

2.

AGE COMPOSITION
OF HADDOCK IN EUROPEAN WATERS.

BY

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I. Introduction.

THE present communication deals with the age composition of the haddock stocks in the several areas throughout the distribution of the species in European waters. The main object of this enquiry is to collect all the data regarding the fluctuations in abundance of the different year classes in order that the relationship between the stocks of the various areas may be clearly defined. Age-assessment of the haddock populations can only be made on a safe basis by the examination of representative scale samples, except perhaps during the first year of life when special methods have to be devised for their capture. Length measurements on a large scale are useful for relative comparison when limited scale samples have been taken at the same time and place. The enquiry, therefore, has been restricted to the results obtained from the examination of material collected by research vessels specially equipped to capture all sizes of haddock and of commercial samples which have been subjected to scale age analysis.

This report deals largely with published data and references are given to these works which are applicable to the purpose of the present enquiry. Free use has been made of Dr. H. Thompson's work on the haddock of the North Sea, Faroes and Iceland and the methods employed by him have been continued on similar lines and the statistics brought up-to-date by Dr. D. S. Raitt who is now engaged on Haddock research. To the latter I owe the preparation of the regional surveys in this report and with him I have also discussed the more general aspects of this enquiry. I am indebted to Dr. Å. V. Tåning for further data from the North Sea, Iceland and Faroe, to Dr. A. Bückmann for North Sea material collected from the "Poseidon", to Dr. Lundbeck for handing over the results of his scale age determinations of recent commercial landings from the Barents Sea, and to Dr. Tesch for scale samples taken during the periodic cruises of the "Nautilus" in the North Sea.

II. Distribution.

a. General.

The haddock is distributed in European seas from Spitsbergen to the Bay of Biscay. Its centre of distribution lies in the North Sea and adjacent waters from which it extends northwards to Bear Island and within the Barents Sea where the numbers are considerable and to Spitsbergen where its occurrence is infrequent. Eastwards it extends into the Skagerak, Kattegat and Belt Sea, but only occasionally reaches the western Baltic. Southwards the numbers decrease rapidly in the English Channel and finally disappear in the Bay of Biscay. Haddock are plentiful along the west coast of the British Isles and particularly on the island plateaus of Rockall, Faroe and Iceland; and in recent years small numbers have been taken in Greenland waters. In those areas, the haddock shows a preference for muddy bottom. The major distribution is restricted by the 200-metre line of depth.

b. Natural Boundaries.

Depth of water, temperature and salinity have been shown by Schmidt¹⁾ to be limiting factors in the spawning places of the haddock so that the distribution at this phase is much more restricted than for the species as a whole. According to Schmidt (l.c.) spawning occurs chiefly within the 200-metre line. Very little production takes place below 50 and over 200 metres, the maximum occurring from 60 to 150 metres. The production of eggs and fry is greatest south and west of Iceland, at the Faroes, along the British Atlantic coasts and in the Northern North Sea. Little or no spawning occurs on the north and east coasts of Iceland, in the Bay of Biscay, in the channel and in the Southern North Sea.

Spawning occurs to a limited extent, according to Damas²⁾ on the Norwegian coast between

¹⁾ The Distribution of the Pelagic Fry and the Spawning Regions of the Gadoids in the North Atlantic from Iceland to Spain. Rapp. et Proc.-Verb., Vol. X. 1909.

²⁾ Contribution à la Biologie des Gadides. Rapp. et Proc.-Verb., Vol. X. 1909.

Romsdal and Trondhjem. Spawning has also been observed in the Barents Sea, but its extent in this region has not been fully explored. The drift of the eggs and larvae tends to widen the extent of the distribution, but though larvae have been found in the upper layers over great depths, the majority occurs normally in moderate depths, within the 200-metre line. The earliest bottom stages as a rule settle down to a bottom habitat in moderately deep water. The slightly later adolescents have been captured by trawls with small-meshed netting in such and shallower areas from the end of June onwards.

c. Fishing Grounds.

