for the 3 year-olds. The data for 1958-1960 from the Scottish II and III maturity stages in June and July and German data for all maturity stages in July are as follows:-

Scottish

	4 year-olds		5 year-olds	
	Narrow	Wide	Narrow	Wide
1958	(79.0)	21.0	(92.5)	7.5
1959	(96.7)	3.3	(89.1)	11.9

German (July)

	4 year-olds		5 year-olds		Older than 5	
	Narrow	Wide	Narrow	Wide	Narrow	Wide
1959	88	6	-	-	64[1)]	27[1)]
1960	60	31	71	21	67	17

(f) Conclusions

With the data available it was possible only to examine in detail the extent of mixing of Downs fish in the north-western North Sea. In the absence of detailed

1) Including 5 year-olds.

German data, broken down into maturity stages, it was not possible to make a detailed assessment for the Fladen and Gut areas.

Although in the Group's view further analysis of the data and a more careful search of the literature are required, it is possible to draw the following tentative conclusions from this preliminary analysis:-

(i) Despite the relatively high proportion of 3 year-old herring in maturity stages II and III in the north-western North Sea (south of 59°N and north of 56°N) in June and July, the proportion of Downs fish amongst these is relatively small, especially since 1952. The l_1 data suggest that this proportion is less than 20%, and that the proportion of Downs of the total 3 year-olds in the north-western North Sea (south of 59°N and north of 56°N) is less than 10% of all maturity stages.

(ii) In the older age groups the proportion of Downs fish in the north-western North Sea is probably larger than for the 3 year-olds, but the available evidence suggests that it is not greater than 30% in the post-war years examined.

(iii) Since 1951 there has been an increase in the proportion of high maturity stages in the north-western North Sea in July, perhaps as a consequence of a decrease in the proportion of late spawners in the North Sea.

The Group considers that a further, more complete analysis is required of the existing data for the north-western North Sea and of the German data for the Fladen and Gut area, once they become available. In particular, it stresses the need for more information on meristic characters, other than vertebral counts for the herring in the feeding and subsequent spawning areas. It also draws attention to the possible importance of fecundity estimates for the early maturity stages as an index of spawning time and place, bearing in mind the large differences between the fecundities of Downs and Banks spawners. In this respect it is noted that estimates made so far in Scotland of maturity stage III fish in July and August, were within the range of the Banks spawners of the north-western North Sea.

The Group also considers that careful consideration should be given to the possibility of further large scale tagging experiments in the north-western North Sea and Fladen ground areas.

B.4. The mixing of Southern Bight fish on the northern spawning grounds (Dogger, Turbot Bank and Shetland)

The material examined for this purpose consisted of mean VS, otolith types (1953-59) and l_1 (1948-58) for fish in maturity stages VI and VII for the Shetland and Buchan fisheries for the period 1952-60.

Dutch material from the Dogger and N.E. Bank areas in the years 1952-60 was also examined in respect of VS, mean length for age, otolith type and l_1. In the years 1952-54 the Dutch data consisted of stages V-VIII, after 1954 these data were for stage VI only. Belgian data from the Dogger area were also examined but found unsuited to this purpose as they were not subdivided by maturity stages. Some English data covering the higher maturity stages from the Shields and Whitby areas were also available.

(a) Vertebral Counts

The most extensive series of data were those dealing with vertebral counts. The vertebral count data for the Shetland area were rather small; in order to get a large enough number of observations to provide a reliable mean it was necessary to group all observations from the years 1952-60 from this area. These gave a mean vertebral count for this area of 56.55 (975); for comparison the figure given by Wood (1936) for Shetland in the pre-war years was 56.43 (1481).

The vertebral count data from the Buchan area provided a large number of observations and here it was possible to deal with individual years. For the spawning shoals of the Buchan area in the pre-war years Wood gave a mean vertebral count of 56.42 (1490). In the post-war period (Table 10 A) the mean counts for all age groups in the years 1952-55 at Buchan were a little different from those found by Wood (1936). After 1955 the vertebral counts for this area were in the range 56.54-56.58, that is 0.12-0.16 vertebrae higher than in the pre-war years. Although prior to 1956 the mean count for all age groups was not significantly higher than the pre-war figure, the 1950 brood recruiting to the fishery in 1953 gave a high vertebral count of 56.55 in every year it appeared in the Buchan fishery.

The Dutch material for vertebral counts (Table 10 B) for the Dogger area was less variable over the years examined than that from Buchan, the range between years being only from 56.54 to 56.57 with an overall mean of 56.55 (6136). This figure should be compared with a mean vertebral count for the Dogger area quoted by Wood (1936) of 56.44.

(b) l_1

Data for l_1 determination from the Buchan area were not extensive enough to permit detailed analysis (Table 11 B). It can only be stated that it showed no clear trend in the post-war years for which data were available nor any significant differences from the limited l_1 data available from this area for the pre-war period. Dutch l_1 data for the Dogger region for the years 1952-60 were also examined and also failed to show any trend over the period (Table 11 A).

(c) Otolith types

From the examination of the otolith material available from Buchan spawners the only obvious change was the occurrence of small numbers of wide-type otoliths amongst the recruit spawners in 1958 and 1959 (Table 12). There is no evidence of any increase in the proportion of "Wides" in the older age groups.

