

International Council for the
Exploration of the Sea

5

C.M. 1963
Herring Committee
H No. 126



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MIXING OF BANK AND DOWNS HERRING IN THE PRESPAWNING
FISHERIES OF THE NORTH SEA

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Apart from the differences in growth, meristic characters, spawning time and place, it has been shown that there are large differences between the fecundities of northern North Sea and Southern Bight spawners (Baxter 1959). Northern North Sea (Bank) spawners are characterised by having relatively high fecundities and small eggs while Southern Bight (Downs) spawners have relatively low fecundities and large eggs. On the other hand, Central North Sea (Dogger) spawners have fecundities which lie within the range of the northern North Sea and Southern Bight spawners. Several hypotheses can be put forward to explain their intermediate fecundities. Two different explanations are suggested.

- 1) That the Dogger is a mixed spawning area at the extreme range of the Bank and Downs groups. The low fecundity fish could be early Downs spawners and the high fecundity fish late Bank spawners.
- 2) That the Dogger spawners are a separate group, having a very wide range of fecundities, some of which are similar to the northern North Sea spawners and others to the Downs spawners.

If the first of these hypothesis is correct fecundity can be considered as a diagnostic character which can be used to identify Bank and Downs herring in the pre-spawning fisheries of the North Sea. However on the second hypothesis it cannot be used as a completely diagnostic character to identify the different spawning groups. Nevertheless, it can still provide maximum estimates of the rates of mixing of either Downs or northern North Sea spawners in the pre-spawning fisheries. With these points in mind, an analysis has been made of the fecundities of herring in the northern North Sea in summer 1961-1963 to obtain estimates of the mixing of Bank and Downs herring.

Material and Methods

The material for this investigation was collected in the months June, July and August in 1961-1963. The area sampled extended from Shetland in the north to the Shields area in the south. Ovaries were collected from fish in maturity stages III-V. Most of the material, however, was taken from Stage III fish. The majority of the egg counts were made by an automatic fish egg counter (Parrish et al 1960) but some of the 1962 and 1963 fecundities were estimated from egg and ovary measurements using the following formula:-

$$F(\text{Fecundity}) = K \frac{\text{Volume of ovary}}{(\text{Diam. of egg})^3}$$

The regression obtained with known values of F is shown in Figure 1.

In 1961 and 1962 the maturities were classified according to the Hjort scale while in 1963 the new international classification of maturity was used. The main difference between these two maturity scales is in the classification of stages II and III. In the new international scale Stage III is composed of both stages II and III of the Hjort scale.

Results

The fecundity distributions for Southern Bight and northern North Sea spawners are given in Figure 2 for ages 3, 4, 5 and 6 and older fish. The fecundities have been arranged in groups of 5,000 (e.g. 23,000-27,000 = 25,000, 28,000-32,000 = 30,000, etc.). Only among the 3 year old fish is there any overlap between the two groups but even in this age group the overlap of the distributions is small. The lower boundary limits between the distributions of the two groups of spawners at age 3 lies between 25,000 and 30,000 and the upper limits between 35,000 and 40,000.

There are about equal proportions of northern North Sea and Downs spawners in the 30,000 group and in the 35,000 group northern North Sea spawners form 70% and Southern Bight spawners 30%. The boundary limits between the fecundity distributions of the two spawning groups for 4 year old fish is between 45,000 and 50,000, for five year old fish between 55,000 and 60,000 and for 6 year and older fish between 65,000 and 70,000.

It is proposed to use these fecundity distributions for northern North Sea and Southern Bight spawners to identify and separate Bank herring from Downs herring in the pre-spawning fisheries.

The fecundity data collected in the North Sea during the summers of 1961-63 are grouped into three main areas which are as follows:-

- 1) Shetland - north of 59°30'N
statistical squares 20D, 19D, 19E, 18D, 18E.
- 2) Buchan and Fladen - 59°30'N - 56°N and between 1°E and 2°W.
- 3) Shields - Statistical squares 8C, 8D, 9D, 10D.

1) Shetland Area

The fecundity data for 4 years and older herring from the Shetland area are presented in Table I. These show the fecundity distributions for stage III fish sampled in June and July 1961 and 1962. Almost all the fish had relatively high fecundities but there are three fish (one in 1961 and two in 1962) with egg counts just below the limits given for northern North Sea spawners. Even assuming that these three fish are Southern Bight spawners, the proportion of Downs herring is not more than 2% of the fish sampled in stage III.