The distribution and extent of the haddock fisheries is indicated in the statistical returns from the various regions which are published annually in the Bulletin Statistique. The position at the present time may be gauged from the following table which gives the actual figures for the years 1932 and 1933.

| Areas | Quantities (in '000 kg.) and percentages of total. | | | |
|---|--|------|---------|------|
| | 1932 | % | 1933 | % |
| North Sea | 97,913 | 44.8 | 108,032 | 50.7 |
| Kattegat | 4,377 | 2.0 | 5,282 | 2.5 |
| Skagerak | | | | |
| Belt | | | | |
| Baltic | — | — | — | — |
| Iceland | 31,937 | 14.6 | 25,699 | 12.1 |
| Faroe | 14,634 | 6.7 | 10,661 | 5.0 |
| Norwegian Sea | 8,838 | 4.0 | 6,990 | 3.3 |
| Barents Sea | 35,956 | 16.5 | 36,613 | 17.2 |
| Spitzbergen | 7,225 | 3.3 | 3,005 | 1.4 |
| Bear Island | | | | |
| Greenland | — | — | 354 | 0.4 |
| Rockall | 667 | 0.3 | 2,491 | 1.2 |
| N W. coast Scotland } N. Ireland | 14,204 | 6.5 | 8,418 | 4.0 |
| English Channel | | | | |
| Irish Sea | 111 | 0.1 | 186 | 0.1 |
| Bristol Channel ... } | | | | |
| W. coast Ireland ... | 520 | 0.2 | 758 | 0.4 |
| S. coast Ireland | 771 | 0.4 | 1,040 | 0.5 |
| Bay of Biscay | 2 | | 13 | |
| Portugal | — | — | — | — |

The main fishery for haddock, therefore, is centred in the North Sea and adjacent waters. Iceland and Faroe are well represented, while the Barents Sea and Bear Island fishery has developed

enormously within the last ten years and has now risen to second place. Haddock have only been recorded at Greenland since 1931, but the numbers have been insignificant. The smallness of the quantities taken off the Norwegian coast has been attributed largely to the rocky nature of the bottom, which is more suitable for cod. The decline in the catches south of Rockall along the west and south coasts of Ireland is significant and suggests proximity to the southern limit of distribution of the species. Similarly the infrequency of the catches at Spitzbergen may be taken to denote the northern limit.

III. The Age Composition of the Haddock Stocks of the Different Fishing Regions of the North-East Atlantic covering the Period 1916—1935.

By

D. S. Raïtt.

The following is a summary of a report upon the stock fluctuations of the haddock of the North-East Atlantic which it is proposed to publish in full in the Scientific Series of the Fishery Board for Scotland. The division of the area into separate regions is based upon available knowledge as to the bathymetric isolation of the different fishing grounds, and as to the different locations in which the haddock spawns, the 200-metre depth contour being taken as the limit beyond which the species is only rarely represented.

The North Sea.

Assessments of the relative numerical strengths of the different age-classes of haddock in the North Sea up to 1927 were published by Thompson. Similar analyses have now been made for the period 1928 to 1935. Both sets of statistics are based upon the average numbers of haddock taken by the Scottish Fishery Research Ship "Explorer" per 10 hours' fishing.

It has been found that over the twenty years 1916 to 1935, there occurred in the North Sea six prolific stock replenishment seasons, 1920, 1923, 1926, 1928, 1931, and 1935, seven poor ones, 1917, 1921, 1922, 1927, 1930, 1932, and 1934, and seven of intermediate nature 1916, 1918, 1919, 1924, 1925, 1929, and 1933.

North-West Scotland.