(d) Conclusions

From the material available it is clear that this group can reach no firm conclusion on the question of whether or not Downs spawners or fish of Downs origin are now spawning amongst Banks spawners. The marked rise in the mean vertebral counts of all the Banks spawning communities in recent years, however, could be interpreted on this basis. Accordingly the matter would seem worthy of further investigation and we would recommend that this should be done once the extensive German material becomes available. It is suggested that the stock separation method, using catches per effort, be tried on spawning community material.

B.5. Missing ring hypothesis

Mr. Popp Madsen outlined his hypothesis as follows:- Hodgson found 0 and I group herring in the same area and at the same time as the present Bløden ground spring fishery. The length distribution of Hodgson's I group is identical with that of the large 0 group fish today - which is an increase from 11.5 cm to 15 cm, an increase of 34% in mean length. At the present time large 0 group fish in the spring fishery appear to become large I group fish in the north-west patch in the following autumn; it appears that the smaller 0 group fish become the I group fish of the Bløden autumn fishery. The large I group fish on the north-west patch range in size from 18-25 cm. A simple explanation of these facts would be that no growth change had taken place and that the large 0 group fish had failed to lay down a winter ring.

Length distributions of 0 group fish from the Bløden autumn fishery are bimodal; the larger mode tends to have a higher VS and a lower K_2 than the smaller mode. The same point can be made from those fish with narrow and wide otoliths. This suggests that the larger mode (similarly with big narrow zoned fish) are really the late spawned fish. If this is true they must be yar older. Only the late spawned fish have apparently lost a ring.

This hypothesis would account for the apparent increase in length for age, the apparent increase in the frequency of high l_1s, the apparent increase in narrow type otoliths in the south, the apparent dominance of younger year-classes and the apparent decrease in the age of first maturity in the south.

Mrs. Bohl showed three types of otolith from young herring of the same length; the differences were in the character of the first ring and in the presence or absence of an increment on the first ring. Dr. Hempel suggested from some aquarium experiments that there was a possibility of missing summer zones, due to the laying down of hyaline zones in the summer period.

The Group drew the following conclusions from the discussion of this item:-

1. that a caution should be accepted in age determination;
2. that a search for evidence for or against the hypothesis be started - for example:
   - (a) the effect of food and temperature on ring formation in aquarium experiments;
   - (b) extensive studies of 0 group herring with special reference to the rate of growth of fish and otoliths.
   - (c) l_1 distributions should be compared from scale and otolith readings.

C. Concluding Remarks

In the time at its disposal, the Working Group was able to examine only the first of the major tasks allocated to it. Its discussions were confined to the problem of stock subdivision of the North Sea herring population, and the mixing of stocks. Furthermore, its treatment of these problems was incomplete, due to the absence of important biological data, especially for the German fisheries in the feeding and spawning areas. The conclusions reached by the Group are therefore preliminary pending a more complete analysis of these extensive data, when they become available. The Group therefore strongly recommends that a further meeting should be held to examine this problem further, and to fulfil the further tasks allocated to it.

In the course of its work the Group encountered a number of difficulties, concerning the comparability of biological techniques used by different workers. These concerned especially the determination of maturity stages and the measurement of l_1. It became evident that different categorisations of maturity stages are used in different countries, particularly of fish in the "recovering spent" stages of adults, and the early maturation stages of recruit spawners (embracing "Hjort" stages VII-II, VIII and II). The Group therefore recommends that a close examination should be made between the criteria and categorisations used in maturity stage assessment in all countries, with a view to their standardisation. Similarly, the need for a close examination of the methods of l_1 determination, and a comparison of results by different workers is also stressed.

A problem of major importance, arising from the estimation of the degree of mixing of Southern Bight (Downs) fish in the northern, feeding areas, was the relative sizes of the separate herring stocks (Banks and Downs) in the North Sea. In the time available, it was not possible to examine fully all the sources of relevant information, but the possible use of larval information for this purpose was stressed. The Group also recommends that consideration should be given to the adoption of large scale tagging experiments in the northern North Sea (Buchan, Fladen, Gut, etc.) for obtaining additional information on the presence of Southern Bight fish in the northern, feeding areas.

Table 1

A.

Fishery	Mean deviation from East Anglian mean	Period
Dutch East Anglian	+0.4 mm	1956-59
Dutch Sandettié	-1.4	1953-59
Dutch Channel	-1.7	1952-59
French "Spawning grounds"	-2.9	1952-59
Belgium Spent	+3.3	1952-59
French "Spawning grounds"	-6.1	1946-51
Belgium Spent	-1.6	1946-51
French Sandettié	-5.5	1933-37
French N. Somme	-2.4	1933-37
French S. Somme	-3.1	1933-37
Belgium Spent	-3.8	1932-39

B. Mean length in cm of age-groups 3-7 (material of all countries combined)

Period	Age				
	3	4	5	6	7
1932-39	22.8	24.1	25.3	26.1	26.7
1946-51	23.4	25.0	25.9	26.7	27.1
1952-59	24.4	26.1	27.3	28.1	28.6

Table 2

Mean l_1 for Southern Bight Regions (4 year-olds)

