REPORT

ON THE

DISTRIBUTION AND SEASONAL ABUNDANCE OF FLATFISHES (PLEURONECTIDAE) IN THE NORTH SEA,

BY

T. WEMYSS FULTON, M.D., F.R.S.E.

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I. INTRODUCTION.

In the following pages I give the main results of an investigation on the relative abundance and distribution of the edible or commercial flatfishes in the North Sea, and it may be desirable at the outset to explain the methods adopted, their scope and limitations. While all sources of information that are available with regard to the distribution and life-history of these fishes have been made use of, and particularly the numerous papers in the various Annual Reports of the Fishery Board, the Journal of the Marine Biological Association, and those published by German and Scandinavian investigators, the basis of this work is the special statistics collected from a large number of Aberdeen trawlers, according to the system I devised and put into operation four years ago, the first report on which appeared in the Twentieth Annual Report of the Fishery Board* dealing with the year 1901. These statistics were collected under my direction until February, 1903, for publication in the ensuing Reports of the Fishery Board, but it was then decided to reserve them for the use of the International Committee, and since that date they have been continued in connection with the International investigations.

The objects I had in view in preparing this scheme of investigation, as fully described in the original report referred to, were (1), and most important, to ascertain in a definite way the fluctuations from year to year in the abundance of the food-fishes on the fishing-grounds, and to what extent impoverishment was taking place, if at all; (2) to determine accurately the limits of the fishing-grounds from which the bulk of the fish supply from the North Sea is drawn, and the extent to which they are fished at different seasons; (3) to throw light on the natural history of the various species of food-fishes, especially their distribution, fluctuations, migrations and spawning.

The ordinary statistics of the fisheries cannot be made use of for these purposes, since the places where the fish are caught and the duration of fishing operations are not recorded, the classification of the fishes taken is incomplete, and the catches by the different methods are not always distinguished.

I think it is now very generally held by experts in fisheries investigation that it is only by means of such statistics as I have described that the fluctuations in the abundance of the food-fishes on the fishing-grounds, whether these are produced by natural causes or by the operations of man, can be measured; and there can be no question that the problem of the impoverishment of the grounds, particularly in the North Sea, is the most important of all with which we have at present to deal in this country. At the present

* "North Sea Investigations," Part III., pp. 73–227.

time most valuable statistics on corresponding lines are being obtained in some other countries, and with similar objects in view. I may specially refer to those obtained by Mr. Archer from the trawlers working in the southern and eastern parts of the North Sea, and particularly on the "small fish grounds" on the eastern side, which have already thrown a great deal of light on the question of the protection of under-sized fish. Dr. Redeke, the director of the scientific fisheries investigations in Holland, has also published quite recently similar statistics concerning the catches of a certain number of Dutch trawlers in the North Sea.* Still earlier than these, and not long after I had put the scheme referred to into operation, Professor Henking published a paper† in which he discussed the statistics collected by Mr. Duge, the harbour-master of Geestemünde, of the catches of German steam-trawlers in the North Sea for a number of years, and in which the fishing-grounds were distinguished in a general way. Quite lately Dr. Henking has published another paper, in which he deals with a similar body of statistical information for the years 1902 and 1903, in connection with the North Sea and Skagerrack, the statistics from the various grounds being grouped together into three divisions, viz., the Northern North Sea, the Southern North Sea, and the Skagerrack.‡

It has been thought desirable, however, although the problem of the impoverishment of the grounds in the North Sea is the chief object of the investigation, and more particularly in connection with the flat-fishes, to reserve this subject in the meantime. The detailed statistics from the trawlers comprise a period of only thirty-three months, and from the liners only twelve months, and it will be better to wait until the statistics cover a longer time before dealing with them from the point of view of over-fishing. In addition to this question the statistics, as I pointed out in the previous report, furnish valuable information as to the seasonal distribution of the fishes included in the returns, and thus throw light on their movements at different times of the year, their relative abundance in different areas, and on other points connected with their natural history. It is with this aspect of the subject that this paper is specially concerned.

(1.) The Nature of the Statistical Information.

1. *The Method of Collection.*

The statistics are limited to a certain number of the vessels fishing in the North Sea from the port of Aberdeen, large enough, it is believed, to indicate both the grounds frequented by the other vessels and the results obtained by them. The information regarding the place of fishing, the amount of fishing, and the depth of the water, was obtained for me from the trawlers by Mr. James Robb, assistant to the Fishery Officer, when the vessels came into harbour; and the statistics of the fishes caught were recorded in great detail on forms provided, the flatfishes under seventeen headings. The place of fishing was usually determined by the course steered from Aberdeen, or in certain cases from Buchanness, and the distance run, the depth being used as a check; and though in some instances it is known that mistakes occurred, there is reason to believe that the great majority of the records are accurate.

The information in regard to the trawlers is for the three years 1901–1903, but the three first months of 1901 are omitted, as I then thought it would be sufficient if the arrival of the vessel was recorded, the dates of departure and return being known, but from 1st April, 1901, the number of hours fishing was ascertained.

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* "Vangstatistieken van Hollandsche Stoomtrawlers, 1903–1904," *Mededeelingen over Visscherij*, XI., 1904.

† *Mittheilungen des Deutschen Seefischerei-Verein*, No. 1, 1901.

‡ Conseil Permanent International pour L'Exploration de la Mer, *Rapports et Procès-Verbaux*, Vol. III., Copenhagen, 1905.

The amount of the fishing by the recording vessels was very different in different parts of the North Sea, the grounds in the southern and south-eastern parts being comparatively rarely visited, while those near the coast of Scotland, in the deep water south and east of the Shetlands, and on the Fisher Bank plateau, were mostly laid under contribution. The amount of fishing in the different regions and in the various months was not quite the same in the three years, and it varied most in 1903. The accompanying table and diagram (Fig. I.) show the total number of hours' fishing and the percentage of the aggregate

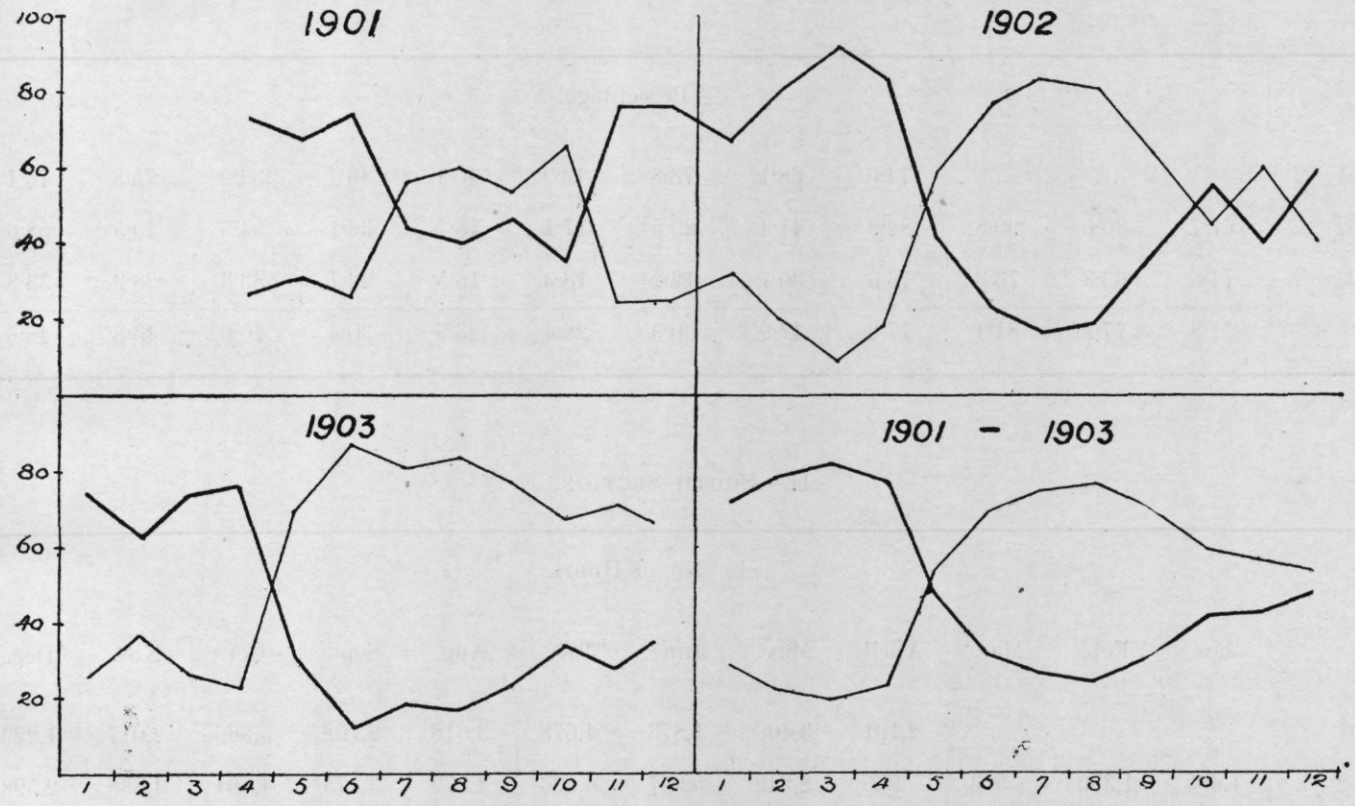


FIG. 1. The thick line represents the percentage proportion of fishing to the north of 58° N. lat., and the thin line the percentage proportion to the south.

fishing in the North Sea, in each month, to the north and to the south of the 58th parallel of N. latitude, which passes from the Naze of Norway to the middle of the Moray Firth, and corresponds fairly with the 50-fathom line of depth. It is a division I have adopted for comparison in the following pages.

I.—North Section.

Year.	No of Hours.											
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	6,240	7,288	5,283	3,657	2,425	2,315	2,980	6,245	3,920
1902 ...	3,361	5,321	5,641	4,663	2,295	1,555	1,241	1,141	1,791	5,717	3,325	5,107
1903 ...	5,577	615	5,278	5,164	3,183	1,674	1,753	1,462	3,150	4,403	4,622	6,861
	8,938	5,936	10,919	16,067	12,766	8,512	6,651	5,028	7,256	13,100	14,192	15,888
	Percentage.											
1901 ...	...	...	...	74·0	68·1	73·8	43·9	40·1	46·1	34·9	75·8	76·1
1902 ..	67·7	80·0	90·8	82·9	41·4	23·5	17·1	18·7	36·1	54·5	40·5	58·6
1903 ...	74·6	63·3	73·3	76·3	30·7	12·2	18·3	16·5	22·7	33·3	28·9	33·8
	71·8	77·9	81·4	77·2	47·9	30·9	26·4	23·9	30·4	40·6	43·8	46·6

II.—South Section.

Year.	No. of Hours.											
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	2,191	3,406	1,873	4,678	3,618	2,702	5,566	2,017	1,229
1902 ...	1,605	1,330	573	960	2,249	5,067	6,033	4,979	3,175	4,804	4,868	2,598
1903 ...	1,897	356	1,926	1,604	7,199	12,061	7,836	7,390	10,726	8,818	11,326	13,397
	3,502	1,686	2,499	4,755	13,854	19,001	18,547	15,987	16,603	19,188	18,211	18,224
	Percentage.											
1901 ...	...	...	...	26·0	31·9	26·2	56·1	59·9	53·9	65·1	24·2	23·9
1902 ...	32·3	20·0	9·2	17·1	58·6	76·5	82·9	81·3	63·9	45·5	59·5	41·4
1903 ...	25·4	36·7	26·7	23·7	69·3	87·8	81·6	83·5	77·3	66·7	71·1	66·2
	28·2	22·1	18·6	22·8	52·1	69·1	73·6	76·1	69·6	59·4	56·2	53·4

As described below, the region of fishing is divided into squares or areas, and the percentage proportion of the fishing in each of them in the three separate years and in the three years together may be also given here, in the following table :—

Year.	XXIII.	XXIX.	XXXI.	XIX.	XXV.	XV.	XIV.	XVIII.	XI.	XXIV.
1901	11·8	13·5	1·4	8·2	2·7	7·6	8·9	12·0	7·9	3·6
1902	11·1	11·2	8·8	7·9	9·0	12·2	6·2	7·5	5·5	4·6
1903	13·7	14·3	13·9	7·6	8·8	3·7	6·4	1·8	1·5	2·1
1901–1903... ...	14·4	13·2	9·3	7·8	7·4	7·2	6·9	6·0	4·2	3·6

Year.	XXX.	XXXII.	XVII.	X.	VII.	XXVI.	XVI.	XXVII.	XIII.	XXI.
1901	1·1	4·5	5·2	1·4	1·7	0·4	2·4	...	0·2	0·1
1902	1·9	1·2	1·5	1·6	1·9	0·8	0·9	...	0·1	0·1
1903	4·0	2·8	2·1	2·2	1·2	2·3	0·5	1·7	...	...
1901–1903... ...	2·7	2·7	2·6	1·8	1·5	1·4	1·1	0·8	0·7	0·6

Year.	VI.	XII.	XXXVI.	XX.	XXVIII.	XXXV.	VIII.	IX.	XXXVII.	XXXIII.
1901	...	0·2	0·12	3·2	0·5	...	0·2	0·3	...	0·09
1902	0·8	0·3	...	3·2	0·3	0·2	0·4	0·4	0·1	0·1
1903	0·7	0·8	1·1	2·4	0·16	0·6	0·2	...	0·4	0·2
1901–1903	0·5	0·5	0·5	0·3	0·3	0·3	0·2	0·2	0·2	0·1

Year.	XXXIV.	XLI.	XLII.	XLIII.	XLIV.	XXII.	XXXVIII.	XLV.	XXXIX.	XL.
1901	0·3	0·18	...	...	...	...	0·03	0·09	...	...
1902	0·1	...	...	...	...	...	...	...	...	...
1903	...	...	...	0·08	...	0·05	0·05	...	...	...
1901–1903... ...	0·09	0·05	...	0·04	...	0·03	0·03	0·02	...	...

In connection with these statistics it is necessary for me to point out that the weights given in the case of Plaice, Lemon Dabs, Whitches, and Megrims, are not strictly accurate. In all cases where the totals of a species are dealt with—that is the sum of "large," "small," &c.—the quantity actually caught, and therefore the average quantity per 100 hours' fishing, is under what it ought to be. The same remark applies to the "large" and "medium" fish, but the "small," as a rule, are about what is represented, or a little under it; that is to say, the average in this case may be over what it ought to be. The reason of this is that each box of fish—and the fish named are sold in boxes—is considered to be 1 cwt., a supposition which greatly simplifies the collection of the statistics of the fish landed, and for some purposes serves

the end well enough. In weighing large quantities of fish for scientific reasons I discovered that in almost all cases the fish sold in boxes was heavier than shown in the statistics; but there is not yet perhaps a sufficient body of facts to enable a precise correction to be made. It is to be pointed out, however, that this fact does not affect the proportions within the limits of the curves and tables to any appreciable extent, since the same method has been used throughout the whole period. Its importance lies rather in connection with the gross productiveness of the grounds fished over, and the comparison of the statistics collected in other countries or ports where a different system may prevail. Later on, when further observations have been made on a large scale, it will be possible to indicate the amount of correction with accuracy; but in the meantime, for comparison, the following may be taken as an approximation to the corrections required :—(1) The excess over a cwt. (in the Tables) is about 20 per cent. for large Plaice, 17 per cent. for medium Plaice, and 10 per cent. for small Plaice; for large Lemon Dabs about 21 per cent., for large Whitches 16 per cent., and for large Megrims about 20 per cent.; (2) the deficiency from a cwt. is about 3 per cent. for small Lemon Dabs, and about 2 per cent. for small Whitches.

In considering the statistics and the discussion on them, it is to be borne in mind that the terms in which the quantities of fish are stated is the weight and not the number of fishes. The number to a cwt. or box varies very greatly, and for certain purposes the statement of the results in terms of numbers would be preferable to terms of weight. A large Plaice obviously weighs a great deal more than a small one, and one cwt. of Halibut has quite a different value from a biological point of view in regard to the fluctuations of the species than one cwt. of, say, Whitches. I have, therefore, prepared a table showing the average number of the various classes that may be regarded as approximately equivalent to one cwt.; but it must be regarded only as furnishing an approximation.

——	Number of Boxes examined.	Average Number of Fish per Box or Cwt.	Approximate Total Number of Fish included in the Tables, 1901–1903.
Plaice—			
Large	103	24·5	42,000
Medium	204	67·5	801,000
Small	46	181·8	139,000
Total	353		982,000
Lemon Dabs—			
Large	106	99·5	840,500
Small	11	297·7	225,000
Total	117		1,065,500
Megrims—			
Large	30	94·3	552,000
Small	7	253·5	429,000
Total	37		981,000
Whitches—			
Large	92	141·7	1,396,000
Small	48	343·3	1,432,000
Total	140		2,828,000

Turbot, Brill, and Halibut are, as a rule, judged by the eye as to weight, but one cwt. is usually taken as representing eight fish in the case of Turbot.

2. *The Method of Tabulation and Treatment.*

The method which I have followed in dealing with the statistics consists in tabulating them in the first place in reference to the place of fishing, and then grouping them together into areas. The areas that I provisionally selected for exhibiting the results are the "squares" formed by the intersection of each degree of latitude with every second degree of longitude, as represented on the charts appended. The superficial extent of the areas thus varies slightly in different parts of the North Sea, but it is for each approximately on an average about 3,600 square (geographical) miles. Obviously, as I pointed out in the preliminary report, any extent of sea may be taken for the purpose, small or large, the important thing in connection with the records being that the actual place of fishing should be ascertained as accurately as possible (and not merely referred to a numbered square as has been proposed). If this is done it is possible to re-arrange the records for each vessel in another system of grouping, as experience may show to be best for any special purpose, or in connection with any particular ground. The example of the Dogger Bank may be taken. This well-known fishing ground, including the "Tail End," lies in five of my squares (XXXV–XXXVII, XL, XLI) and does not completely occupy any of them; no square could therefore be taken as representing the Dogger or part of it. But if later on it is desired to deal with the Dogger Bank by itself—and the same would be true of any other fishing ground—it will be a matter of comparative ease to separate all the records dealing with it alone, and to show the fluctuations on it from year to year and month to month. This, however, would be impossible if a system of dividing the North Sea into a small number of large areas and merely indicating the number of the square or area, without defining the precise position of the fishing vessel, had been adopted.

The system of squares adopted by me and above described is obviously artificial, and has not necessarily any relation to particular fishing banks. The difficulty of adopting the "banks" or grounds as a basis for the classification and treatment lies in the fact that in the regions mostly frequented by the Aberdeen vessels, viz., the northern and north-eastern parts of the North Sea, very few of them are named, differing in this respect from the southern portion, where almost all the grounds are named and distinguished by fishermen and cartographers. Nevertheless, I am of opinion that classification according to the "banks" or "grounds" is the more natural and proper method and is the one that will be ultimately adopted. The conditions on a "bank" or well-defined fishing ground, both physical and zoological, are more uniform than in many or most of the "squares," which may include waters of very different depths, bottoms of a very different kind, and thus a fish population differing in the relative proportions of the species in different parts. The difficulty at present is one of nomenclature, and if, as I think is now generally held by those studying fishery questions in their broad aspect, the solution of the main problems can only be obtained by the organisation of a statistical system on the lines described, it would be a distinct step in advance if some general agreement could be reached as to the naming or numbering of the various fishing grounds or banks in the North Sea, so as to ensure uniformity in the treatment of results. It is a subject which might well be dealt with by the International Council. In the meantime, however, the system of numbered squares as adopted in my preliminary report may be adhered to; all the more, since Mr. Walter Archer has used the same divisions in dealing with the trawlers' catches in the southern parts of the North Sea, as mentioned above.*

The averages were obtained by dividing the quantities of fish by the number of hours' fishing in each month in each of the squares, and refer to the quantity per 100 hours' fishing. They might equally well,

* Report of the Committee on Sea Fisheries Bill (H. L.), 1904, Maps 2, 3.

of course, have been expressed in other terms ; and Dr. Henking, in the paper referred to, uses terms of lbs. per day's fishing, while Dr. Redeke uses lbs. per hour. In calculating the annual averages and those for the years combined, whether in connection with the separate squares or the whole of the North Sea, it seemed desirable to me not to take the mean of the averages, but to calculate the final average in the way indicated, dividing the sum of the quantities by the sum of the amount of fishing. The deviation between the averages obtained by the two methods depends in its extent, as a rule, on the size of the figures—the number of observations. In the simplest cases amongst the squares, where the amount of fishing was very different in the various years, the deviation is often considerable ; on the other hand, at the opposite extreme, the aggregates for the whole region or period, the deviation is very much less, and, as a rule, quite inconsiderable (*see* p. 507). This method, though much more laborious, seemed to me preferable to the simple one of taking the mean of the separate averages, which would give the same value to a small as to a large number of observations, as, for example, to 50 hours' fishing as to 1,000.

The method here adopted of presenting the results in averages, though the usual one followed in similar cases, has lately been criticised by Mr. Walter Archer, more particularly with reference to its application to the fluctuations on the fishing-grounds in connection with the question of over-fishing. He has pointed out that, unless on the assumption that the supply of fish in the sea is unlimited, the average take per boat or per net cannot be taken alone as evidence either of increase or decrease in the abundance of fish on the fishing-grounds, apart from consideration of increased or decreased intensity of fishing ; that a decrease, for example, in the average take per boat might be due simply to the catch of fish being distributed among a larger number of boats, and not to any depletion of the fishing grounds.* The validity of this objection is now generally admitted, and the importance of the point in discussing the evidence with reference to over-fishing is obvious, but I do not think that it can to any material extent affect the conclusions and results in this paper. At the same time, it may be admitted that even in dealing with such questions as the proportional distribution of the fish on different grounds and at different seasons it would be more satisfactory to have particulars concerning the other boats fishing there.

One circumstance which must not be lost sight of in considering the statistics dealt with in this paper is the incompleteness of the observations in many of the areas and regions of the North Sea. The ideal condition would be to have a large amount and an equal amount of fishing in each square in each month of the year. This is far from having been the case. In certain of the areas, though the amount of fishing differs in different months, the aggregate in each month is so large that the averages deduced may be regarded as quite satisfactory, and it is probable that in such instances an increased amount of fishing would have but slightly affected the averages. In many cases, however, the amount of fishing differs so much in the different months that the various averages have by no means the same value. Again, in a number of squares one or several or most months may be unrepresented, and thus the average based on them, referring to the distribution of the fish in comparison with other areas, may be unreliable. This imperfection will, doubtless, be to some extent got rid of as the statistics accumulate, but it will not be removed until the corresponding statistics of English and foreign trawlers, working over many of the areas in far greater numbers than the Aberdeen vessels, are combined in a common plan.

In all cases where the number of monthly averages allowed it to be done, curves have been made to show in graphic form the variations in abundance throughout the year, and many hundreds of these have been prepared. In studying the various species separately I found it advantageous to place these curves on skeleton charts, so that they might be compared together and side by side. In other cases curves were drawn showing the fluctuations of the various species in one and the same area, some of which are reproduced in the following pages, and are indeed required to enable the description to be followed.

* *Sea Fisheries(England and Wales) Fifteenth Annual Report of the Inspectors* for 1900, p. 5 ; *Report of Committee on Ichthyological Research*, p. 66.

II. DISCUSSION OF RESULTS.

(1) The Extent of the Information.

The extent of the statistical information which is available for the investigation is, as we have seen, very considerable. It comprises thirty-three successive months and 4,931 voyages, or landings, of the recording steamers, the quantity of flatfishes taken exceeding 50,000 cwts. In the recent report by Professor Henking, to which reference has been made, the number of voyages recorded in 1902–1903 was 3,432, of which 1,898 were made in the North Sea and the remainder in the Skagerrack; of the North Sea voyages only 160 were made in the northern portion, including the Great Fisher Bank, the Fladen Ground, the Long Forties, and the area between them and the Shetlands, the great majority belonging to the Southern North Sea, where the Aberdeen trawlers fish comparatively little. The particulars as to the gross quantity of flatfishes taken by the Aberdeen vessels, and the average catch in terms of the duration of the fishing and the weight, are given in the appended Table :—

—	Voyages or Landings.	Number of hours' Fishing.	Gross Quantity of Flat Fishes taken.	Average Catch.	
				Cwts. per 100 hours.	Lbs. per hour.
1901	1,148	67,633	12,853¼	19·0	21·2
1902	1,407	81,402½	12,736⅜	15·65	17·5
1903	2,376	128,278½	24,859⅞	19·38	21·7
1901–1903	4,931	277,314	50,449½	18·19	20·37

It will be observed that the correspondence in the average catch in 1901 and 1903 is very close indeed.

The particulars as to the weight and average catch, per 100 hours' fishing, for each of the species of flatfishes recorded in the Tables are as follows :—

—	1901.		1902.		1903.		1901–1903.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Turbot	440	0·65	422½	0·523	917½	0·713	1,780	0·643
Brill	106⅝	0·158	40⅜	0·093	118	0·05	265	0·96
Halibut	719⅝	1·064	763⅞	0·938	1,149⅛	0·896	2,632⅝	0·949
Whitch	4,760	7·04	4,578½	5·624	4,684¼	3·652	14,022¾	5·056
Megrim	2,070¾	3·061	2,034⅜	2·498	3,441⅞	2·68	7,547	2·72
Lemon	2,232¼	3·3	2,132¼	2·62	4,704⅜	3·65	9,068⅞	3·268
Plaice	2,299	3·4	2,577¾	3·167	2,449⅜	7·366	14,326⅛	5·166
Dab	225	0·33	186¾	0·229	395⅜	0·308	807⅛	0·291

The largest quantity, it will be seen, taking the whole period, consisted of Plaice, closely followed by Whitches, but in 1901 and 1902 Whitches took first place, the second place being occupied by Plaice; in 1903 Plaice come first, Lemon Dabs second, and Whitches third. The differences are due to differences in the place of fishing.

The percentage proportions of each species by weight are as follows :—

—	1901.	1902.	1903.	1901–1903.
Turbot	3·4	3·3	3·7	3·5
Brill	0·8	0·3	0·5	0·5
Halibut...	5·6	6·0	4·6	5·2
Whitch	37·0	36·0	18·9	27·8
Megrim...	16·1	15·9	13·8	14·9
Lemon Dab	17·4	16·7	19·0	18·0
Plaice	17·9	20·2	38·0	28·4
Dab	1·7	1·5	1·6	1·6

As might be expected, from the great size of the region of investigation—extending from about 54° to 61° N. latitude, and from 3° W. to 8° E. longitude—and from the very different depths and physical conditions in different areas, the proportional abundance of the species of flat fishes enumerated varies greatly in different quarters. This is well shown by contrasting a few areas where the conditions differ and comparing the proportions in which the various species are represented in each.

For this purpose I have taken the following squares, in which the fishing was very large and most regular, and representing parts of the North Sea at a distance from one another and with different depths. Squares XIV, XV, and XIX represent the deep water area in the north, to the south and south-east of the Shetlands, the latter containing the well-known Fladen Ground ; XXIII and XXIX lie along the east coast of Scotland in comparatively shallow water, the former comprising part of the Long Forties ; XXV and XXXI are situated on the western part of the Fisher Bank plateau, and lie in the middle of the North Sea. The proportions are shown in percentages of the total weight of flat fishes from the various squares.

—	XIV.	XV.	XIX.	XXIII.	XXIX.	XXV.	XXXI.
Turbot	0·1	0·35	0·65	8·3	10·7	5·6	3·1
Brill	0·01	0·03	0·03	1·6	0·3	0·4	0·01
Halibut... ...	6·8	10·37	5·3	1·3	1·34	11·2	6·14
Whitch	47·8	76·4	83·6	5·2	0·5	11·4	16·0
Megrim... ...	17·7	9·7	6·6	9·2	1·4	0·5	0·23
Lemon Dab ...	5·2	1·2	2·1	40·5	64·2	14·1	18·38
Plaice	20·6	1·8	1·5	28·8	19·2	57·8	55·6
Dab	1·5	0·0	0·09	5·0	2·3	0·06	0·6

The quantity of flat fishes taken from these seven squares amounted in the three years to 27,283$\frac{5}{8}$ cwts., or 54 per cent. of the aggregate taken by the recording vessels. In XXV there was no fishing in January and February, and in XXXI there was none in January, February, and April, a circumstance that may to a small extent affect the proportions. Of the three northern squares, it may be

said that XIV is the only one in relation to coast, as it contains Fair Isle and a small part of Shetland, around Sumburgh Head, and this no doubt accounts for the higher proportion of Plaice and Lemon Dabs in particular in it compared with the other two.

In the two typical deep-water areas, away from land and occupying the middle of the northern portion of the North Sea, it will be observed that Halibut, Megrims, and especially Whitches, abound, and form about 96 per cent. of the total flat fishes inhabiting that region. In the part contiguous to the east coast of Scotland (XXIII, XXIX), on the other hand, and particularly in the most southerly (XXIX), these species are poorly represented, the great bulk of the flat fishes consisting of Lemon Dabs and Plaice, the latter diminishing and the former increasing in the southern area.

In the areas in relation to the Fisher Bank, Plaice form more than half of the total and Lemon Dabs are second, but far behind. Halibut and Whitches, both of them northern forms, are here much more abundant than in the two areas off the Scotch coast, the former indeed being at least as abundant as in the deep-water squares referred to. Megrims, however, are scarce on the Fisher Bank compared with the grounds off the coast of Scotland or the northern areas. Turbot are in fair abundance on the Fisher Bank, still more so off the Scotch coast, and least of all in the deep-water areas, and there the highest percentage is in the deepest and most southerly of them (XIX). The proportion of Brill is in all cases small, but the highest is in the most northerly of the two areas along the coast of Scotland; in XXV, on the Fisher Bank, it is a trifle higher than in XXIX. Dabs are also in highest proportion in areas XXIII and XXIX, especially in the former.

The proportions between the various species differ in corresponding fashion if groups of squares be contrasted, and also between the northern and the southern portions of the North Sea. Thus, if the whole region be divided into a north and a south section by the 58th parallel of N. latitude, that is, by a line passing from the Naze of Norway to the middle of the Moray Firth, the contrast in most cases is great. This line broadly corresponds to the 50-fathom line of depth, but part of the northern section on the eastern side is under 50 fathoms, and part of the southern section on the western side off the Scottish coast is over 50 fathoms. The percentage proportions of the various species in the two sections bear the following ratio to the total quantity taken from each section :—

——	Turbot.	Brill.	Halibut.	Whitch.	Megrim.	Lemon Dab.	Plaice.	Dab.
North	1·04	0·47	6·48	45·5	25·8	5·43	14·25	0·9
South	6·21	0·63	3·86	8·73	3·2	31·47	43·6	2·3

(2.) The Fluctuations in Abundance.

The determination of the fluctuations in the abundance of the species which take place at different times of the year, while one of the most interesting points in the enquiry, is also one of the most difficult. The subject may be considered either by taking up the species separately and tracing the fluctuations of each in different areas or groups of areas, or by taking up a particular area and considering the concurrent fluctuations within it of all the species represented. The latter method may be here adopted with reference to a few of the squares, for it brings out some interesting points showing the relation between the fluctuation of one species and the fluctuation of another on the same grounds in the same period, and opens up some important problems as to the cause of the periodical variation in abundance. It will be found that, as a rule, when one or more species fluctuate in one direction another species, or several species, may fluctuate in the contrary direction.