2) Buchan and Fladen Areas

The fecundity distributions for samples taken in the Buchan and Fladen areas between 1961 and 1963 are given in Tables II-VI.

a) 1961 Data (Tables II and III)

In 1961 sampling was conducted in the Fladen area (stat. squares 17D, 15E, 16E and 17E) in July and in the Buchan and Fladen areas in August (stat. squares 14C, 15C, 12D, 13D, 13E, 15E, 16E). Among the stage III fish sampled in the Fladen area in July, 4 out of 60 or about 7% of the fish had low fecundities similar to Southern Bight spawners (Table IIa). All the fish in stages IV and V appeared to be Bank spawners (Table IIb).

The samples in August 1961 were in maturity stages IV and V. With the possible exception of one fish in stage IV, all appeared to be northern North Sea or Bank spawners (Table III).

b) 1962 Data (Table IV)

Sampling in the Buchan area in 1962 was confined to August. There were only a small number of stage III fish and from the distribution of their fecundities they appeared to be a mixture of Bank and Downs herring. The fish in stages IV and V on the other hand were mainly Bank spawners.

c) 1963 Data (Tables V and VI)

The majority of the fish sampled in the Buchan area in June and July 1963 were 3 year old recruits of the 1960 year class. From the distribution of their fecundities, these young fish in stage III in June and July were a mixture of Bank and Downs herring (Table V). The June samples were taken from statistical square 13D and it is estimated, from the data for this square, that the 3 year old fish were composed of 85% Bank herring and 15% Downs herring. In the July samples the proportion of Downs herring increased to 22%. This increase in the percentage of Downs herring from June to July may have been due to the fact that a proportion of the Downs herring in June were still in a very early stage of maturity for which we have no fecundity data. In this area in June 1963 there were 19.3% in stage II while in July there were only 4.5% in this stage.

The small number of fish sampled at ages greater than 3 in stage III and also all the fish in stages IV and V appeared to be Bank spawners.

3) Shields Area

The data from the Shields area were obtained from samples taken in July 1961 and July and August 1962 (Tables VII-IX).

The stage III fish in July 1961 were composed mainly of 3 year old recruits of the 1958 year class (Table VIIa). The distribution of their fecundities indicated that these young recruits consisted of a mixture of Bank and Downs herring. It is estimated from the available data that the proportion of Bank herring was about 60% and Downs herring 40%. The majority of the 4 year old and older herring in stages III and IV appeared to be Bank herring.

In the 1962 samples from the Shields area the 1958 year class again predominated. From the fecundity data stage III and stage IV fish in July were mainly Bank spawners (Table VIII). The proportion of Downs herring among the 1958 year class (4 year olds) appeared to be much lower than in 1961 when they first recruited.

Out of 67 fish sampled seven had relatively low counts and the remainder had high ones similar to northern North Sea spawners.

A small number of fish were sampled in the Shields area in August 1962 and the data are given in Tables IXa and IXb. All the fish in stages IV and V had high fecundity counts, of those sampled in stage III only two could be classified as Downs herring.

Thus in the Shields area as in the other areas sampled the majority of the fish had high fecundities within the range expected for northern North Sea or Bank spawners. Only among the 1958 year class which appeared as 3 year old recruits in the 1961 samples, and as 4 year olds in the 1962 samples did Downs herring appear to be present in any appreciable numbers and even within this group Bank herring predominated.

Conclusions

At present fecundity estimates can only be obtained for fish in stages III-V and therefore the results obtained using fecundity differences only apply to that part of the stocks in these stages of maturity.

The estimated percentages of Downs herring in each of the areas sampled are given in Table X.

In the Shetland area the herring were almost entirely Bank spawners. The proportion of Downs herring at the very most was between 1 and 2%.

In the Buchan and Fladen area a much higher proportion of Downs herring were detected principally among the 3 year old recruits of the 1960 year class which was very abundant on the Buchan grounds during the summer of 1963. It was estimated that Downs herring formed from 15 to 22% of these recruits.

Except for a few fish sampled in stage III in August 1962 the proportion of Downs herring among the 4 year old and older herring was generally much lower. The greatest estimate of Downs herring for this group was 7% of stage III in July 1961. The stage IV and V fish were almost all Bank spawners.

In the Shields area most of the fish which could be classified as Downs spawners were among the three year old recruits. Up to 40% of these recruits in July 1961 were estimated to be Downs herring. Among the 4 year old and older herring in stage III from 9-18% could be classified as Downs herring. Herring in stages IV and V in this area were predominantly Bank herring.

Thus from the Shetland to the Shields area Bank herring predominated. The proportion of Downs herring increased from north to south and they were detected principally among the 3 year old recruits in stage III, sampled in the Shields area in 1961 and in the Buchan area in 1963.

It must be emphasised, however, that these mixing rates for Downs herring may be very much over-estimated because they may contain a proportion of low fecundity Dogger spawners.