Year	East Anglian pre-spawning (English data)	Belgium Spent fishery (Belgian data)	Sandettié Spawning (Dutch data)	Channel Spawning (Dutch data)
1944	10.1	10.1	-	-
1945	9.9	10.2	-	-
1946	10.0	10.4	-	-
1947	10.3	11.1	-	-
1948	9.6	10.8	10.2	-
1949	9.7	11.0	11.1	10.7
1950	12.0	13.0	13.2	13.2
1951	11.8	12.9	12.7	12.3
1952	17.2	12.8	12.9	13.9
1953	11.0	12.4	13.1	11.6
1954	10.8	-	11.2	12.1
1955	12.3	-	13.7	12.2

Average Sandettié and Channel l_1 for 1949-55 year classes:

Sandettié	12.3 cm
Channel	12.6 cm

Table 3

A. Otolith types for East Anglia. Combined English and Dutch Data

Year-class (ages used 3 & 4 yrs.)	Otolith type % Narrows
1947	22
1948	7
1949	11
1950	45
1951	58
1952	55
1953	43
1954	17
1955	70
1956	25
1957	27

B. Otolith types for Channel and Sandettié. Dutch data only

Year-class (3 & 4 year-olds)	Otolith type - % Narrows	
	Sandettié	Channel
1952	46	64
1953	37	49
1954	15	19
1955	77	68
1956	26	25
1957	26	28

Table 4

A. Mean vertebral counts by area and period[1]

Area / Period	1928-1937	1945-1951	1952-1959
Sandettié[2] (trawl)	56.56(F)	56.57(F)	56.54(F) 56.53(G) 56.56(D)
Channel (trawl)	56.64(F)	56.65(F)	56.54(E) 56.59(G) 56.56(D)
East Anglian region (driftnet)	-	56.51(E)	56.54(E) 56.59(G)
Spents fishery (trawl)	56.57(B)	56.59(B)	56.58(B)

1) The averages given are averages of mean vertebral counts.

2) B = Belgian data; D = Dutch data; E = English data; F = French data; G = German data.

B, Mean vertebral counts by month
Belgian spent fishery

Period	Dec.	Jan.	Feb.
1930-1938	56.53	56.60	56.56
1945-1951	56.55	56.60	56.62
1951-1960	56.60	56.59	56.61

C. Mean vertebral counts by age

East Anglian fishery (English data)			
Year-class	3 year	4 year	5 year
1943-1947	56.47	56.53	56.52
1949-1955	56.53	56.55	56.54
Sandettié fishery (Dutch data)			
1950-1956	56.56	56.57	
1950-1955	56.56	56.55	56.58
Channel fishery (Dutch data)			
1949-1953 1956	56.67	56.65	
1949-1952	56.66	56.63	56.70

Table 5

Maturity data for East Anglian fishery. English data

	Stages VI, VII, II 3 year-olds	All	Stages IV, V 3 year-olds	All
1947	19	42	81	58
1948	15	15	80	84
1949	9	6	89	94
1950	5	5	92	94
1951	10	5	85	91
1952	9	9	83	88
1953	2	3	95	94
1954	8	5	89	92
1955	7	5	91	94
1956	7	7	89	90
1957	9	10	88	88
1958	16	11	83	88
1959	5	7	93	92
1960	15	16	85	83

Table 6

Proportions of maturity stages II and III (per mille).

1930 1959. Scottish Buchan fisheries. All age groups

Mat.	June			July			August		
	II	III	II+ III	II	III	II+ III	II	III	II+ III
1930	568	67	635	283	297	580	42	161	203
1931	167	177	344	181	195	376	97	193	290
1932	384	138	522	195	504	699	114	234	348
1933	489	86	575	386	176	562	36	111	147
1934	433	53	486	573	198	771	19	75	94
1935	630	25	655	573	206	779	139	127	266
1936	539	110	649	183	214	397	100	288	388
1937	552	62	614	275	293	568	122	118	240
1938	404	164	568	504	275	779	112	264	376
1939	559	77	636	433	344	777	66	238	304
1943	-	-	-	171	398	569	18	163	181
1947	-	-	-	419	221	640	12	69	81
1950	529	129	658	-	-	-	-	-	-
1951	447	16	463	442	199	641	65	85	150
1952	532	28	560	326	227	553	25	100	125
1953	413	65	478	272	176	448	52	40	92
1954	269	41	310	279	164	443	40	63	103
1955	480	94	474	217	299	516	11	52	63
1956	453	107	560	194	317	511	21	45	66
1957	490	72	562	344	300	644	80	207	287
1958	710	86	796	130	276	406	70	135	205
1959	594	139	733	158	450	608	30	176	206

Table 7

Maturity composition in German Fladen trawl samples 1955-1959. (All age groups)

Mat.	I	II	III	IV	V	VI	VII	VII-II
1955								
June	145	390	320	115	25	0	5	-
July	190	360	340	80	30	0	0	-
Aug.	61	112	112	237	299	3	176	-
1956								
June	240	380	290	90	0	0	0	-
July	157	193	333	243	73	0	0	-
Aug.	25	220	100	165	410	20	60	-
1957								
June	0	200	390	400	10	0	0	-
July	73	158	338	291	140	0	0	-
Aug.	90	105	185	260	250	0	110	-
1958								
June	40	260	580	120	0	0	0	0
July	3	69	314	357	254	0	0	3
Aug.	10	50	0	50	648	191	0	47
1959								
June	-	-	-	-	-	-	-	-
July	79	150	393	324	54	0	0	0
Aug.	100	25	55	240	520	0	50	10