1. *Complementary or Compensatory Fluctuations among different Species on the same Grounds.*

In studying this important subject, we may first of all take a square in which the fishes are represented, on the one hand, by species which live mostly in moderate depths, and, on the other hand, by species which live mostly at greater depths. A square of this kind with a varied fish fauna is XIV, to the south of the Shetlands, and in relation to a small part of its coastline. The percentage proportions of the species of flat fishes in it are given on p. 482, Whitches being the predominant fish, with 47·8 per cent., while there are two other species, with fairly high percentages, viz., Plaice with 20·6, and Megrims with 17·7, per cent. The curves for the monthly averages are represented in the accompanying diagram (Fig. 2), and it will be seen that various species show the complementary or compensatory fluctuations alluded to. Thus, at the

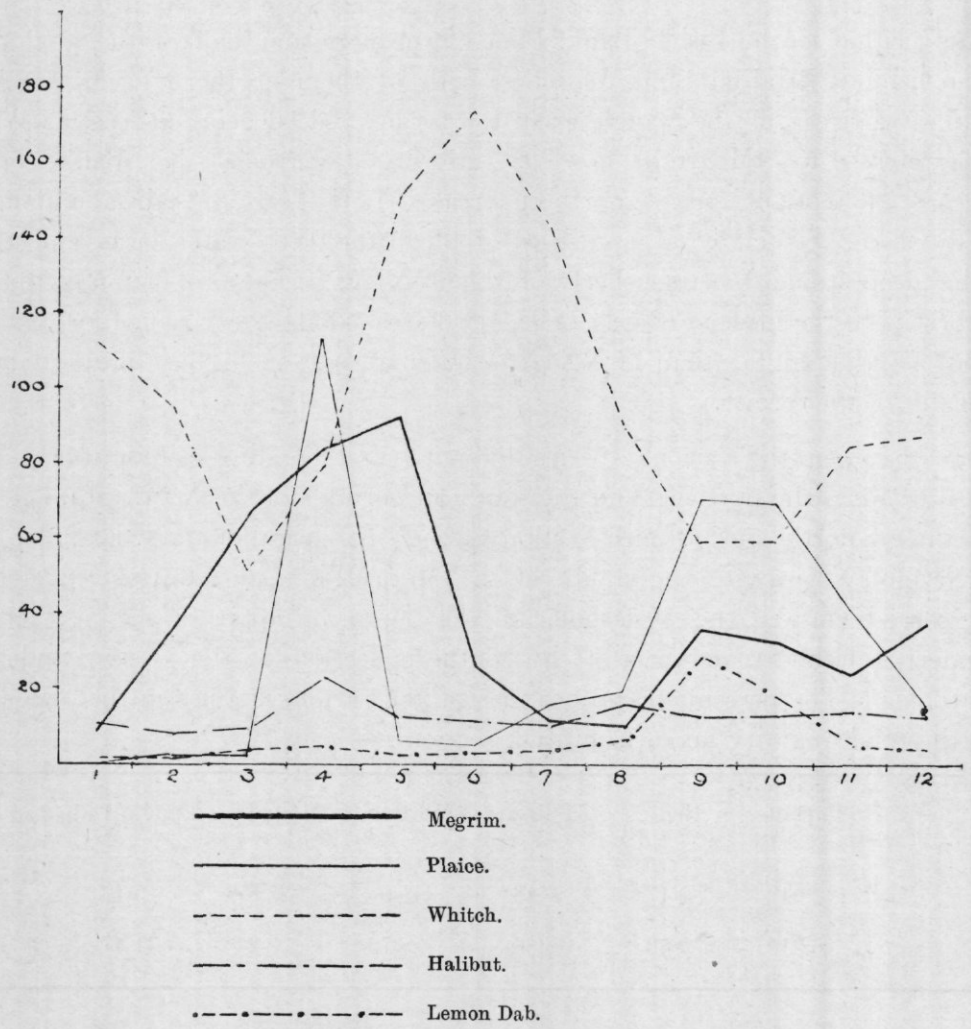


FIG. 2. Seasonal fluctuations of flatfishes in area XIV.

time the predominant species, the Whitch, is at its minimum, other species are at their maximum. In September and October the Whitch is comparatively scarce, while at this time Plaice, Megrims, Lemon Dabs, and Dabs, are relatively abundant. Again, Whitches are very scarce in March and April, at about the very time that Plaice, Megrims, and Halibut are at their maximum for the year. So also in the winter months, Whitches are comparatively numerous, and all other species, with the partial exception of Halibut and Megrims, at a minimum. Then, further, in the summer months, when the Whitch is in greatest abundance, all the other species are greatly reduced in numbers.

It thus happens that, although taking the whole period there is a great excess of Whitches so that they form nearly half of the total flat fishes of the area, there are certain times of the year when other species may exceed it in abundance. Thus, Megrims were more abundant than Whitches in March; Megrims and Plaice were more numerous than Whitches in April; and, again, in September and October Plaice exceeded Whitches in amount.

It is, therefore, apparent that some sort of connection exists between the fluctuations of one species and those of another, and it may be of a complex character. It is, moreover, of interest to note that the periodicity is not always absolutely synchronous. The method of monthly averages is not perhaps the best to bring out this point ; weekly or tri-monthly averages would have been better ; but, still, they serve to show it. Thus, while the spring minimum for Whitches is in March, the maximum (for the year) of Plaice, Halibut and Brill is in April ; the maximum for Megrims is a trifle later—it is, indeed, in April, in the smoothed curve. Lemon Dabs, Turbot, and common Dabs also show an increase in April ; in the case of the two former, whose maximum is later in the year, it is insignificant ; in the case of the common Dab it is large, the average being, with that of October, the maximum for the year. Incidentally, it may be here pointed out that those species whose maximum abundance is in spring are spring-spawners, and those whose maximum abundance is later in the year are not spring but summer-spawners. The facts referred to thus show that the increased abundance of the species named follows the period of greatest scarcity of Whitches. The rapidity of the increase and decrease at this time varies, moreover, with different species, but it is usually sudden, as with Plaice, Brill, Dabs, and Halibut—to fill up the gap, as it were, caused by the scarcity of Whitches.

Then, it will be found that the other species diminish in abundance as the predominant flat fish, the Whitch, increases, and they become very scarce at, or shortly after, that species attains its maximum, in June. This is so with Plaice, Halibut, Brill, Dabs, and Megrims ; it is very slightly indicated with Lemon Dabs, but not with Turbot, which has a maximum coinciding with the Whitch, and both are summer-spawners.

The decrease of Whitches from their maximum abundance in mid-summer (June) goes on through July and August especially, the second period of scarcity of this fish occurring in September and October, and this movement of diminution is immediately associated with an increase in the numbers of Plaice, Megrims, Lemon Dabs, Brill, Halibut, and Turbot. Thus, with several of these species (Halibut, Plaice, Brill, Megrim) there is a second period of maximum abundance in the year coinciding more or less closely with the second period of minimum abundance of Whitches ; in the case of the Lemon Dab it is the predominant maximum of the year, one might say the only maximum, because the rise in Spring is exceedingly slight.

Finally, after October, Whitches gradually increase in abundance to the end of the year (and on to January) and the other species diminish, though not in so uniform a way with all, Megrims showing a slight increase in December. The decrease in Plaice, which, as already stated, is the predominating fish in September and October, when it even exceeds Whitches in abundance, proceeds regularly, *pari passu*, with the increase in Whitches.

In this area, therefore, the fluctuations of the various species appear to be co-ordinated and not fortuitous, the tendency being, if one may so speak, for the fish fauna inhabiting it to be kept at a uniform level of abundance throughout the year, a periodical decrease in the case of one or more species being approximately balanced by a corresponding increase in one or more of other species. It happens in this case that most of the species of flat fishes show two more or less well-marked periods of maximum abundance, and two equivalent periods of minimum abundance. It is thus with the Whitch, Halibut, Plaice, Brill, Megrim, and Dab, but it does not appear to be the case with the Turbot, or only doubtfully, nor with the Lemon Dab, though both show a slight increase in spring.

It is to be noted, moreover, that among those species with a double maximum, the greater of the two, that is, the period of greatest abundance, corresponds to the spawning-time of the species. Among spring-spawners (Plaice, Brill, Megrim, Halibut, Dab) this is in spring, while the second maximum, or

the secondary cone on the curves, is in autumn, and its importance, or relation to the primary spring cone, may vary ; it is smaller in the Megrim and Halibut than in the Plaice, Brill, or Dab. Its position is also somewhat more variable, and it is separated from the spring, or spawning, cone by a period of about two or three months. This group is scarce in winter, the Halibut and the Megrim—both northern forms—least so.

Among summer-spawners the best example is the Whitch itself, which has the cone of maximum abundance in the middle of summer, and the second maximum in the winter, chiefly January and also February. The period of maximum abundance of the Turbot is also in summer, or the spawning time, from June to August ; but with the Lemon Dab in this area the period of maximum abundance is rather later, viz., September, though within the limits of the spawning season.

The interpretation of the phenomena in a complex case, such as is presented by the fluctuations of the species I have described, must necessarily be cautious, but I do not think the facts are strained in suggesting that one of the chief causes of the fluctuations is the congregation of the fishes for reproduction at the spawning-season. It is well known that trawlers visit these deep-water northern areas in spring mostly for the great catches of mature Haddocks they obtain, and it is then that the great maximum for that fish occurs, and the close coincidence that I have shown to exist between the maximum abundance of the other species and their spawning-period can scarcely be the result of accident. The existence of a second maximum of abundance in so many cases is not, at first sight, so easily explained ; it is a very common feature both among round fishes and flat fishes, and is referred to later.

I have made a similar study, and constructed curves of the fluctuations, among the flat fishes in most of the other chief squares, but space will allow only the leading points to be referred to.

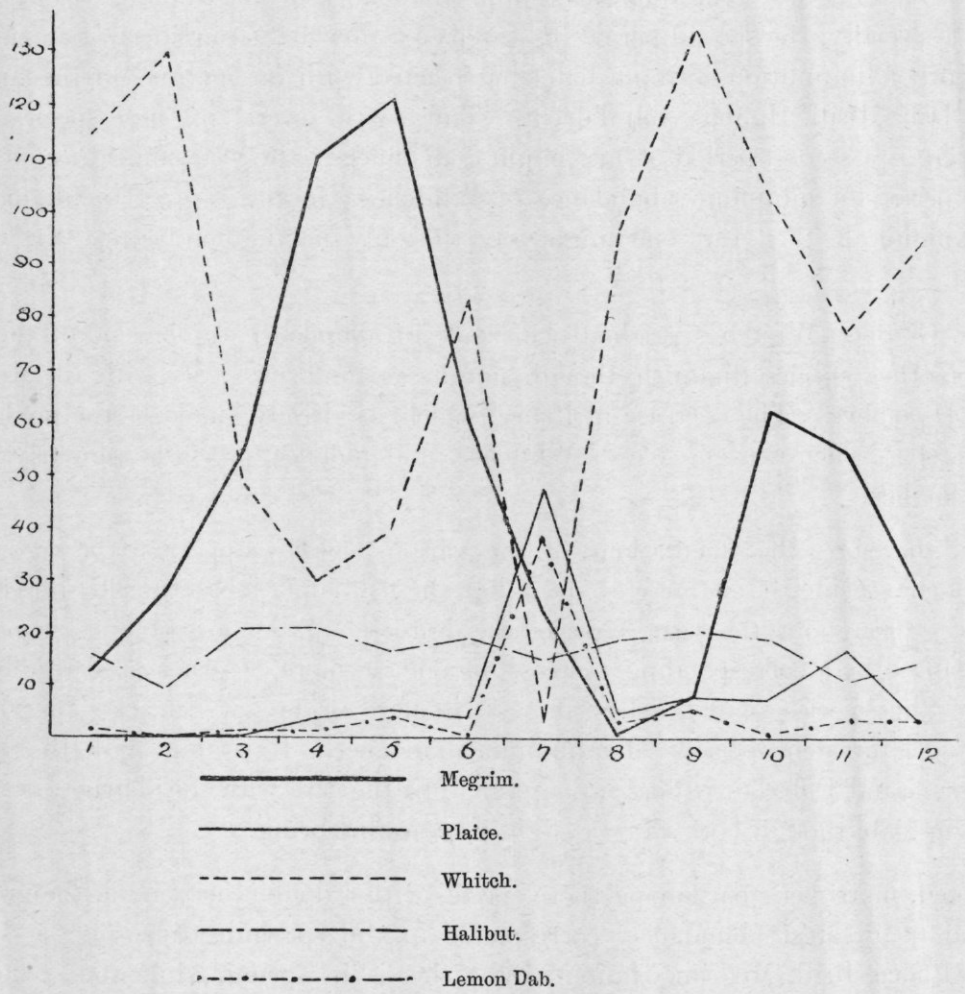


FIG. 3. Seasonal fluctuations of flatfishes in area XI.

In square XI, lying to the north of the above and to the east of the Shetlands, in rather deeper water, the predominant flat fish is the Megrim, the Whitch coming second, and the Halibut third. The percentage proportions of the various species are these :—

Turbot.	Brill.	Halibut.	Whitch.	Megrim.	Lemon Dab.	Plaice.	Dab.
0·4	0·05	11·2	32·7	51·4	1·2	2·9	0·05

From the accompanying diagram (Fig. 3) it will be seen that the fluctuations of the various species are also to a large extent complementary ; Brill, Turbot, and Dabs are omitted owing to the exigencies of the scale. The curve for the aggregate of flat fishes shows three cones or maxima, a small one in February, formed by the Whitch, a larger one in May, formed mostly by the Megrim, and a third in October, formed chiefly by the Whitch and Megrim ; the period of greatest scarcity is July and August, and next March.

The periodicity of the Whitch, as the figure shows, is different from XIV, and largely complementary to it, and the summer maximum is greatly reduced. Megrims show the double maximum even better than in XIV, and also the complementary relation to the fluctuations of the Whitch. The decrease in Whitches and Megrims in July is partly compensated by the sudden increase of Plaice and Lemon Dabs, both comparatively scarce at other times of the year, though a small but distinct second maximum of Plaice occurs in November, when the number of Whitches is again reduced. The fluctuations in Halibut, as shown on a curve of larger scale, are complementary to Whitches during the first half of the year, while from June to December these two species fluctuate together. Brill are only present in April and May, while Turbot, present in all months except January, August–October, and December, form a cone of maximum abundance, like Plaice and Lemon Dabs, in July.

In XV, lying to the east of XIV, and south of XI, Whitches greatly preponderate, forming 76·39 per cent. of the total flat fishes ; the percentages are given on p. 482 (Fig. 4). The curve for the

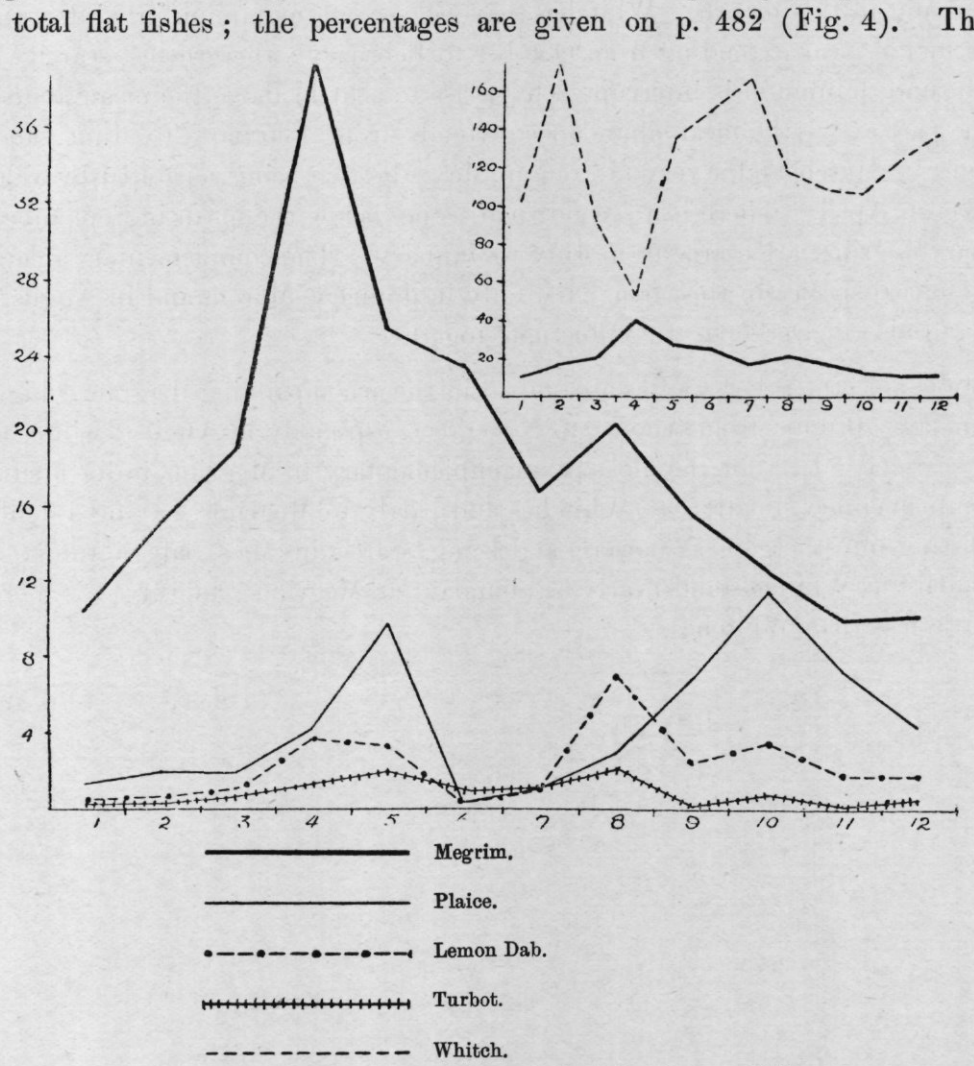


FIG. 4. Seasonal fluctuations of flatfishes in area XV

aggregate of flat fishes is determined by that of the Whitch, there being two maxima, one in February and the other from May to July, March and April as well as autumn being characterised by scarcity. Halibut, the next in abundance to Whitches, is complementary in its fluctuations to that species in almost all the months of the year, most notably in the first half, the maximum abundance being in August, and in April and May. Megrims, third in abundance, are likewise complementary to Whitches in almost every month, the maximum occurring in April. Brill, also, has its maximum in April, and is not present in any other month except February. Plaice and Lemon Dabs have each two maxima, both being abundant when Whitches are scarce, and *vice versâ* ; the curves thus exhibit two cones, a spring and an autumn one, and depressions, representing scarcity, in mid-summer and winter. Turbot, with a general maximum well above the mean from April to August, is partly complementary to Whitches, showing comparative scarcity in June and July, and abundance in August and April and May. In this area, in all the months of the year, Whitches are the predominant fish, but in April Megrims are not much less numerous.

In XVIII, another contiguous square, nearer to the coast of Scotland, Whitches also predominate, taking the whole year, Megrims coming second and Lemon Dabs third. The percentage proportions here are these :—

Turbot.	Brill.	Halibut.	Whitch.	Megrim.	Lemon Dab.	Plaice.	Dab.
1·2	0·1	4·7	52·4	31·6	7·7	2·2	0·2

Whitches are the most abundant in all the months of the year except March, April, and May, when they are exceeded by Megrims. The curve for the aggregate of flat fishes shows a fairly uniform level except in May, which is characterised by a very lofty cone of maximum abundance, caused mostly by a great increase in the numbers of Megrims, but partly by an increase of Whitches, the maximum for the year for both occurring in this month. Whitches have a second maximum in winter, the part above the level of the mean for the year extending from October to February ; the greatest scarcity is in March and April, while the autumn minimum is interrupted by a rise to a little above the mean abundance in August. With Megrims the part above the mean abundance extends from February to June, and there are two cones, a small one in March and a very tall one in May, the two being separated by a depression, almost to mean abundance, in April. There is a second small cone, below the mean in September, but it may be said generally that Megrims are scarce from July to January. The complementary relations between the fluctuations of these two species in this area exist only in January–March, and in August–October ; from April to August and also in December they fluctuate together.

The fluctuations of the other species are shown in the accompanying diagram (Fig. 5). Halibut is most abundant in late autumn, from August to November, especially in August, winter and spring being a period of great scarcity. It is for the most part complementary to Megrims in its fluctuations. Lemon Dabs show a complementary relation to Whitches and partly to Megrims, having a double maximum, in April and July, fitting into the gaps as it were, and being scarce in May, late autumn, and winter. In April it is as abundant as Whitches and nearly as abundant as Megrims ; in July it is more abundant than Megrims and a little less than Whitches.

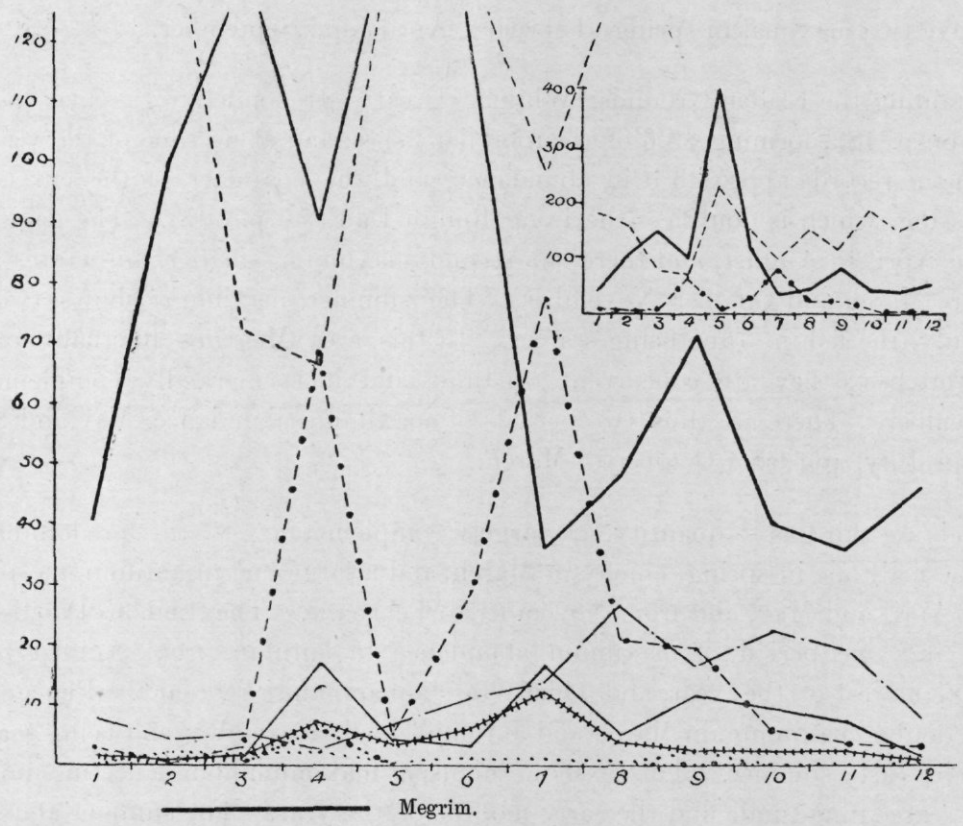


FIG. 5. Seasonal fluctuations of flatfishes in area XVIII.

Plaice has three maxima, April, July, and October, the latter smaller than the others ; it is scarce in December–March, June–July, and in September. It is thus also complementary to Whitches, and resembles Lemon Dabs, except for the small autumnal cone. Brill has its maximum, as usual in the deep water squares, in April, and is scarcely represented in the rest of the year, though there is a trace of increase in June and July. Turbot has its usual general maximum in summer, the part of the curve above the mean being from April to August, but there are two cones, in April and in July (the larger) separated by a depression in May ; it is scarce from September to March. It is thus complementary to the predominant species, and it is interesting to note how the summer maximum fluctuates in relation to them. Dabs have two maxima, in spring (February–April) and September.

In XIX, containing the Fladen Grounds, Whitches greatly preponderate, as may be seen from the percentages given on p. 482, forming 83·6 of the total flat fishes, and at no time of the year does any other species included in the records approach it in abundance, and the character of the curves here suggests that a factor is missing, which is doubtless the Long Rough Dab (*see* p. 507). The maximum abundance is in summer, from April to August, and there is a second maximum, smaller, in winter ; the periods of greatest scarcity are March and October–November. The summer maximum shows two waves, one in May and one in July, the fish in June being scarcer. In this area Megrims fluctuate for the most part along with the Whitches ; they are concurrent to June, and most markedly complementary in July, August, and September. There are thus two periods of maximum abundance, May and September, while this fish is scarce in July, and from October to March.

Halibut, which are third as to quantity, are largely complementary to the predominant fish. There are two maxima, a small one in spring, chiefly in March, and a large one in autumn, mostly in September ; they are scarce in April and May, and from November to February. The Lemon Dab is complementary to the Whitch, having one period of maximum abundance in autumn, from August to October ; it is scarce throughout the rest of the year, and chiefly in January and February. Plaice are also complementary, having a double maximum, in March and autumn, chiefly November, and being scarcest in January and February and in early summer. Turbot show the usual maximum abundance in summer, from April to July, and are scarce in autumn and the early months of the year. The summer abundance is reduced in May, when the Whitch is at its maximum. Brill has the usual spring maximum, in this case in March and April, and it is scarce or absent during the rest of the year. The Dab also has its maximum in March, and is absent in all the other months, except January and February.

We may now consider the relations between the monthly fluctuations of the various species of flat fishes in some of the more southerly areas, taking first XXIII, on the east coast of Scotland, where over 6,000 cwts. were caught. The general curve for the aggregate of all kinds shows a maximum abundance from February or March to October or November, the period of chief scarcity being December, and especially January. The averages for the aggregate of the species do not vary greatly from February to November, except that for March, which forms a fairly high cone, referable, as we shall see, to Plaice.

The predominant fish in this area is Lemon Dab, the percentage being 40·5, while Plaice come second, with a percentage of 28·8, and Megrims are third with 9·2 per cent. The Lemon Dab predominates in all months, except in March and April, when Plaice are in greatest numbers, *i.e.*, at its

spawning-time, while Lemon Dabs are in greatest numbers from July to September. As may be seen from the accompaning diagram (Fig. 6) the two chief fish, Plaice and Lemon Dabs, exhibit complementary

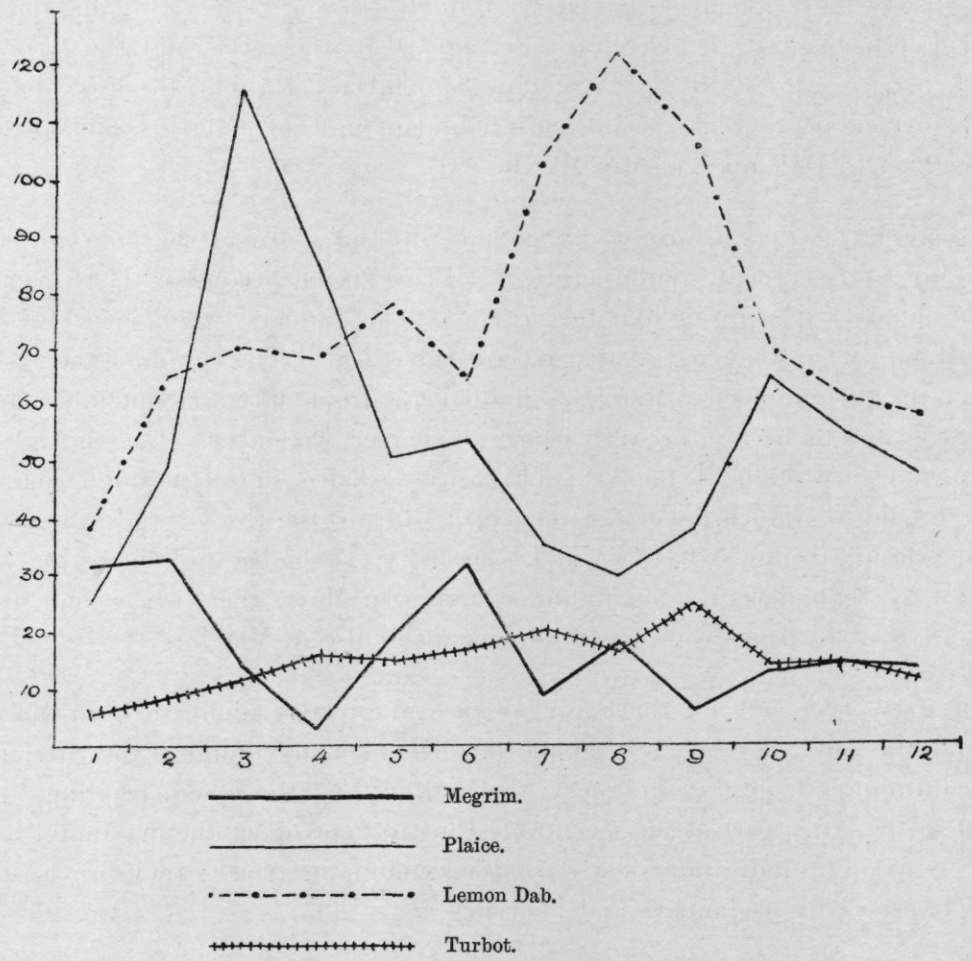


FIG. 6. Seasonal fluctuations of flatfishes in area XXIII.

fluctuations, most noticeable from May to October. Plaice have two periods of chief abundance, the first and greatest in spring, and mostly in March, and the second and lesser in autumn, mostly in October and November; they are very scarce when Lemon Dabs are most abundant, in July, August, and September, and also in January.

Lemon Dabs are in maximum abundance in the months stated, and scarcest in winter, especially in January; but there is a tendency here also to a rise in spring, very distinct in 1902, indicated in 1903, but absent in 1901. The curve for Megrims presents a different character in this area, somewhat resembling that for Whitches in XI. There are two maxima, one in winter (January and February) when the fish is most abundant, and the other in June; they are scarcest in April and next in September. Their fluctuations are complementary in a general way to Plaice in the first half of the year and to Lemon Dabs in the second half.

Turbot, which in this area forms 8·3 per cent. of the aggregate, fluctuates with the other summer-spawner, the Lemon Dab, but the scale of the diagram (Fig. 6) does not show it well; it is most abundant from July to September, especially in the latter month, and least from November to March, and especially in January. Dabs show two maxima, the smaller in March and the larger in October; the period of least abundance is from June to August, and then from December to February. Brill have three maxima—one in March, the second, depending on 1903 alone, in June, and the third in November; they are scarcest in August and in December–January. Whitches have at least two maxima, the greatest in winter, November–February; but the December average is on the mean, and the second from June to August, while this fish is scarcest in March and in September. Halibut, the least abundant fish in this area, is rather complementary to Plaice, being most abundant in June and July and also in August, and scarcest from September to December, also in March.

In XXIX, lying along the east coast of Scotland, to the south of the above, Lemon Dabs again preponderate, forming 64·2 per cent. of the aggregate, Plaice being second with 19·2 per cent. Lemon Dabs are the most abundant fish throughout the year except in January, when they are slightly exceeded by Plaice, and in March, when they are greatly exceeded by them. The curve for the aggregate flat fishes shows a maximum in spring, chiefly March, a gradual fall from May to September, and a more rapid decline thereafter, the minimum for the year being November–December. Lemon Dabs and Plaice are generally complementary throughout the year (Fig. 7). Plaice shows a single maximum of great abundance in March, and to a much less extent in April; during the rest of the year it varies little, the period of greatest scarcity being November and, especially, December. Lemon Dabs are in greatest numbers from May to September, the maximum occurring in May; there is a second small maximum in February. They are scarcest from November to January and also in March.

Turbot, forming 10·7 per cent. of the aggregate, are in greatest numbers from March to June and mostly in April and May, and there is a second and much smaller maximum in the latter part of the year; they are scarce in autumn and again in February, the data in the latter case depending on 1903. Halibut are most abundant in the latter part of summer, from June to September, the maximum being in the latter month, and there is a slight indication of a second maximum in April; they are least abundant from November to March, especially in January and February.

The Megrim in this quarter has a winter maximum, December–March, and is scarce all the rest of the year, most in July, there being barely a trace of the second summer maximum that is present in XXIII. It is interesting to note how, as we pass down the coast from the deep northern square XI, the spring cone of maximum abundance disappears and the winter maximum is developed. Its fluctuations in this area are complementary to the summer maxima of Turbot, Lemon Dab and Halibut. The Whitch, which is scarce here, the percentage being 0·5, is in maximum abundance in February; it is scarce all the rest of the year, being, however, in rather greater numbers from April to August. Brill has its maximum abundance in spring, mostly in March, a small second maximum occurring in November; it is scarce from June to September. Dabs have two maxima, the greatest from October to January, the next from March to May; it is scarce in July, August and September, and also in February. These species thus show complementary fluctuations to the predominant fish, Lemon Dabs.

In XXIV, lying on the eastern, or seaward, side of XXIII, we find the same complementary relations in the fluctuations. The predominant fish are Lemon Dabs (39·3 per cent.) and Whitches (36·5 per cent.). When Lemon Dabs are at their minimum abundance, in April and May, Whitches are at their maximum; when

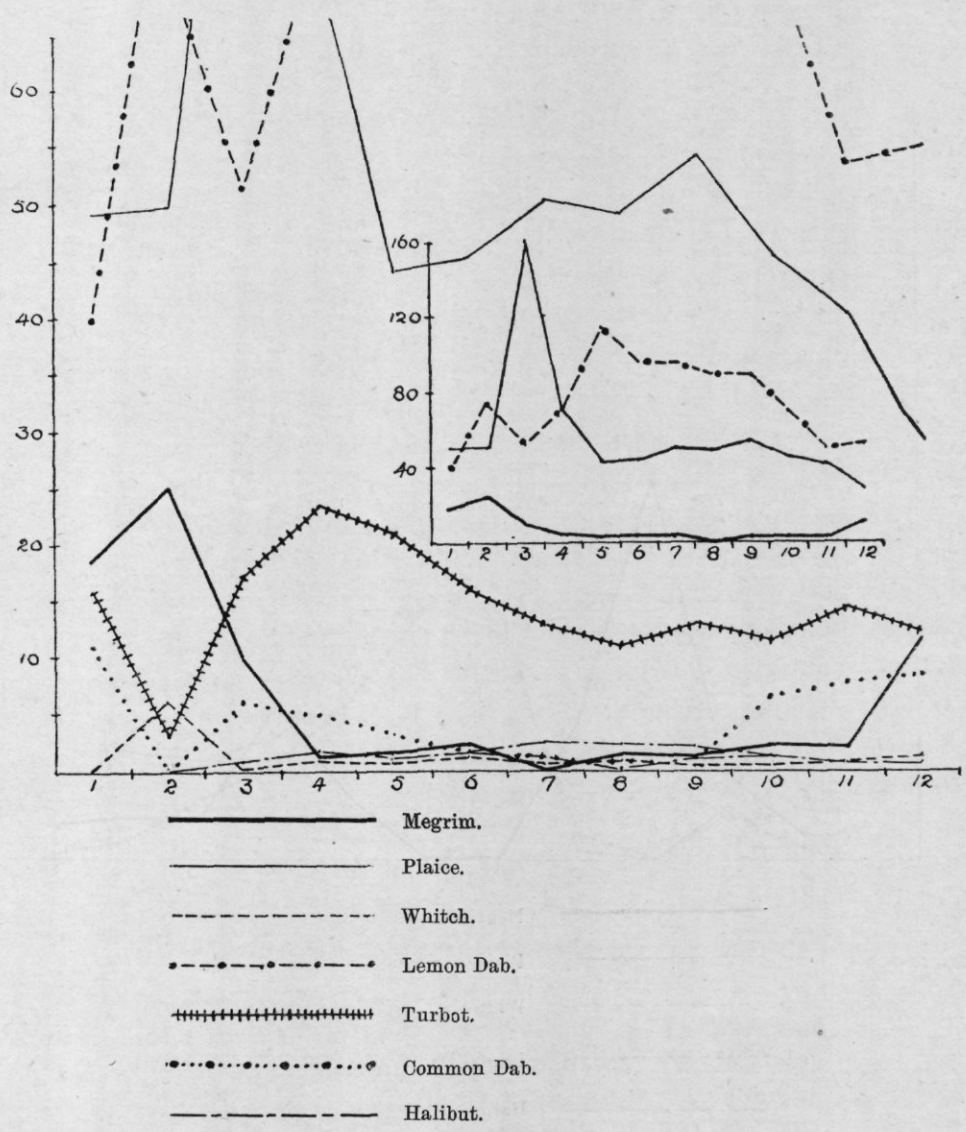


FIG. 7. Seasonal fluctuations of flatfishes in area XXIX.