References

- Baxter, I. G. 1959. "Fecundities of winter-spring and summer-autumn herring spawners". J. Cons. int. Explor. Mer., 25: 73-80.
- Parrish, B. B., Baxter, I. G., and Mowat, M. J. D. 1960. "An automatic fish egg counter". Nature, Lond. 185: 777.

Table I

SHETLAND AREA

a) June and July 1961

Maturity Stage III

| Fecundity X 1,000 | Age/years | | |
|----------------------|-----------------|-------------------|-------------------|
| | 4 | 5 | > 5 |
| | No. of fish | No. of fish | No. of fish |
| 50 | | Downs Herring | |
| 55 | 1 | 1 | Downs Herring |
| 60 | | 1 | |
| 65 | | 2 | |
| 70 | Bank Herring | 5 | |
| 75 | | 3 Bank Herring | 2 |
| 80 | 1 | 13 | 1 Bank Herring |
| 85 | | 11 | |
| 90 | | 5 | 4 |
| 95 | 1 | | 1 |
| 100 | | | 3 |
| 105 | | | |
| 110 | | | 1 |
| 115 | | | |
| 120 | | | |
| 125 | | | |
| 130 | | | |
| 135 | | | |
| 140 | | | 1 |
| Total | 3 | 41 | 13 |

b) June and July 1962

Maturity Stage III

| Fecundity X 1,000 | Age/years | | |
|----------------------|----------------|------------------|--------------------|
| | 4 | 5 | > 5 |
| | No. of fish | No. of fish | No. of fish |
| 50 | | Downs Herring | |
| 55 | | | |
| 60 | 1 Bank | | Downs Herring |
| 65 | 1 | 1 Bank | 2 |
| 70 | Herring | 2 Herring | 9 |
| 75 | 2 | 4 | 10 |
| 80 | | 3 | 15 Bank Herring |
| 85 | | 2 | 17 |
| 90 | | 3 | 16 |
| 95 | | 7 | 14 |
| 100 | | 5 | 20 |
| 105 | | | 9 |
| 110 | | 2 | 7 |
| 115 | | | 8 |
| 126 | | | 6 |
| 125 | | | 3 |
| 130 | | | 2 |
| 135 | | | 1 |
| Total | 4 | 29 | 139 |

Table II
FLADEN AREA

July 1961

a) Maturity Stage III

| Fecundity X 1,000 | Age/years | | | |
|----------------------|-------------------|---------------------|---------------------|--------------------|
| | 3 | 4 | 5 | > 5 |
| | No. of fish | No. of fish | No. of fish | No. of fish |
| 50 | 1 Bank Herring | 1 Bank 1 Herring | Downs Herring | 1 |
| 55 | | | 4 | 1 Downs Herring |
| 60 | | | | 2 |
| 65 | | | 5 | 1 |
| 70 | | 2 Bank 8 Herring | | 1 |
| 75 | | 3 | 2 Bank 3 Herring | |
| 80 | | | 1 | |
| 85 | | 2 | 3 Herring | |
| 90 | | | 1 | |
| 95 | | 5 | 1 | |
| 100 | | | 1 | |
| 105 | | 3 | 2 | |
| 110 | | | 1 | |
| 115 | | 3 | 1 | |
| 120 | | | 2 | |
| 125 | | 3 | 1 | |
| 130 | 2 | | | |
| 135 | 3 | 1 | | |
| Total | | 1 | 4 | 36 |

b) Maturity Stages IV and V

| Fecundity X 1,000 | Age/years | | | |
|----------------------|----------------|------------------|-------------------|------------------|
| | 4 | 5 | > 5 | |
| | No. of fish | No. of fish | No. of fish | |
| 40 | 2 | Downs Herring | Downs Herring | |
| 45 | | Downs Herring | | Downs Herring |
| 50 | | | | |
| 55 | | Downs Herring | | |
| 60 | | | Downs Herring | |
| 65 | | Downs Herring | | |
| 70 | | | Bank 1 Herring | 1 |
| 75 | | 1 | 5 | |
| 80 | | | 3 Bank | 1 Bank |
| 85 | | 1 | 4 Herring | 1 Herring |
| 90 | | | 3 | 2 |
| 95 | | 5 | 6 | 4 |
| 100 | | | 5 | 4 |
| 105 | | 1 | 1 | 2 |
| 110 | | | 2 | 4 |
| 115 | | 1 | 1 | |
| 120 | 1 | | | |
| 125 | 1 | 1 | | |
| 130 | | 1 | | |
| Total | 9 | 27 | 18 | |