Table 8

Mean vertebral counts of age groups 3-7 in maturity stages II + III in the Buchan Area (south of 59°N) in June and July. 1952-1960

Year	Age 3	4	5	6	7
			J U N E		
1952	56.48 (366)	56.32 (158)	56.50 (127)	56.36 (116)	56.59 (43)
1953	56.55 (277)	56.49 (305)	56.49 (88)	56.45 (41)	56.63 (57)
1954	56.59 (371)	56.56 (135)	56.49 (53)	56.53 (23)	56.51 (15)
1955	56.46 (709)	56.64 (168)	56.69 (16)	56.67 (24)	56.14 (7)
1956					
1957	56.55 (329)	56.48 (98)	56.55 (42)	55.98 (5)	56.39 (8)
1958					
1959	56.53(1057)	56.41 (54)	56.06 (14)	(56.00 (2))	(56.00 (1))
1960	56.54 (133)	56.44 (203)	(56.00 (1))	(56.00 (2))	-
			J U L Y		
1952	56.45 (282)	56.58 (181)	56.57 (173)	56.55 (202)	56.70 (87)
1953	56.53 (506)	56.56 (283)	56.44 (69)	56.89 (34)	56.45 (42)
1954	56.44 (555)	56.52 (151)	56.50 (62)	56.59 (25)	56.68 (10)
1955	56.43 (745)	56.46 (108)	56.61 (20)	(56.40 (5))	(56.00 (2))
1956					
1957	56.50 (834)	56.57 (144)	56.36 (29)	(56.83 (6))	-
1958					
1959	56.49 (708)	56.67 (55)	(56.60 (5))	-	-
1960	56.50 (151)	56.38 (222)	-	-	-

Table 9

Mean lengths of age groups 3-7 in maturity stages II + III in the Buchan Area (south of 59°N) in June and July. 1952-1960

JUNE

Year	Age 3		4		5		6			
1952	24.6	(373)	25.8	(169)	26.5	(132)	26.8	(119)	27.0	(43)
1953	24.8	(284)	26.0	(315)	26.8	(91)	27.8	(42)	27.8	(58)
1954	24.8	(378)	26.7	(136)	27.4	(55)	28.0	(20)	28.1	(15)
1955	24.3	(723)	26.6	(188)	26.9	(27)	28.8	(25)	29.3	(8)
1956										
1957	24.1	(811)	26.2	(207)	27.5	(73)	28.9	(7)		
1958	24.6	(223)	26.2	(822)	27.5	(145)	28.4	(129)	29.0	(22)
1959	24.1	(1568)	26.2	(65)	26.9	(14)	28.0	(2)	29.0	(1)
1960	24.3	(560)	25.4	(818)	26.8	(18)	28.0	(8)	-	

JULY

Year	Age 3		4		5		6			
1952	25.2	(287)+	26.3	(187)-	26.8	(178)	27.1	(208)	27.5	(91)
1953	24.7	(520)+	25.9	(287)-	26.7	(69)	27.4	(36)	27.6	(22)
1954	24.7	(603)+	26.2	(156)-	27.2	(62)	27.7	(25)	28.3	(11)
1955	24.7	(670)+	26.4	(105)-	57.0	(21)	28.3	(5)	29.0	(2)
1956										
1957	24.5	(1496)+	26.2	(287)-	27.6	(56)	27.9	(11)	27.0	(2)
1958	24.8	(226)+	26.4	(450)-	27.6	(64)	28.6	(44)	29.1	(10)
1959	24.7	(1451)-	26.0	(57)-	27.0	(9)				
1960	24.7	(742)-	25.5	(649)-	26.5	(10)	27.0	(1)	-	

Table 10

Mean vertebral counts for age groups 3-4 for spawning herring from the Buchan and Dogger area, 1952 - 1960

A Dogger Area (Scottish Material)

Age	1952	1953	1954	1955	1956	1957	1958	1959	1960
3	56.51 (109)	56.55 (204)	56.36 (139)	56.42 (492)	56.46 (188)	56.65 (104)	-	56.60 (424)	56.57 (57)
4	56.46 (86)	56.36 (292)	56.55 (212)	56.50 (498)	56.55 (459)	56.67 (72)	56.50 (87)	-	56.63 (76)
5	56.43 (163)	56.42 (91)	56.41 (330)	56.57 (234)	56.68 (161)	56.53 (113)	56.47 (45)	-	-
6+7	56.42 (89)	56.45 (272)	56.55 (226)	56.46 (236)	56.49 (132)	56.45 (62)	-	56.50 (10)	-
Total	56.44 (374)	56.44 (896)	56.47 (907)	56.46 (1356)	56.54 (1022)	56.58 (353)	56.49 (132)	56.59 (434)	56.61 (133)
								56.58 (699)	

Table 10 (continued)