The haddock of the north-west of Scotland are included as part of the North Sea stock. Waters of less than 200 metres are continuous from the

North Sea, round the Orkney and Shetland islands, and down the west of Scotland. So is the production of haddock fry, and, moreover, from the North Sea into north-west Scottish waters the successive year-classes of the species migrate with advancing age. In no way may the two areas be treated separately.

Northern Ireland.

The "Explorer" has paid eight visits in recent years to the grounds off the north of Ireland, trawling being executed at Skerryvore, Dubh Artach, Stanton Banks, and Inishtrahull. The period covered was 1927 to 1935. The most successful haddock broods encountered were year-classes 1923, 1926, 1928, 1931 and 1935. Those of 1927, 1930, 1932, 1933 and 1934 were much less well represented, and 1929 was of intermediate nature. With the exception of 1924, which was only fair and 1925 which was good, the incidence of successful and unsuccessful brood years was therefore exactly as in the North Sea, and with 1924 and 1925 the discrepancies were of no great consequence.

It, of course, must not be taken that in these years the amplitude of new broods elsewhere in Irish waters, from which no material is available, will necessarily have been the same.

The Skagerak and Kattegat.

From the work of Molander, Andersson, and Höglund, it has been established that in the Skagerak and Kattegat between 1923 and 1933 the strongest broods of haddock were those of 1923, 1926, 1928, 1931 and 1933, 1925 not being particularly strong and the remainder being of inferior order. Here, again, there is agreement with the results obtained in the North Sea.

Waters of less than 200 metres extend from the North Sea into the Skagerak as also does the production of haddock eggs and fry.

The Belt Sea and Western Baltic.

In normal years haddock are either entirely absent or are caught only in negligible amount in the Belt Sea and Western Baltic. Johansen, however, recorded unusually large catches there in the winters of 1925—26 and 1926—27. These belonged almost entirely to the 1923 brood, which was so abundant everywhere in the North Sea.

According to Poulsen, the species does not propagate in these waters and such supplies as do occur come from the Kattegat in years when an especially strong inflow of water takes place therefrom immediately after the spawning time of the species. The year-class 1923 he states to have been "completely predominant", while recruitment by the broods of 1922, 1924, and 1925 is given

as "fairly poor", and by that of 1926 as "very poor". The brood of 1927 is recorded as having been "fairly numerous", and larvae are said to have "streamed in" from the Kattegat during the early summer of 1928.

Though disagreements with Skagerak and Kattegat brood strengths are bound to occur, as in 1926 and 1927, this fishery must obviously be regarded as subject to the same year-class fluctuations as the areas in which its supplies are spawned.

Iceland.

Thompson also published age-class strength assessments of Iceland haddock covering the periods 1898 to 1908 and 1916 to 1925. He employed five categories to indicate degree of success. They were Poor, Moderate, Normal, Good and Very Good.

Assessments have now been prepared covering, on similar lines, the period 1925 to 1935. They are based on details of "Dana" catches at Iceland in 1927, "Thor" data for 1927, 1928 and 1929, further "Dana" hauls made from 1931 to 1934, and certain commercial samples collected in 1935.

The broods of 1927 and 1929 were found to be of the Poor survival category; 1926, 1930, and 1934 were Moderate; 1928 and 1933 were Normal; 1932 was Good; 1925 and 1931 were Very Good.

Faroe.

The "Explorer" surveyed the haddock of the Faroes in 1922, 1923, and 1924, and, in addition, every second year from 1927 to 1935. Details of the haddock caught in Faroe waters in recent years by the "Dana" are also available, as well as length measurements and scale samples collected from a number of Faroe catches made by commercial vessels.

The combined evidence indicates that from 1916 to 1934, year classes 1917, 1925, 1928, 1932 and 1933 were definitely successful, 1919, 1920, and 1927 were definitely unsuccessful, and the remainder were of intermediate order.

Rockall.

Rockall is situated in the Atlantic some 230 miles west of the outer Hebrides. Around it the 200-metre line circumscribes a bank about 60 miles in length and 40 in width. The nearest waters of similar depth are on the west of Scotland and over 130 miles away.