Table III

BUCHAN AND FLADEN AREA

August 1961

Maturity Stages IV and V

| Fecundity X 1,000 | Age/years | | | |
|----------------------|-------------------|-------------------|------------------|------------------|
| | 3 | 4 | 5 | >5 |
| | No. of fish | No. of fish | No. of fish | No. of fish |
| 50 | 1 Bank Herring | 1 Bank Herring | Downs Herring | Downs Herring |
| 55 | | | 2 | |
| 60 | | | 5 | |
| 65 | | | 5 | |
| 70 | | | 9 | |
| 75 | | | 12 Bank | 1 |
| 80 | | | 10 Herring | 1 |
| 85 | | | 7 | 1 Bank |
| 90 | | | 14 | 1 Herring |
| 95 | | | 5 | 2 |
| 100 | | | 8 | 1 |
| 105 | | | 3 | 4 |
| 110 | | | 1 | |
| 115 | | | | 2 |
| 120 | | | | |
| 125 | | | | |
| 130 | | | | |
| Total | 1 | 3 | 81 | 14 |

Table IV
 BUCHAN AREA
 August 1962

a) Maturity Stage III

| Fecundity X 1,000 | Age/years | | |
|----------------------|--------------------------|-------------------|-------------------|
| | 3 | 4 | 5 |
| | No. of fish | No. of fish | No. of fish |
| 15 | Downs Herring | 1 | Downs Herring |
| 20 | | Downs Herring | |
| 25 | | 2 | |
| 30 | | | |
| 35 | | | |
| 40 | 1 1 Bank 1 Herring | 2 | Downs Herring |
| 45 | | 1 | |
| 50 | | 1 Bank Herring | |
| 55 | | | |
| 60 | | | |
| 65 | | | 1 Bank Herring |
| Total | 3 | 7 | 1 |

b) Maturity Stages IV and V

| Fecundity X 1,000 | Age/years | | | | |
|----------------------|-------------------|--------------------|------------------|--------------------|-----------------|
| | 3 | 4 | 5 | 6 | |
| | No. of fish | No. of fish | No. of fish | No. of fish | |
| 45 | 1 Bank Herring | Downs 1 Herring | Downs Herring | Downs 1 Herring | |
| 50 | | 1 | | | |
| 55 | | | | | |
| 60 | | | | | |
| 65 | | | | | |
| 70 | | 2 Bank | | | 1 |
| 75 | | 1 Herring | | | 1 |
| 80 | | 1 | | | Bank Herring |
| 85 | | 2 | | | |
| 90 | | 1 | | | |
| 95 | | | | | |
| 100 | | | | | 3 |
| 105 | | | | | |
| 110 | | | | | |
| 115 | | | | | |
| Total | 1 | 9 | 5 | 40 | |

Table V

BUCHAN AREA (Statistical square 13D)

Maturity Stage III

a) June 1963

| Fecundity X 1,000 | Age/years | | | |
|----------------------|----------------|---------------|----------------------|------------------|
| | 3 | | 4 | > 4 |
| | No. of fish | % | No. of fish | No. of fish |
| 10 | 1 | 0.5) | | |
| 15 | 1 | 0.5) Downs | | |
| 20 | 3 | 1.6) Herring | | |
| 25 | 11 | 5.7) | | |
| 30 | 12 | 6.2 Region of | | |
| 35 | 25 | 13.0 overlap | | |
| 40 | 37 | 19.2) | Downs Herring | Downs Herring |
| 45 | 37 | 19.2) | | |
| 50 | 21 | 10.9) Bank | | |
| 55 | 26 | 13.5) | | |
| 60 | 9 | 4.7) Herring | 1 | |
| 65 | 6 | 3.1) | 1 Bank Herring | Bank Herring |
| 70 | 4 | 2.1) | | |
| 75 | | | | |
| 80 | | | 1 | |
| 85 | | | | |
| 90 | | | | |
| 95 | | | | 2 |
| 100 | | | | 1 |
| Total | 193 | | 3 | 3 |

b) July 1963

| Fecundity X 1,000 | Age/years | | | |
|----------------------|----------------|---------------|----------------------|----------------------|
| | 3 | | 4 | > 4 |
| | No. of fish | % | No. of fish | No. of fish |
| 10 | 2 | 1.6) | | |
| 15 | 4 | 3.1) Downs | | |
| 20 | 7 | 5.5) Herring | | |
| 25 | 6 | 4.7) | | |
| 30 | 6 | 4.7 Region of | Downs Herring | Downs Herring |
| 35 | 22 | 17.2 overlap | | |
| 40 | 10 | 7.8) | | |
| 45 | 24 | 18.8) Bank | | |
| 50 | 18 | 14.1) Herring | | |
| 55 | 15 | 11.7) | | |
| 60 | 9 | 7.0) | | |
| 65 | 4 | 3.1) | | |
| 70 | 1 | 0.8) | 1 Bank Herring | 1 Bank Herring |
| 75 | | | | |
| 80 | | | | |
| 85 | | | 1 | |
| Total | 128 | | 1 | 2 |