B	Dogger Area (Dutch Material)								
Age	1952	1953	1954	1955	1956	1957	1958	1959	1960
3	56.64 (157)	56.51 (234)	56.52 (295)	56.53 (233)	56.56 (380)	56.49 (228)	56.56 (40)	56.54 (618)	-
4	56.56 (170)	56.60 (240)	56.51 (53)	56.52 (90)	56.60 (115)	56.71 (119)	56.30 (23)	56.67 (268)	56.44 (497)
5	56.62 (66)	56.38 (122)	56.68 (25)	56.42 (33)	56.69 (35)	56.48 (295)	56.76 (21)	56.42 (72)	56.60 (105)
6	56.45 (104)	56.50 (508)	56.40 (10)	56.54 (50)	56.44 (70)	56.57 (74)	56.56 (27)	56.38 (55)	56.66 (32)
7	56.35 (203)	56.49 (210)	-	56.41 (46)	56.43 (53)	56.79 (28)	-	56.51 (108)	56.68 (19)
Total	56.51 (700)	56.51 (1314)	56.54 (383)	56.51 (457)	56.55 (653)	56.54 (744)	56.54 (111)	56.56 (1121)	56.48 (653)
					56.55 (6136)				

( ) Brackets denote number of herring

Table 11

L_1 data for spawning herring from the Dogger and Buchan areas

A. Dogger: Mean L_1s for age groups (Dutch Material)

Year	Age Group 3	4	5	6	7	8	9	10
1952	12.54	12.01	11.32	11.33	-	-	-	-
1953	13.07	12.17	12.00	11.39	11.17	12.40	12.56	-
1954	14.21	13.18	12.33	12.30	-	13.11	-	-
1955	14.39	14.33	13.96	13.41	13.24	12.75	12.68	-
1956	14.40	13.97	13.78	14.00	13.63	13.00	12.56	12.39
1957	14.00	15.03	14.92	15.27	14.74	15.25	12.60	13.35
1958	15.12	13.52	14.02	14.30	13.79	13.54	12.64	-
1959	12.34	14.45	13.00	13.51	13.79	13.45	14.57	13.29
1960	14.00	12.30	15.14	13.42	12.95	14.12	-	-

B. Buchan: L_1 distributions and means for all age groups combined

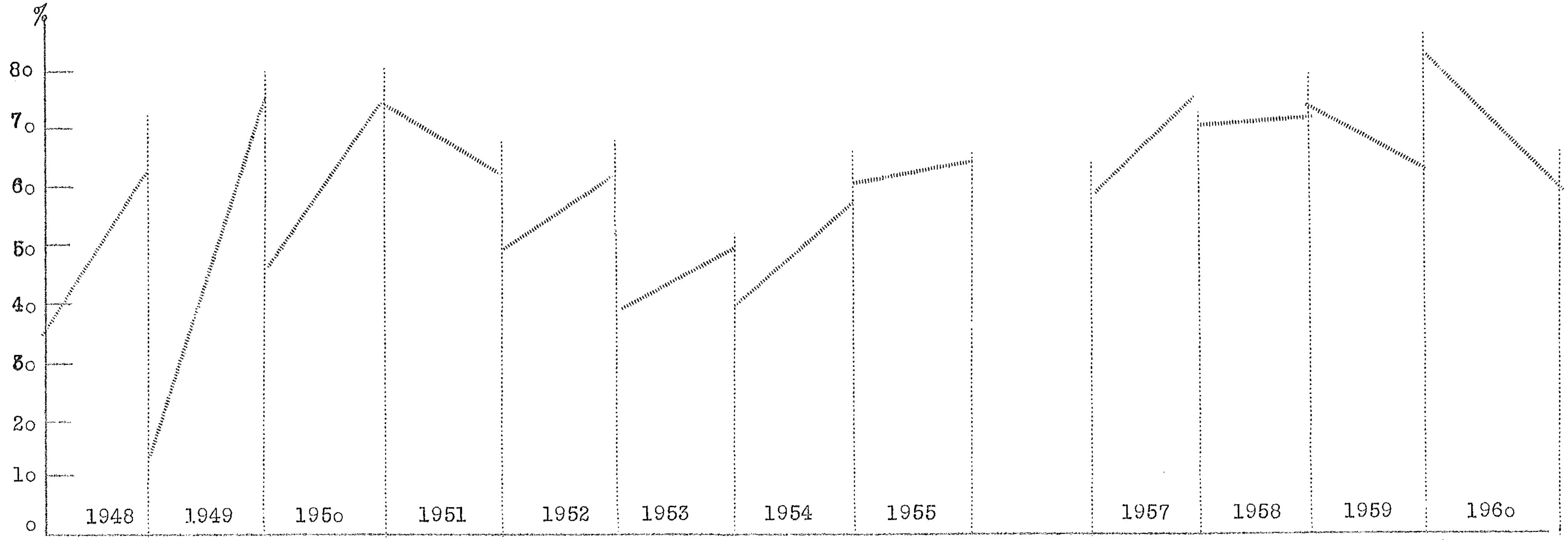
	1948	1951	1952	1953	1954	1955	1958
8.0	-	1	1	0.3	1	-	-
9.0	-	4	5	4	1	2	2
10.0	2.6	11	6	7	4	2	2
11.0	13	11	9	7	8	5	6
12.0	16	18	12	10	7	12	14
13.0	5	10	13	13	12	10	13
14.0	8	15	18	15	18	20	17
15.0	16	14	16	18	18	15	20
16.0	24	6	13	10	14	17	10
17.0	13	7	6	9	10	9	11
18.0	2.6	3	1	5	6	4	5
19.0		1	0.3	3	2	1	2
	38	101	343	295	251	89	163
Mean	14.3	13.2	13.5	13.9	14.4	14.3	14.3