Whitches are most scarce, in June, July and August, Lemon Dabs are most numerous (Fig. 8). Plaice (8·5 per cent.) here synchronises in its fluctuations with Lemon Dabs, the minimum being in April and May, and the maximum in June, July and August ; both have even a small cusp caused by the elevation

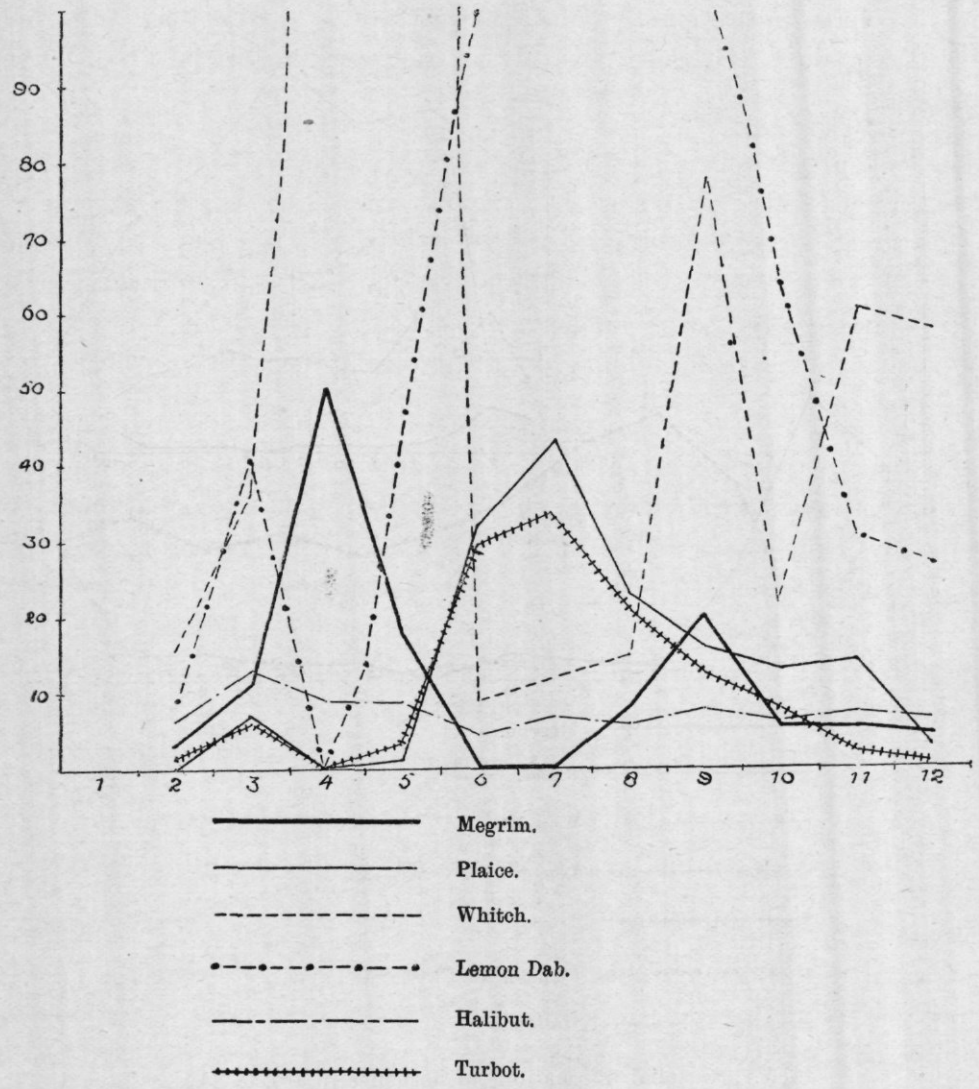


FIG. 8. Seasonal fluctuations of flatfishes in area XXIV.

of the March average above that of February. Turbot (5·5 per cent.) fluctuates with Plaice in the closest manner, the curves being almost identical, and the maximum and minimum corresponding ; here also there is a little March cusp, exactly as with Plaice and Lemon Dabs.

The fluctuations of the Megrim (5·5 per cent.) on the other hand synchronise with those of the Whitch ; the maximum is in April and May, the minimum in June and July, and there is a second small maximum in September, which is also represented in the curve of the Whitch. Here, in deeper water, the periodicity of the Megrim is the same as in the more northerly squares, where it is a predominant fish. The fluctuations of the Halibut (4·4 per cent.), not so uniformly regular, are complementary to the Lemon Dab on the whole. The maximum abundance is in spring, March especially, and the minimum in June ; the averages from July to January range about the mean, or a little below it. Brill, very scarce (0·03 per cent.), show the usual spring maximum in March, and there is another small maximum in November. Dabs were at their maximum in February and March, and were absent in all the other months except November.

The curve for the aggregate flat fishes in this area is characterised by a very tall cone in April and May, when they were twice more abundant than at any other period of the year, and it was due almost entirely to Whitches (the averages for this fish in March, April, May and June were respectively 3·7, 42·1, 40·9, 0·9). From June to October Lemon Dabs predominated over Whitches, as did also Plaice and Turbot in June, July and August. The sudden and enormous increase of Whitches in April and May, and their equally sudden decrease in June, indicates probably the visit of shoals to this area at that time.

Going now to some of the squares on the other side of the North Sea, in the region of the Fisher Bank plateau, we may first examine the fluctuations in XX, which is on its northern border and extends in part into deep water. Here the predominant fish are Plaice (36·2 per cent.) and Whitches (33·3 per cent.). Whiches predominate over Plaice from October to April and in August, while Plaice predominate over Whitches in the other months. Plaice are in maximum abundance in summer from May to September, but there is a sudden scarcity in August and the September cone is the maximum, and they are very scarce in winter, especially in January and February. The fluctuations of the Whitch are complementary to those of the Plaice (Fig. 9). The maximum abundance is in winter, especially in January and February, and the minimum from April to July, while the decreased abundance of Plaice in August is compensated by an equally sudden increase in the number of Whitches, and contrariwise the sudden increase of Plaice in September is associated with an equally abrupt diminution in Whitches.

The complementary relations of the other species in this area are not so noticeable, perhaps partly because the numbers are not large (the total flat fishes amounted to 750½ cwts.). Lemon Dabs (7·8 per cent.) have a great maximum from June to October, especially in June and July, and they are very scarce from November to May. Turbot (3·6 per cent.) are in greatest abundance in summer, as usual, from May to July, especially in the latter month ; they are scarcest from November to January. Halibut (15 per cent.) are most abundant in the first half of the year, to July, and very scarce thereafter, most so in November ; in the former period two cones are shown in the curve, one, corresponding to the spawning season, in March, April and May, and the other, a tall and slender one, in July ; the minima, in this part of the curve, are in February and June and they are on the mean. Megrims (3 per cent.) are most abundant in spring, February to April, but the March position is low, and least abundant in June and July, after which the curve is zigzag. Brill (1 per cent.) are most abundant in spring, from March to June, and especially in May, while they are absent in all the other months. Dabs were absent all the year, so far as the statistics show.

In XXV, to the south of the above and on the plateau, there was unfortunately no fishing before March and very little before May. Plaice is the predominant fish (57·8 per cent.) in all months except March, when it is exceeded by Whitches, and April, when Halibut come first, Whitches second, and Plaice and Lemon are equal. Plaice are in greatest abundance in May and June, rather less abundant in July–September, still less in October, while in November and December they become again numerous. They are very scarce in March and April. Lemon Dabs (14·1 per cent.), Halibut (11·2 per cent.), and Whitches (11·4 per cent.) are all about equally abundant. The fluctuations of Turbot (5·6 per cent.) and Halibut are much the same as those of Plaice, the decrease in autumn being, however,

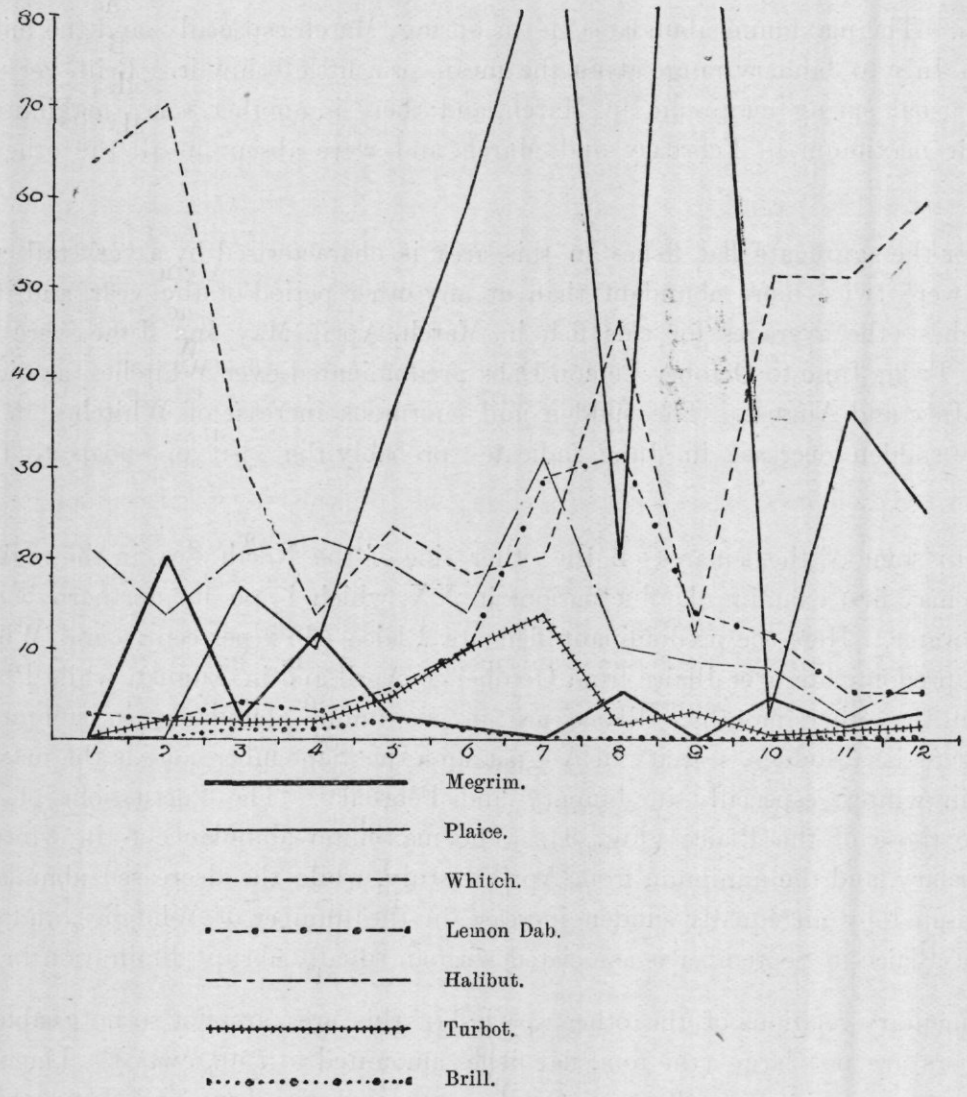


FIG. 9. Seasonal fluctuations of flatfishes in area XX.

greater, and the increase towards the end of the year less marked. The maximum of Halibut is in April and May, and they gradually diminish thereafter to September, increasing slightly in the three last months. Turbot have their maximum from April to June or July, and are most scarce in August–November. Lemon Dabs are most abundant in May, July, September and November, but the curve shows comparatively little variation in abundance from April to December, August being lowest. Whitches are at their maximum in March and December, an indication probably of a winter abundance, but there are no data for January and February. They are at their minimum in summer, especially June–July, and increase thereafter to December. Megrims, which are very scarce (0·5 per cent.), were

present in April, May and June, and towards the end of the year, October–December, while in 1901 they were relatively very abundant in August. Brill were most numerous in March and April, and gradually diminished in numbers thereafter to June ; none were taken in July–November, but there were a few caught in December. Dabs were extremely scarce, a few being taken in May and September. In this area, then, one does not see the close supplementary fluctuations exhibited in the other areas, which may be partly owing to the great predominance of Plaice over every other species and the imcomplete fishing.

In the next area to the south, XXXI, also on the plateau, there was trawling only in March and from May to December. Plaice (55·6 per cent.) again predominates, and is only exceeded in December by Whitches. The maximum abundance is in June, but it is not very much greater than in the other months, and all of them except December, the minimum, show a fairly uniform abundance.

Lemon Dabs are next in amount (18·38 per cent.), and they also are fairly uniform in abundance in the various months, fluctuating a little, complementarily to Plaice, until about August ; the maximum is in May and the minimum in December. Whitches come third (16 per cent.), and their fluctuations are in the main complementary to Plaice. They are abundant in March and May and gradually diminish to a minimum in July–September, after which they increase in numbers, attaining their maximum in December, when they are the predominating flat fish in the area. Halibut (6·1 per cent.) vary in abundance in much the same way as Whitches. They are most abundant in May, gradually diminish to October, the minimum, increasing again slightly in November and December ; they are also scarce in March.

Turbot (3·1 per cent.) are most numerous in May–July, after which they rapidly diminish to September and October, increasing slightly in November and diminishing in December. Megrims are very scarce (0·23 per cent.) ; they were in greatest abundance in August–October, and least so in March, May–July, and again in November. Their fluctuations are in general complementary to Turbot. Brill, hardly represented (0·01 per cent.), were got in May and to a much less extent in October. Dabs (·6 per cent.) were most abundant in June–September, and mostly in August, and scarcest in December, March, and May. Their fluctuations were complementary to the Whitch for the most part.

In these two areas on the Fisher Bank plateau, therefore, the complementary relations of the fluctuations of the different species are by no means so evident as in the other areas above described. It might have been different if the whole year were represented, but it is not unlikely that the great predominance of one species, Plaice, and still more its stability or uniformity in abundance, in part at least, accounts for it. If there had been marked fluctuations in the abundance of the predominant fish, it is likely that compensatory fluctuations in the abundance of other species would have been more marked.

It is to be regretted that the fishing in the southern and eastern parts was so limited, but I am tempted to refer to XXXVI, from its relation to the Dogger Bank, though the fishing in it was confined to February, May, and August–December, practically all in 1903, and never very large in amount. So far as the statistics go, the predominant fish were Dabs and Plaice, with percentages of 33·5 and 33·1 respectively. Plaice were most abundant in March and May, and least in September and December. Dabs were least abundant in March and May, and in September, while in October they were extremely abundant and predominant, and the December average was high. Lemon Dabs (11·6 per cent.) showed the same fluctuations as Plaice in March, May, and August, but they were in greatest numbers in September–November. Whitches (11·4 per cent.) were in greatest abundance in February, scarcer in May, least abundant in August, and with a period of abundance in September–November, and mostly in October, becoming scarce again in December. Halibut (2·9 per cent.) showed almost exactly the same variations as Whitches. Turbot (5·5 per cent.) were abundant in May, scarce in February and in August-October, increasing much thereafter, and having their maximum in December. Brill (0·8 per

cent.) were only taken in October, November, and December, and were most abundant in the latter month. Megrims (1·3 per cent.) were only taken in October.

I think that it will be admitted that the co-ordinated fluctuations of the various species of flat fishes living on the same grounds, as above described and figured, is of interest. It shows how closely they are related in life and habits, and there is little doubt that the periodical variations in abundance are correlated, as with, for example, birds and plants on land. Some of the lessons from a study of the fluctuations may be summed up as follows :—

(1.) The variations in the abundance of a species in an area is usually associated with complementary or compensatory variations in the abundance of one or more other species, so that the aggregate of the various species of flat fishes tends to be uniform throughout the year.

(2.) When two species are about equally represented in an area, their fluctuations as a rule are co-ordinated and compensatory.

(3.) The fluctuations of any given species in an area are usually double within the year, there being two periods of maximum abundance, separated by two intervening periods of scarcity. Thus, omitting the eastern squares where the early months are not represented, and considering the remaining eight areas, Plaice has a double maximum in six of them, Whitches in seven, Megrims in seven, Halibut in seven, Dabs in five, Lemon dabs in five, Brill in three ; Turbot often also exhibits a double maximum, but as a rule it is formed by depressions (or scarcity) in the summer maximum, so common in connection with this fish, and these minor fluctuations are usually related to contrary fluctuations in other species. The relative importance of the two maxima and minima, both in regard to intensity and time, varies ; they are usually, but not always, separated by two or three months, and, as a rule, the maximum coinciding with the time of spawning of the fish is the greatest in those areas where the fish is a predominant species.

(4.) The greater the fluctuations in the predominant species, the greater the fluctuations among the minor species, as a rule, and conversely, as on the areas on the Fisher Bank plateau.

(5.) The existence of these complementary or compensatory fluctuations explains many apparent anomalies in the averages or curves for a given species when considered alone, *e.g.*, the sudden increase of Plaice and Lemon Dabs in XX in July, arbitrary standing alone, but filling up the gap, so to speak, that is caused by the diminished numbers of Whitches and Megrims. Many such little and apparently accidental variations in the curves, really significant, may be eliminated by smoothing the curves.

2. *Relation of the Fluctuations to the Spawning Period.*

The fluctuations are obviously not due to one cause alone, and a full explanation of their significance need not at present be attempted, but there are reasons for thinking that many of them are directly due to the congregation of the fish at the spawning time, and others indirectly caused in the same way. In the description of the fluctuations above given, and in the diagrams which illustrate them, the influence of the reproductive period is evident. I have already referred to this when dealing in detail with XIV (p. 486), and the relation which the advent of the spawning-season may have directly on the fluctuations of predominant species, and indirectly on the fluctuations of minor species, is illustrated in other of the squares, as in XI and XVIII with Megrims, in XV and XIX with Whitches, in XXIII and XXIX with Plaice and Lemon Dabs.

A study of the periods of maximum abundance of the various species in the areas referred to throws light on this. Thus with Plaice, one of the periods of maximum abundance, what I may term with reference to the curve "the spawning-cone," coincides with the spawning-season in six of the eight areas, and it is the maximum for the year in five. In the case of the Whitch the spawning-cone is present in seven, and in five it is the greatest for the year. With Megrim it is present in six, and in five it is the maximum for the year. With Halibut it is present in five, and the greatest in three. With Brill it is present in all eight ; it is the only one in four, and the greatest in the other four. With Dabs it is present in six and is the greatest in four. With Lemon Dabs it is present in five, and with Turbot in seven. In the case, however, of the Turbot, and to a less extent with the Lemon Dab, both summer-spawners, the summer maximum is very often irregular, but it is interesting to note that these irregularities, puzzling and apparently accidental when considered alone, are often associated with complementary fluctuations of more predominant species, so that in the curves they, so to speak, fit into one another.

It may, however, be noted that the areas in which the spawning-cone is most prominent and best shown (or, in other words, where the coincidence of the maximum abundance of the fish and the spawning-season is most marked) are those where the fish is normally most abundant, where it has its head-quarters or centre of distribution. Thus it is with Plaice and Lemon Dabs in XXIX and XXIII, with Megrims in XI and XIV and XVIII, with Whitches in XIV, XV, XIX, &c. The converse is also true, as a rule, that the further from the centre of abundance of the species the more the spawning-cone is diminished or disappears. Thus it is with the northern species, Whitch, Megrim, Halibut, as one proceeds south or south-east to the shallower areas (*see* p. 508), and with the more shallow-water species, as the Plaice and Lemon Dab, as one proceeds to the deeper areas. Exceptions appear to occur in the Brill, which is found at the spawning-season, and usually only then, in the deeper areas, and also with the Turbot.

The bearing of these facts on the problems of the migration of the fishes and their principal spawning-regions is obvious.

An examination of the curves for the other squares and for the groups of squares shows also the general coincidence of a maximum abundance with the spawning season. Thus Turbot almost everywhere have a summer maximum, and Brill a maximum in spring, about two months earlier. Megrim have a spring-cone in the northern areas, diminishing towards the coast, where it is most abundant in winter. Whitches have a summer maximum in the northern areas, also diminishing towards the shallower waters, and the abundance in winter in the latter areas is still more marked. Halibut have a spring-cone in the northern areas (XV is its chief one) which diminishes towards the south (XIX, XVIII), and the autumnal cone increases, and near the coast the spring cone disappears and there is a depression, the fish being present in abundance in autumn. An exception takes place, offering a contrast to the Whitch in the same region, on the Fisher Bank plateau, where the chief feature of the curves, so far as they exist, is a cone in spring and early summer, great scarcity in late summer and autumn, and a slight increase in winter.

Lemon Dabs have a general maximum, like the Turbot, in summer, and Plaice have a spring maximum, especially notable in the areas in the neighbourhood of the coast, and this is also the case with Dabs.

In dealing with each fish, I have grouped a number of the areas together, and it will be found that in those which include the region of maximum abundance of the fish there is a wave of increase corresponding to the spawning-period. In some others the maximum corresponds to the interval between the spawning-seasons. Thus with Megrims, in the northern group there is a great wave of maximum in April-May, and the averages for March–June are above the mean ; there is a small cusp, or secondary maximum, in autumn (September–October) scarcely reaching the mean, and the fish are scarce in winter (November–

January) and in July–August. In the coastal group the fish are most numerous in winter (November–February), and especially in December; scarce in July–October, and the spring cone is represented in April and May. In the group XXIII, XXIV, XXV, and XXIX, the curve is cup-shaped, showing relatively great preponderance in winter and extreme scarcity in summer. It is the same with Whitches; the northern areas, where the Whitch abounds, show great abundance of the fish at the spawning-season, a second smaller maximum in winter, and the greatest scarcity in March and April, *i.e.*, when Megrims abound. The curve for the group XXIII, XXIV, XXV, XXIX, is almost the exact reverse, the fish being scarce in summer, abundant in April and May, and they are also fairly abundant in winter. Other groups embracing the coast, or the Fisher Bank plateau, show the cup-shaped curve of abundance in winter and scarcity in summer.

With Halibut in the northern squares there is the wave of increased abundance during the spawning-season, scarcity in summer, and a second wave of increase in autumn. In the coastal group there is great scarcity in spring and abundance in autumn; on the Fisher Bank plateau there is abundance in spring and great scarcity in autumn, and in XXIII, XXIV, XXV, and XXIX combined, there is abundance in May and June and scarcity at other times of the year. With Plaice the same variation occurs according to the grouping. Near the coast and in the squares further off (as XIV, XV, XVIII, XIX) they are abundant in spring, but also in autumn or summer, and the increase near the coast is most marked in March and February, and in the other group in April. On the Fisher Bank plateau they are scarcest, so far as the statistics go, in March and April, and abundant throughout the summer. With Lemon Dabs, on the other hand, the corresponding groupings show a maximum abundance in summer, and it is the same with Turbot, though in some a small spring cone may be also present. With Brill, the spring cone is present in all, and may be the only one.

We may now consider the fluctuations in the abundance of the various species, taking the whole region over which the recording vessels trawled, that is the sum of the squares. The curves reveal features of remarkable uniformity, exhibiting a characteristic symmetry that is repeated with more or less exactness, and sometimes with almost absolute similarity, in the different years. As a rule there are two cones or periods of abundance, the origin of which we have seen above, one much more marked than the other, and which may be distinguished as the primary and secondary cones. In describing them it will be convenient to relate them to the line of the mean, *i.e.*, to the average for the whole year, to distinguish the apex of the cone, and also the central ordinate or perpendicular, that is, the ordinate placed on the middle of the base of the cone where it is cut by the line of the mean.

A striking feature in most of the curves is the coincidence of the primary or predominant cone with the spawning-period of the fish, but in some cases the opposite prevails. There is the coincidence with the Turbot, Brill, Halibut, Megrim and Lemon Dab, but not with the Whitch, Plaice and Dab.

In the Turbot the cone of maximum abundance extends on the line of the mean from the early part of April to the latter part of September, the apex is in July, and the central ordinate at the end of June. In all the other months the abundance is below the mean. As stated on p. 511, the spawning period of the fish extends from April to August and the beginning of September. In 1902 the cone extended from about the middle of April to the end of September, the apex being in June and the central ordinate in the early part of July. In 1903 it extended from the same point to the middle of September, the central ordinate is in the end of June or beginning of July, and the apex is bifid, the points being in May and July. In 1901 the part above the calculated mean (January–March being omitted in that year) extends from April to the end of September, the apex is in July, and the central ordinate at the end of June. There is a small secondary cusp in November in 1901, especially, and in 1903, but it is absent in 1902. The period of greatest scarcity is December–March, and mostly January.

In the Brill, the maximum abundance above the mean is from the latter part of February to the beginning of July, the apex is in April, and the central ordinate at the end of April or beginning of May. The spawning period is described (p. 523) as extending from the end of March to the beginning of July. The central ordinate of the cone of the Brill is thus two months earlier than that of the Turbot, and the apex three months ; the former is the better guide, for in neither case is the cone quite symmetrical. The period of greatest scarcity is August and January, and there is an indication of increased abundance towards the latter part of the year. The curves for the separate years show slight deviations ; in 1901 the cone extends to July, and the May average touches the mean ; in 1902 the cone extends from January to June, and in 1903 from the end of February to July, and in both cases the April average is lower than those on each side of it, so that the apex is bifid.

With Halibut the cone extends from the middle of March to the middle of June, the apex is about the end of April or beginning of May, and the central ordinate about a week earlier. The spawning-period of this fish has not been well determined (p. 534), but the evidence points to its extending from March to June, a supposition that receives support from the curve. There is a small secondary cusp in September, and the period of greatest scarcity is October–February. The curves for the separate years show the same features. In 1901, from the absence of data in the early months, it is not so well marked ; there is a cusp in August, and the greatest scarcity is in October and November. In 1902 and 1903 the cone is conspicuous and has the same relation to the line of the mean and central ordinate, but the apex in 1902 is in May, while in 1903 it is in April, the May position being a trifle lower. In the curve for the line-caught fish the cone is not so sharply separated from the secondary cone, and is a little later, from the middle of March to the middle of July, at which point it does not quite reach the line of the mean. The apex is in May, but the April average is nearly as high, and the central ordinate is about the latter part of May.

With the Megrim the primary cone extends from the beginning of February to the end of May ; the apex is in April, and the central ordinate at the end of March or beginning of April. The secondary cone, here rising above the mean, is in December, and the period of scarcity is in summer and on to November, and also in January. The curves for the separate years show slight differences. In 1901 the part of the cone represented extends into June ; in 1902 it begins in January and extends to May, the apex is in March and the central ordinate also in March ; in 1903 it extends from February to May, the apex and central ordinate being in April. The spawning period of this species is not well known (p. 560), but Holt found it spawning on the Irish coast in March, April and May, and thinks it may do so also to some extent in June.

The curves for the large and small Megrims are almost identical, the cone occupying a position on the line of the mean from the beginning of February to the end of May. The apex in both is in April, but with the small Megrims the average for March is relatively higher than with the large ; the central ordinate in each is at the junction of March and April. The same relations are observed in the separate years.

With Lemon Dabs the central summer cone is pronounced, but is less symmetrical than in the other cases described. It extends on the mean from the middle of May to the early part of October ; the apex is in July, but the August point is nearly as high, and the central ordinate at the end of July or the beginning of August. The spawning-period on the east coast is described as lasting from the middle or latter part of April to well on in September, and at its height in June and July (p. 574). The period of greatest scarcity is from November to March, especially January. In 1901 the cone, which in this year is least perfect, extends from the end of June to the latter part of October, the central ordinate being in August ; the apex is flattened from July to October, the July position being slightly the highest. In 1902 it extends from about the middle of May to the beginning of October, the apex is in August, the

July position being slightly lower, and the central ordinate is at the end of July. In 1903 it extends from the beginning of May to the beginning of October, the apex is in July, as is also the central ordinate. The curves for the large fish are practically the same as for the total fish, but in that for the small there is a slight elevation above the mean in April, and a marked cone from the beginning of July into October, the apex being in August.

With the above species, therefore, the curve shows that the fish are in maximum abundance at the spawning-season, taking the region as a whole, but the curves for the Whitch, Plaice and Dab differ.

The case of the Whitch is the most noteworthy and interesting. The curve shows two cones, a large and prominent one and a small one, which does not quite reach the mean for the year. The former is in winter, extending on the line of the mean from about the middle of November to the middle of March; the apex is about the end of January and the central ordinate about the middle of that month. It shows that taking the whole region fished over the Whitch was most abundant in winter. In 1901–1902 the apex was in December and in 1902–1903 it was in January. The curves for the large and for the small Whitches show the same features, both for the three years combined and for the three years separately. The small secondary cone, on the bottom of the cup-like curve, is formed by the averages for May, June, and partly July; in 1901 the apex is in June, in 1902 in May, and in 1903 in July, and it is least prominent in the latter year; it is rather more prominent with the large than with the small Whitches. The spawning season of the Whitch corresponds pretty closely to that of the Lemon Dab, extending from April to September (p. 547). It is clear, therefore, that in this case it is the small secondary cone which represents the spawning-time, and the large one the interval between. We have already seen that, even in the areas where the fish is most abundant, there is a winter maximum as well as a summer one, and that towards the coast and the south the latter dwindles and the former increases.

The curve for the total Plaice, taking the three years together, shows maximum abundance from March or April to December, and greatest scarcity in January and February, and on the line of the mean, two cones, unsymmetrical, one low extending from May to August, and the second higher and entirely formed by the average for September. Neither of them corresponds with the spawning-period, which, on the contrary, is characterised by low averages. With trifling differences these features are repeated in the curves for the large and medium Plaice; in that for small Plaice, however, there are only three averages above the mean, viz., May, September and December, the one in May forming a tall cone, due to 1903. In the curves for each year the cones do not coincide in position; in 1901 only part of the first is represented and it ends in May, and the second is formed by the July average alone; in 1902 the first, which is the more prominent, extends from May to August, the second is small and has its apex in November; in 1903, where the mean is much higher, the first extends from April to June, with it apex in May, and the second, more pronounced, has its apex in September. In each case the line covering the spawning-period is at its lowest and below the mean. The constitution of the curve of the aggregate is, in part at least, due to the fishing in the latter part of the year having been largely on areas where Plaice were taken almost only after the early part of the year, as on the Fisher Bank grounds.

With Dabs, the only cone above the line of the mean is at the end of the year, in October, and the period of greatest scarcity is summer.

In considering the curves which are formed by a combination of the statistics from the whole area fished over, it is necessary to bear in mind the statement made on page 475 as to the inequality of the fishing in different regions of the North Sea. The bulk of the trawling fleet may and do fish in different quarters at different periods of the year, the majority of the vessels fishing north of 58° N. in the early months, and to the south of that line during the rest of the year, especially in summer. Since the abundance of a species may vary considerably in the two regions, apart from seasonal fluctuations, it follows that the averages derived from the aggregate fishing may not represent the natural changes, and may indicate the

migration of the fishing vessels rather than the migration of the fish. The variation due to this cause diminishes as the area whence the statistics are derived diminishes, and when dealing with the various species in the following pages groups of areas as well as the areas themselves are considered.

MONTHLY AVERAGES FOR THE DIFFERENT FLAT FISHES IN CERTAIN SQUARES.

Square XV.

Name of Fish.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Turbot ...	0·006	0·072	0·062	0·124	0·179	0·094	0·104	0·203	0·000	0·057	0·004	0·004
Brill ...	0·000	0·018	0·000	0·096	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
Halibut...	1·230	1·298	1·548	2·439	2·158	1·434	2·135	2·674	1·794	1·707	1·850	1·238
Whitch ...	10·296	17·575	9·328	5·526	13·648	14·894	16·667	11·860	10·949	10·827	12·491	13·809
Megrim...	1·070	1·525	1·926	3·941	2·556	2·342	1·667	2·035	1·565	1·223	1·012	0·985
Lemon ...	0·032	0·027	0·088	0·372	0·332	0·021	0·104	0·697	0·231	0·334	0·163	0·156
Plaice ...	0·122	0·181	0·176	0·399	0·955	0·021	0·104	0·291	0·694	1·129	0·711	0·414
Dab ...	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0

Square XX.

Turbot ...	0·0	0·200	0·171	0·191	0·490	0·918	1·383	0·157	0·357	0·000	0·062	0·078
Brill ...	0·0	0·0	0·101	0·106	0·210	0·120	0·0	0·0	0·0	0·0	0·0	0·0
Halibut...	2·143	1·400	2·083	2·193	1·910	1·430	3·125	1·022	0·831	0·750	0·250	0·652
Whitch ...	6·429	7·000	3·125	1·384	2·369	1·807	1·964	4·560	1·071	5·071	5·068	5·950
Megrim...	0·000	2·000	0·233	1·107	0·210	0·090	0·000	0·472	0·000	0·359	0·125	0·365
Lemon ...	0·357	0·200	0·424	0·362	0·636	0·994	2·946	3·144	1·421	1·143	0·447	0·469
Plaice ...	0·0	0·0	1·689	1·009	3·661	5·873	8·250	2·044	12·589	0·214	3·564	2·557
Dab ...	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0

Square XXIV.