Table VI

BUCHAN AREA (Statistical square 13D)

Maturity Stages IV and V

July 1963

| Fecundity X 1,000 | Age/years | |
|----------------------|------------------|----------------|
| | 3 | >6 |
| | No. of fish | No. of fish |
| 45 | Downs Herring | |
| 50 | 1 | |
| 55 | 1 Bank | Downs |
| 60 | 1 Herring | Herring |
| 65 | | |
| 70 | 2 | |
| 75 | | |
| 80 | | |
| 85 | | 1 Bank |
| 90 | | |
| 95 | | Herring |
| 100 | | |
| 105 | | 1 |
| 110 | | |
| 115 | | |
| 120 | | 1 |
| 125 | | 1 |
| Total | 5 | 4 |

Table VII
SHIELDS AREA

July 1961

a) Maturity Stage III

| Fecundity X 1,000 | Age/years | | | | | |
|----------------------|----------------|------|----------------|----------------|---|-----------|
| | 3 | | 4 | | 5 | |
| | No. of fish | % | No. of fish | No. of fish | | |
| 10 | 1 | 4.5 | | | | |
| 15 | 2 | 9.1 | Downs | | | |
| 20 | 1 | 4.5 | Herring | | | |
| 25 | 2 | 9.1 | | Downs | | |
| 30 | 4 | 18.2 | Region of | 1 Herring | | |
| 35 | 3 | 13.6 | overlap | | | |
| 40 | 3 | 13.6 | | | | Downs |
| 45 | 4 | 18.2 | Bank | | | 1 Herring |
| 50 | 1 | 4.5 | Herring | | | |
| 55 | 1 | 4.5 | | | | |
| 60 | | | | Bank | | |
| 65 | | | | 3 Herring | | 1 |
| 70 | | | | 1 | | 1 Bank |
| 75 | | | | | | 3 Herring |
| 80 | | | | | | |
| 85 | | | | | | 1 |
| Total | 22 | | | 5 | | 7 |

b) Maturity Stage IV

| Fecundity X 1,000 | Age/years | |
|----------------------|----------------|------------------|
| | 4 | 5 |
| | No. of fish | No. of fish |
| 40 | Downs | |
| 45 | 1 Herring | |
| 50 | 1 | Downs Herring |
| 55 | | |
| 60 | | 1 |
| 65 | Bank | |
| 70 | 1 Herring | |
| 75 | 1 | |
| 80 | 1 | Bank Herring |
| 85 | | |
| 90 | 1 | |
| 95 | | |
| 100 | | |
| 105 | | |
| 110 | | 1 |
| Total | 6 | 2 |

Table VIII

SHIELDS AREA

July 1962

a) Maturity Stage III

| Fecundity X 1,000 | Age/years | | | |
|----------------------|------------------------|----------------|----------------|----------------|
| | 3 | 4 | 5 | 6 |
| | No. of fish | No. of fish | No. of fish | No. of fish |
| 20 | Downs | | | |
| 25 | Herring | | | |
| 30 | 1 Region of overlap | 3 Downs | | |
| 35 | | Herring | | |
| 40 | 4 | 4 | | |
| 45 | 2 Bank | | Downs | |
| 50 | 5 Herring | 6 | Herring | |
| 55 | 2 | 10 Bank | | Downs |
| 60 | | 9 Herring | 1 | Herring |
| 65 | 1 | 8 | | |
| 70 | | 9 | 1 Bank | 2 |
| 75 | | 6 | 1 Herring | 1 |
| 80 | | 3 | | Bank |
| 85 | | 3 | | 1 Herring |
| 90 | | | | 5 |
| 95 | | | 1 | 1 |
| 100 | | | | 1 |
| 105 | | | | 1 |
| Total | 15 | 61 | 4 | 12 |

b) Maturity Stages IV and V

| Fecundity X 1,000 | Age/years | | |
|----------------------|----------------|----------------|----------------|
| | 3 | 4 | > 5 |
| | No. of fish | No. of fish | No. of fish |
| 20 | | | |
| 25 | Downs | | |
| 30 | Herring | | |
| 35 | | Downs | |
| 40 | | Herring | |
| 45 | 1 Bank | | |
| 50 | Herring | | Downs |
| 55 | | | Herring |
| 60 | | | |
| 65 | | 1 Bank | |
| 70 | | 3 Herring | |
| 75 | | 3 | 1 |
| 80 | | 1 | 1 Bank |
| 85 | | 1 | 2 Herring |
| 90 | | 1 | 2 |
| 95 | | 1 | |
| 100 | | | 2 |
| 105 | | | |
| 110 | | | 2 |
| 115 | | | |
| 120 | | | |
| 125 | | | 1 |
| 130 | | | |
| 135 | | | 1 |
| Total | 4 | 14 | 12 |