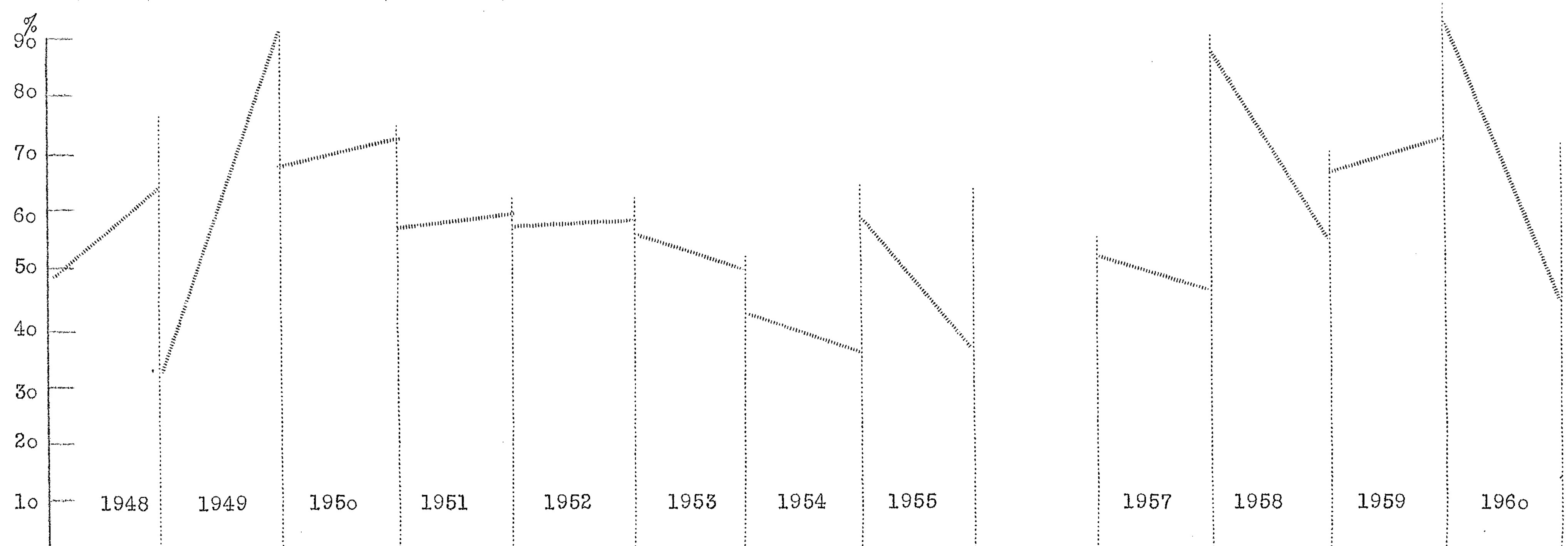
Table 12

% occurrence of otolith types in Buchan spawners, 1953-1959

Year	Age Group													
	3		4		5		6		7		8 - 10		>10	
	N	W	N	W	N	W	N	W	N	W	N	W	N	W
1953	100	0	66	34	74	26	52	48	52	48	60	40	63	37
1954	100	0	83	17	69	31	77	23	61	39	66	34	73	27
1955	100	0	94	6	77	23	46	54	68	32	55	45	71	29
1956	100	0	95	5	90	10	78	22	59	41	54	46	73	27
1957	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1958	95	5	87	13	98	2	84	16	-	-	-	-	-	-
1959	96	4	-	-	-	-	95	5	-	-	-	-	-	-

Figure 1. Percentages of [illegible]turity [illegible]ages II and III, amongst 3-year-olds in buchan area, in June and July. 1948-6o.





~~**Figure 2.** Percentages of maturity stages II and III amongst 4-year-olds in Buchan area, in June and July. 1948-59.~~