Turbot ...	...	0·078	0·637	0·0	0·323	2·945	3·349	2·061	1·265	0·804	0·221	1·801
Brill ...	...	0·000	0·042	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·014	0·006
Halibut...	...	0·625	1·295	0·902	0·916	0·441	0·697	0·613	0·793	0·613	0·756	0·637
Whitch...	...	1·562	3·705	42·083	40·948	0·882	1·169	1·488	7·834	2·229	6·154	5·816
Megrim...	...	0·312	1·084	5·00	1·832	0·00	0·00	0·774	2·037	0·571	0·565	0·427
Lemon ...	...	0·938	4·096	0·00	1·401	11·176	13·511	11·594	11·309	6·328	3·102	2·714
Plaice ...	...	0·000	0·728	0·00	0·108	3·235	4·339	2·313	1·588	1·319	1·434	0·278
Dab ...	...	0·625	0·361	0·00	0·000	0·000	0·000	0·000	0·000	0·000	0·057	0·000

Square XXIX.

Name of Fish.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Turbot ...	1·614	0·312	1·718	2·397	2·122	1·573	1·316	1·108	1·278	1·156	1·456	1·273
Brill ...	0·045	0·000	0·343	0·090	0·100	0·016	0·003	0·016	0·011	0·049	0·108	0·068
Halibut...	0·000	0·000	0·049	0·168	0·113	0·185	0·249	0·203	0·208	0·141	0·035	0·059
Whitch ...	0·000	0·625	0·024	0·104	0·075	0·092	0·064	0·115	0·008	0·021	0·054	0·098
Megrim...	1·779	2·500	0·982	0·155	0·151	0·205	0·011	0·118	0·124	0·214	0·179	1·185
Lemon ...	3·969	7·500	5·206	7·050	11·670	9·640	9·671	8·961	9·012	7·022	5·444	5·604
Plaice ...	4·927	5·000	16·134	6·953	4·439	4·547	5·016	4·909	5·453	4·629	4·108	2·909
Dab ...	1·095	0·000	0·638	0·466	0·415	0·174	0·085	0·029	0·113	0·667	0·745	0·842

Square XI.

Turbot ...	0·000	0·027	0·045	0·054	0·085	0·232	0·403	0·000	0·000	0·000	0·017	0·000
Brill ...	0·000	0·000	0·000	0·024	0·006	0·000	0·000	0·000	0·000	0·000	0·000	0·000
Halibut...	1·594	0·934	2 094	2·119	1·668	1·860	1·532	1·875	1·967	1·932	1·069	1·420
Whitch ...	11·376	12·967	4·882	3·061	4·035	8·430	0·323	9·722	13·524	10·349	7·854	9·470
Megrim...	1·268	2·802	5·632	10·991	12·143	6·104	2·419	0·139	0·819	6·172	5·487	2·715
Lemon ...	0·073	0·000	0·054	0·117	0·234	0·000	3·871	0·278	0·451	0·062	0·368	0·221
Plaice ...	0·000	0·000	0·009	0·339	0·512	0·407	4·677	0·416	0·819	0·784	1·736	0·316
Dab ...	0·000	0·000	0·000	0·022	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000

Square XIV.

Turbot ...	0·000	0·041	0·068	0·150	0·105	0·330	0·230	0·281	0·137	0·108	0·058	0·092
Brill ...	0·000	0·000	0·000	0·025	0·000	0·000	0·000	0·017	0·014	0·000	0·000	0·000
Halibut...	1·115	0·769	0·921	2·405	1·323	1·115	1·048	1·654	1·347	1·294	1·338	1·229
Whitch ...	11·239	9·546	5·184	7·916	15·043	17·355	14·263	8·873	5·931	5·953	8·345	8·579
Megrim...	0·811	3·463	6·655	8·371	9·159	2·624	1·129	1·021	3·491	3·219	2·265	3·662
Lemon ...	0·156	0·094	0·302	0·376	0·273	0·331	0·346	0·599	2·932	1·783	0·532	0·381
Plaice ...	0·000	0·239	0·179	11·323	0·630	0·516	1·636	1·937	7·039	6·847	4·237	1·592
Dab ...	0·000	0·000	0·027	0·601	0·084	0·000	0·046	0·422	0·043	0·604	0·485	0·036

Square XXIII.

Name of Fish.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Turbot ...	0·611	1·164	1·557	1·614	1·535	1·589	2·048	1·689	2·497	1·555	1·513	1·239
Brill ...	0·111	0·427	0·817	0·276	0·378	1·007	0·212	0·043	0·196	0·211	0·425	0·164
Halibut...	0·236	0·245	0·192	0·267	0·297	0·497	0·512	0·400	0·144	0·147	0·137	0·092
Whitch ...	1·443	1·155	0·336	0·607	0·434	1·259	0·915	1·159	0·434	1·005	1·635	0·743
Megrim..	3·256	3·374	1·385	0·336	1·944	3·142	0·847	1·749	0·729	1·404	1·509	1·371
Lemon ...	3·768	6·496	7·038	6·815	7·768	6·645	10·551	12·225	10·771	6·985	6·172	5·933
Plaice ...	2·579	4·956	11·654	8·598	5·208	5·599	3·666	3·054	3·795	6·515	5·719	4·772
Dab ...	0·755	0·727	0·885	1·235	0·679	0·324	0·091	0·108	0·615	2·142	1·228	1·089

Square XVIII.

Turbot ...	0·166	0·036	0·137	0·714	0·297	0·616	1·135	0·358	0·172	0·152	0·203	0·039
Brill ...	0·000	0·000	0·009	0·619	0·000	0·036	0·034	0·000	0·000	0·010	0·000	0·008
Halibut...	0·801	0·442	0·529	0·261	0·595	1·107	1·364	2·620	1·718	2·191	1·864	0·734
Whitch ...	17·698	16·355	7·189	6·762	23·155	14·846	9·841	15·044	11·539	18·831	15·938	17·540
Megrim...	4·039	10·059	14·495	9·000	38·810	11·848	3·656	4·771	7·195	3·977	3·700	4·649
Lemon ...	0·242	0·037	0·230	6·809	0·535	2·891	7·750	2·136	1·933	0·650	0·348	0·230
Plaice ...	0·159	0·037	0·157	1·643	0·417	0·278	1·607	0·524	1·124	0·933	0·641	0·160
Dab ...	0·000	0·172	0·127	0·190	0·000	0·035	0·027	0·000	0·173	0·000	0·000	0·000

3. *The Secondary Fluctuations. The Relation between Spring-Spawners and Summer-Spawners.*

We have already seen (and the subject is more fully discussed under the various species in the following pages) that there may be several fluctuations in the abundance of a given fish within the same area in a year ; and that, as a rule, there are two of chief importance, one of which we have shown to be referable to the spawning-season. The causation of the second maximum, when the fishes again become abundant, is not so immediately apparent, and is not, like the other, obviously related to any phenomenon in the life-history of the fish. It is, of course, quite natural and normal that fishes, and not merely those dealt with here, congregate at a particular season for reproduction and then disperse. The fact is a commonplace in connection with fisheries. But why, after dispersing, they should again congregate and again disperse, is not so clear. It might be attributed to feeding or to temperature changes, but the phenomena are too irregular in different areas and with different species to be explained in this way.

I think careful study of the facts described in connection with the congregating of the fish at spawning, and illustrated in the foregoing diagrams, furnishes a clue. I have shown how extremely

important and closely related the fluctuations of different species on the same grounds may be, and that when the numerical stability of one is disturbed the numerical stability of another, or others, is also disturbed, and the fluctuations become complemental or compensatory. I have also shown that one of these fluctuations is a necessity in the life of the fish, and this may be regarded as a controlling condition.

Now, it is an interesting and important fact that in an area the predominant fishes whose fluctuations are compensatory have different spawning-periods, in one case being spring-spawners and in the other summer-spawners. It is thus with Megrims and Whitches in XI, with Whitches and Megrims, and Halibut and Plaice in XIV, with Plaice and Lemon Dabs in XVII, XXIII, XXVIII, and XXIX, with Whitches and Megrims and Lemon Dabs in XVIII and XXIV (*see* Figs. 2–9), and it is also exceedingly common, as we have seen, among the fishes not present in such abundance. Thus, the spawning-seasons are complementary, and when the shoals of spring-spawners begin to disperse, the summer-spawners begin to arrive or increase, and when they, in turn, begin to diminish in numbers, as the spawning-season closes, the spring-spawners begin again to increase, and a second or double maximum is formed. Among the minor species in an area, that is those present in relatively small numbers, the complementary fluctuation may be within the limits of its spawning-season, as with Lemon Dabs and Turbot in July in XI (Fig. 3), and there may be more than one secondary fluctuation, as with Plaice in the same area. Moreover, among the minor species there may be compensatory or opposing fluctuations among themselves when the spawning-season is the same, if one of them is distant from the "headquarters" of the species, as in XVII, where Lemon Dabs and Plaice are complementary, and Whitches fluctuate with Plaice and against Lemon Dabs.

I think it is highly likely that if the tabulation of the records had been related to distinct grounds, and not grouped artificially in squares, this relationship of the fluctuations would have been still better shown, since in some cases one appears to get, so to speak, an oblique section of the phenomena, or only the corner of a natural area.

In connection with this explanation of the fluctuations, the compensation of spring-spawners with summer-spawners, it is of interest to discover that the percentage of the two groups from the whole region investigated for the three years combined is almost exactly equal, as the following table shows :—

WHOLE AREA.

Year.	Spring Spawners.	Summer Spawners.
1901	42·1	57·8
1902	43·9	56·0
1903	58·5	41·6
1901–1903... ...	50·6	49·3

NORTH SECTION.

1901–1903... ..	47·95	51·98

SOUTH SECTION.

1901–1903... ...	53·63	46·41

The variation in 1903 is, at least in part, explicable by two circumstances: (1) fishing in that year was carried on to a greater extent in the southern and shallower water areas than in the two preceding years; (2) an important flatfish (from this point of view) which spawns in spring and inhabits the deeper waters in abundance is not included in the returns, as it is not a commercial species, viz., the Long Rough Dab (*Hippoglossoides platessoides*). Its spawning-period is from the latter part of January well into May,* and I am aware from my own experience—and it is well known to all trawlers—that this fish is found in great numbers in the deep water northern areas. I have taken over 3,000 in a little over two hours, with a small-meshed net, in the central part of XV, and the absence of this fish there helps to explain the incomplete compensation in spring (Fig. 4).

I have made a similar percentage table for most of the squares, and may compare or contrast some of them. In XV the percentage of the summer-spawners, mostly Whitches, was 81·1, while the spring-spawners showed 21·9 per cent.; in XVIII they were respectively 61·3 and 38·8; in XIX 86·35 and 13·5; in XXIV 81·3 and 18·6; in XXIX 75·4 and 24·5. In all these cases there is little doubt that the inclusion of Long Rough Dabs would have gone a long way to restore the balance between the two groups. On the other hand, in XIV, the proportion was 53·6 and 46·6; in XI 34·3 and 65·6; in XXIII 54 and 45·9; in XX 44·7 and 55·2; in XXV 31·3 and 69·9; in XXXI 37·5 and 62·5. The last three areas are in relation to the Fisher Bank plateau.

The general compensation that becomes established, notwithstanding the fluctuations, may be also indicated in another way. I have tabulated the total flat fishes (included in the returns) under each month for the whole region investigated and for the north and south sections previously described (p. 475), and have calculated for the monthly aggregate the average number of cwts. per 100 hours fishing. In doing the latter, I may say, I have adopted both methods referred to on page 480, the first being the method used in this paper and the second the mean of the sum of the averages; it will be seen how closely they agree.

The figures are as follow:—

NORTH SECTION.

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(1) ...	17·31	19·40	16·70	20·09	23·0	24·54	24·92	23·67	21·38	18·59	17·56	25·44
(2) ...	17·29	19·40	16·77	20·09	23·0	24·54	24·90	23·67	21·38	18·56	17·56	25·43

SOUTH SECTION.

(1) ...	12·84	17·69	20·75	19·33	19·88	15·73	15·48	14·69	21·01	14·28	15·57	11·41
(2) ...	12·81	17·70	20·745	19·32	19·88	15·71	15·47	14·68	21·01	14·28	15·55	11·41

WHOLE REGION.

—	16·15	19·09	17·45	19·91	21·61	18·55	18·21	17·21	21·68	16·25	16·50	18·23

Curves have been constructed on these figures, and it will be seen how high the averages remain throughout the year. The curve for the south section is to a large extent compensatory to that for the

* *Tenth Ann. Rep. Fishery Board for Scotland, Pt.* III., p. 242.

north section. The curve for the latter exhibits a lower position in winter, a low but somewhat higher position in the middle of summer, a maximum in spring and another in September. The curve for the northern section shows a depression in March and one in autumn (October–November), and a high winter position, and there is a symmetrical cusp of maximum in the summer, extending like an arch from the spring minimum to the autumn minimum, and having its highest part in July. The curve for the whole region is less variable than the others, and shows a slight depression in summer, the peak in September, and another in May. Considering that the Long Rough Dab is not included in the records, and that many of the Common Dabs are not brought ashore in summer (p. 616), the uniformity of the results is noteworthy.

I believe that the discovery of this principle or law of compensatory fluctuations, as described in this paper, will materially assist in the explanation of many points in the natural history of the food-fishes that are at present obscure.

(3.) The Migrations of the Fishes.

I do not propose to discuss here in any detail the relation of the fluctuations to the migrations of the species. The two, I have no doubt, are closely connected, since, unlike some round fishes, the flat fishes keep to the bottom and move along it, and we know from experiment and otherwise that they may travel, and do travel, long distances ; and it is probable that the fluctuations are caused mainly by the migrations of the fishes from one area to another. In some cases this appears to be well shown in the comparison of the curves, and the distance to be traversed from one to another is not great. It is only 30 miles from the centre of one square to the boundary of another, and it is known that Plaice, at least, may move quickly. Heincke records two which travelled about 88 miles in 28 days, or on an average not less than three miles a day, and another which went about 120 miles in 43 days,* and I have shown that adult Plaice, swimming leisurely in the large spawning-pond at the Fishery Board's Laboratory at Aberdeen, may move 100–140 feet per minute, or considerably over a mile an hour.† Comparison of the curves for the various areas shows that the matter is one of complexity, and the subject had better in the meantime be reserved. There are, however, some general matters that may be referred to.

It appears evident from what is said above and in the pages devoted to the separate species, that many of the fishes perform considerable migrations from and towards the areas where they are normally most abundant, and the fact would have been clearer if it had been possible to publish the detailed charts showing the curves for each species on each square. Thus, Whitches and Megrims appear to migrate southwards and coastwards to the shallower waters in winter, withdrawing again before the spawning season ; and Megrims are, relatively to the Whitch, more partial to the western side of the North Sea, and Whitches to the eastern side. This conclusion is also in keeping with the proportion between the large and the small fish on the different grounds, in both cases the proportion of small forms diminishing towards the shallower water. While small Megrims are about one-third of the large in the northern areas, they are about one-seventh to one-sixteenth on the east coast of Scotland and one-twelve and one-twentieth on the Fisher Bank grounds. It is the same with the Whitch, the proportion in the deeper areas in the north being about a half of the large, and on the Fisher Bank plateau about one-fiftieth.

Halibut also shows a somewhat similar movement, being scarce in the coastal areas in spring and abundant later in the year, while they are abundant on the northern grounds, and on the Fisher Bank plateau, in spring. It is possible that the latter phenomenon is connected with the deep water off the Norwegian coast, and I may say that in none of the squares, except these (XXV especially) does the curve show a predominating spring cone compared with the secondary autumnal one, giving the impression that the principal spawning-areas of this fish are in deeper water to the north.

* *Rapports et Procès-Verbaux*, III., Cons. Perm. Intern. p. l'Explor. de la Mer, App. E., p. 22.
† *Twenty-first Ann. Rep. Fishery Board for Scotland*, p. 42.

On the other hand, one may trace a similar movement in the contrary direction with Plaice in summer and autumn, and with Brill in spring ; both penetrate at these periods into the deeper water in the north. Large and medium-sized Plaice are found in the deep-water areas in autumn and in early summer in some (and I can confirm this by observations made), but rarely during the spawning season (XVIII, XIX) when they are most numerous near the coast, and the facts suggest that the spawing of this fish takes place for the most part not at great distances from land, and that afterwards they go out into the deeper water, probably performing extensive migrations. On the Fisher Bank plateau they are abundant in summer.

Dabs do not appear to penetrate to the deeper areas to any extent at any time of the year, so far as these statistics show, and when found it is in spring (XI, XVI, XIX, XXIV). For the reason already given (p. 508) the value of these statistics as regards the Dab is somewhat problematical, and I have got Dabs in the deep-water areas in considerable numbers, and it is noteworthy that the curves do not show Dabs present in any quantity in any of the squares in the hotter months of the year.

Lemon Dabs are found near the coast and on the Fisher Bank plateau (as far as the statistics go) throughout the year, but most abundantly in summer, and in the deeper offshore areas in summer and autumn, but rarely in spring (XVIII, XV). They probably, therefore, migrate to these areas.

The same observations apply to Turbot, with this difference, that this fish is found on the offshore grounds earlier and much more uniformly throughout the summer ; on the grounds near the coast it may be abundant in spring (XXIX, XXIII, XVII). It is a curious circumstance that the Turbot should be found so widely distributed over the whole North Sea during its spawning-season, and that the Brill in spring, at its spawning-season, should likewise be widely distributed, and in the deep-water areas where it is hardly ever found at any other time, inasmuch as the young of both forms, so far as known, are only to be found in the shallow water with young Plaice. The explanation, no doubt, is the habit of the post-larval Turbot and Brill, which are provided with an air-bladder, of floating at the surface for long periods (pp. 513, 524). This provision is tantamount to the spawning-places being nearer the coast. The impression derived from the curves as to the spawning-places of the fishes is that Whitches, Megrims and Halibut spawn mostly in the deeper waters of the north ; that Turbot and Brill spawn over a great part of the North Sea, near the coast as well as far from it, and that Plaice spawn near the coast and not far from land.

There is one matter in regard to the seasonal abundance of the fish that may be briefly referred to, viz., the great decrease that occurs with most of them in winter. The outstanding exception is the Whitch, which is the only fish that exhibits, in the areas where it is most common, a great abundance in winter, and this is shown, as we have seen, in the southern shallower areas to a still greater extent. A great wave of Whitches, so to speak, comes south and coastwards in winter, to occupy the positions from which the other flat fishes have retreated. The Megrim also is much more abundant in the southern and coastal areas in winter than in summer, and it is thus compensatory like the Whitch. But it does not maintain its abundance in the deeper waters in winter to anything like the same extent, and is, taking the whole northern region, scarce in January and February.

Over the region as a whole, or the northern and southern sections, Halibut are also very scarce in winter, but they are relatively more numerous in the northern areas (XI, XV, XIX, XIV), and there is an upward tendency in the latter part of the year on the Fisher Bank grounds and the Orkney-Shetland group of areas.

Taking the whole region, Plaice are scarcest in January and February, but at the end of the year they are comparatively numerous on the Fisher Bank grounds and in the coastal areas ; the same may be

said of the Lemon Dab. The Turbot is scarcest in January–March, taking the whole region, but in some of the coastal areas (X, XVII, XIII, XXVIII, XXIX) and some of those in the south-east (XXXI, XXXII) they are much more common than on the offshore grounds at this time of the year; and the same remarks apply to the Brill.

The evidence seems to point to a withdrawal of flat fishes to the coast in winter, not necessarily to the shallow water, but to moderate depths. In this connection it must be borne in mind that a considerable part of the grounds in such depths are not included in the region of fishing, the whole of the Moray Firth, all the bays, and the waters within the three-mile limit, being excluded. Henking, in the paper alluded to (p. 474), states that in the Skagerrack the greatest catches of Plaice are in the winter months, and this is also the case with Turbot and Brill, which are at their minimum in summer.

It would have been of much interest if there had existed temperature observations over the area of fishing so that one could have compared the fluctuations in the fish with the changes in the temperature. Unfortunately, however, the temperature observations in connection with the International investigations are only made quarterly, four times in the year, which is insufficient for the purpose, and the monthly observations taken off a part of the coast of Scotland only extend back to September last year. When they have been obtained for a year or two, or even for one full year, they will be of great value in connection with the study of the fishes inhabiting this region of the North Sea.

III. AN ACCOUNT OF THE SEPARATE SPECIES.

1. The Turbot (*Rhombus* (*Bothus*) *maximus*).

The annual value of the Turbot landed in the United Kingdom may be put approximately at a quarter of a million sterling, the great bulk being derived from the North Sea. There are also important Turbot fisheries on the Continental coasts. With regard to its natural history, while a good deal is now known that was obscure a few years ago, there are still many points about which information is scanty and imperfect.

One of the best ascertained facts in connection with the habits of the Turbot is that it is eminently predaceous, living mostly upon small fishes, particularly Sand-eels (*Ammodytes*) and Sprats, and also on young Herrings and other species. This fact is of some importance in relation to its distribution and movements. Like most other predaceous forms, it is rarely found in large numbers at one spot, unless in connection with reproduction; but occasionally a considerable number may be caught if a shoal of Sand-eels or Sprats are on the ground. In Scottish waters, even under such circumstances, it is rare for more than four or five to be taken in a single drag of the trawl-net, although several miles of the bottom may be swept. The trawlers landing fish at Aberdeen, with whose statistics we are dealing here, seldom have more than a fraction of a hundredweight of Turbot as the result of a voyage; not uncommonly their catch may amount to one hundredweight, but takes of three, four or five cwt. may be said to be rare, and then it is usually at the spawning time when the fish have necessarily collected together. In these statistics one hundredweight represents, on an average, eight Turbot, whence it may be seen how sparsely distributed this fish is. In past times very large takes of Turbot have occasionally been obtained. The largest of which I have found a record was by a trawler, the "Night Hawk," which in June, 1870, is said to have caught no less than 1,500 in a single night, on grounds about forty miles from Heligoland. I refer below to cases where over 600 and 700 were taken on the virgin grounds at St. Kilda when trawling was first started there a few years ago.

The Turbot is said to prefer sandy bottoms or sand mixed with mud; but it may also be found in considerable numbers on rocky ground, where the trawl cannot be worked. In such places excellent catches are sometimes obtained with the hook, or with "bret" nets or set-nets; and trawlers are of opinion that they generally get better catches on the edge of the "hard." There are extensive tracts where the bottom is unsuitable for trawling, not because of a continuity of rock, but because of the existence of reefs or boulders, between which may be numerous patches and strips of sand, very suitable for flat fishes.

In the North Sea the Turbot spawns later than the majority of fishes. When investigating this question fifteen years ago, I found that spawning began early in April and was continued through April, May, June, and July, the height of spawning being in June.* At Grimsby, Holt confirmed this, but found a certain number spawning throughout August, while a few were not yet finished in early September; he places the chief period in June and July.† The Turbot examined by Holt doubtless came, largely at least, from the southern and eastern parts of the North Sea; but for the eastern side Heincke and Ehrenbaum state definitely that the Turbot spawns in the vicinity of Heligoland from the middle of April to the middle of August‡; they found the floating eggs from 19th April to 14th August. As confirming the prolonged duration of the spawning period of this fish and its extension into August, it may be mentioned that Williamson obtained the floating eggs in Loch Fyne from 14th March to 9th August, the maximum number being obtained in June.§

Our knowledge as to where the Turbot spawns is less satisfactory. In the papers above referred to, I expressed the opinion that the Turbot spawned at great distances from the coast; Holt also states that so far as he knows they do not spawn very close to our own coast, but rather on the offshore grounds, but he found that on the Continental grounds spawning fish may be got in comparatively shallow water and fairly close inshore.‖

The Turbot is one of the most prolific of sea fishes. The number of eggs in five specimens that I examined varied from 5,612,000 to 10,115,000,¶ the heaviest of these specimens weighing only 21 lbs.; it is certain that larger specimens are still more fertile. Buckland records a specimen of 32 lbs.; and one of 44 lbs. has also been recorded.

As to the rate of growth of the Turbot, we know little. One, which was marked when six inches long, on 27th May, 1891, was eight inches in length when caught again on 31st August, having increased by exactly two inches, notwithstanding that the mark was affixed by a silk cord through the flesh.** Cunningham has dealt with the measurements of a number of Turbot, mostly of small size, and expressed the opinion that specimens of from nine to twelve inches were probably one year old and those about twenty-four inches at least four years old.†† From the researches which have since been made on an extended scale on other flat fishes, I am inclined to think that Cunningham's estimate of the age of his specimens was too low. The specimen I marked, referred to above, showed considerable growth, but the period of the year was that when growth is by far the most rapid—especially in a fish like the Turbot, which passes the earlier years of its existence in shallow water, and is thus subject to unfavourable temperatures in winter—and it was, moreover, at the age when growth in length is most rapid. Judging from other cases it seems to me probable that the Turbot does not reach maturity before its fourth year and probably not until its fifth.

* *Seventh, Eighth, Tenth Annual Reports, Fishery Board for Scotland*, Part III., pp. 192, 264, 233 and Plate vi.
† *Journ. Marine Biol. Assoc.*, II., p. 375.
‡ Eier und Larven von Fischen der deutschen Bucht, II., *Wissensch. Meeresunters.*, (3), *Helgoland*, 2, p. 230.
§ *Seventeenth Ann. Rep., Fishery Board for Scotland*, Part III., pp. 82, 98.
‖ *Journ. Marine Biol. Assoc.*, III., p. 390.
¶ *Ninth Ann. Rep., Fishery Board for Scotland*, Part III., p. 262.
** *Eleventh Ann. Rep., Fishery Board for Scotland*, Part III., p. 195.
†† *Journ. Marine Biol. Assoc.*, II., 105.

On this point—the size when maturity is first attained—observations have not been so extensive as is desirable. In the first paper dealing with the subject* I stated that of 68 specimens examined, four were ripe, the smallest being 23 inches in length, and six were nearly ripe, the smallest being 18 inches long. These figures referred to both sexes together, and I assigned as the limit between mature and immature the size of 18 inches. During the Irish survey Holt found the smallest ripe male, among 55 Turbot examined, to be 18 inches, and the smallest female approaching ripeness 22½ inches.† In the same year I stated that, of 42 examined, the smallest ripe male was 21½ inches and the smallest approaching ripeness 14½ inches; the smallest female approaching ripeness was 16 inches, while the smallest of five spent was 23 inches.‡ After examining much material at Grimsby, Holt assigned 18 inches as the limit between mature and immature females, and had never found a fully mature female under 18½ inches.§ Cunningham, however, found among a number of Turbot from the Amrum Ground and south of Horn Reef a mature female of 14 inches and mature males from 11 inches. It is evident that the Turbot does not reach maturity at the same size in different parts of the North Sea, but I believe it does so at the same age, in this respect agreeing with the Plaice.

Another important phenomenon in the life-history of the Turbot is the difference in the horizontal and bathymetrical distribution of the young and of the adults. It is now well-established that young Turbot are only to be got—they have hitherto at all events only been got—in quite shallow water at the margin of the sea. On our coasts, however, they are extremely scarce, and one may make dozens and scores of push-nettings on the beaches without finding any. I have taken them at Donmouth in Aberdeen Bay, in the Moray Firth, and in Loch Fyne; they have also been caught in fair numbers on the sands to the west of Dunbar and in St. Andrew's Bay, and Holt found them in spring and summer sparingly among the Shrimps and small Plaice at the extreme margin of the Humber estuary; these last measured from about three to five inches and belonged to the previous season's brood, a fact which bears upon what I have said above as to the rate of growth. Holt has also taken them at Filey and Cromer.‖ They appear to prefer the mouths of estuaries or streams. Three which were got at Donmouth on 18th September measured 48, 55, and 44 mm.—from 1¾ to 2¼ inches; the next sizes obtained by the small-meshed nets on board steam trawlers working into five and six fathoms, in various months and various localities, were 276, 276, 278, 285, 288 mm.—10¾-11½ inches—and this only on one occasion (in October) in Aberdeen Bay. The young Turbot, in fact, have been mostly taken in fixed stake-nets on the shore. Thus 56, ranging in size from four to eleven inches, were caught in the stake-nets in Montrose and St. Cyrus Bays, on the coast of Forfar and Kincardine, between May and July, 1891.¶

In striking contrast to the paucity of young Turbot on our coasts is their abundance in the shallow waters on the other side of the North Sea. Holt was informed that they are common in spring and summer in the shallow sandy expanses about and within the barrier chain of islands on the Dutch and Danish coasts,** and Petersen mentions their occurrence in "multitudes" on the shores of the Cattegat, the Belts, and the Sound, from under an inch to about five inches in length. He says further that specimens of from about 8½ to 10½ inches are not rare in the Danish fjords.†† There is no doubt that on our own coasts also the somewhat older Turbot under 10 or 11 inches are denizens of the shallow inshore waters and do not pass out into the deeper waters. In the course of the extensive trawling investigations

* *Eighth Ann. Rep. Fishery Board for Scotland*, Part III., pp. 161–163, 1890.
† *Rep. Roy. Dubl. Soc. for 1891*, p. 271, *et seq.*
‡ *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 239a.
§ *Journ. Mar. Biol. Assoc.*, III., pp. 377, 378.
‖ *Op. cit.*, III., p. 391.
¶ *Eleventh Ann. Rep. Fishery Board for Scotland*, Part III., p. 189.
** *Op. cit.*, p. 391.
†† *Fourth Report of the Danish Biological Station*, p. 41, 1894.

made by me around the Scottish coasts, no Turbot under the size above mentioned (October, Aberdeen Bay) were procured, though the depth was often under six and even five fathoms and usually below twelve ; nor do I recollect of a single unmarketable Turbot having been caught.* On the eastern side of the North Sea Holt and Cunningham show that Turbot about the sizes mentioned are relatively more numerous than on this side in water where trawling may be carried on.† In the investigation made by Hoek along the Dutch coast from Terschelling to Ijmuiden, and out midway to the English coast, only 13 Turbot were procured, the smallest measuring 19 cm. and the next 22·5 cm. ($7\frac{1}{2}$ and $8\frac{3}{4}$ inches), and they were taken close to the coast in from seven to four fathoms. The smallest outside the three-mile limit was 31 cm. (12 inches), got in 12 fathoms.‡ The Turbot does not appear to penetrate into the Zuider Zee, and none were found in the course of Hoek's enquiry into the fish caught by bag-net fishing in the Hollandsch Diep and Haringvliet, although in each of these places Flounders, Plaice, and Soles were obtained.§

These remarks have their bearing on the question of the migration of Turbot into the deeper and more distant parts of the North Sea. As I explain below, adult Turbot are found, sparsely distributed, practically all over the North Sea up to its northern boundary and in the central areas between this country and the Continent, and in depths ranging up to between 70 and 80 fathoms. If the younger stages, during the first few years of life, are passed exclusively in the shallow waters at the margin of the sea, it follows that the older forms found in the deep water at great distances from land must have wandered there after they had attained a certain size—approximately twelve or thirteen inches and over—and this shows that the migrations of this flat fish may be considerable. It is probable that in their movements from the coast they follow definite paths from one plateau to the next of greater depth, and their distribution or relative abundance is correlated with the depth. The marking experiments now being carried on will doubtless clear up this and many other allied questions within the next few years.

One peculiarity of the post-larval Turbot may be referred to in connection with this subject, namely, its habit of swimming at the surface of the sea, as it is enabled to do by the possession at this stage of an air-bladder. Buckland mentions that such young forms, of the size of a halfpenny, may be found floating close inshore among the seaweed in June and July ; and the subject has been fully examined by Cunningham,‖ who found them, up to 25 mm., brought into Sutton Pool by the flood-tide in August and September. This habit probably enables the Turbot to be more widely dispersed than it otherwise would be at this stage, and if that be so, it would tend still further to accumulate the young forms on the sandy stretches of the Continental coast, whither the surface drift of the North Sea moves.

With regard to the distribution of the Turbot, it extends from the Mediterranean and Black Sea northwards to the northern part of the North Sea ; on the Norwegian coast it is of frequent occurrence as far as Bergen, about 60° 30′ N. latitude, but it is also found sparingly in Trondhjem Fjord (about 63° 50′ N.) and occasionally much further north, within the Arctic circle, among the Lofoten Islands.¶ On the east it extends to the eastern parts of the Baltic, and on the west to the western coasts of Ireland, the

* *Twenty-second Ann. Rep., Fishery Board for Scotland*, Part III., p. 14, 1904.

† *Journ. Mar. Biol. Assoc.*, Vol. III., p. 392, Vol. IV., p. 33 *et seq.*, 107, Vol. II., p. 382.

‡ Rapport over het Visschen met den Stoomblazer H. D. 318, *Verslag Staat Nederl. Zeevisscherijen*, 1893.

§ Hoek, The Fishes of the Zuider Zee, *Tidschr. der Nederlandsche Dierkundige Vereeniging* 2, III, Afl. 1, p. 38, 1890; Rapport over Ankerkuil en Staalboomen-Visscherij op het Hollandsch Diep en Haringvliet, pp. 78, 88, Leiden, 1888.

‖ *Journ. Marine Biol. Assoc.*, II., p. 105 ; Marketable Marine Fishes, p. 264, 1896.

¶ Fries, Ekstrom and Sundevall, Hist. Skand. Fishes, p. 438 ; Storm, Trondhjems Biologiske Station. *Meddelelser fra Stationsanlaeggets Arbeidskomité*, p. 18, 1901.