Table IX

SHIELDS AREA

August 1962

a) Maturity Stage III

| Fecundity X 1,000 | Age/years | |
|----------------------|----------------------|-------------------------|
| | 3 | 4 |
| | No. of fish | No. of fish |
| 20 | Downs Herring | 1 Downs 1 Herring |
| 25 | | |
| 30 | Region of overlap | |
| 35 | | |
| 40 | 1 Bank | |
| 45 | | |
| 50 | 1 Herring | 3 |
| 55 | | 4 Bank |
| 60 | | 1 Herring |
| 65 | | 1 |
| Total | 2 | 11 |

b) Maturity Stages IV and V

| Fecundity X 1,000 | Age/years | | |
|----------------------|-------------------|------------------|-------------------|
| | 3 | 4 | 4 |
| | No. of fish | No. of fish | No. of fish |
| 20 | Downs Herring | Downs Herring | Downs Herring |
| 25 | | | |
| 30 | | 1 | |
| 35 | | | |
| 40 | 2 Bank Herring | 1 Bank | 1 |
| 45 | | 1 Herring | |
| 50 | | 5 | Bank 4 Herring |
| 55 | | 2 | |
| 60 | | 3 | 2 |
| 65 | | 5 | |
| 70 | | 4 | 7 |
| 75 | | 2 | |
| 80 | | 1 | 7 |
| 85 | | 1 | |
| 90 | | | 6 |
| 95 | | | |
| 100 | | | 1 |
| 105 | | | |
| 110 | | | 2 |
| 115 | | | |
| 120 | | | 3 |
| 125 | | | |
| 130 | | | 1 |
| 135 | | | |
| 140 | | | 1 |
| Total | | 2 | |

Table X

Estimated percentages of Downs herring for each of the areas sampled between 1961 and 1963. (In brackets is the number of fish.)

| Year | Area | Month | 3 year old | | 4 year old and older | |
|------|-------------------------|---------------|-------------|-----------------|----------------------|-----------------|
| | | | Stage III | Stages IV and V | Stage III | Stages IV and V |
| 1961 | Shetland | June and July | - | - | 2 (57) | - |
| | Buchan and Fladen | July | 0 (1) | - | 7 (59) | 0 (54) |
| | | August | - | 0 (1) | - | 1 (98) |
| | Shields | July | 40 (22) | - | 16 (12) | 13 (8) |
| 1962 | Shetland | June and July | - | - | 1 (172) | - |
| | Buchan and Fladen | August | 0 (3) | 0 (1) | 63 (8) | 2 (54) |
| | | Shields | July | 3 (15) | 0 (1) | 9 (77) |
| | August | | 0 (2) | 0 (1) | 18 (11) | 0 (59) |
| 1963 | Buchan | June | 15 (193) | - | 0 (6) | - |
| | | July | 22 (128) | 0 (5) | 0 (3) | 0 (4) |