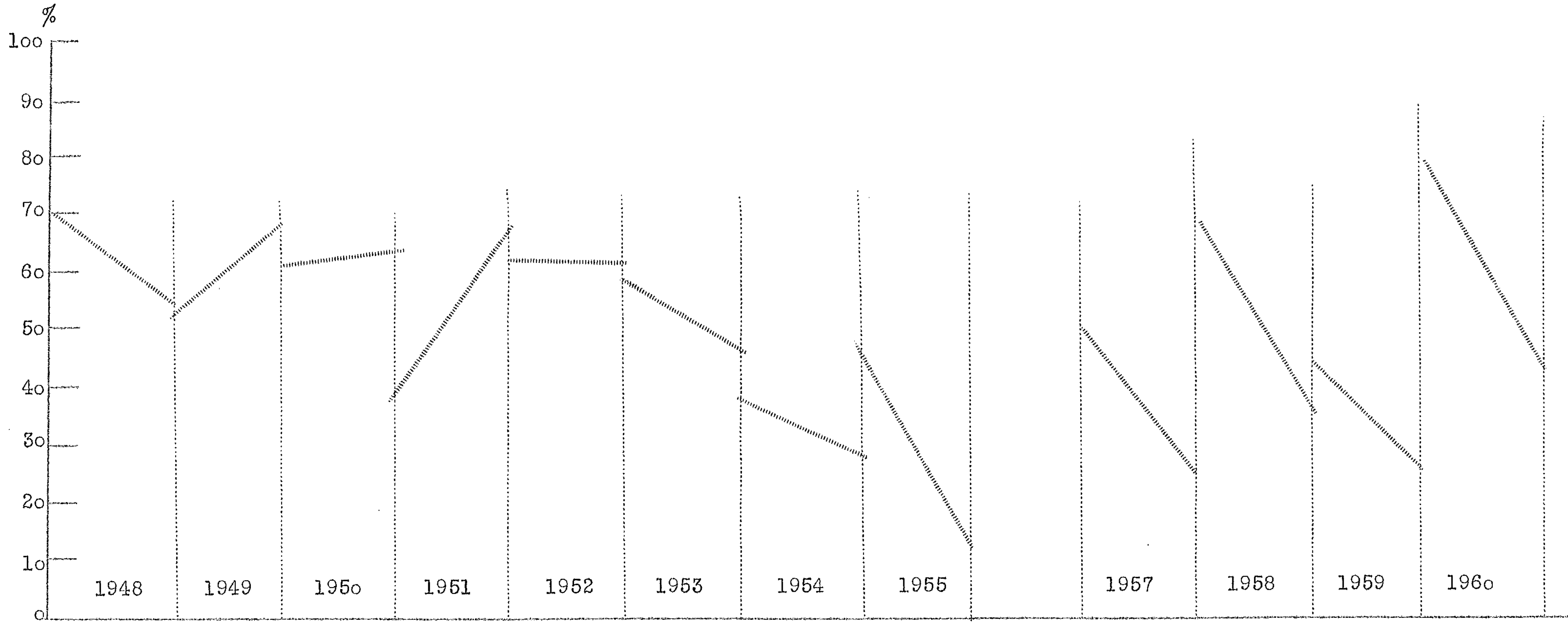
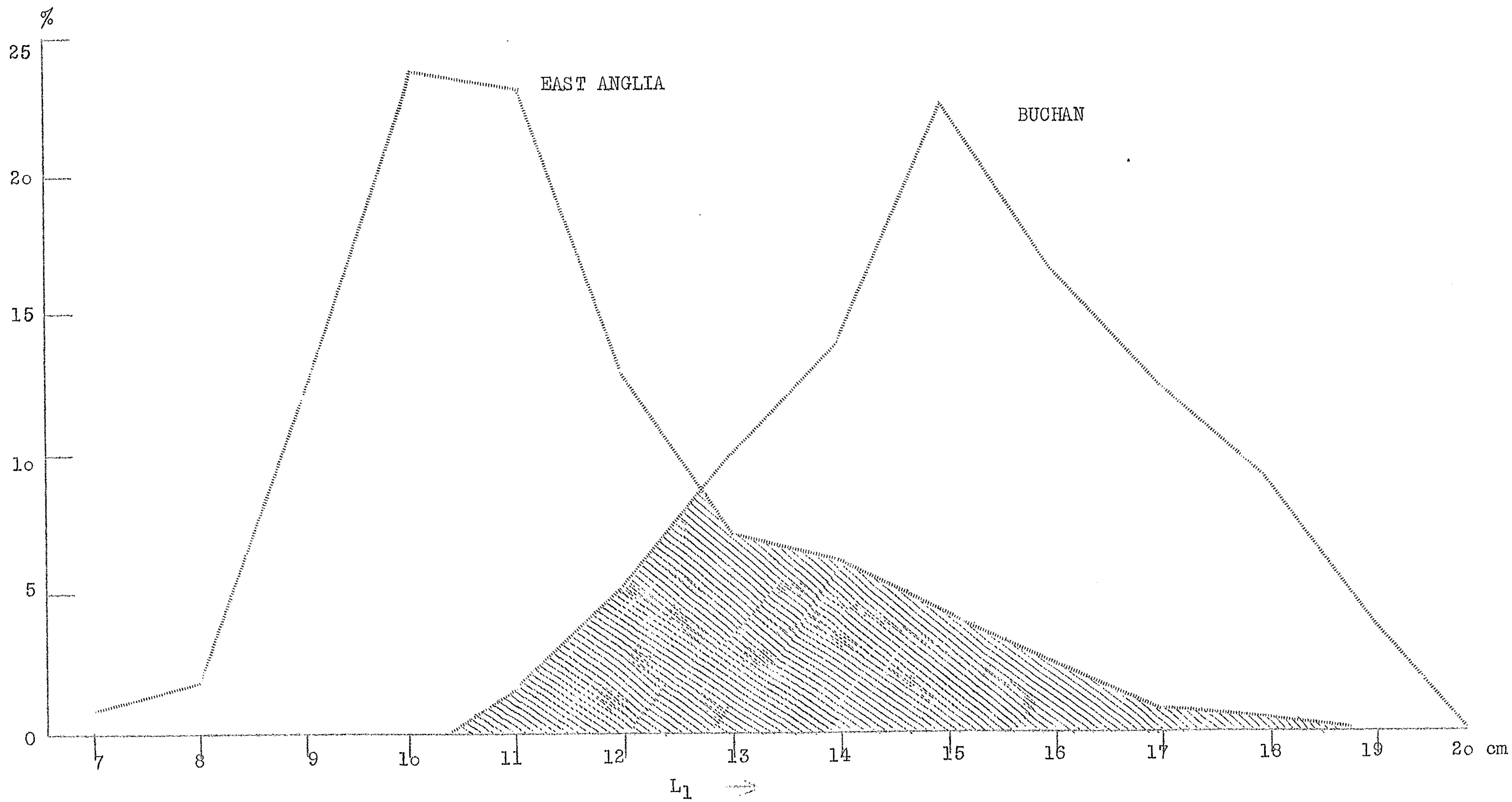