Hebrides and St. Kilda. It appears to be absent from the Faeroes and Iceland,* nor does it occur on the other side of the Atlantic.†

With regard to bathymetrical distribution, the Turbot has hitherto been regarded as a shallow water fish, and is so described by Cunningham in his work on British Marine Fishes. Its range in depth, however, is greater than has been generally supposed. In Holt's work on the west coast of Ireland, no Turbot were taken in water of over 38 fathoms, although twenty recorded hauls were made in depths from 40 to 500 fathoms, and numbers of other flat fishes obtained in many of them. The number of Turbot recorded by Holt was 58, and of these the distribution of 53 is given in tabular form ; 14 only were in water over 20 fathoms deep. In a recent report of the Fishery Board I recorded a few cases of Turbot being caught in the North Sea at a depth of 70 fathoms,‡ and stated that the Turbot, like the Plaice, extends its wanderings into comparatively deep water at a distance from the land. The statistics of the recording trawlers fully bear this out, and it may be accepted as well established that the Turbot may penetrate, in the North Sea, into water between 70 and 80 fathoms deep.

Distribution.

In our trawling statistics for the three years 1901–1903, comprising thirty-three months, the total quantity of Turbot caught by the recording vessels amounted to 1,780 cwts., which gives, for the whole period and region, an average of 0·643 cwt. per 100 hours' fishing, or 0·72 lb. per hour.

The quantities and averages in each of the years are these :—

Year.	Cwts.	Cwt. per 100 hours.	Lb. per hour.
1901...	440	0·650	0·728
1902...	422½	0·522	0·585
1903...	917½	0·713	0·799

The statistics show that the Turbot is widely, but sparsely, distributed throughout the North Sea. Turbot were taken in all the 36 squares in which trawling was carried on by the recording vessels, but their abundance in different portions of the North Sea varied considerably, and there is no doubt that if the vessels had fished to a greater extent in the southern parts the averages given would have been much increased.

Owing to the inequality of the fishing, both in point of season and of duration, the statistics do not offer material for an accurate picture of the proportional distribution of the Turbot over the whole region. On the southern and south-eastern grounds, especially, where the fish is known to be more abundant, the fishing was limited to a few months of the year and there are thus no statistics to show its abundance in the other months. The particulars of the fishing in each area will be found in the Tables (p. 392). Bearing this qualification in mind, it may be said that the extreme range of the averages for different squares is from 0·056 cwt. per 100 hours, for square XV, which lies about midway between the Orkney

* *Fiskeri-Beretning*, 1902–1903, pp. 282, 288, Copenhagen, 1904.

† *Vide*, on this and other points, Hoek, Conseil perm. int. pour l'exploration de la mer, *Publications de Circonstance*, No. 3, p. 49, Copenhagen, 1903, where a resumé is given of the literature. It may be mentioned that when the trawling ground at St. Kilda was discovered in 1896 enormous takes of Turbot were made for a short time, the two best voyages yielding 744 and 660 Turbot. Fulton, *Twentieth Ann. Rep. Fishery Bd. for Scot.*, Part III., p. 85.

‡ *Twenty-first Ann. Rep. Ibid.*, Part III., p. 52.

Islands and Norway, with a depth mostly exceeding 70 fathoms, to 5·625 cwts., or 100 times greater, for square XXXVIII, lying off the coast of Jutland, with a depth mostly under 20 fathoms. The other high averages are for squares in the same region of the North Sea, while the lower averages are found in the deeper waters of the north.

The contrast in the relative abundance of the Turbot in the northern and southern parts of the North Sea may be brought out by comparing the averages of the squares north and south of a line drawn from the southern part of Norway to the Moray Firth, parallel to the 58th degree of north latitude—a line which also broadly corresponds with the 50-fathom line. The general average for the 16 squares in the northern section (VI–XXI) is 0·217 ; the number of hours fishing being 125,254 and the quantity of Turbot taken 271¼ cwts. The corresponding average for the 20 squares in the southern section is 0·992, or nearly five times greater, the number of hours fishing being 152,060 and the quantity taken 1,508¾ cwts.

In the squares north of 56° N. latitude the amount of fishing was much more regular, and the highest averages in this region are to be found in the areas lying off the east coast of Scotland, viz., XXII, XXIII, XXVIII and XXIX, where the depth is under 50, and mostly under 40 and 30 fathoms. The great bulk of the Turbot landed came from these areas. It is noteworthy that all the areas extending across the North Sea from the coast of Aberdeenshire to the Skagerack (squares XXIII to XXVII) have higher averages than those lying immediately to the south of them, with the exception of XXVII, though the depth in the more southerly areas is less.

To sum up, the averages show that as one proceeds from the northern to the southern areas of the North Sea, the abundance of Turbot generally increases, and as one proceeds from the central parts of the North Sea towards the coasts the abundance also increases. The fish is found in greatest numbers (so far as the statistics show) in the south-eastern parts, or German Bight ; next in order of abundance on the east coast of Scotland, and in least abundance on the deep-water grounds in the north.

Seasonal Abundance.

Those areas in which the fishing was most extensive and regular throughout the year may first be considered. Square XXIII is an area of this kind ; the largest quantity of Turbot from any square was taken from it, the amount of fishing is the second greatest, and the average for the year is high ; the lowest aggregate number of hours fishing for any month was 1,300 hours—for March. This area adjoins the coast of Aberdeen ; the depth, outside the three-mile limit, is mostly between 40 and 50 fathoms, part being between 30 and 40 fathoms ; the bottom is largely composed of fine sand, and there is a stony patch occupying the south-east quarter.

The monthly averages for the thirty-three successive months are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	1·17	1·07	0·17	2·0	1·38	3·2	0·67	2·8	0·91
1902 ...	0·39	1·24	2·32	1·08	0·87	0·21	0·72	1·7	3·17	1·86	0·65	1·24
1903 ...	0·8	0·8	1·3	2·9	2·7	1·95	2·3	1·87	2·0	2·0	1·4	1·3

The curves formed by these figures do not quite correspond in each of the years, that for 1902 being the most regular. The winter averages are low, with the exception of November, 1901.

The curve for 1902 exhibits two well-marked cones, separated by a deep depression. The first cone has its apex in March, the line rising from January to March, and then falling to June ; the second cone is taller, with its apex in September, the line rising symmetrically from June to that point, and falling thereafter to November. In this year, then, Turbot were abundant in March, growing scarcer and scarcer to June, when they were at a minimum for the year ; gradually increasing in numbers till September, their maximum of abundance, and then decreasing to the end of the year. The curve for 1901 agrees in the main with this ; the line falls from April to June, which was again the least productive month of the year, and it rises to September, when the fish were again most numerous. In 1903, starting from the minimum in January and February, there was a gradual increase till April, when the maximum for the year was reached, and then a fall to June. The fall in June, however, was not so marked as in the other years, and after this month the line is irregular, maintaining much the same level to October, after which it falls to the end of the year. The first portion of the curve therefore corresponds, the apex of the spring cone being in April instead of March, and the June depression being indicated, but the great rise in September is not shown.

In order to elicit the predominant type for this area, I have combined the figures for the different years. The compound curve for 1901–1903 exhibits the two great cones, with their apices about March and September respectively—the latter being the higher—and with a central depression, reaching its lowest point in June ; the winter averages are low.

In this area then, contiguous to the coast of Aberdeen and the southern part of the Moray Firth, our statistics show that Turbot increase in numbers in spring ; they become scarce in June and then increase rapidly in numbers to September, about which time they are most numerous, diminishing thereafter.

The curves of monthly abundance must be cautiously interpreted, but in the present case it may be pointed out that the Turbot are in least numbers during the spawning-season, and that it would appear as if they were moving out in spring from the inshore waters (within or near the three-mile limit) to the spawning places further off, returning again and passing the autumn in the area in question on their way to the inshore grounds again. The statistics for the shallower inshore squares, such as XXVIII and those on the south-eastern parts of the North Sea, show high winter averages ; and this is borne out by the trawling experiments in the Moray Firth, while, as we shall see, the winter averages in the offshore areas are very low.

The statistics for the adjoining square, XXIV, further from land, are of interest in this connection. It contains a portion of "The Gut" and "Long Forties," with water for a considerable part between 40 and 50 fathoms, most of the remainder between 50 and 60, and a small part over 60. The aggregate fishing was 9,923 hours, the quantity of Turbot taken 90$\frac{7}{8}$ cwts., and the general average for the whole period 0·915 cwt. per 100 hours.

The detailed averages for the thirty-three months are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·00	...	...	3·90	0·90	0·10	0·56	1·30	0·00
1902 ...	...	0·07	0·13	0·00	0·12	2·96	0·25	2·96	1·64	0·41	0·05	0·04
1903 ...	. .	...	0·00	...	1·6	..	2·38	1·34	1·40	2·70	0·15	0·13

There are not, it will be seen, complete averages for any one of the years. The most complete is for 1902, which shows a central cone in summer (interrupted by a minimum, based on only 50 hours' fishing,

in July), the catches till June and in autumn being all low. In 1901 the part of the curve that exists agrees, except that the July average was the maximum, and there was a slight rise in November. In 1903 no Turbot were taken in March (320 hours' fishing), the average in May was relatively high, it was higher still in July, low in August and September, high and at the maximum in October, and very low in November and December. In each case then the summer average was high.

The curve for the three years combined is remarkably symmetrical. There is a great central cone, with its apex in June–July, the line thereafter descending symmetrically to the end of the year. In this square then the conditions are the reverse of what obtains in XXIII in regard to the outstanding feature. The Turbot are scarce in spring, and are most abundant in June and July, at which time they are scarce in area XXIII. A possible explanation is, therefore, that the Turbot migrate regularly from one square to the other, proceeding to the one furthest from shore at the spawning-time and returning later on.

The averages for the years 1901–1903 combined are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
...	0·08	0·63	0·00	0·32	2·94	3·35	2·06	1·265	0·804	0·211	0·08

Square XXIX is also an important one. The quantity of Turbot taken on it in the three years was 515⅝ cwts., the aggregate fishing being 36,168 hours, and the general average 1·425 cwts. per 100 hours' fishing. This square lies immediately to the south of XXIII, and its prevailing depths are from 30 to 40 fathoms. The bottom consists for the most part of fine sand and sand and shells, and there are only a few very small patches of rocky ground. It nowhere touches the coast ; at its northern corner it is separated from it—at Stonehaven—by a distance of about seven miles, and in the south by about the same distance from the Berwickshire coast at Eyemouth. It thus subtends the great arc formed by the coast from a little south of Aberdeen to near St. Abbs Head, its border lying about eighteen miles from Fifeness, and is opposite the mouths of the Firth of Forth and St. Andrew's Bay, from which it is separated by area XXVIII.

The averages for this area in the thirty-three months are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	2·8	2·37	1·9	1·7	1·15	1·5	0·86	1·9	0·70
1902 ...	...	...	1·78	2·63	2·73	1·76	1·37	1·04	0·83	1·89	1·91	1·56
1903 ...	1·7	0·3	1·7	2·0	1·6	1·14	1·05	1·12	1·32	1·15	1·16	1·20

The curves formed by these figures show general agreement in the different years, exhibiting a great relative abundance of Turbot in spring, a paucity in late summer and a fair abundance in autumn. In 1901 and 1903 the apex of the great spring cone is in April, while in 1902 it is in May, though the position in April is almost as high. In 1901 the line falls steadily from the April maximum till autumn ; there is a considerable rise in November and a fall in December to the minimum. In 1902 we have the same general features, but a month later. There was no fishing in January and February in this year ; from March there is a considerable rise to April and May, in which month the maximum occurs, and then the same sharp and regular fall to September, which is the minimum for the year, and after this a rise to October and November, and a fall to December. The features of the curve for 1903 are much

the same, a rise taking place from the February average, to a maximum in April, then a gradual fall to July, where the minimum is reached, and after that a slight rise. The average for January in this year—and there is no January figure for the other years—is relatively high, viz., 1·7 ; the fishing was for 274 hours.

Combining the figures for the three years the averages are as follows :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1·614	0·312	1·718	2·397	2·122	1·573	1·316	1·108	1·278	1·156	1·456	1·273

The curve here shows the great spring cone, rising from a minimum in February to a maximum in April, falling away gradually to the second lowest point in August, and rising slightly and somewhat irregularly thereafter.

Another example of a square, lying far from shore, may be taken, namely, XXV, on the north-west flat of the Fisher Bank, in from 33 to 51 fathoms, but nearly all under 40. The aggregate fishing was 20,249¾ hours, the quantity taken 144¼ cwts., and the general average 0·712 cwt. per 100 hours fishing.

The details for each year are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	...	...	1·06	1·60	1·90	0·15	0·14	0·10	...	...
1902 ...	...	...	...	...	...	1·24	0·96	0·57	0·18	0·07	0·13	0·07	0·19
1903 ...	...	...	...	0·556	0·90	1·05	0·74	0·50	0·40	0·30	0·70	0·30	0·40

The fragmentary curves show the following :—In 1901 a rise from May to July, when the maximum is reached, a sharp fall to August, and a trifling drop thereafter ; in 1902 a fall from May to September and a small rise later ; and in 1903 a rise from March to May, and a descent in each succeeding month to September. Contrasting this area with XXIV, the main difference is the abundance of Turbot about two months earlier.

The combined figures for the three years are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
...	...	0·556	0·909	1·122	0·838	0·776	0·241	0·215	0·259	0·204	0·367

The feature of the curves is therefore a great maximum cone in early summer with the apex in May, and a regular fall from May to September. Turbot in this area are thus abundant from April to July and scarce thereafter.

Without entering at present into further details as to the various squares, the following general statement may be made as to the periods of maximum and minimum abundance of the Turbot, as indicated by the curves for each square :—

(1.) In the great majority of areas there is a preponderance of Turbot in the summer months, the period of maximum abundance varying to some extent, but being generally from May to

August; in two the actual maximum is in April, in three in May, in two in June, in six in July, in two in August, in two in September.

(2.) In the offshore areas in the northern and western parts of the North Sea the preponderance in summer is marked, and the winter averages are very low.

(3.) In the areas adjoining the east coast of Scotland, while the summer averages are nearly always highest, the late autumn and winter averages are relatively high compared with the offshore areas to the north, *e.g.*, in XXVIII, embracing the Firth of Forth and St. Andrew's Bay, they are highest; they are also high in IX, X, and XVII.

(4.) In the areas in the south-eastern parts the winter averages tend to be high, as in XXVII, XXXII, XXXVI, XXXVII, while the summer averages are also as a rule high. The fishing in these areas, however, was not very extensive.

As already stated, the interpretation of the curves must be made with caution, but there appears to be evidence of a withdrawal of the Turbot in winter to the inshore grounds. In the trawling experiments that I have conducted in the Moray Firth and Aberdeen Bay during the last few years Turbot were taken in greater numbers in the winter months.

In addition to considering the statistics for the individual squares, it is desirable to collect them into groups, and to show the average quantities taken in such groups in the various months and years. At present it is difficult to select any group of areas which might be looked upon as a natural group from the point of view of the natural history of the species. Henking in the paper referred to, published in the Report of the International Bureau, has grouped the fishing grounds of the North Sea into two divisions, viz., the northern North Sea and the southern North Sea. I had made a similar, but not identical, division, dividing the two by the 58th parallel of latitude, which extends from the middle of the Moray Firth to the Naze of Norway, and corresponds fairly closely with the 50-fathom line. The northern section includes squares VII to XXI, and the southern section squares XXII to XLV.

Year.	Northern Section.		Southern Section.	
	Cwts. per 100 hours.	Lbs. per hour.	Cwts. per 100 hours.	Lbs. per hour.
1901	0·248	0·278	1·248	1·398
1902	0·138	0·155	0·909	1·018
1903	0·266	0·298	0·936	1·048
1901–1903	0·217	0·243	0·992	1·111

The average quantities of Turbot caught in the two sections are given in the accompanying table. Of the aggregate quantity of Turbot taken by the recording vessels in the three years, the northern section yielded 14·18, and the southern section 85·81, per cent.

In no month of 1901 was the average in the northern section so high as the corresponding average in the southern section, though the averages for October are very close together. In 1902 the November average in the northern section exceeds the November average in the southern section, and in 1903 the August, September and October averages are much higher in the northern section. In 1901 the

maximum in the southern section is in December and the minimum in October, and there is a second, but lower, maximum in July. In 1902 the maximum is in spring, the apex of the cone being in April, and the minima are in January and November. In 1903 the maximum is in April and the autumn averages are low.

When the figures for the three years are combined the curve formed by the monthly averages in the northern section make a great cone in the summer months, with the apex in July, and the base on the line of the mean extending from April to September. The line rises with fair regularity from the minimum in January to the maximum in July, and falls thereafter to the end of the year, save for a slight elevation in November.

The corresponding curve for the southern section shows a large cone with the apex in April and a smaller one with the apex in July, the part above the line of the mean extending from the middle of February to the middle of August, while the minimum is in January and the averages in the three last months of the year are low.

The process of synthesis may be carried further by combining the figures for all the squares fished by the recording vessels in each of the three years and for the three years together. The averages obtained are as follows ; and in that for the three years combined I have also given the result in terms of lbs. per hour's fishing (2) as well as in terms of cwts. per 100 hours (1).

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·605	0·608	0·670	1·211	0·728	0·687	0·384	0·570	0·318
1902 ...	0·186	0·294	0·245	0·469	0·802	1·057	0·886	0·845	0·619	0·417	0·302	0·277
1903 ...	0·246	0·360	0·432	0·733	1·106	0·886	1·114	0·891	0·740	0·586	0·651	0·524
1901–3 (1)	0·222	0·303	0·345	0·711	0·843	0·871	1·080	0·831	0·704	0·478	0·542	0·421
1901–3 (2)	0·25	0·34	0·39	0·80	0·94	0·97	1·21	0·93	0·79	0·53	0·61	0·47

The curves are of the same type for each of the three years, each showing a large maximum in the summer months and low winter averages (Fig. 10). In 1901 and 1903 there is a very small and probably insignificant secondary cusp in November, which is absent in 1902. The winter averages in 1903 are higher than in the other years, doubtless because the fishing in that year at that time was more in the south. The apex in 1901 is in July, in 1902 in June, and in 1903 a double cusp occurs in May and July, but the June average is also high. The part above the line of the mean is in 1901 from June to September, but the averages for May and April are but little below it ; in 1902 the part above the line of the mean extends from April to the end of September ; and in 1903 it is the same. In each of the two years in which January is represented the average for that month is the lowest.

The curve for the three years combined (Fig. 11) has accordingly as its outstanding feature a great cone or pyramid in summer. The apex is in July and the part above the line of the mean extends from April to September, the central perpendicular or ordinate being situated at the junction of June and July. The minimum is in January, and the averages for the first three months of the year are the lowest, the next three lowest being for October, November and December.

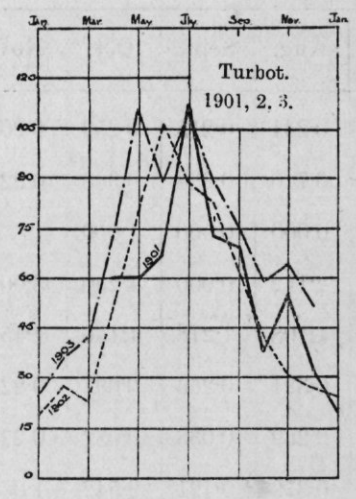


FIG. 10.

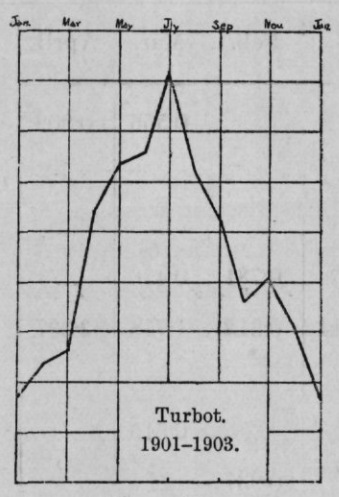


FIG. 11.

(1) MONTHLY AND ANNUAL AVERAGES OF TURBOT (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	0·54	0·042	0·135	...	...	...	...	...	...	...	0·113
VII	...	...	0·00	0·234	0·079	...	...	...	...	...	...	...	0·187
VIII	...	...	...	0·215	0·092	...	...	...	...	0·000	...	...	0·159
IX	0·156	...	...	...	1·309	...	0·632	1·218	0·893	1·092	1·376	0·167	0·793
X	0·00	0·803	0·368	0·218	0·692	0·312	...	1·154	0·486	0·044	0·364	0·773	0·500
XI	0·00	0·027	0·045	0·054	0·085	0·232	0·403	0·00	0·00	0·00	0·017	0·00	0·068
XII	...	...	0·053	0·00	0·267	...	...	...	...	0·062	0·104	0·166	0·081
XIII	...	0·00	...	0·468	...	1·607	0·00	0·00	0·284	0·492	0·00	0·238	0·302
XIV	0·00	0·041	0·068	0·150	0·105	0·330	0·230	0·281	0·137	0·108	0·058	0·092	0·117
XV	0·006	0·072	0·062	0·124	0·179	0·094	0·104	0·203	0·00	0·057	0·004	0·004	0·056
XVI	...	0·00	0·056	0·272	0·062	...	...	...	0·000	0·833	0·016	0·055	0·110
XVII... ...	...	0·721	0·288	0·770	0·775	0·419	0·608	0·741	1·420	0·281	1·165	0·709	0·675
XVIII ...	0·166	0·036	0·137	0·714	0·297	0·616	1·135	0·358	0·172	0·152	0·203	0·039	0·347
XIX	0·013	0·022	0·092	0·551	0·200	0·393	0·387	0·115	0·092	0·035	0·178	0·027	0·132
XX	0·00	0·200	0·171	0·191	0·490	0·918	1·383	0·157	0·357	0·00	0·062	0·078	0·351
XXI	...	...	...	...	...	...	...	...	...	0·073	...	0·000	0·065
XXII ...	...	...	...	...	...	...	...	...	...	...	1·07	...	1·071
XXIII ...	0·611	1·164	1·557	1·614	1·535	1·589	2·048	1·689	2·497	1·555	1·513	1·239	1·508
XXIV ...	...	0·078	0·637	0·00	0·323	2·945	3·349	2·061	1·265	0·804	0·211	0·081	0·915

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
XXV... ...	...	...	0·556	0·909	1·122	0·838	0·776	0·241	0·215	0·259	0·204	0·367	0·712
XXVI ...	...	...	...	...	1·740	1·096	1·364	0·740	0·238	0·368	0·928	0·101	0·827
XXVII ...	...	...	...	...	0·000	...	...	0·000	0·500	1·000	...	...	0·526
XXVIII ...	...	0·781	0·416	...	0·331	0·746	1·708	2·142	0·000	1·250	3·000	3·409	1·146
XXIX ...	1·614	0·312	1·718	2·397	2·122	1·573	1·316	1·108	1·278	1·156	1·456	1·273	1·425
XXX... ...	...	...	...	...	...	...	0·505	0·321	0·266	0·097	0·224	0·150	0·173
XXXI ...	...	...	0·615	...	0·608	0·526	0·554	0·269	0·088	0·082	0·298	0·059	0·305
XXXII ...	...	0·937	...	...	1·020	0·637	0·857	0·379	0·491	0·542	1·064	1·388	0·721
XXXIII ...	...	...	...	...	...	0·530	1·641	...	0·00	0·097	...	...	0·604
XXXIV ...	...	...	...	...	...	...	...	0·625	0·434	0·208	...	...	0·426
XXXV ...	...	...	...	...	0·666	...	2·291	0·416	...	0·208	0·078	0·00	0·457
XXXVI ...	...	0·00	...	...	1·250	...	...	0·378	0·333	0·407	0·670	1·770	0·716
XXXVII ...	...	...	...	...	0·416	...	...	2·333	1·333	...	...	3·390	2·439
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·813	...	20·000	5·625
XLI	...	...	...	...	...	...	...	0·416	...	...	...	...	0·416
XLIII ...	...	..	...	3·819	...	...	...	...	...	...	...	...	3·819
XLV	...	...	...	0·416	...	...	...	...	...	...	...	...	0·416

(2) MONTHLY AND ANNUAL AVERAGES OF TURBOT (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION, 1901–1903.

Months.	1901.	1902.	1903.	Total.
January	...	0·186	0·246	0·222
February	...	0·294	0·360	0·303
March	...	0·245	0·432	0·345
April	0·605	0·469	0·733	0·711
May	0·608	0·802	1·106	0·843
June	0·670	1·057	0·886	0·871
July	1·211	0·886	1·114	1·080
August	0·728	0·845	0·891	0·831
September	0·687	0·619	0·740	0·704
October	0·384	0·417	0·586	0·478
November	0·570	0·302	0·651	0·542
December	0·318	0·277	0·524	0·421
	0·650	0·522	0·713	0·643

II.—THE BRILL (*Rhombus lævis*, Rond.).

From an economic point of view the Brill is a much less important fish than the Turbot. In England the total quantity landed in 1902 was 23,624 cwts., valued at £60,419, of which 16,541 cwts. were landed on the east coast; in Ireland the total for 1903 was 637 cwts., of the value of £1,430; in Scotland separate returns are not made for this fish in the general statistics of the Fishery Board.

In its natural history the Brill closely resembles the Turbot. It is found, as a rule, on the same grounds, and usually in much greater numbers; it also is piscivorous, living mostly upon Sand-eels, Sprats, and young Herrings, but taking other fishes occasionally.* There are some facts which go to show its abundance compared with the Turbot. Thus Holt records the capture of 58 Turbot and 94 Brill during the Irish survey; Hoek, in the trawling off the Dutch coast previously referred to, took 13 Turbot and 13 Brill; in Kyle's trawlings in Start Bay, Torbay, and Teignmouth Bay, 13 Turbot and 144 Brill were caught.† In my own trawling investigations in Aberdeen Bay and the Moray Firth, 120 Turbot and 798 Brill were taken, and I may mention that in one locality, in November and December, 37, 36, 17, 31, and 15 Brill were taken in single hauls, usually accompanied by from one to five Turbot. These fish had collected to feed on Sprats and young Herrings. The above figures show that Holt's opinion that the Brill is more abundant than the Turbot on our coasts is correct, and there are facts to indicate that the Turbot, as he says, appears to be more abundant than the Brill on the continental coast. Hoek's trawling experiments have been referred to above (p. 513), and I find from the figures given by Cunningham as to the results of two trips he made on a trawler to the eastern grounds in May and June, that rather more Brill than Turbot were caught. He does not enumerate all the catches, but in those which are so distinguished there were 116 Turbot and 105 Brill; the grounds visited were about 20 miles west of the Sylt and off the Horn Reef in from about 10 to 14 fathoms.‡ Petersen's observations are to the same effect. He says that young Brill are less numerous than young Turbot in the Cattegat and Belts, and it is the same with the older fish; in the Baltic, Brill are especially scarce as compared with Turbot.§

The Brill spawns earlier than the Turbot. On the east coast of Scotland I found that the period was from the end of March to the beginning of July, the maximum occurring in May.‖ Holt found from the Brill examined at Grimsby that the spawning-period commenced in the latter part of April, became genera in May, and continued so in the early part of June, after which it diminished and was practically over by the end of July.¶ Cunningham states that the spawning-time at Plymouth is chiefly April, May, and June.** Heincke and Ehrenbaum assign a longer period for the North Sea, viz., from March to August but they say that at Heligoland it is mainly from May to July.†† Petersen states that the spawning-time of the Brill on the Danish coast, apparently of the Cattegat, agrees with that of the Turbot—namely May to July.‡‡ It is thus possible that the Brill spawns a little later on the continental side, where also, as we have seen, it is less abundant. On the west coast of Ireland Holt found the spawning-time to be principally in April, May, and June, but extending also into July.§§

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* Holt, *Rep. Roy. Dub. Soc. for* 1891, p. 315.
† *Journ. Mar. Biol. Ass.*, VI., pp. 508–515.
‡ *Journ. Mar. Biol. Ass.*, IV., p. 33.
§ *Op. cit.*
‖ *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 233, 234, pl. vi.
¶ *Journ. Mar. Biol. Ass.*, II., p. 376.
** *Marketable Marine Fishes*, p. 268.
†† *Op. cit.*, pp. 105, 106.
‡‡ *Op. cit.*, p. 44.
§§ *Op. cit.*, p. 257.

The Brill is probably less fertile than the Turbot, at least if we may judge from the single specimen in which the number of eggs has been determined. It was a fish weighing only 5½ lbs., and had about 825,000 eggs.* The post-larval stages have the same habit as was alluded to in regard to the Turbot, of floating and swimming at the surface†; there is this difference, however, that while the Turbot are found chiefly in August and September the young Brill are got in May and June.

Little is known as to the rate of growth of this fish. Cunningham is of opinion that the growth is slow, not exceeding four inches per annum; and he assigns a probable age of six months to specimens of 70 to 98 mm. which had been kept in tanks and were measured in October. Some of these specimens reared in captivity measured 3·3 to 3·7 inches (*circa* 85 to 100 mm.) in twelve months, *i.e.*, after passing through one winter. Other specimens obtained in the shove-net and shrimp-net, at and near Cleethorpes, between 25th April and 15th June, and measuring from 74 to 108 mm., he believes to be about one year old,‡ but he thinks they represent rather the smaller specimens of the previous year than a fair sample. Those got by me in Aberdeen Bay on 18th September measured 38, 40, 47, 49, 51, and 54 mm., and they clearly belonged to the previous spawning; one taken in the Solway on 30th April measured 82 mm., and doubtless was spawned in the previous year. Probably the female Brill does not reach maturity before the fourth or fifth year.

As to the size at which maturity is first attained, Holt examined 79 specimens during the Irish survey, of which 17 were ripe, the smallest female and smallest male measuring 15 inches; of 20 approaching ripeness, the smallest of five females was 20 inches, and the smallest of 15 males 10½ inches.§ Of those he examined at Grimsby—and the number was large—males were found mature between 12 and 15 inches, and females at 15 inches.‖ On the south coast Cunningham found the sizes much the same as the above, but in those he examined from the eastern grounds, south of Horn Reef, he found males mature at 10 inches and over, and females from 13 inches upwards.¶ It appears, however, that, on board ship at least, Cunningham considered Turbot and Brill as mature in which the roes were in process of maturation, though many of them had not begun to spawn.**

In its distribution the Brill closely resembles the Turbot. It is found in the Mediterranean and Adriatic, and in the north as far as the neighbourhood of Bergen, between 61° and 62° N. latitude, thus not extending so far north as the Turbot. It does not penetrate far into the Baltic; it is absent from the Færoes and Iceland. As shown above, it appears to be more abundant on the British than on the continental coast. The young Brill have the same habitat as the young Turbot, at the margin of the sea on sandy ground, and they move out after reaching a certain size. The smallest obtained by me in the course of trawling investigations in the Moray Firth and Aberdeen Bay, carried into five and six fathoms, measured 23·3, 23·4, 23·5 cm., or over nine inches, and extremely few unmarketable individuals were taken. In Kyle's investigation, above referred to, 36 of the 144 Brill were less than 10 inches in length, most of them being got in Teignmouth Bay in between four and five fathoms. On the west coast of Ireland Holt found that the immature Brill between eight and 14 inches in length were most abundant about the 10-fathom line, and he gives a table of 16 under the larger size named which were taken between five and 10 fathoms. There was, however, only one at eight inches, the next size being 10 inches —of which there were two—one at 11, five at 12, five at 13, and two at 14, while there were 25 above

* *Ninth Ann. Rep. Fish. Board, Scot.*, Part III., p. 262.
† Cunningham, *Op. cit.*, p. 270.
‡ *Journ. Mar. Biol. Ass.*, II., pp. 106, 355.
§ *Rep. R. Dub. Soc.*, pp. 273, 278.
‖ *Journ. Mar. Biol. Ass.*, II., p. 3; III., pp. 377, 382.
¶ *Ibid.*, III., p. 77; IV., p. 107.
** *Ibid.*, IV., p. 39.

fourteen inches from between the depths specified. On the Scottish coast there is no doubt that the majority of the smaller Brill are found well under the 10 fathom line. Later, Holt found that the proportion of immature Brill on the Eastern Grounds in the North Sea was a very small one.*

The bathymetrical distribution of the Brill is more restricted than that of the Turbot; it is more of a shallow-water fish. On the west coast of Ireland, Holt found that of 98 Brill six were got under five fathoms, 45 from five to 10, 20 from 10 to 15, 10 from 15 to 20, nine from 20 to 25, two from 25 to 30, two from 30 to 35, and four between 35 and 40 fathoms.† I did not get any specimens of Brill in the deeper waters off the east coast of Scotland, where Turbot were taken during the trawling there.

Distribution.

During the 33 months for which our statistics exist, the quantity of Brill landed by the recording vessels was comparatively small, amounting in the aggregate to only 265 cwts. Considering what has been said above with regard to the relative abundance of Brill and Turbot on our coasts, this may seem surprising. The explanation is partly that the Brill is a much lighter fish than the Turbot, many more being required to make up a hundredweight, and partly that it is more of a coast fish than the Turbot, and thus many of its most productive haunts are closed against trawlers.

The number of areas or squares from which Brill were taken in the three years was 30, and the general average for the whole region and period was only 0·096 cwts. per 100 hours' fishing. The proportion caught in the different months was very different. Of the total, 147 cwts. or 56 per cent. were taken in the three months April, May, and June, and the averages per 100 hours' fishing were also highest in these months.