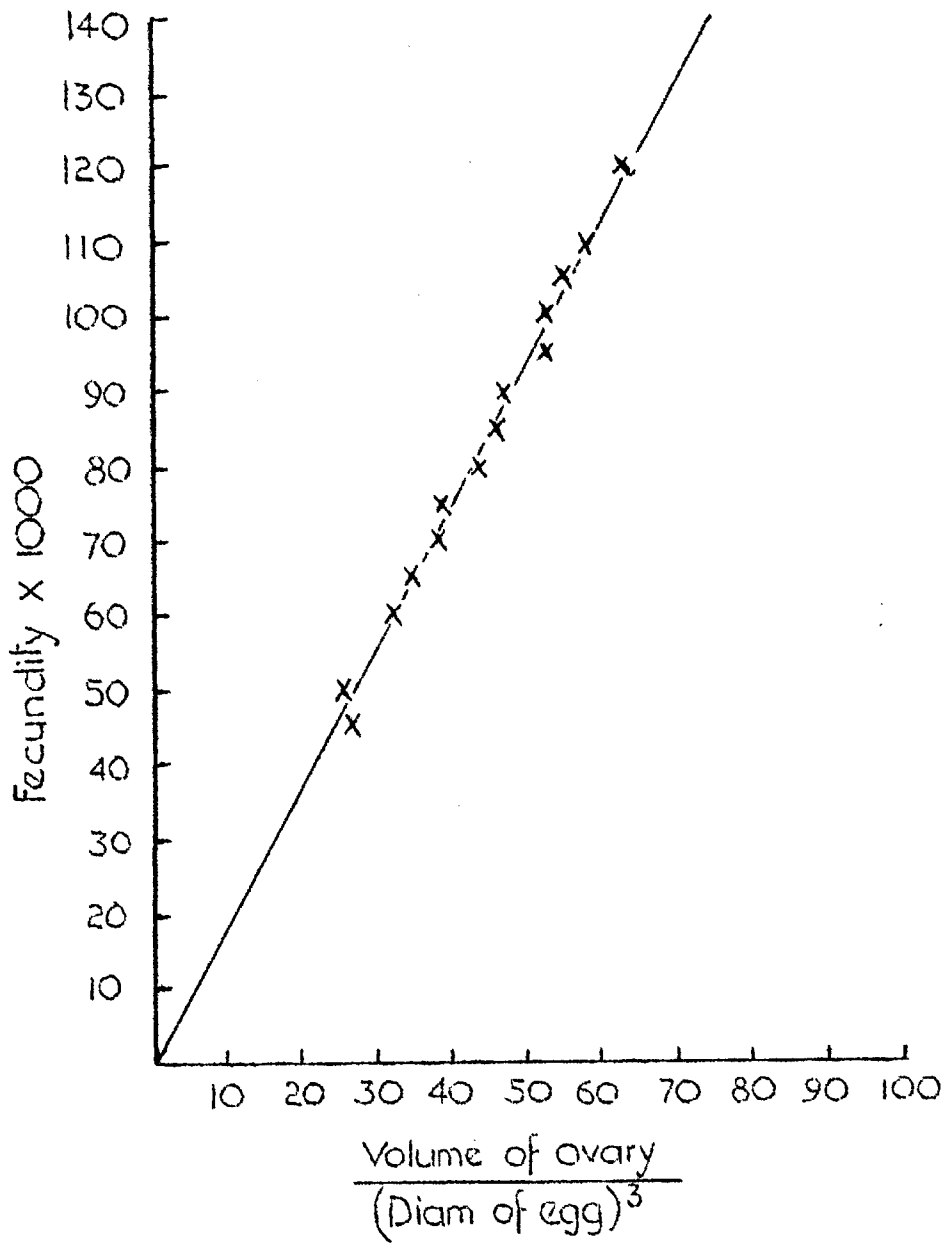
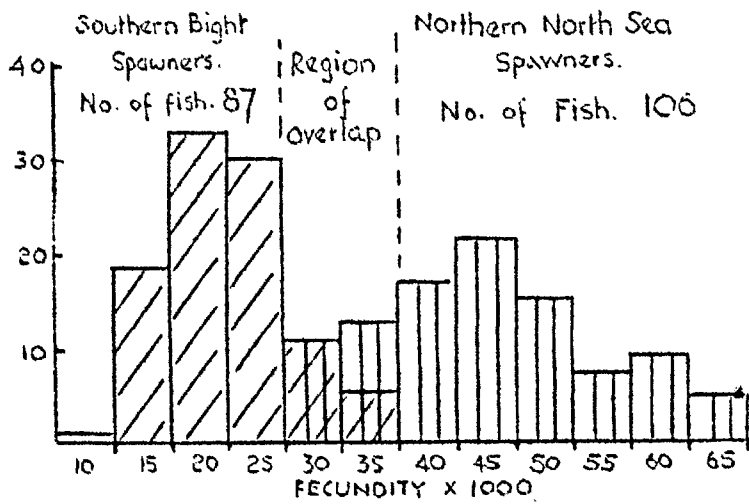


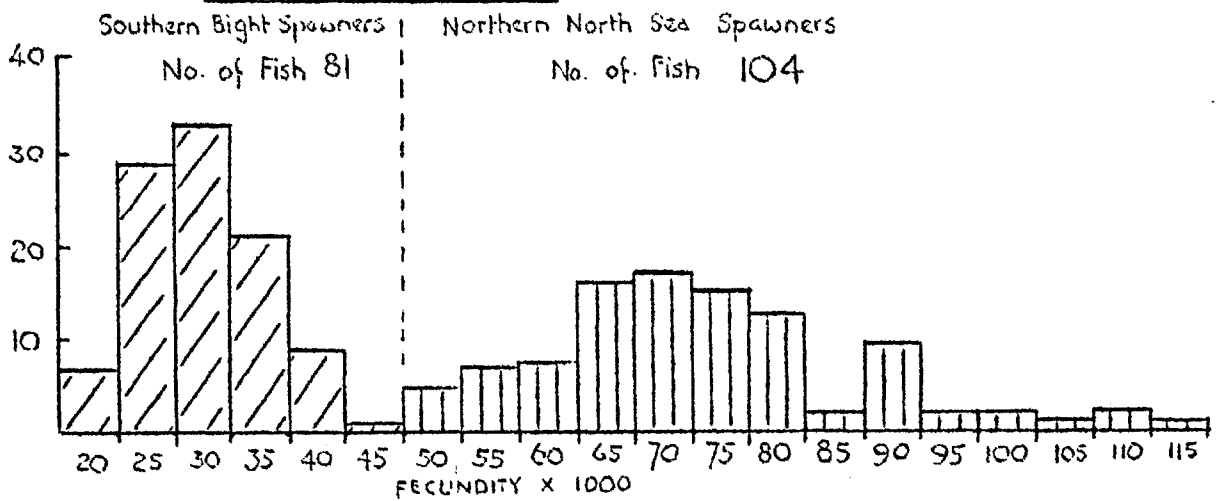
Fig. 1. Relationship between fecundity and the ratio $\frac{\text{Volume of ovary}}{(\text{Diam. of egg})^3}$