Figure 3. Percentages of maturity stages II and III amongst 5-7-year-olds in Buchan area in June and July.



<u>Figure 4.</u> l_1 distribution of 3-year-olds in the Buchan area (maturity stages II + III in June) and at East Anglia in 1953 (195o year-class).

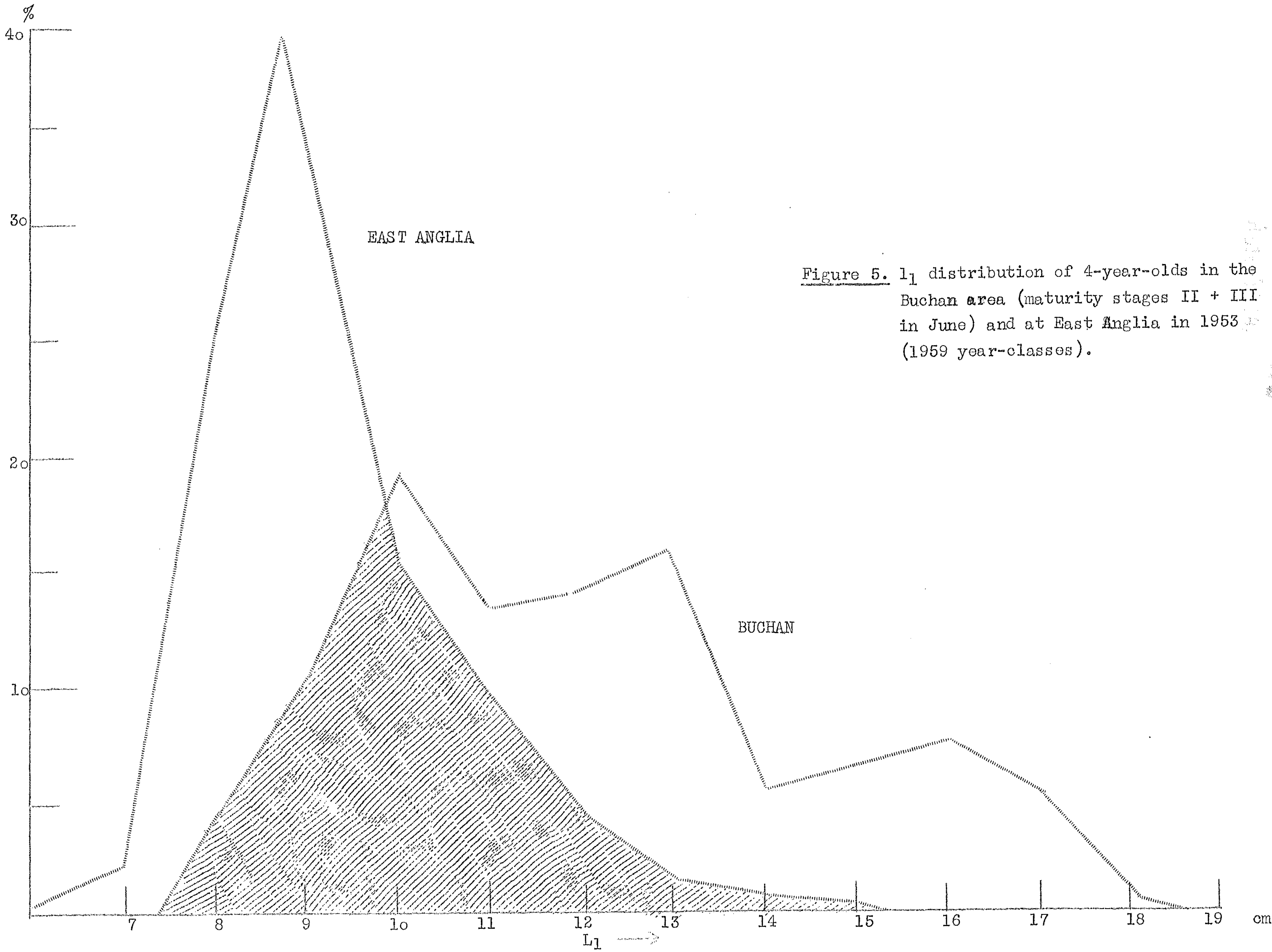


Figure 5. l_1 distribution of 4-year-olds in the Buchan area (maturity stages II + III in June) and at East Anglia in 1953 (1959 year-classes).