The quantities and averages in each of the years are as follow :—

Year.	Cwts.	Cwts. per 100 hours.	Lbs. per hour.
1901...	106⅝	0·158	0·177
1902...	40⅜	0·093	0·104
1903...	118	0·05	0·056

The comparatively small quantities of Brill taken make it necessary to be cautious in drawing conclusions as to distribution, though the *number* of fish is probably greater than the number of Turbot, and the inequality of the fishing in many of the areas, as previously referred to, must be borne in mind. It is plain, however, from the statistics that in the region comprised by the recording vessels this fish is most abundant (1) in the south-eastern parts of the North Sea and (2) off the east coast of Scotland. In the northern and deeper parts it is extremely scarce, though present. In the areas on the eastern side under 50 fathoms, as on the Fisher Bank plateau, Brill were taken in moderate quantities.

The highest averages were obtained in square XVII, *i.e.*, that embracing the southern portion of the Orkney Islands, viz., 5·1 cwts. per 100 hours' fishing, in April, 1901, and March, 1902; but in this area many of the months are blank, so far as Brill are concerned. In the three most northerly areas, VI, VII, and VIII, in which fishing took place in the spring only of each year, no Brill were taken except on one occasion, and then perhaps doubtfully. In areas XI, XII, XIV, XV, XVI, XVIII, XIX, and XXIV, though fishing in many of them was large in amount, Brill were only got rarely, and then generally in

* *Journ. Mar. Biol. Assoc.*, III., p. 392.
† *Op. cit.*, p. 295.

spring. In a few squares, as XXIII, XXIX, XXVIII, and XVII, all of which adjoin the Scottish coast, they were got in most of the months in which trawling was carried on.

The square from which most Brill were taken was XXIII, viz., 103 cwts., the average for the whole period being 0·301. The next was the more northerly area, XVII, with $88\frac{3}{8}$ cwts. and an average of 1·120. The next was the more southerly square, XXIX, with $15\frac{7}{8}$ cwts. and the low average of 0·043. In the square lying between this and the east coast the quantity was only $4\frac{5}{8}$ cwts, but the amount of fishing was much less, and the average per 100 hours was here 0·606 cwts.

Seasonal Abundance.

Taking the square in which most Brill were caught, though the average is not the highest, viz., XXIII, the annual average in each of the years was—1901, 0·203 ; 1902, 0·22 ; 1903, 0·37 cwts. per 100 hours' fishing, and the detailed averages for each month are as follow :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·18	0·037	0·00	0·16	0·017	0·74	0·14	1·10	0·25
1902 ...	0·16	0·50	0·73	0·85	0·03	0·00	0·00	0·25	0·05	0·21	0·07	0·12
1903 ...	0·06	0·05	0·84	0·21	1·10	1·27	0·33	0·165	0·10	0·28	0·33	0·17

The curves for each year, as in many other cases, especially near the coast, do not quite correspond. In 1902 and 1903 the pronounced feature is a spring cone showing maximum abundance, followed by a depression in summer and a slight rise in autumn. In 1902 the spring cone is formed by the February, March, and April averages, the apex being in April ; there is a great fall to a low point in May, and to zero in June and July ; there is a slight rise in August, followed by a zig-zag to the end of the year. In 1903 the January and February averages are low, there is a considerable rise in March, followed by a depression in April, and then a taller cone is formed by May and June, which is the maximum, and then there is a great depression in July–October, with a slight rise in November. In 1901 the averages for January to March are wanting ; that for April is not very high, and the line then falls to May and June, where the minimum is reached, and the chief feature of the year is the high average in September and November. While, therefore, the same sort of cycle of abundance appears in each of the curves—a maximum in the early part of the year followed by a minimum in summer and a second maximum in autumn, much lower—the periodicity varies somewhat in the different years as well as the relative preponderance in 1901.

In square XVII, from which the next largest quantity of Brill was taken, the fishing did not comprise the whole twelve months in any of the years, and the curves present the same sort of features as in the above case. The averages are as follow :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	5·104	0·57	2·40	1·50	0·00	...	...	0·00	...
1902 ...	...	0·06	5·14	0·22	0·00	0·00	0·00	0·00	...	0·07	0·21	0·11
1903 ...	...	...	0·24	0·06	0·70	1·60	0·00	0·00	3·80	1·50	0·63	0·76

The curves for these figures correspond in certain particulars and differ in others. In 1901 and 1902 the maximum is respectively in April and March, and a rapid fall takes place to May ; in 1901 there is a subsequent rise to June and a fall to August. In 1902, on the other hand, May to August is blank, and there is a slight rise in autumn. In 1903 the opposite feature is presented ; the averages in March and April are low, while the second cone, with its maximum in June, is well represented, as in 1901 ; there is the great rise in September, which, however, depends on only 88 hours' fishing, and there was no fishing in this month in any of the other years.

The curve for the three years combined is somewhat irregular. It shows relative abundance of Brill from March to July ; absence in August, notwithstanding fishing in that month in each of the years, and the tall cone in September, depending on the average in 1903, above referred to.

The next square, XXIX, lying off the Scotch coast, furnished 15⅞ cwts. for 36,168 hours' fishing, the general average being 0·043, much lower, therefore, than the preceding square to the north of it (XXIII). The monthly averages are :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·023	0·00	0·01	0·013	0·00	0·04	0·011	0·00	0·00
1902 ...	...	...	...	2·38	0·02	0·59	0·01	0·00	0·04	0·00	0·17	0·01	0·04
1903 ...	0·05	0·00	0·25	0·17	0·05	0·02	0·00	0·01	0·00	0·025	0·18	0·08

The curves here show a preponderance of Brill in March, a fall to June-September, and a slight rise thereafter. The compound curve for the three years shows the same general features. In this area, therefore, Brill are at their maximum in spring and their minimum in summer.

In square XXVIII, lying to the inside of the above, the fishing was irregular in the different years. In 1901, when it was most regular, the maximum was in December, 2·8 ; the average for July was next, 0·6, that for November third, 0·5, and that for May lowest, 0·44. No Brill were taken in June, August, September or October. In the following year there was fishing only in February, March, July and October, the respective averages being 2·34, 0·5, 2·5 and 0·39. In 1903 there was fishing only in June and July, the averages being 0·2 and 0·0. The curve formed by the combined figures for the whole period thus shows a maximum in February and December, and a low position from March to October, except for a cusp in July.

In the squares in the deeper water, east and south of the Shetlands, one type of curve prevails, consisting of a single maximum in spring. Although the quantities taken in these areas were small, the fishing was large in amount and was carried on in almost all the squares in each month of the year ; so that the uniformity of result is noteworthy. The same type is present in squares XI, XII, XIV, XV, XVI, XVIII, XIX and XX, in the northern section of the North Sea, and in all of them the averages for the rest of the year indicate complete absence or great scarcity of Brill, with the exception of XIV, when a few were caught in autumn. The curves for Brill in these areas thus resemble those for Turbot, but there is this difference, that the maximum is earlier in the year, and the absence or paucity of fish in the other months of the year is much more marked. It is as if the Brill moved thither only for a brief season, while the Turbot remain longer. The following comparison of the maximum abundance of each of these species in the squares referred to makes this clear :—

Name of Fish.	XI.	XII.	XIV.	XV.	XVI.	XVIII.	XIX.	XX.
Turbot	June, July.	May.	June to August.	April to August.	October and April.	June, July.	April to July.	June, July.
Brill	April.	March.	April.	April.	March.	April.	March.	April to June.

In the squares to the south-east of the above, on the Fisher Bank plateau, the same type prevails, so far as the fishing indicates (for there was no fishing in most of them during the first two or three months of the year), but there is a slight difference in this respect, that while in the northern group there is no indication of a rise in the curve, or re-appearance of fish, at the end of the year, such an indication is present in the latter areas. Thus in XXIV, lying to the east of XXIII, already described, a few Brill were only taken in March, November and December (1903) ; in XXV, on the Fisher Bank grounds, where there was no fishing before March, they were taken only in March, April, May, June and December, the line of the curve falling rapidly from March to June, and Brill were entirely absent from June to December. The same features are shown in squares XXVI, XXXI and XXXII, but in February in XXXII, and in March in XXXI, when there was trawling, no Brill were taken.

In the group of squares lying to the south-east of the above, viz., on the Dogger and in the German Bight, the fishing was less regular, but in each case, where two or more months are represented, the December average is the highest. The square with the most fishing amongst these is XXXVI, lying over part of the Dogger, and in it no Brill were taken in February, May, August and September, while the averages in the other months in which there was trawling were October, 0·12, November, 0·09, and December, 0·4. In XXXVII, lying further to the east, there was trawling in May (1902) and in August, September and December (1903), and Brill were only taken in the last-named month, the average being 0·36.

While the evidence for any single square of the above two groups—Fisher Bank and south-east grounds—is slender, the uniformity of the tendency to a rise at the end of the year is not without importance. The phenomena presented by the curves for the squares south of 58° N. and east of 2° W. would be explicable on the supposition that there was a migration to the north-west early in the year—to the Fisher Bank plateau—and a withdrawal to the south-eastern grounds in winter. Professor Henking states that in the southern North Sea, as defined by him, there is a slight increase in Brill in winter, and that on the Jutland coast, in the region of the Skagerack, this fish (like the Turbot) is most abundant in December.

A further remark may be made about these squares in a general survey of them, viz., that for those nearest to the coast our results are the least simple ; and this is true for all those areas lying along the coast of Scotland. On the other hand, in the squares in deeper water, where the conditions are more uniform, the curves are much more simple and uniform. The same remark applies to the Turbot, though in a less degree.

We may now proceed to combine the facts referring to the individual squares, and one group may be taken comprising those along the east coast of Scotland, viz., XVII, XXIII, XXVIII and XXIX. In these four squares the aggregate of fishing was 78,548 hours, the weight of Brill taken was $211\frac{7}{8}$ cwts., or 79·9 per cent. of the whole, and the general average was 0·27 cwts. per 100 hours' fishing. Combining the data for the three years we get a curve whose pronounced feature is a great cone in spring, with the apex in April, and extending on the line of the mean for the year from February to June. The minimum is in August and September, the averages for October, November and December being higher, and forming a small secondary cusp, which is also indicated in the combined curve for three of the squares, viz., XXIII, XXIX and XXVIII.

In this group, therefore, Brill are in their maximum numbers in spring, being most abundant in April, and at their minimum in late summer.

In a second group, of deep-water areas, XI, XIV, XV, XVIII and XIX, the quantity taken was

small, aggregating only 9¼ cwts., but the amount of fishing was large, viz., 88,466 hours, and it was regular. The general average was 0·013 cwts. per 100 hours.

Here the curve, as might be expected from the curves for the separate squares, described above, shows a great cone in spring, with the apex in April. The cone, moreover, is very narrow, being formed almost entirely by the averages for the month named, but slightly by the March figures. In May there is a great fall; notwithstanding that 6,750 hours' fishing took place in that month, and it occurred in each of the squares, only ⅛ cwt. being taken (in XI). The curve exhibits a very slight secondary cusp, below the mean, in June and July, referable to XVIII; the rest of the line is low, no Brill being taken in November. The quantities are very small and by smoothing the averages the deep fall in May is partially obliterated, so it may be said that in these deep water regions Brill are present in spring and especially in April, and practically absent during the rest of the year, or at all events extremely scarce and rare.

Another group of squares may be taken in relation to the Fisher Bank plateau, viz., XX, XXV, XXVI, XXXI, XXXII. The total quantity of Brill caught here was 27¼ cwts., the hours fishing was 64,897, and the general average per 100 hours was 0·042 cwts. In the early part of the year there was comparatively little fishing, viz., 35 hours in January (XX), 165 in February (XX, XXXII), 1,361 in March (XX, XXV, XXXI), and 642 in April (XX, XXV); but after that there was abundance of fishing in each month and in each of the squares. The pronounced feature of the curve is a great spring cone of maximum abundance, marked paucity of Brill in summer and early autumn, and a slight rise at the end of the year. The apex of the cone is in May; the part above the mean-line for the year comprises the months March–June, and the central perpendicular or ordinate is placed towards the end of April. No Brill were taken in January or February (when the fishing was small in amount), nor in September, with 7,530 hours. In March Brill were caught in two of the three squares in which there was fishing; in April in the two in which there was fishing; in May in each of the five squares; in June in three of the five; in July in one; in August in one; in September in none; in October in one; in November in two; in December in three. These facts confirm the curve and show that a rise at the end of the year really takes place, so that in this case there exists a small secondary cusp, as in many other cases; but the fishing in January and February was too limited to enable us to say much about the averages in these months, or where this secondary cusp ends.

A fourth grouping may be made, viz., of the squares in the south-eastern part of the North Sea, XXXVI, XXXVII, XXXVIII, and XLIII. The fishing in these squares was limited to 2,325 hours, the quantity taken was only 6½ cwts., the general average being ·280 per 100 hours' fishing. The fishing was here also confined to certain months. There was none in any of the squares in January, March, April, June, or July, and in the other months the aggregates were as follows:—February 40 hours (XXXVI), May 308 (XXXVI, XXXVII, XLIII), August 273 (XXXVI, XXXVII), September 225 (XXXVI, XXXVII), October 459 (XXXVI, XXXVIII), November 410 (XXXVI), December 610 (XXXVI, XXXVII, XXXVIII).

The curve consists of a spring cone, with its apex in May, a minimum in late summer, and a marked rise at the end of the year. The May position depends on 108 hours' fishing in square XLIII, no Brill having been taken in that month in XXXVI (80 hours) or in XXXVII (120 hours), and there was no fishing in XLIII in any other month. Although it quite agrees with the features in the curve for the adjoining group of squares—those of the Fisher Bank—stress cannot be laid on it. The latter portion of the curve is of greater validity, the December average depending on three squares, XXXVI, XXXVII and XXXVIII, the curve for each of which exhibits the same thing.

Taking now the two sections of the North Sea, as defined above, north and south of 58° N. latitude, the quantity of Brill taken in the northern section was 112 cwts., or 41·59 per cent. of the aggregate, the average being ·09. The outstanding feature of the curve is a spring cone, with the apex in April, and a second one with the apex in June, the part above the line of the mean being April, May, June and July. The minimum is in January and the maximum in April. The averages from August to the end of the year are low. The presence of the second elevation is due to the preponderating influence of squares XVII and XIII.

In the southern section the quantity taken was 153 cwts., or 58·41 per cent., the general average being 0·101. Here a spring cone is pronounced, showing the maximum abundance in February and March, the highest point being in the latter month. The part above the line of the mean extends from the end of January to the end of May, and the average for May is a little higher than that for April ; the central ordinate on the line of the mean is at the end of March. The rest of the curve is low, and there is a very slight upward elevation at the end of the year.

Proceeding now to consider the curves for the whole region visited by the recording vessels in each of the years and in the three years together, we find the following (Fig. 12).

In 1901—comprising the months April to December—the aggregate quantity taken was 106$\frac{5}{8}$ cwts. ; the fishing extended over 19 squares, and the general average was 0·158, this relatively high average being in part due to the omission from the records of the earlier months when the average is low. In this year by far the greatest quantity was taken in April, viz., 44·75 cwts.

The averages in the various months are :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
...	...	...	0·530	0·140	0·216	0·178	0·008	0·067	0·020	0·088	0·068

The curve begins with a very high average in April, higher by much than the average for any other month in the three years, and falls irregularly thereafter to a minimum in August.

In 1902 the quantity was small, 40$\frac{3}{8}$ cwts. ; the fish were caught in only 12 squares, and the general average was 0·05 cwts. per 100 hours' fishing.

The averages in the various months were :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·055	0·096	0·116	0·075	0·110	0·051	0·005	0·026	0·010	0·041	0·016	0·025

The curve formed by these figures shows a gradual rise to March and a fall from May to the minimum in July, after which the curve takes an irregular course.

In 1903 the quantity taken was 118 cwts. ; the fish were caught in 25 squares, and the general average was 0·092 cwts. per 100 hours' fishing.

For each month the averages were as follows :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·015	0·052	0·189	0·066	0·240	0·197	0·058	0·007	0·052	0·039	0·087	0·053

The curve shows a gradual rise to March, then, after a drop in April, a rise in May to the maximum, and a fall in August to the minimum.

In each year, therefore, the curve presents the same general character. By smoothing the somewhat irregular lines the features remain the same; each year shows a maximum in spring, with the greatest abundance in April and May, a minimum in late summer, and a slight upward curve at the end of the year.

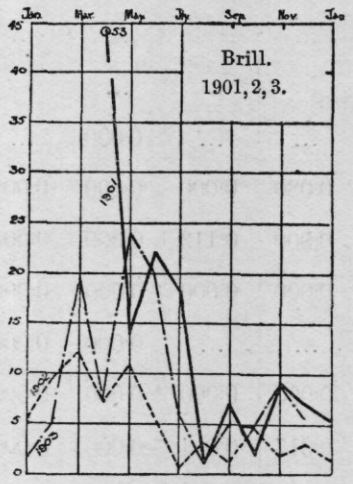


FIG. 12.

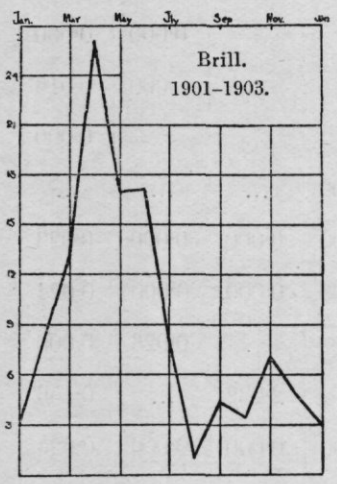


FIG. 13.

Finally, combining the averages for the three years we get the following means :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·031	0·093	0·155	0·261	0·173	0·174	0·081	0·013	0·046	0·035	0·067	0·052

The outstanding features of the curve formed by these figures (Fig. 13) are the great preponderance of Brill in spring and their scarcity in late summer. From January to April there is a gradual, regular, and large increase in the numbers of Brill, the maximum being reached in the latter month; from April to August there is a constant and almost equally regular decrease in their abundance, the regularity in the fall being only slightly interrupted in June. To the minimum in August there succeeds a slight rise in the last month of the year. By smoothing the averages, the April apex of the spring cone is reduced, the average for May being made a trifle higher than that for April, but the position of the cone on the line of the mean, and of the central ordinate, remains the same; the upward tendency in the latter months of the year also remains.

The compound curve for the Brill, therefore, resembles that for the Turbot in having a great cone limited to a part of the year, but it differs in this respect that the cone—the preponderating abundance of the fish—is placed two months earlier.

(1) MONTHLY AND ANNUAL AVERAGES OF BRILL (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	0·000	0·000	0·000	...	...	...	...	...	...	...	0·000
VII	...	...	0·000	0·016	0·000	...	...	...	...	...	...	...	0·009
VIII	...	...	...	0·000	0·000	...	...	...	...	0·000	...	...	0·000
IX	0·000	...	...	...	0·000	...	0·248	0·080	0·000	0·000	0·000	0·020	0·061
X	0·000	0·000	0·000	0·023	0·000	...	0·000	0·000	0·113	0·000	0·000	0·000	0·029
XI	0·000	0·000	0·000	0·024	0·006	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·009
XII	...	...	0·026	0·000	0·000	...	...	...	...	0·000	0·000	0·000	0·009
XIII	...	2·232	...	0·156	...	0·000	0·871	0·000	0·000	0·000	0·000	0·014	0·119
XIV	0·000	0·000	0·000	0·025	0·000	0·000	0·000	0·017	0·014	0·000	0·000	0·000	0·002
XV	0·000	0·018	0·000	0·096	0·000	0 000	0·000	0·000	0·000	0·000	0·000	0·000	0·005
XVI	...	0·000	0·056	0·000	0·000	...	...	...	0·000	0·000	0·000	0·000	0·012
XVII... ...	...	0·060	0·750	2·142	0·580	2·122	1·216	0·000	3·835	0·394	0·352	0·266	1·120
XVIII ...	0·000	0·000	0·009	0·619	0·000	0·036	0·034	0·000	0·000	0·010	0·000	0·008	0·030
XIX	0·003	0·000	0·046	0·019	0·000	0·007	0·000	0·000	0·000	0·000	0·000	0·004	0·005
XX	0·000	0·000	0·101	0·106	0·210	0·120	0·000	0·000	0·000	0·000	0·000	0·000	0·090
XXI	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XXII ...	...	...	...	...	...	...	...	...	...	...	0·178	...	0·178
XXIII ...	0·111	0·427	0·817	0·276	0·378	1·007	0·212	0·043	0·196	0·211	0·425	0·164	0·301
XXIV ...	...	0·000	0·042	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·014	0·006	0·005
XXV... ...	...	...	0·277	0·227	0·159	0·027	0·000	0·000	0·000	0·000	0·000	0·047	0·050
XXVI ...	...	...	...	...	0·568	0·268	0·100	0·000	0·000	0·000	0·000	0·203	0·100
XXVII ...	...	...	...	...	0·250	...	...	0·000	0·047	0·000	...	...	0·050
XXVIII ...	...	2·343	0·500	...	0·442	0·186	0·465	0·000	0·000	0·312	0·500	2·840	0·606
XXIX ...	0·045	0·000	0·343	0 090	0·100	0·016	0·003	0·016	0·011	0·049	0·108	0·068	0·043
XXX... ...	...	...	...	...	...	...	0·000	0·000	0·000	0·000	0·011	0·013	0·010
XXXI ...	...	...	0·000	...	0·015	0·000	0·000	0·000	0·000	0·000	0·004	0·000	0·001
XXXII ...	...	0·000	...	...	0·890	0·000	0·000	0·034	0·000	0·006	0·060	0·130	0·078
XXXIII ...	...	...	...	...	...	0·000	0·000	...	0·000	0·000	...	...	0·000
XXXIV ...	...	...	...	...	...	...	...	0·000	0·086	0·000	...	...	0·047
XXXV ...	...	...	...	...	0·166	...	0·000	0·000	...	0·000	0·000	0·000	0·014

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXXVI ...	...	0·000	...	...	0·000	...	....	0·000	0·000	0·093	0·091	0·364	0·106
XXXVII ...	...	...	...	...	0·000	...	...	0·000	0·000	...	...	0·357	0·200
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	1·250	0·041
XLI	...	...	...	...	...	...	...	...	...	...	...	...	...
XLIII ...	...	...	...	...	3·125	...	...	...	...	...	...	...	3·125
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(2) MONTHLY AND ANNUAL AVERAGES OF BRILL (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Totals.
January	...	0·055	0·015	0·031
February	...	0·096	0·052	0 093
March	...	0·116	0·189	0·155
April	0·530	0·075	0·066	0·261
May	0·140	0·110	0·240	0·173
June	0·216	0·051	0·197	0·174
July	0·178	0·005	0·058	0 081
August	0·008	0·026	0·007	0·013
September	0·067	0·010	0·052	0·046
October	0·020	0·041	0·039	0·035
November	0·088	0·016	0·087	0·067
December	0·068	0·025	0·053	0·052
	0·158	0·050	0·092	0·096

III.—THE HALIBUT (*Hippoglossus vulgaris*, Flem.).

The Halibut or Holibut, while the largest, is at the same time the most important for man of all the Pleuronectidæ, forming a staple fishery in the arctic and sub-arctic seas of the European, American, and Asiatic continents. In the British fisheries it takes second place as to quantity, and third as to value, among all the flat fishes, but a large proportion of the Halibut landed in this country comes from Iceland and Faeroe. The quantity landed in England in 1902 was 126,079 cwts., valued at £252,722—and all but 1,577 cwts. were landed at east coast ports. The quantity landed in Scotland in 1903 was 28,892 cwts., of the value of £49,186 ; the Halibut is not separately recorded in the Irish statistics.

Among all the flat fishes, with the possible exception of the Flounder, it is the only one of which the greater quantity is taken by line-fishing and not by trawling. This is partly accounted for by its preference for deep water and hard bottom, where the trawl cannot work, partly because it is a voracious and piscivorous fish and takes the bait readily, and, no doubt, also because it is a large, swift, and powerful fish and can in many cases evade the trawl. It is the least "flat" of all the flat fishes.

There are many points about its natural history still obscure. It is known to live mostly on other fishes, but it also takes crustacea, and I have found the remains of sea-urchins in its stomach ; there is room for a more extensive investigation of the food of the Halibut than has yet been made.

With regard to its reproduction we know something. The mature or nearly mature eggs were not described until 1885, when Mr. George Brook gave an account of them in the Fourth Report of the Fishery Board (pp. 224, 249). The fish was taken 100 miles off St. Abbs Head on 18th May, and weighed 91 lbs., the weight of the ovary being estimated at about 18 lbs. The bulk of the ovary consisted of unripe eggs, about 2·55 mm. in diameter, with numerous yolk spherules, and among them little clusters of larger ova, which were quite transparent, and showed no division of the yolk into small spherules. It is probable that these eggs were quite ripe. They floated at first in sea water, but being dead they soon sank to the bottom. The largest measured about 4·25 mm. in diameter. Mr. Brook estimated the number of eggs in the ovary at about 1,327,000. On a later page the eggs were described as "floating." In 1892 Holt obtained ripe eggs by pressing a female Halibut in the Grimsby market on 30th April ; they measured from 3·07 to 3·818 mm. and, though they were not in very good condition, Holt concluded they were pelagic, and he obtained others in the same way at the end of August.* In the same year I obtained supplies of ripe eggs through some of the Fishery Officers, viz., on 27th April, from a fish caught on Bergen Bank, about 150 miles E.N.E. from Peterhead, and also in May, and these were described by Professor McIntosh, to whom they were forwarded—they were pelagic and measured from 3·13 to 3·762 mm.† In the following year half a gallon of ripe eggs were obtained by Mr. R. Duthie from a female of 22 lbs., also caught on Bergen Bank on 5th May, specimens of which were sent to Professor McIntosh.‡ So far as I am aware they have not been got since, and they have not yet been obtained from the tow-nets, in this country ; but Hjort mentions having taken them with other pelagic eggs in the tow-nets off the northern coast of Norway, sometimes in considerable numbers.§

The limits and duration of the spawning-period of the Halibut have not been well determined. The floating eggs referred to by Hjort were taken in May, and the ripe eggs obtained in Scotland were got in April and May ; Parnell says the Halibut spawns in spring ‖ ; Couch states that in Cornwall they spawn in April ; Malm also gives April, and mentions that he found one with the roe running on the 26th of that month, and Möbius and Heincke say it spawns in spring. On the other hand, Holt got ripe eggs from a specimen at the end of August, and from the condition of other large females about the same time and in the early part of September he concludes that some spawning probably takes place in autumn, on the Iceland grounds, at any rate, from which his fish appear to have come.¶ The records which I got some of the Fishery Offiers to keep on the coast of Scotland some years ago show the following :—Of three examined in December, 13 in January, and 14 in February, none were ripe ; of six examined in March,

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* *Journ. Mar. Biol. Assoc.*, II., pp. 399, 378.
† *Tenth Ann. Rep. Fishery Board for Scot.*, Part III., p. 286.
‡ *Op. cit.*, p. 244.
§ Fiskeri og Hvalfangst i det nordlige Norge, pp. 44, 45. Bergen. 1902.
‖ Fishes of the Firth of Forth, p. 373.
¶ *Op. cit.*, p. 379.

one male and two females are described as ripe ; of 122 examined in April, two were spent ; of 238 examined in May, two males and three females were ripe and four spent ; of 213 in June, three males and two females were ripe and three spent ; and of 42 examined in July none were found ripe or spent.* During the Irish Survey Holt secured three female specimens ; one was half-ripe in the middle of April, another not quite three-parts ripe at the end of May, and the other was spent in the middle of July ; of the former, one was 53 and the other 29 inches.† From the not very ample evidence it appears probable that the spawning time of the Halibut in the North Sea is from March to June.

As for the places where spawning occurs in relation to the coast and depth, all that can be said is that in the cases mentioned above the mature females were got in one instance 100 miles off the Berwickshire coast, and in the others on the Bergen Bank.

Until quite recently the early stages of the Halibut were unknown, but Dr. Johs. Schmidt, in the course of the Danish investigations at Iceland and the Faeroes last year, procured a series of pelagic post-larval forms, measuring from 13·5 to 34 millimetres, which he has described and figured.‡ They were taken in May, June and July from near the surface downwards, west of the Faeroes, off the southern coast of Iceland, and, especially, off the western coast, in Denmark Straits. The next size of Halibut, above the largest of the post-larval forms he refers to, measured 120 mm. ($4\frac{3}{4}$ inches), and he states that young Halibut of a length of about 20 cm. (8 inches) are very common in shallow water around Iceland.

Specimens of young Halibut in our waters are very rare. The smallest specimens of which I have record are as follows:—One measuring 18·8 cm. ($7\frac{3}{8}$ inches) caught in Aberdeen Bay in 8 to 18 fathoms, on 1st November ; one of 28·5 cm. ($11\frac{1}{4}$ inches) off the coast of Caithness in from 25 fathoms, on 10th October ; and some from Faeroe, caught from 24–30 April, in from 48 to 63 fathoms, about six miles off shore, Fugla bearing N.W., measuring 220, 254, 260, 274, 283, 280, 285, 304, 303, 311, and 312 mm. ($8\frac{1}{4}$–$12\frac{1}{4}$ inches). The next sizes on my records are 35·3, 48·7 cm., &c. McIntosh refers to two specimens of 12 inches caught by a trawler in St. Andrew's Bay on 13th November,§ and states that similar small specimens are occasionally caught on the lines ; and he describes a still smaller specimen measuring only 97 mm. or a little over $3\frac{3}{4}$ inches, taken from the stomach of a coalfish, caught in 105 fathoms about 50 miles from the coast of Norway and 220 from Aberdeen on 31st May. It was slightly digested, but he states that it was apparently a Halibut.‖

It is probable that the very young Halibut, as McIntosh thinks, are found only in deep water, but the investigations now being made by the Danish Department at Iceland and the Faeroes will no doubt throw light on this. It may be mentioned that the Peterhead liners used to get large catches of Halibut off the coast, and in 1883 they are said to have discovered a haunt of young Halibut at a place over 90 miles E. by S. from Peterhead ; a fleet of herring nets sank there, and on being hauled they were found to contain "hundreds of young Halibuts, about four inches in length," and on shooting their lines at the place the men caught about 150 large Halibut at one haul.¶ More exact testimony is, however, desirable.

The rate of growth of this fish can only be conjectured. The small specimen mentioned by McIntosh, if beyond doubt a Halibut, and the author does not positively affirm it to be so, and omits

* *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 233.
† *Rep. Council Roy. Dubl. Soc. for* 1901, p. 255.
‡ *Meddelser fra Kommissionen for Havundersögelser, Ser. Fiskeri*, Bind. I., p. 1, Copenhagen, 1904.
§ *Fourth Ann. Rep. Fishery Board for Scotland*, Part III., p. 208.
‖ *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 285, 1891.
¶ *Vide Ninth Ann. Rep. Fishery Board for Scotland*, Part III., p. 182.

reference to it in his later work when dealing with the young stages of the fish,* would be at the time one year old or thereabout. The specimen got by myself on 1st November, measuring $7\frac{3}{8}$ inches, would on the above assumption be about seventeen months old, and it appears to me, judging from other flat-fishes whose rate of growth is better known, that this is more likely to be correct than to suppose it to belong to the year's brood and to be six months old or thereby. The larger specimens of 11 and 12 inches caught in October and November also probably belonged to the previous year, representing larger individuals of the same series. As for those got at Faeroe in April, measuring from $8\frac{1}{4}$ to $12\frac{1}{4}$ inches, they must have been at least one year old, and, on the presumption of a later spawning period there as at Iceland, were probably eighteen or twenty months old. It may be mentioned that a Halibut that was caught at Iceland in the spring of 1904, measuring 64 cm. and weighing 2·35 kilogrammes, had certain markings on it, the lettering " T.M. 1901 " being distinct, and others that may have stood for " August." If the date is authentic, it would imply that the growth of the Halibut is not rapid in proportion to its size, as about two years and eight months must have elapsed between the markings and the capture of the fish, which must at the time have attained some size.†

Nor can it be said that the size at which the Halibut first begins to reproduce has been well determined. Holt examined 150 at Grimsby, and concludes that the male may be mature at about 30 inches, and is probably never mature at less than 25 inches, and that the female probably does not spawn until she is about four feet long. He, however, pending the examination of other specimens, assigned as a limit 36 inches, and repeats this in his later work as being a probably extreme minimum.‡

With regard to the distribution of the Halibut, it is, as above stated, a sub-arctic species with a wide range, coinciding broadly with that of the cod. It takes a prominent place in the fisheries of Norway, the Murman coast, Greenland, Iceland, the Northern Pacific or Alaskan and Atlantic coasts of America, and the coast of Siberia ; it is found at Bear Island and Spitzbergen and on the coast of Greenland, at least up to 71° N. lat. On the south it is rarely got beyond the Channel or Ireland, but one specimen has been recorded from Biarritz ; in the English statistics only 20 cwts. (of the 126,079 landed) are recorded for the south coast and only three specimens were procured during the Irish survey. It is rare in the Baltic ; on the other side of the Atlantic it is found as far south as Cape Cod. It is most abundant at considerable depths—from 50 to 150 fathoms and more. It will thus be seen that the area with which I am dealing—the North Sea—lies at the southern part of its region of distribution, the opposite therefore to the case of the Turbot and Brill.

Distribution.