Crosses represent mean values.

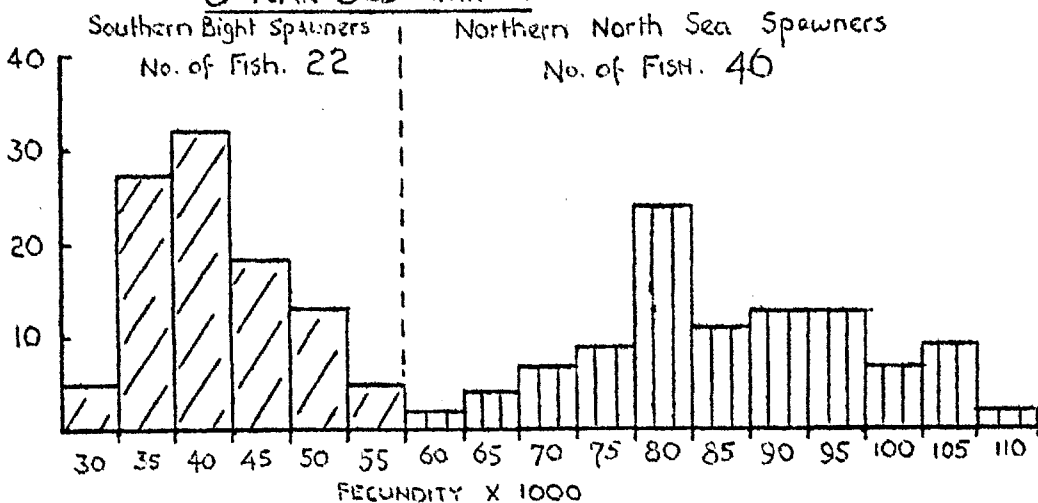
3 YEAR OLD HERRING.



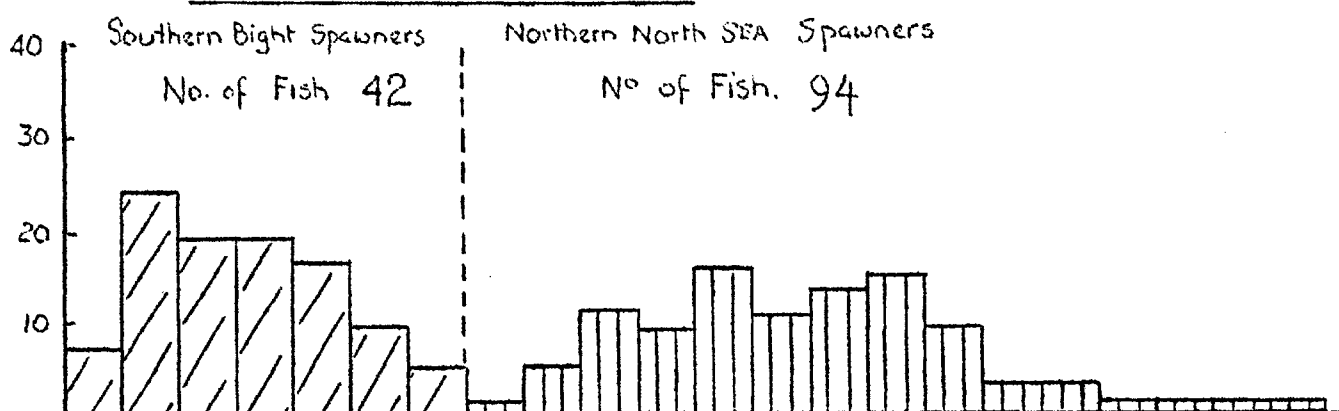
4 YEAR OLD HERRING



5 YEAR OLD HERRING.



6 YEAR OLD, & OLDER HERRING.



PERCENTAGE NUMBER OF FISH