Scales from the haddock landings of trawlers fishing Rockall Bank were collected at Aberdeen Fish Market in 1929 and 1930. The dominant age groups were found to be those of 1919, 1922, 1924 and 1925. Those of 1920 and 1923 were poorly represented, and 1921 intermediate.

The Barents Sea and Bear Island.

Two Russian investigators, Suvorov and Wadova, have published age-class-frequency statistics of Barents Sea trawl catches in 1927 and 1928, and Lundbeck has made available his age analyses of German haddock landings from the Barents Sea and Bear Island from 1929 to 1934, which have not yet appeared in print.

A voyage to Bear Island on a commercial vessel was made by Robertson of Lowestoft in July 1930. Age readings of the haddock scale material collected were made for him by Sund.

The Scottish Fishery Board also sampled commercial landings from the region of the Kanin peninsula in 1928.

At present, however, the stock fluctuations of these Arctic waters must be treated with considerable reserve. While some workers regard the area as a homogeneous one from a racial point of view, others certainly do not. Russian biologists have established a number of cod "differentia" and at least two morphologically distinct haddock stocks have been recorded. Spawning of cod and haddock takes place within the region but, according to some, the amount is insignificant compared with the abundance of adult stock these waters support. It has long been contended that the stocks of the Barents Sea are recruited from spawning grounds in the neighbourhood of Lofoten.

Until more is known, it must remain an open question as to how much differences in age composition from ground to ground are due to seasonal and maturity migrations, and how much to the existence of independent stocks. In the meantime no more may be said than that in the material outlined and over the region as a whole, the years 1920 to 1923 and 1926 to 1928 would appear to have been more favourable for brood survival than 1924 and 1925.

The Norwegian Coast.

Separating the waters of the Norwegian coast from the 200-metre limit of the North Sea plateau is the Norwegian Deep, a through of about 300 to 400 metres. Haddock eggs and larvae are recorded as occurring from Romsdal Bank to about Trondhjem Fjord but not extending as far as the Lofotens.

Thompson has given the results of scale readings of two samples of haddock from the Norwegian coast. The first, taken in 1917, showed a preponderance of the year class born in 1912. The second, taken in 1923, was dominated by the brood of 1919.

A further sample is to hand of scales of 98 fish collected at Aberdeen in May 1927 from a commercial vessel which had been fishing in the neighbourhood of Aalesund. The best represented year classes were those of 1921 and 1922.

IV. Comparison of Year-Classes in Different Regions.

From the data available, it has not been possible to assess the productivities of the various grounds with the same degree of consistency. The North Sea and adjacent waters of the north of Scotland have provided the most detailed information and the data, owing to the regularity of the trawling observations over a long period of years, have been treated numerically as shown in Section III. A similar procedure could not be followed in the case of Iceland and Faroe owing to the patchy nature of the observations but the material from these areas has been on a large enough scale to allow of the adoption of terms of general significance — poor, moderate, normal, good and very good. In the case of most of the other regions, an even more general system of evaluation has had to be adopted owing to the paucity of the data and the two categories, moderate and normal, have been combined under an intermediate grade. The following diagram, therefore, has been compiled on this principle so that some idea may be obtained of the status of year-classes as captured in the different areas.