The statistics show that the Halibut is very widely distributed in the North Sea, and on the whole very regularly, with diminishing abundance as one passes from the north—the deeper water—to the south and shallow waters. The total quantity taken by the recording vessels throughout the whole region in the three years was $2{,}632\frac{5}{8}$ cwts., the general average being 0·949 cwts. per 100 hours' fishing or 1·06 lbs. per hour. Its general distribution is also shown by the fact that of 36 squares fished over Halibut were taken in 32 of them, the exceptions being XXII, XXXVIII, XLIII, and XLV, the three last being the three areas most to the south and east in the shallowest water, and all of them also with comparatively

* British Marine Food Fishes, p. 319, 1897.
† *Twenty-Second Ann. Rep. Fishery Board for Scotland*, Part III., p. 287.
‡ *Journ. Mar. Biol. Assoc.*, II., 379 ; III., 377.

little fishing in them, so that the absence of Halibut in the statistics for these areas must not be taken as proving the entire absence of the fish. The particulars for each of the years are :—

Year.	Squares Fished.	Squares with Halibut.	Cwts. Caught.	Average Cwts. per 100 Hours.	Lbs. per Hour.
1901	30	27	719⅝	1·064	1·19
1902	29	28	763⅞	0·938	1·05
1903	31	28	1,149⅛	0·896	1·00
			2,632⅝	0·949	1·004

As stated, the northern deep water areas have the highest averages, the three highest (irrespective of the period of year) being for VIII, IX, and XII, and the three lowest for XXXIV, XXIX, and XLI. The diminishing abundance from the north southwards is best exhibited by contrasting the averages for the successive squares in the same direction (*see* Table, p. 545). The areas in the central part of the North Sea, for example, from north to south (VIII–XLV), extending from about 61° 30′ N. latitude to 53° 50′ N. latitude, and with water whose depth diminishes from 100 fathoms and over to 15 and 16 fathoms south of the Dogger, have the following averages :—2·319, 1·954, 1·372, 1·454, 1·417, 0·612, 0·379, 0·208, 0·00. The fifty-fathom line makes a considerable difference, and I may contrast the averages for the two regions by combining the data for the squares in either, north and south of 58° N. latitude, *i.e.*, a line from the Naze of Norway to the middle of the Moray Firth. In the 16 squares in the northern section the general average is 1·35, and in the southern section 0·62, the respective quantities being 1,694⅜ cwts. and 938¼ cwts.

There are some features in regard to the distribution in the different parts that may be referred to. Thus as a rule the averages for the areas near the coast are not so great as those for the areas distant from it, though the prevailing depths in the latter may be less. In this respect squares XXIX and XXXIV, for example, contrast with the squares to the east of them. Another feature is the relatively high averages for those near the Norwegian deep channel and the Skagerack, even when the water is of moderate or small depth. This possibly points to the supply of Halibut to those areas coming mostly from the deep water in question, *i.e.*, from the eastward. The average for square XXVII, lying at the mouth of the Skagerack, is the fourth highest. The averages for the squares comprising the Fisher Bank plateau are also relatively high, viz., 1·417, 1·263, 0·612, and 0·950, though the depth in some of them is under 40 fathoms and partly under 30.

Seasonal Abundance.

The Halibut is a deep water fish, and the greatest quantities and highest averages were obtained in the northern areas. In considering the seasons of maximum and minimum abundance of this fish some of these areas may be examined. The one in which the greatest quantity was taken was XV, lying midway between Norway and the Orkneys, viz., 327¼ cwts., and the average was 1·665 cwts. per 100 hours fishing, the fishing being moreover in each month.

The monthly averages for each year are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	1·3	2·2	1·4	2·1	2·7	1·05	2·9	2·16	1·53
1902 ...	1·44	1·35	1·27	1·66	2·24	1·29	...	2·68	1·94	1·60	1·69	1·11
1903 ...	1·126	0·75	1·9	2·9	0·50	...	...	...	...	1·65	1·60	1·15
	1·230	1·298	1·548	2·439	2·158	1·434	2·135	2·674	1·794	1·707	1·830	1·238

The curves for the separate years are a little irregular. That for 1902, in which the fishing took place in eleven months, is the best, and it shows a double maximum in May and August. The line falls from December in the previous year to March, and then rises abruptly to April and May, falling in June; the highest point is in August, from which the line falls rapidly and with fair regularity to February of the following year, the minimum being in December. In 1903 it rises with equal suddenness to March and April, the maximum point, and falls to the minimum in May. The next fishing was in October, the average being high; November is much the same, and there is a fall in December. In 1901 the line is irregular; there are maxima in May, August, and October, the latter being the highest, and minima in June and September, the latter being the lowest for the year.

When the averages for the three years are combined the curve exhibits two well-marked maxima; the first, or spring cone, is formed by the averages for April and May, which are nearly the same, April being a little higher; the second is formed by the averages in July, August, and September, with the apex in August. The lowest points are in January, December, and February.

Another of the deep water squares is XIV, to the south of the Shetlands, in which the quantity was 240⅛ cwts., the average for the whole period being 1·256 cwts. per 100 hours, and fishing took place in each month.

The monthly averages are these :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	2·2	1·82	1·1	0·98	1·8	1·8	1·4	1·0	1·6
1902 ...	0·46	0·76	1·35	1·66	0·83	0·00	...	1·27	1·57	1·47	1·01	1·29
1903 ...	1·2	1·4	0·72	3·2	...	...	1·875	...	1·10	1·20	1·76	1·00
	1·115	0·769	0·921	2·405	1·323	1·115	1·048	1·654	1·347	1·294	1·338	1·229

In 1901 and 1902, and less marked in 1903 also, there is a double maximum; in 1901 it occurs in April and May, and August and September; in the next year in April and March, and September, and in 1903 in April and July, the November position being also high. The minimum in 1901 is in July and June; in 1902 in June, January being also low; and in 1903, in which June, May, and August are not represented, it occurs in March.

The compound curve of the averages combined shows a high and pronounced cone of maximum abundance in spring, the apex being in April, and a secondary cone in August. The minimum is in February, and there is a second minimum in June and July.

In XIX, lying midway between Norway and Scotland, the quantity taken was 241¼ cwts., the general average being 1·123 cwts. per 100 hours' fishing.

The monthly averages are these :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·15	0·55	2·10	2·60	2·37	1·77	0·38	0·750	1·39
1902 ...	0·68	0·58	1·09	0·97	1·08	0 76	1·71	1·50	3·33	2·60	1·54	0·89
1903 ...	0·91	0·94	1·60	1·40	1·50	1·10	1·09	1·30	2·20	2·90	1·40	1·10
	0·854	0·680	1·454	0·872	0·863	1·384	1·542	1·504	2·105	1·415	1·004	1·061

The curve for each year shows as its most prominent feature a tall cone, and in the years in which each month is represented, 1902 and 1903, there is also a small secondary cone. The maximum abundance in 1901 is in June–September, the apex of the cone being in June–July ; the April average is the lowest and the next lowest is in October, from which in this year the line rises to December. In 1902 the autumnal maximum is from July to November, the apex of the cone being in September. There is a small secondary cone or cusp in spring formed by the averages for March, April, and May ; the January, February, June, and December averages are low. In 1903 the curve is of precisely the same form ; the autumnal tall cone of maximum abundance has its apex in October ; the smaller spring cone, here relatively more important, is again formed by the averages for March, April, and May ; the lowest averages are again in January and February, the next in June and July, while December is low. From the variation of 1901 from the type of the other years, the compound curve is not so well proportioned. There is a small spring cusp, with the apex in March, and a large autumn cone of maximum abundance, with the apex in September, and extending from June to October. The February and January averages are lowest. The combination of 1902 and 1903 probably shows the normal condition better ; the small truncated spring cone separated from the great autumal one by the depression in June.

Thus the features in this square contrast with those in the two squares referred to above by the diminished abundance in spring and the increased abundance in autumn ; the two maxima being still, however, present.

In square XVIII, lying nearer to the coast of Scotland, in somewhat shallower water, this process of depression of the spring cone and elevation of the autumnal one—increased diminution of Halibut in spring and increased abundance later in the year, is carried a step further. Instead of a spring cone, there is a depression, Halibut being then scarcer than at any other time of the year, the minimum being in April. On the other hand, the maximum abundance is from August to November, the maximum in the compound curve being in August. The periods do not quite correspond in the different years ; in 1901 the maximum is in August especially, but extends to September and October, and the minimum is in April and May. In 1902 the maximum is in October and November, and the minimum in April. In 1903 the curve is less regular ; the maximum is in November and October, and the lowest average is in August, the spring averages being also low. In this year, however, the amount of fishing in this area was not very great (aggregating 2,278 hours as compared with 8,133 in 1901 and 6,141 in 1902), and there was no fishing in April and May.

The averages for this square are as follows, the quantity taken in it being 203¾ cwts., and general average 1·23 :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·24	0·59	1·46	1·7	3·1	2·1	2·4	1·77	0·70
1902 ...	0·76	0·47	0·56	0·31	...	...	0·79	0·54	0·78	1·56	1·53	0·77
1903 ...	1·04	0·15	0·27	...	...	0·45	1·00	0·11	0·00	1·50	3·30	...
	0·801	0·442	0·529	0·261	0·595	1·107	1·364	2·620	1·718	2·191	1·864	0·734

If we now group together the information for the chief squares in the deep water region, XIV, XV, XVI, XIX, XX—the aggregate quantity being 961¼ cwts., or 36·5 per cent. of the whole, and the average 1,374—we have the following monthly averages :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1·34	1·23	1·58	1·91	1·46	1·34	1·96	1·71	1·71	1·08	1·05	1·09

The curve—and it is for the whole period of three years—has two conspicuous maxima, one in spring and one in autumn. The spring cone has its apex in April, and the autumnal one its apex in July, the averages for that month being somewhat higher than those for August and September. The part of the curve above the line of the mean for the year extends from the end of February to the end of May, and from the latter part of June to the end of September ; the central ordinate of the first cone is placed about the middle of April, that of the second in the early part of August. The lowest averages are those for October-December, January and February being a little higher. The smoothed curve gives two cusps, not so markedly separated, the highest point of one being in April and of the other in August.

In these deep water squares, therefore, it is clear that Halibut are in special abundance at two periods —one in spring, during the spawning-time, and the other in autumn.

In the areas adjacent to the east coast of Scotland we find repeated the main features of the curve for XVIII., that is to say, paucity of Halibut in spring, early summer, and winter, and a maximum in autumn. Without entering into the details for each (the averages will be found on p. 545), we may group together the facts for all of them and for the whole period, premising that the curves for the squares may differ a little from one another, as in the period or month of maximum or minimum abundance. Doing this, then, for areas X, XIII, XVII, XXIII, XXVIII, XXIX, we get the following averages, which I give as calculated (1) and as smoothed (2) :—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(1) ...	0·18	0·52	0·29	0·51	0·52	0·73	0·51	1·86	1·0	0·19	0·41	0·97
(2) ...	0·56	0·33	0·44	0·44	0·59	0·59	1·03	1·12	1·02	0·53	0·52	0·52

The curve shows a great cone in autumn, with its apex in August, the line from February to June rising slowly and slightly, and the January and October position low and equal ; there is a rise at the end of the year in November and December, the December position being much higher than that of January. In the smoothed curve the blunt cone or cusp in autumn has its highest point in August, the position in July and September being nearly as high, and the isolated winter cusp tends to disappear.

In the areas adjacent to the coast, therefore, the Halibut are scarce during the spring (or spawning time) and abundant in July, August, and September. The facts may be capable of another explanation, but it may be suggested that in spring the fish are rather on the offshore grounds, as in the deep-water group of squares, for spawning purposes, becoming abundant in autumn when the herring shoals are along the coast.

In the same way another group of squares may be taken, viz., those of the Fisher Bank plateau. Grouping together the facts for XXV, XXVI, XXXI, and XXXII, in one or other of which there was trawling in each month except January, we have the following averages, as calculated (1) and as smoothed (2) :—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(1) ...	...	0·94	0·37	2·73	2·35	1·23	1·59	0·92	0·67	0·49	0·81	0·91
(2) ...	0·92	0·74	1·35	1·82	2·10	1·72	1·25	1·06	0·69	0·66	0·73	0·88

The chief feature of the curve is the presence of a cone in spring and early summer, when there is a maximum abundance of Halibut; great scarcity in late summer and autumn, and a rise in the winter months. In the unsmoothed curve there is a descent from February to the minimum for the year in March, a great rise to the maximum in April, a fall to June, a slight rise in July, a decline to the second lowest point in October, and a slope upwards to December. In the smoothed curve the base of the cone on the line of the mean is broadened, extending from March to the beginning of August, the depression in June disappearing; otherwise it is the same save that the depression in March is curtailed.

On the Fisher Bank, therefore, Halibut have their maximum abundance in April, May, and June, and their minimum in September, October, and November.

Taking now the two sections of the North Sea, as above explained, we find that in the northern section the quantity of Halibut taken was 1,694⅜ cwts., or 67·84 per cent. of the whole, the average being 1·35 cwts. per 100 hours' fishing, or 1·5 lbs. per hour.

The monthly averages are these:—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·97	0·85	1·35	1·74	1·42	1·18	1·34	1·89	1·60	1·42	1·21	1·17

Here the curve shows two marked and sub-equal maxima, formed by a cone in spring, with the apex in April, and another in autumn, with the apex in August; the June average is low, and those for November and December at the same level as it; still lower are the averages in January and February, the latter being the minimum for the year. The autumn cone is a little higher than the spring one; the part above the mean extends from March to May and from July to October.

In the northern part of the North Sea, then, Halibut are abundant in spring, scarce in the middle of summer, abundant in autumn, and scarcest of all in winter.

In the southern section the quantity was 938¼ cwts., or 32·16 per cent. of the aggregate for the North Sea, the average being 0·62 cwt. per 100 hours' fishing, or 0·69 lb. per hour.

The monthly averages as calculated (1) and as smoothed (2) are as follow:—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(1) ...	0·23	0·33	0·34	0·28	1·37	0·86	0·72	0·51	0·65	0·38	0·44	0·39
(2) ...	0·32	0·30	0·32	0·66	0·84	0·98	0·70	0·63	0·51	0·49	0·40	0·35

The curve, unsmoothed, shows a cone of maximum abundance in May and June, the apex being in May, and there is, perhaps, an indication of the autumnal maximum in a small cusp in September. The averages above the mean for the year are April, May, June, September. The winter position is low and level, especially in the early months of the year. In the smoothed curve the cone is shifted a little later, the apex being in June, and the autumn cusp is obliterated, being indicated only by the wavy, slowly-descending line.

In the southern part of the North Sea, then, taken together, Halibut are scarce in winter, abundant in early summer, scarcer in late summer, and a little more abundant in autumn. The two maxima are present, but the autumnal one is little more than indicated.

Henking found that in the southern North Sea the Halibut was taken in somewhat greater quantities in March-April, and in the Skagerack there was a small increase in the catch in February and March and in August-September.*

Combining now the whole of our information for the whole region in the various years and for the three years together, we have the following monthly averages :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
...	...	...	1·329	1·175	1·146	1·045	1·251	1·034	0·823	0·789	0·985
0·737	0·749	1·151	1·396	1·729	0·919	0·838	0·578	0·777	0·995	0·828	0·723
0·786	0·669	1·183	1·518	1·451	0·886	0·777	0·747	0·968	0·639	0·753	0·710
0·767	0·740	1·168	1·408	1·397	0·961	0·884	0·842	0·943	0·804	0·778	0·754

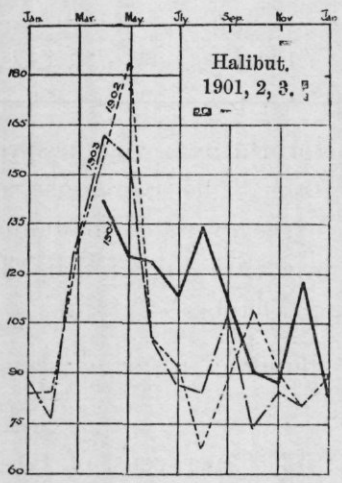


FIG. 14.

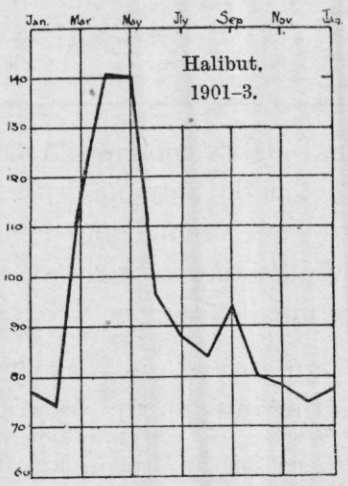


FIG. 15.

The curves for the three separate years (Fig. 14) are essentially the same. There are in each two cones of maximum abundance, spring and autumn, but the spring one is by far the most important. In 1901 it is imperfect from the absence of data before April, but the highest point for the year is in that month ; the secondary cone is in August, and from that point the line falls to the minimum in October and November, and in this year rises in December. In 1902 the spring cone is formed by the averages March, April, and May ; the apex is in May and the part above the mean from the beginning of March to the middle of June ; the central ordinate is placed towards the latter part of April. The period of minimum abundance is in August, the apex of the autumn cone being in October ; the winter averages are low. In 1903 the spring cone extends from the beginning of March to the middle of June on the line of the mean, or precisely as in 1902, and the central ordinate is also placed towards the latter part of April. There is a minimum in July and August, but not quite so low as the point in October and February. The autumn cone is small, with the apex in September.

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* *Op. cit.*, pp. 13, 18.

The compound curve for the whole region and period shows a great preponderance of Halibut in March, April and May, and a second much smaller maximum in September. The spring cone extends from the beginning of March to the middle of June on the line of the mean, the apex is at the end of April and commencement of May, and the central ordinate towards the end of April. Its position, therefore, corresponds with the spawning-season. In July there is a minimum, and the averages for the latter months of the year and for January and February are still lower, the lowest being for February. (Fig. 15.)

Statistics of Liners.

I have mentioned above that the greater proportion of the Halibut landed is caught, not by the trawl, but by hook and line, and this fish forms a highly-important item in the catches of the long-liners, and especially the steam liners, frequenting the port of Aberdeen. In the scheme which I prepared to show the relation between the amount of fishing and the quantity of fish caught in the various areas in the North Sea in different years and seasons, it was therefore necessary to indicate this relationship in the case of lining in another way than by the number of hours' fishing—viz., by the length of line used in the course of each voyage or shot.

The statistics in this case refer only to the year 1903, and Halibut were taken in 19 of the 21 squares in the North Sea in which the steam-liners fished (*see* Tables, p. 470). South of 57° N. lat. they fished only two squares—those nearest the Scottish coast, viz., XXIX and XXX, while to the north of the line mentioned they fished in all the squares fished by the trawlers except VII, VIII, XII and XIX. On the other hand, some fishing took place in square V, where no trawling occurred.

As one would expect, the averages for the line-fishing do not correspond to those for the trawlers. The areas in which the highest average catches were secured were IX, X, XXI, XXVI, XVI and XII that is, those at the Shetlands and to the west of them, towards the deep water, and those bordering the Norwegian deep water on the eastern side—the average for XXI being the third and that for XXVI the fourth highest. Here we see, just as in the case of the trawlers, the apparent influence of the Norwegian channel on the adjoining areas of shallower water.

The average catches per 100 lines shot for the various areas were as follows :—

V.	IX.	X.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XX.
20·0	56·7	57·1	39·7	22·0	0·00	20·6	44·5	14·7	2·45	22·2

XXI.	XXII.	XXIII.	XXIV.	XXV.	XXVI.	XXVII.	XXVIII.	XXIX.	XXX.
49·7	0·25	6·7	3·83	8·3	44·7	6·6	0·00	0·418	0·578

The fishing, for an obvious reason, was not so regularly distributed throughout the year as with the

trawlers, fishing for Halibut being concentrated for the most part in the spring months. In some of them, however, there are a number of successive months, and the following may be given :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
XIII ...	...	...	29·2	23·8	35·0	...	...	...	...	...	...	0·00
XVI ...	...	...	...	88·2	40·1	25·8	...	...	23·7	...	...	...
XVII ...	0·75	0·73	2·3	69·6	...	...	...	...	...	...	0·00	0·30
XVIII ...	0·00	0·00	2·0	1·25	8·3	8·0	...	...	...	...	0·00	0·00
XX ...	...	...	...	...	47·7	31·4	38·0	19·9	6·24	6·7	4·2	...
XXIII ...	0·20	3·25	5·66	1·9	45·7	5·25	1·96	...	2·9	...	0·04	0·14
XXIX ...	0·00	...	0·02	0·017	0·012	0·0151	2·39	2·08	0·021	0·00	0·00	0·04

The maximum, it will be observed, is in almost all cases in April and May, but there was comparatively little fishing in the autumn. In XXI, in which fishing was limited to three months, the maximum was not in May but in June ; this area borders the Norwegian Channel. The only squares for which there are complete, or nearly complete, records in the various months are XXIII and XXIX, lying off the east coast of Scotland. The curve for each is characterised by a tall cone of maximum abundance, but the period differs. In the more northern area, where the water is deeper, XXIII, the cone is in May ; in the more southern one, XXIX, it is in July and August. In the latter case the averages for the rest of the year are extremely low, so that the line is practically horizontal throughout. In XXIII there is a very slight rise or elevation in March, but from July to the end of the year the line is extremely low and level.

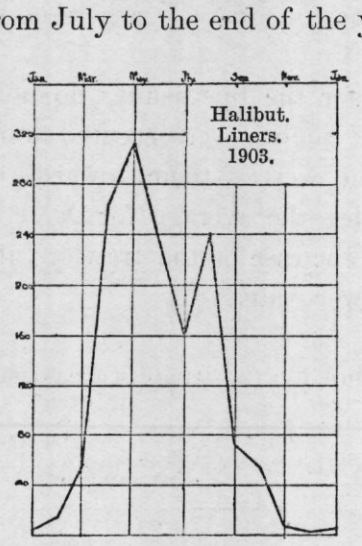


FIG. 16.

Considering now the variation according to the months, and combining the whole of the information for the year, one discovers a general correspondence to the results brought out by the trawling statistics. The averages are as follows :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·41	1·33	5·59	26·37	29·3	23·70	15·96	24·12	7·07	5·45	0·71	0·087

The curve formed by these figures (Fig. 16) has a general resemblance to the corresponding one for trawling. The line rises slowly to February, a little more rapidly in March, and then there is a steep ascent to April, and the maximum is attained in May ; from this point a rapid fall occurs to July where it is arrested by a considerable rise in August, then it falls steeply to September and more gradually thereafter to the close of the year. The base of the cone on the line of the mean extends from the beginning of April to the end of August, the depression in July just failing to reach it.

(1) MONTHLY AND ANNUAL AVERAGES OF HALIBUT (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	1·756	1·768	1·756	...	...	...	...	...	...	...	1·766
VII	...	...	1·444	2·009	1·502	...	...	...	...	...	...	...	1·847
VIII	...	...	...	2·687	1·944	...	...	...	...	1·153	...	...	2·319
IX	0 469	...	...	...	4·096	...	5·165	2·544	1·293	1·274	0·230	0·841	2·309
X	0·300	0·938	0·573	1·505	1·766	...	0·156	3·295	2·500	0·616	1·122	2·980	1·666
XI	1·594	0·934	2·094	2·119	1·668	1·860	1·532	1·875	1·967	1·932	1·069	1·420	1·845
XII	...	...	2·484	2·076	1·964	...	...	...	...	1·312	1·510	1·333	1·954
XIII	...	1·786	...	0·312	...	1·968	1·132	6·666	0·533	0·061	0·312	1·860	1·496
XIV	1·115	0·769	0·921	2·405	1·323	1·115	1·048	1·651	1·347	1·294	1·338	1·229	1·256
XV	1·230	1·298	1·548	2·439	2·158	1·434	2·135	2·674	1·794	1·707	1·830	1·238	1·665
XVI	...	2·000	1·888	1·659	1·062	...	...	...	2·500	0·238	0·811	1·250	1·372
XVII... ...	...	0·180	0·634	0·304	0·328	0·419	0·640	0·604	0·426	0·168	0·623	0·620	0·429
XVIII ...	0·801	0·442	0·529	0·261	0·595	1·107	1·364	2·620	1·718	2·191	1·864	0·734	1·231
XIX	0·854	0·680	1·454	0·872	0·863	1·384	1·542	1·504	2·105	1·415	1·004	1·061	1·125
XX	2·143	1·400	2·083	2·193	1·910	1·430	3·125	1·022	0·831	0·750	0·250	0·652	1·454
XXI	...	...	...	...	...	...	...	...	...	1·323	...	0·625	1·250
XXII... ...	...	...	...	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	0·236	0·245	0·192	0·267	0·297	0·497	0·512	0·400	0·144	0·147	0·137	0·092	0·239
XXIV ...	...	0·625	1·295	0·902	0·916	0·441	0·697	0·613	0·793	0·613	0·756	0·637	0·707
XXV... ...	...	...	0·277	2·727	2·458	1·329	1·243	0·809	0·708	0·763	0·843	0·862	1·417
XXVI ...	...	...	...	...	3·941	1·462	2·520	1·645	0·833	0·455	0·877	1·524	1·263
XXVII ...	...	...	...	...	4·250	...	...	5·921	1·637	5·208	...	...	1·861
XXVIII ...	...	0·000	0·000	...	0·111	0·559	0·388	0·000	2·083	0·000	0·250	0·000	0·262
XXIX ...	0·000	0·000	0·049	0·168	0·113	0·185	0·249	0·203	0·308	0·141	0·035	0·059	0·178
XXX... ...	...	...	...	...	...	...	0·757	0·522	0·444	0·568	0·393	0·519	0·500
XXXI ...	...	...	0·469	...	1·248	0·851	0·679	0·511	0·557	0·286	0·503	0·590	0·612

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
XXXII	...	0·937	...	...	1·760	1·275	1·932	0·724	0·589	0·442	1·014	0·651	0·950
XXXIII	...	...	...	...	...	0·379	1·111	...	1·488	1·465	...	...	0·950
XXXIV	...	...	...	...	...	...	...	0·208	0·086	0·208	...	...	0·142
XXXV	...	...	...	...	2·333	...	0·208	0·250	...	1·666	0·312	0·179	0·529
XXXVI	...	0·937	...	...	0·469	...	...	0·189	0·666	0·469	0·366	0·104	0·379
XXXVII	...	...	...	...	1·042	...	...	0·000	0·333	...	...	0·000	0·242
XXXVIII	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·208	...	...	...	...	0·208
XLIII	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(2) MONTHLY AND ANNUAL AVERAGES OF HALIBUT (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903	Total.
January	...	0·737	0·786	0·767
February	...	0·749	0·669	0·740
March	...	1·151	1·183	1·168
April	1·329	1·396	1·518	1·408
May	1·175	1·729	1·451	1·397
June	1·146	0·919	0·886	0·961
July	1·045	0·838	0·777	0·884
August	1·251	0·578	0·747	0·842
September	1·034	0·777	0·968	0·943
October	0·823	0·995	0·639	0·804
November	0·789	0·828	0·753	0·778
December	0·985	0·723	0·710	0·754
	1·064	0·938	0·896	0·949

IV. THE WHITCH OR POLE DAB (*Pleuronectes cynoglossus, L.*).

For a number of years past, since trawling was extended into somewhat deep water, the Whitch has formed an important part of the flat-fishes landed, particularly at Aberdeen. It has not yet been separately distinguished in the fishery statistics, but at Aberdeen it ranks next to Plaice as to quantity, and is third as to value, among the flat-fishes landed. It is exclusively taken by trawl.

The natural history of the Whitch is now fairly well known. Like the Lemon Dab its food consists for the most part of annelids. Thus of 150 stomachs examined which contained food, annelids were present in 72 per cent., crustacea in 20 per cent., mollusks in 14 per cent., and echinoderms in 3 per cent.* On the west coast of Ireland Holt examined 16 stomachs containing food ; annelids were present in 80 per cent., echinoderms (brittle stars) in 40 per cent., and crustacea in 26 per cent.

The Whitch is one of the summer spawners. In the western parts of the North Sea I found the duration of the spawning season to be from May to September, and chiefly in July and the latter part of June.† Cunningham found it spawning in the Clyde towards the end of June,‡ and Williamson obtained the floating eggs in Lochfyne in each month from April to August inclusive, and most abundantly in June.§ On the west coast of Ireland Holt got ripe specimens in March, April, and May, and expressed the opinion that it also spawns there in June,‖ and Herdman and Dawson describe it as spawning in the Irish Sea from May to July.¶

The number of eggs found in three specimens I examined ranged from 473,000 to 883,254,** so that its fecundity is fairly high.

Until quite lately very little was known as to the post-larval and early stages of this fish, but a large series taken by myself during the trawling investigations, and by the "*Garland*," has been recently described by Dr. H. C. Williamson.†† The post-larval or pelagic period is of long duration ; transformation is not completed until a size of over 40 mm. ($1\frac{5}{8}$ inches) is reached, and in October, November, and in January, post-larval Whitches were taken in the tow-nets in considerable numbers, in the two former months, and particularly in October, measuring from 12 mm. upwards, in Aberdeen Bay, and they doubtless occur there also in December. They evidently gradually find their way shorewards, but the small newly-transformed Whitches were only rarely taken in the fine-meshed trawl net in the in-shore waters, their proper habitat being in deeper water. Thus on 24th October, in sixty fathoms, some miles off Aberdeen, nine specimens were caught, five of which measured 42 mm., one 40 mm., one 43 mm., and the other two, in which transformation was not yet complete, 37 and 38 mm. In the Moray Firth, where the Whitch is abundant in some places, young stages measuring from 40 mm. upwards were taken on several occasions in October, November, and January, in from 30 to 50 fathoms ; and specimens a little larger were taken in the Clyde in from 35 to 52 fathoms in September.‡‡ On the Irish coast Holt caught specimens of 42 mm. in 80 fathoms in August.§§

Sufficient observations with fine-meshed nets have not yet been made in the deep offshore waters of the North Sea to decide whether or not the very young Whitches are also present in numbers there in areas where the adults are abundant. The hauls made by myself in the deep water off the Shetlands yielded only one very young Whitch, though great numbers of very small long rough Dabs were obtained—fishes which could escape through the meshes as readily as the Whitch. The specimen referred to was taken on the 10th March, in 70 fathoms, about 75 miles east of Balta Sound, midway between the

* Ramsay Smith, *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 214.

† *Eighth Ann. Rep. Fishery Board for Scotland*, Part III., p. 263 ; *Ninth Ann. Rep. Fishery Board for Scotland*, Part III., p. 264 ; *Tenth Ann. Rep. Fishery Board for Scotland*, pp. 234, 242.

‡ *Trans. Roy. Soc. Edin.*, XXXII., Part I., p. 101.

§ *Seventeenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 99.

‖ *Roy. Dub. Soc. Rep. to Council for* 1891, p. 258.

¶ Fishes and Fisheries of the Irish Sea, p. 55.

** *Ninth Ann. Rep. Fishery Board for Scotland*, Part III., p. 264.

†† *Twenty-second Ann. Rep. Fishery Board for Scotland*, Part III., p. 270.

‡‡ *Ibid.*, p. 190.

§§ *Sci. Trans Roy. Dub. Soc.*, V. (Ser. II.), p. 85.

Shetlands and Norway; it measured 59 mm., or $2\frac{3}{8}$ inches. The next smallest example measured 126 mm., and was taken in 75 fathoms, about 70 miles S.E. by E. of Sumburgh Head.*

With regard to the rate of growth, the Whitch appears to increase in length in much the same ratio as other flat fishes. From an investigation I recently made on this subject the average size of a Whitch about one year old is approximately $3\frac{1}{2}$ inches, and when two years old the length is a little under 7 inches. The size at which maturity is first reached is not yet well determined. I found females ripe at 14 inches, spent at 13 inches, and nearly ripe at $12\frac{3}{4}$ inches.† On the west coast of Ireland the smallest ripe female found by Holt was 12 inches and the smallest approaching ripeness was also 12 inches; the smallest ripe male was $10\frac{1}{2}$ inches, and the smallest approaching ripeness 10 inches.‡ On the whole, it appears probable that the female Whitch does not spawn before the fourth year, while some males may possibly become mature in their third year.§ The largest Whitch measured by me was 62·1 cm., or about $24\frac{1}{2}$ inches, but they are rare above about 55 cm.

The Whitch is widely distributed in the North Atlantic, extending from the western coast of France or the Bay of Biscay to the Trondhjem Fjord on the coast of Norway; on the other side of the Atlantic it occurs from Greenland to the vicinity of Cape Cod; it is also found at Iceland and the Faeroe Isles, all around the British coasts and the Irish coast, but is rarer in the Channel. With regard to its bathymetrical distribution, it extends from moderately shallow water into great depths. I have occasionally taken specimens in water as shallow as 10 and 12 fathoms, but it is rare under 20 or 30 fathoms, and usually inhabits greater depths. Holt took it in 144 and 220 fathoms on the west coast of Ireland, and on the south-west coast it has been obtained at 732 fathoms. On the other side of the Atlantic, the steamers of the U.S. Fish Commission have taken it at depths up to 732, 788 and 858 fathoms.‖

Distribution.

The total quantity of the Whitch taken by the recording vessels from the whole of the area where fishing operations were carried on during the three years amounted to $14{,}022\frac{3}{4}$ cwts., the general average being 5·056 cwts. per 100 hours' fishing. The fish was taken in 31 of the squares in greater or less quantity.