| Year-Class | Iceland | Faroe | Rockall | W. Scotland N. Ireland | North Sea | Skagerrak Kattegat | Belt Sea W. Baltic | Norway | Bear Island Barents Sea |
|------------|---------|-------|---------|---------------------------|-----------|-----------------------|-----------------------|--------|----------------------------|
| 1916.. | ● | ● | | | ● | | | | |
| 1917.. | ● | ● | | | ● | | | | |
| 1918.. | ● | ● | | | ● | | | | |
| 1919.. | ● | ● | ● | | ● | | | | |
| 1920.. | ● | ● | ● | | ● | | | | |
| 1921.. | ● | ● | ● | | ● | | | ● | |
| 1922.. | ● | ● | ● | | ● | | ● | ● | |
| 1923.. | ● | ● | ● | ● | ● | ● | ● | | |
| 1924.. | ● | ● | ● | ● | ● | ● | ● | | ● |
| 1925.. | ● | ● | ● | ● | ● | ● | ● | | ● |
| 1926.. | ● | ● | | ● | ● | ● | ● | | |
| 1927.. | ● | ● | | ● | ● | | ● | | |
| 1928.. | ● | ● | | ● | ● | ● | ● | | |
| 1929.. | ● | ● | | ● | ● | ● | | | |
| 1930.. | ● | ● | | ● | ● | ● | | | |
| 1931.. | ● | ● | | ● | ● | ● | | | |
| 1932.. | ● | ● | | ● | ● | ● | | | |
| 1933.. | ● | ● | | ● | ● | ● | | | |
| 1934.. | ● | ● | | ● | ● | | | | |
| 1935.. | | | | ● | ● | | | | |

Comparison of Age-Groups in Different Regions.

● = Poor. ● = Intermediate. ● = Abundant.

The data cover a period of twenty years (1916—1935). There are no age data from Greenland waters. At Iceland during this period there were seven successful and three unsuccessful year-classes, while nine were either of moderate or normal strength. Abundant year-classes in succession occurred three times in 1921; 1922; in 1924, 1925; and in 1931, 1932. At Faroe there were five good years, eleven of intermediate strength and three definitely poor. There are as yet no observations regarding the strength of the 1935 recruitment in either area. The year-classes 1925 and 1932 were prolific in both regions, while 1919 and 1927 were poorly represented. In 1918, 1923, 1926, 1930, 1934, recruitment was moderate or normal in both areas. There is no indication of a year-class being abundant in one area and negligible in the other. The data for these regions tend to fluctuate and do not show any definite signs of interchange between the stocks.

In the North Sea, six prolific, seven intermediate and seven poor year-classes were encountered during the period. Normal recruitment occurred twice in successive years but highly prolific years occurred only after a lapse of one to three years. Two bad years in succession were experienced only once in 1921 and 1922. The table shows little agreement between North Sea broods and those of Faroe or Iceland. On the other hand, there is a definite relationship between the stocks of the North Sea and those of the areas within the continental plateau, W. and N. Scotland, N. Ireland, Skagerak, Belt Sea and Western Baltic. Rockall appears to harbour an independent stock. Observations in the Norwegian and Barents Sea have not been carried far enough to establish any definite findings, but the stocks in these regions appear to

show little inter-relationship with the North Sea, Iceland or Faroe. The distance from these areas and the intervening stretches of deep water would appear to render recruitment during the pelagic phase improbable or ineffective. The absence of age determination data from the West, South and East coasts of Ireland and from the Bay of Biscay precludes any attempt to discuss the relative conditions in these regions.

V. Conclusions.

The evidence so far obtained from the analysis of the data in the various regions indicates that several independent stocks of haddock inhabit the North-East Atlantic and the neighbouring seas. The restricted nature of the spawning concentrations, the retention of the majority of the pelagic larvae within moderate depths and the results of the statistical analyses of the year-classes in the different regions lend support to this view. At Iceland, the Faroes and in the North Sea and adjacent continental plateau regions, the investigations have been carried out more frequently and with greater regularity than in the other areas. Consequently the position is much clearer at these localities and there seems no doubt that the stocks in these regions are quite independent of each other. As regards Rockall, the Barents Sea and Norwegian Sea, sufficient sampling has not been done to permit of definite conclusions. With independent stocks, subject to different environmental conditions, the chances are that all areas will not be depleted or replenished on the same scale contemporaneously and that a lucrative fishery will be possible somewhere throughout the distribution of the haddock.