In this case the fish are classified as "large" and "small," and the particulars are as follow:—

—	1901.		1902.		1903.		Total.	
	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.
Large ...	$3{,}260\frac{7}{8}$	4·82	$3{,}123\frac{7}{8}$	3·837	$3{,}467\frac{1}{8}$	2·703	$9{,}851\frac{7}{8}$	3·55
Small ...	$1{,}499\frac{1}{8}$	2·217	$1{,}454\frac{5}{8}$	1·79	$1{,}217\frac{1}{8}$	0·95	$4{,}170\frac{7}{8}$	1·504
Total ...	4,760	7·04	$4{,}578\frac{1}{2}$	5·624	$4{,}684\frac{1}{4}$	3·652	$14{,}022\frac{3}{4}$	5·056

The proportion of "small" fish in this case is large, the percentages for the various years being:—1901, 31·5; 1902, 31·8; 1903, 26·0, and for the whole period, 29·75. The catch over the whole period

* *Twenty-first Ann. Rep. Fishery Board for Scotland*, Part III., p. 50.
† *Eighth Ann. Rep. Fishery Board for Scotland*, p. 161; *Tenth Ann. Rep. Fishery Board for Scotland*, p. 239.
‡ *Rep. Roy. Dub. Soc. for* 1901, p. 272.
§ *Twenty-second Ann. Rep. Fishery Board for Scotland*, Part III., pp. 193, 195.
‖ Goode and Bean, Oceanic Ichthyology, p. 430.

for both large and small together was at the rate of 5·66 lbs. per hour's fishing, being 7·88 in 1901, 6·3 in 1902, and 4·09 in 1903.

Taking the large and the small together, we find that the relative abundance of the Whitch in the different parts of the North Sea varies widely. In certain areas (XXII, XXXVIII, XLI, and XLV) none were caught, but the fishing in these areas was not extensive. On the other hand, in the deeper and central parts of the North Sea the fish was common, the averages for the three highest squares being respectively 17·513, 13·824, and 12·263 cwts. per 100 hours' fishing. Contrasting the areas north of the 50-fathom line with those south of it—that is, north and south of 58° N. latitude –we have the following results :—In the 16 northern squares the aggregate amount caught was 11,902¾ cwts. and the general average was 9·5 per 100 hours' fishing ; in the 20 southern squares the aggregate quantity was 2,120 cwts. and the general average per 100 hours was 1·394 cwts. The Whitch thus resembles the Halibut in this respect and differs from the Turbot and Brill. It differs from the Halibut, however, in that the averages do not increase as one travels northwards into deeper and deeper water, but after a point they diminish. In other words, the maximum abundance is not in the deeper water of the most northern grounds, but in those somewhat shallower to the south. Probably, however, the thing that determines the distribution of this fish is not so much the depth *per se* as the nature of the bottom ; it is most abundant on the soft clayey grounds, *e.g.*, in square XIX, on the Fladen Ground, where the maximum numbers were obtained. The same thing has been noticed in the Moray Firth—which is outside the scope of these statistics—and elsewhere, as in the Cattegat.

If we take the central squares in the North Sea from the north to the south we find the averages, as indicated, increasing and then diminishing. Thus proceeding from square VII to square XXXV the averages are successively as follow :—1·041, 5·402, 12·263, 17·513, 6·053, 3·682, 1·300. In the similar series lying further to the east—VIII to XLI—the corresponding averages are :—2·290, 3·756, 8·022, 3·264, 1·446, 1·597, 1·499, 0·000, 0·417. Taking similar series from west to east from the British to the Continental coast, we have the following from XVII to XXI :—0·701, 13·824, 17·513, 3·264, 0·921 ; from XXII to XXVII :—0·000, 0·939, 6·053, 1·446, 0·904, 0·706 ; from XXVIII to XXXIII :—0·818, 0·069, 3·682, 1·597, 1·327, 1·267, and from XXXIV to XXXVIII :—0·189, 1·300, 1·499, 0·222, 0·000. It is clear from those figures that, contrary to the conditions relating to the Lemon Dab, the abundance of the Whitch, as a rule, increases as one passes from the coast towards the central parts of the North Sea. Thus comparison of the averages and the depths of the various squares shows that the distribution is not determined solely by the latter. The area formed by 58° and 60° N. latitude and 2° E. and 2° W. longitude is that in which the Whitch is most abundant.

Seasonal Abundance.

The abundance of the Whitch varies in different areas, but in many of them a summer cone is present, and in most the position of the winter averages is high. Commencing with square XIX, lying about midway between Caithness and Norway, and containing the Fladen Ground, in which square the largest quantity was taken, 3,761⅛ cwts., and the average is highest, viz., 17·513 cwts. per 100 hours' fishing, or 19½ lbs. per hour, we find the monthly averages are these :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	20·8	23·4	13·3	15·6	28·42	11·9	10·75	14·9	17·9
1902 ...	14·48	16·41	19·12	18·26	39·13	25·6	17·77	19·0	25·0	11·66	8·33	13·49
1903 ...	17·25	13·25	9·0	26·45	41·35	31·0	35·02	18·0	23·4	16·5	7·4	16·4
	16·57	15·558	11·99	22·875	29·94	22·444	26·74	20·0	18·279	11·67	12·26	15·41

Here the compound curve resembles that for area XIV referred to below, but is not so symmetrical. Its leading feature is a large pyramid in summer with the two minimum points in March and October ; it has a bifid apex, one in May and the other in July. The line falls from a relatively low average in January to March, then rapidly rises to April and May, falls in June, rises in July, and falls thereafter to October, rising somewhat in November and December. The maximum is in May and the minimum in October, though the March average is almost as low as the latter.

The portion of the curve which is above the line of the mean for the year extends from the end of March to the beginning of September, and the centre of the base of the cone on this line is placed in June. The broad feature of the curve is, therefore, a great abundance of Whitches in this area between the months named, and especially from May to July ; there is also evidence of a small secondary maximum in winter, even in the smoothed averages. These features are also represented in the curves for the individual years, but with less regularity.

The quantity taken in square XV, lying to the north of the last, was 2,409⅞ cwts.—the second highest amount from any square, and the general average was 8·768 cwts. per 100 hours' fishing.

The monthly averages are as follow :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	6·6	13·6	15·7	16·66	14·7	10·4	23·8	18·7	20·4
1902 ...	15·31	17·97	12·54	7·5	13·64	11·85	...	8·65	11·06	10·32	10·73	12·49
1903 ...	7·88	13·4	4·85	5·0	14·0	...	...	...	...	7·0	6·64	9·65
	10·296	17·57	9·33	5·526	13·648	14·89	16·667	11·86	10·95	10·83	12·49	13·809

The curves for the individual years show little obvious uniformity except in the spring depression, but the compound curve for the three years is fairly symmetrical, showing two minima and two maxima. The central summer cone is conspicuous, as in square XIX, though smaller ; it extends on the line of the mean from May to July, or the beginning of August. It is separated from the other maximum, in February, by a deep depression in March and April, while the second minimum in September and October is not low. The averages above the mean are February, May, June, July and December, while November coincides with it.

In the adjoining square, XIV, the quantity taken was 1,675⅞ cwts., the general average being 8·77 cwts. per 100 hours' fishing. The fishing in none of the years extended over twelve months, and the curves are thus imperfect, but in each of them the summer averages are high, except in July and August 1901, while a winter cone is present in 1902–1903, and indicated in 1901–1902. The compound curve for the three years is a most symmetrical one, with a central cone having the apex in June, a deep depression on either side, and a second maximum in winter. The part above the mean extends from the end of April to the early part of August ; and the averages for January and February are above the mean, those for November and December being just below it. The periods of maximum abundance in this area are thus the middle of summer, and secondly, and to a less extent, the middle of winter, about January and December.

In other squares we get another type of curve, in which the winter characters, as above described, are emphasized, and the summer character reduced. Thus in XX, which includes part of the Fisher Bank plateau, and in which 252 cwts. were taken, the average being 3·264, the compound curve is cup-shaped

with a cone projecting from the bottom, due to the August average in 1903. The line falls from January and February, the two highest for the year, to April, and then continues irregularly level to September, rising in the three last months of the year. The months whose averages are above the level of the mean are October–February, and August. The paucity of Whitches in summer in this area, with the exception of August, 1903 (84 hours' fishing), is shown each year, and the winter cone in 1901–1903 is a very prominent one. The period of maximum abundance here is thus in winter.

This type of curve, with a winter maximum and a summer minimum, prevails in all the areas on the Fisher Bank plateau and on the south-east and south ; it may be said indeed to prevail, so far as the statistics go, to the south of a line drawn from the neighbourhood of the Firth of Forth to the Naze of Norway, that is, broadly, under 50 fathoms. In a few of these areas, as in XXV, there may be a trace of the summer cone also, but it is a mere trace. It thus appears that the maximum abundance of the Whitch in the southern part of the North Sea is in winter. It will be seen from the Tables (p. 555) that this type of seasonal distribution is found in square XXV (293 cwts. and average 1·45) where the cup is a deep one, the line curving from the maximum in March—there was no trawling in it in January and February—to the minimum in July, and rising thereafter, with a relatively high average in August, to the second highest average in December. It is also found in XXVI, XXXI (with 409¼ cwts. and an average of 1·6, and where it is well-marked), XXXII, XXXIII, and XXXVII. It may be also worth pointing out that in the three squares running from north to south in this region—XX, XXV, and XXXI—the bottom of the cup—the summer averages—becomes more uniform, the little August cusp becoming smaller and smaller.

In the squares lying to the westward, between the Fisher Bank plateau and the east coast of Scotland, the curves are not so simple. Though the winter averages are high, a summer cone is also present, and the December average is often, or usually, lower than the November one. This is also the case in XXXV and XXXVI, each of which includes a part of the Dogger Bank, though the amount of fishing there was not great ; in these indeed the line falls straight from October to December.

In square XXIII, off the coast of Aberdeen, where 321¾ cwts. were taken and the average was 0·94, the compound curve shows a maximum in winter and a second maximum in summer, the latter from July to August, though the average for July is a trifle below the mean. The period of greatest scarcity is March, April, and May, and September. The averages for January, February, October, and November are above the mean, the highest being November, while that for December is on it.

Passing now to the consideration of groups of squares and the collective results, I have tabulated the following groups for comparison :—

(1) XIV, XV, XVIII, XIX, consisting of deep water areas, south of the Shetlands. (2) X, XI, XIII, XVII, XX, the Shetland-Orkney group, with one to the east of the Shetlands and one to the north of the Fisher Bank. (3) XX, XXV, XXVI, XXVII, XXXI, XXXII, XXXIII, the Fisher Bank group. (4) XXIII, XXIV, XXV, XXIX, and (5) IX, X, XIII, XVII, XXIII, XXIX, the latter being those contiguous to the land along the east coast.

The monthly averages for these various groups are these :—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(1) ..	14·6	14·8	8·36	10·73	19·85	17·4	16·67	14·16	10·30	9·64	11·35	14·11
(2) ...	10·6	7·45	4·16	2·18	2·39	2·54	0·95	2·49	3·12	5·31	5·59	9·11
(3) ...	6·4	4·125	2·36	1·6	2·67	1·19	0·710	1·38	0·868	2·65	2·36	3·15
(4) ...	1·33	1·19	0·96	2·0	1·66	0·76	0·39	0·63	1·86	0·99	1·89	1·81
(5) ...	3·78	1·43	3·13	1·46	0·66	0·56	1·93	0·603	0·68	1·34	2·37	4·10

The quantity taken in (1) was 10,135¾ cwts., or 72·3 per cent. of the whole, the average being 13·1 ; in (2) the quantity was 1,334¼ cwts., or 9·5 per cent., the average being 3·84 ; in (3) the quantity was 1,149¼ cwts., or 8·2 per cent., and the average 1·5 ; in (4) the quantity was 1,240½ cwts., or 8·8 per cent., the average being 1·23 ; in (5) the quantity was 846⅞ cwts., or 3·2 per cent., and the average 2·37.

The curves offer great contrasts. In the first group, comprising the areas which are, *par excellence*, the " Whitch grounds," the great features are the presence of a central cone extending on the line of the mean from the end of April to the latter part of August, the apex being in May and the centre of the part cut by the line of the mean towards the latter part of August. On each side of this central cone there is a spring and autumn hollow, formed by the averages for March and April, and for September, October, and November respectively. There is a rise at the end of the year and a fall from the beginning, the averages for January, February, and December being above the mean.

In this case it is clear there are two periods of maximum abundance and two periods of minimum abundance. The greater maximum, when Whitches are specially abundant in these areas, occurring in the middle of summer, with its centre about June, and the lesser maximum occurring in winter, with its centre about January.

In the second group the curve forms a bowl-shaped hollow, sloping from the highest average in January to the lowest in July, and gradually rising thence to the second highest average in December. The summer maximum is barely indicated by a slight elevation in May and June. The three first and the three last months of the year are above the line of the mean, and the six intervening months are below it. In this case the great maximum of abundance is in winter, about December–January, and the second maximum cannot be said to exist except as a rudiment. Whitches are scarcest in the summer months, the very opposite of the condition in the first group of areas.

It is as if the Whitches in this group of areas—which lie around the " Whitch Ground " group, XIV, XV, XVIII, and XIX—moved into the latter in summer, which, as we have seen, corresponds to the spawning-period.

The curve for the third, or Fisher Bank group, is of the same type, showing a pronounced maximum in winter and a minimum in summer. In this group the averages for the three first months are all higher than the averages for the three last months, but the former depend on square XX. The curve here also suggests the possibility of migration of the Whitches in the summer-time north-west to the deeper water, or it might be elsewhere.

The curve for the fourth group is almost the exact reverse of that for the first group. There is a deep symmetrical depression in summer, between the high averages for April and September, the greatest scarcity being around July ; there is a spring cone in April and May, the average for April being the highest for the year. The winter position is also high, especially about December. In this curve the October average is low, and it is so in each of the component squares.

In the fifth group the curve is cup-shaped, with the lowest point of minimum abundance in May and June and the highest point of maximum abundance in winter, about December–Jannary. The hollow of the curve is interrupted by two cones, one formed by the March and partly by the April average, and the other one by July.

Taking now the two sections of the North Sea, as before, north and south of 58° N. lat., we have the following averages for each, the quantity taken in the northern section being 11,902¾ cwts., or 84·88 per cent. of the aggregate, and the average being 9·5 cwts. per 100 hours or 10·7 lbs. per hour, and in the

southern section 2,120 cwts., or 15·1 per cent. of the total, the average being 1·394 cwts. per 100 hours, or 1·56 lbs. per hour.

—	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
North ...	14·3	13·4	6·42	3·39	8·34	13·28	11·85	10·55	7·71	8·77	9·72	12·5
South ...	1·33	1·21	0·955	1·814	1·83	0·903	0·52	0·69	1·42	1·40	1·9	2·53

The curve for the northern section is of the characteristic "Whitch ground" type, with this difference that the summer maximum is rather less than the winter maximum. There are two maxima and two minima. The summer maximum has its highest point in June, the part above the line of the mean extending from the latter part of May to the latter part of August. The winter maximum is centred about January, which is the highest point, and the averages for November–February are above the mean. The spring minimum is about April, which is very low, and the autumn minimum is in September and October, and is not nearly so low.

The curve for the southern section has the same general features, but the incidence of the maxima and minima in relation to the period of the year show an interesting difference. The greater maximum is in winter, about December and November, and the smaller maximum is in April and May; the greatest minimum is in June, July, and August, chiefly in June. Thus the minimum in the northern section in spring is mostly represented by a maximum here, and the summer maximum in the north is represented by a summer minimum in the south. In both there is a maximum in winter, but whereas the main period in the north is in January and February, it is in December and November in the south. There are in each two waves of maximum abundance, their incidence differing by about two months in the north and the south, and the interval between them in each case is about six months from crest to crest, the spring interval being less than the summer interval.

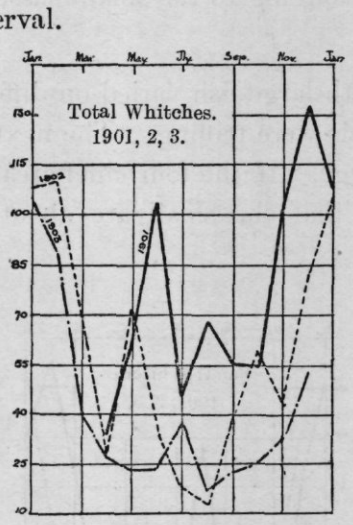


FIG. 17.

Considering now the averages for the three years as a whole, and for the whole region, we find they are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	3·446	6·242	10·261	4·640	6·774	5·656	5·418	10·230	13·199
1902 ...	10·826	10·972	6·983	2·816	7·151	3·522	1·825	1·315	3·818	5·862	4·357	8·179
1903 ...	10·511	8·869	4·041	2·697	2·443	2·438	3·806	1·704	2·316	2·560	3·279	5·195
	10·638	10·704	5·404	3·032	4·949	4·733	3·510	3·049	3·330	4·392	5·324	7·164

The compound curve for the whole period and region (Fig. 19) shows as its outstanding feature great scarcity of Whitches in summer and maximum abundance in winter, the curve forming broadly a cup-shaped depression extending from January and February to December. The summer cone, so characteristic of the northern section, and especially of the "Whitch ground" squares, is not however absent, but its relative importance to the winter cone is greatly reduced. It forms a cusp rising almost, but not quite, to the level of the mean, in May and June. The winter cone of maximum abundance has its highest point in January and February, the part above the mean extending from about the middle of November to about the middle of March. The lowest points are in April and August.

The curves for the separate years (Fig. 17) exhibit the same general characters. The winter cone in 1901–1902 and 1902–1903 is tall and conspicuous and forms in each case the maximum. The summer cone of maximum is represented in 1901 in June, in 1902 in May, and in 1903 in July, and here it is smaller. In 1901 the spring minimum (April) is lower than the autumn one, but in the other years the lowest point is in August.

The Large and the Small Whitches.

As stated above, the proportion of small fish among the total Whitches brought to the market is considerable, and it is necessary to consider briefly the facts concerning them. With regard to size, the extreme range of the "small fish" is from 14 centimetres (5½ inches) to 44 centimetres (17½ inches), these extremes of course being rare. The mean size is about 29 centimetres (11½ inches). The "large" Whitches range from extremes of 25 centimetres (10 inches) to about 57 centimetres (22½ inches), their mean size being about 38 centimetres (15 inches). The mean division between the two classes is about 33 centimetres (13 inches), the great bulk below this size being classed as "small" and the great bulk above it as "large." Practically, all the large Whitches are adult, and the same may be said of about one-third, or nearly so, of the females belonging to the small class, and the proportion of adult males in this class is still larger.

The quantity of small compared with large fish varied on different grounds. The largest proportion was in XXVIII, where however the totals were trifling. The next highest was in the chief area XIX, viz., 6·273 cwts. of small to 9·972 of large. If the four chief areas in this quarter are grouped together, XIV, XV, XVIII, XIX, then we find that the small are about half the large as to weight. In the

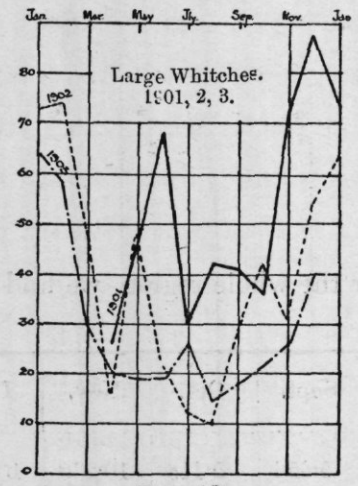


FIG. 18.

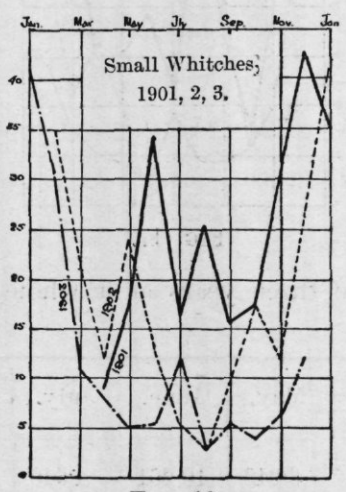


FIG. 19.

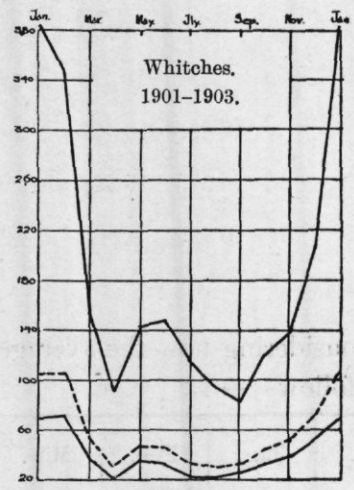


FIG. 20.

Lowermost curve. Large Whitches.
Middle curve, Total Whitches.
Uppermost curve, Small Whitches, on a scale 10 times that of the others.

deeper water areas to the north and east the proportion is about one-third, or rather less, and in the coastal series, X, XIII, XVII, XXIII, XXIX, the proportion is a little over one-third. The lowest proportion of all is found on the areas on the Fisher Bank plateau, XXV, XXVI, XXXI, XXXII, where the small Whitches scarcely exceed one-fiftieth of the large.

With regard to seasonal abundance (Figs. 18–20) the compound curves for the whole period and region are the same for the large and small fish, the features being those above described for the total fish. The main difference is that the characters are more pronounced in the curve for the large, the winter maximum being a little higher relative to the line of the mean for the year, and the spring and autumn minima lower, and thus the summer maximum more distinct.

(1) TOTAL WHITCHES.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI ...	...	...	1·351	1·460	7·621	...	...	...	...	...	...	...	2·179
VII	...	...	4·000	1·024	0·478	...	...	...	...	...	...	...	1·041
VIII	...	...	...	2·111	0·370	...	...	...	...	5·000	...	...	2·230
IX	4·062	...	...	...	1·605	...	0·934	1·959	1·299	0·243	3·670	2·602	1·802
X	9·600	2·500	10·984	1·309	0·692	...	8·750	0·000	1·878	5·458	6·651	10·758	4·047
XI	11·376	12·967	4·882	3·061	4·035	8·430	0·323	9·722	13·524	10·349	7·854	9·470	5·402
XII	...	...	5·662	2·641	3·928	..	...	...	...	3·750	1·875	1·500	3·755
XIII	...	1·250	...	4·688	...	0·000	0·881	0·000	0 461	1·108	0·000	10·295	6·671
XIV	11·239	9·546	5·184	7·916	15·042	17·355	14·263	8 873	5·931	5·953	8·345	8·579	8·768
XV	10·296	17·575	9·328	5·526	13·648	14·894	16·667	11·860	10·949	10·827	12·491	13·809	12·263
XVI	...	13·400	4·456	5·128	4·375	...	...	...	11·875	10·000	11·234	10·222	8·022
XVII... ...	...	1·622	1·886	0·579	0·473	0·891	0·032	0·385	0·000	0·225	2·196	0·088	0·701
XVIII ...	17·698	16·355	7·189	6·762	23·155	14·846	9·841	15·044	11·539	18·831	15·938	17·540	13·824
XIX	16·573	15·558	11·990	22·875	29·945	22·444	26·736	20·000	18·279	11·674	12·257	15·411	17·514
XX	6·429	7·000	3·125	1·384	2·369	1·807	1·964	4·560	1·071	5·071	5·068	5·950	3·264
XXI	...	...	...	...	...	...	...	...	...	1·029	...	0·000	0·921
XXII ...	...	...	...	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	1·443	1·155	0·336	0·607	0·434	1·259	0·915	1·159	0·434	1·005	1·635	0·743	0·939
XXIV ...	..	1·562	3·705	42·083	40·948	0·882	1·169	1·188	7·834	2·229	6·154	5·816	6·053
XXV... ...	...	...	4·444	1·818	1·479	1·043	0·720	1·845	1·585	1·625	2·165	3·767	1·446
XXVI ...	...	...	...	...	0·497	0·243	0·000	0·000	0·476	1·148	1·352	1·829	0·904
XXVII ...	...	...	...	...	5·500	...	...	0·000	0 597	4·167	...	...	0·706

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXVIII ...	...	0·000	0·000	...	0·000	0·000	0·315	0·000	31·944	0·000	0·000	0·000	0·819
XXIX ...	0·000	0·625	0·024	0·104	0·075	0·092	0·064	0·115	0·008	0·021	0·054	0·098	0·069
XXX... ...	...	...	...	...	...	...	2·525	0·522	1·599	4·301	3·358	4·073	3·682
XXXI ...	...	...	2·500	...	2·418	1·513	0·899	0·853	0·947	1·869	1·930	3·683	1·597
XXXII ...	...	1·250	...	...	3·775	1·786	0·676	1·034	0·806	1·554	1·275	0·521	1·327
XXXIII ...	...	...	...	...	...	0·757	0·000	...	0·595	3·125	...	...	1·267
XXXIV ...	...	...	...	...	...	...	...	0·000	0·341	0·000	...	...	0·189
XXXV ...	...	..	...	...	1·167	...	0·000	1·139	...	3·333	2·031	0·178	1·300
XXXVI ...	...	3·125	...	...	1·250	...	...	0·379	1·167	2·256	1·799	0·677	1·499
XXXVII ...	...	...	...	...	0·833	...	...	0·000	0·000	...	...	0·171	0·222
XXXVIII ...	...	. .	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	. .	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	...	...	0·417	...	...	...	...	...	...	...	...	0·417

(2) LARGE WHITCHES.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	0·811	1·204	0·509	...	...	...	...	...	...	...	1·726
VII	...	...	3·111	0·807	0·478	...	...	...	...	...	...	...	0·845
VIII	...	...	...	1·439	0·370	...	...	...	...	3·461	...	...	1·590
IX	1·562	...	...	...	1·605	...	0·714	1·006	0·807	0·243	3·670	2·093	1·324
X	7·000	2·321	6·229	1·079	0·692	0·000	5·625	0·000	1·267	2·817	5·134	5·492	2·709
XI	8·188	8·791	3·222	2·267	2·830	5·814	0·323	7·500	9·672	8·292	5·645	7·197	3·882
XII	...	...	2·558	2·751	3·214	...	...	...	...	3·625	1·771	1·333	3·044
XIII	...	1·250	...	3·437	...	0·000	0·535	0·000	0·390	1·108	0·000	7·697	5·021
XIV	6·716	6·385	3·754	5·511	10·756	11·591	8·594	5·845	4·208	4·170	5·105	5·764	5·791
XV	9·046	11·765	6·609	4·203	9·106	9·557	11·250	7·500	8·009	7·711	8·831	9·148	8·545
XVI	...	1·600	3·436	4·091	3·250	...	...	...	8·750	7·143	8·766	8·167	6·245
XVII... ...	...	1·382	0·423	0·481	0·442	0·891	0·032	0·275	0·000	0·225	1·599	0·089	0·534
XVIII ...	12·275	11·387	5·093	4·905	16·964	10·047	6·371	8·742	8·254	12·114	10·932	11·390	9·176

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XIX	9·083	9·665	8·710	14·909	19·564	13·294	16·756	15·800	13·848	7·783	8·936	9·972	11·244
XX	5·714	3·400	2·468	1·192	1·757	1·687	1·964	4·559	1·071	3·714	4·083	4·593	2·591
XXI	...	...	...	...	...	...	...	...	...	1·029	...	0·000	0·921
XXII ...	...	...	...	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	1·099	1·046	0·279	3·395	0·375	1·067	0·825	0·769	3·382	0·851	1·202	0·533	0·728
XXIV ...	...	1·250	2·982	23·555	24·353	0·882	1·169	1·086	5·452	1·862	4·664	4·784	4·311
XXV	...	...	4·444	1·818	1·357	1·038	0·720	1·506	1·396	1·596	2·032	3·065	1·356
XXVI ...	...	...	...	...	0·497	0·243	0·000	0·000	0·476	1·105	1·342	1·829	0·901
XXVII ...	...	...	...	...	4 500	...	0·311	0·000	0·538	4·167	...	...	0·628
XXVIII ...	...	0·000	0·000	...	0·000	0·000	0 054	0·000	18·055	0·000	0·000	0·000	0·492
XXIX ...	0·000	0·625	0·024	0·103	0·058	0·092	2·525	0·111	0·007	0·021	0·054	0·098	0·065
XXX	...	...	...	...	...	...	...	0·522	1·481	4·106	3·347	3·815	3·491
XXXI ...	...	...	2·500	...	2·326	1·469	0·899	0·853	0·934	1·869	1·894	3·499	1·563
XXXII ...	...	1·250	...	...	3·776	1·326	0·676	1·034	0·806	1·393	1·275	0·521	1·256
XXXIII ...	...	...	...	...	...	0·757	0·300	...	0·595	2·148	...	...	0·979
XXXIV ...	...	...	...	...	...	...	...	0·000	0·347	0·000	...	...	0·189
XXXV ...	...	...	...	...	1·000	...	0·000	1·139	...	3·333	2·031	0·178	1·286
XXXVI ...	...	3·125	...	...	1·250	...	...	0·379	1·167	1·730	1·707	0·677	1·343
XXXVII ...	...	...	...	...	0·833	...	...	0·000	0·000	...	...	0·107	0·222
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	...	...	0·417	...	...	...	...	...	...	...	...	0·417

(3) SMALL WHITCHES.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	0 541	0·256	1·622	...	...	...	...	...	...	...	0·454
VII	...	...	0·889	0·217	0·000	...	...	...	...	...	...	...	0·196
VIII	...	...	...	0·672	0·000	...	...	...	...	1·538	...	...	0·700
IX	2·500	...	...	...	0·000	...	0·220	0·953	0·492	0·000	0 000	0·509	0·478

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
X	2·600	0·178	4·754	0·230	0·000	0·000	3·125	0·000	0·611	2·641	1·517	5·263	1·337
XI	3·188	4·176	1·661	0·794	1·205	2·616	0·000	2·222	3·852	2·057	2·209	2·273	1·520
XII	...	...	1·442	0·566	0·714	...	...	...	...	0·125	0·104	0·167	0·711
XIII	...	0·000	...	1·250	...	0·000	0·346	0·000	0·071	0·000	0·000	2·598	1·650
XIV	4·504	3·161	1·430	2·405	4·454	5·764	5·668	3·028	1·723	1·783	3·240	2·815	2·977
XV	1·250	5·809	2·719	1·323	4·541	5·338	5·417	4·360	2·940	3·386	3·660	4·747	3·718
XVI	...	2·800	1·020	1·091	2·125	...	...	...	3·125	2·857	2·468	2·055	1·776
XVII... ...	...	0·240	0·962	0·099	0·031	0·000	0·000	0·110	0·000	0·000	0·596	0·000	0·166
XVIII ...	6·091	4·968	2·096	1·857	6·190	4·799	3·476	6·302	3·284	6·717	5·012	6·150	4·647
XIX	7·490	5·893	3·289	7·982	10·382	9·150	9·979	4·120	4·431	3·930	3·321	5·438	6·273
XX	0·714	3·600	0·657	0·192	0·611	0·120	0·000	0·000	0·000	1·357	0·985	1·357	0·673
XXI	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XXII ...	...	...	..	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	0·341	0·109	0·058	0·212	0·060	0·192	0·163	0·389	0·051	0·154	0·433	0·209	0·211
XXIV ...	...	0·312	0·723	19·028	16·681	0·000	0·000	0·402	2·382	0·367	1·489	1·031	1·743
XXV... ...	...	...	0·000	0·000	0·124	0·005	0·000	0·339	0·186	0·027	0·133	0·575	0·090
XXVI ...	...	...	...	...	0·000	0·000	0·000	0·000	0·000	0·000	0·010	0·000	0·003
XXVII ...	...	...	...	...	1·000	..	0·000	0·000	0·059	0·000	...	...	0·078
XXVIII ...	...	0·000	0·000	...	0·000	0·000	0·000	0·000	13·889	0·000	0·000	0·000	0·328
XXIX ...	0·000	0·000	0·000	0·000	0·017	0·000	0·010	0·004	0·000	0·000	0·000	0·000	0·004
XXX... ...	...	..	...	...	...	...	0·000	0·000	0·118	0·194	0·011	0·258	0·191
XXXI ...	...	...	0·000	...	0·092	0·043	0·000	0·000	0·014	0·000	0·036	0·184	0·034
XXXII ...	...	0·000	...	...	0·000	0·459	0·000	0·000	0·000	0·161	0·000	0·000	0·070
XXXIII ...	...	...	...	...	...	0·000	0·000	...	0·000	0·977	...	...	0·288
XXXIV ...	...	...	...	...	...	...	...	0·000	0·000	0·000	...	...	0·000
XXXV ...	...	...	...	...	1·667	...	0·000	0·000	...	0·000	0·000	0·000	0·014
XXXVI ...	...	0·000	...	...	0·000	...	..	0·000	0·000	0·501	0·091	0·000	0·156
XXXVII ...	...	...	...	...	0·000	..	...	0·000	0·000	...	...	0·000	0·000
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(4) TOTAL WHITCHES.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Month.	1901.	1902.	1903.	Totals.
January	...	10·826	10·511	10·638
February	...	10·972	8·869	10·704
March	...	6·983	4·041	5·404
April	3·446	2·816	2·697	3·032
May	6·242	7·151	2·443	4·949
June	10·261	3·522	2·438	4·733
July	4·640	1·825	3·806	3·510
August	6·774	1·315	1·704	3·049
September	5·656	3·818	2·316	3·330
October	5·418	5·862	2·560	4·392
November	10·230	4·357	3·279	5·324
December	13·199	8·179	5·195	7·164
	7·038	5·624	3·652	5·056

(5) LARGE WHITCHES.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Month.	1901.	1902.	1903.	Totals.
January	...	7·322	6·444	6·797
February	...	7·443	5·805	7·234
March	...	4·855	2·964	3·840
April	2·559	1·602	2·021	2·126
May	4·491	4·775	1·892	3·512
June	6·838	2·223	1·893	3·258
July	3·002	1·255	2·586	2·340
August	4·214	0·972	1·405	2·086
September	4·092	2·882	1·769	2·489
October	3·654	4·196	2·137	3·209
November	7·210	3·146	2·645	3·936
December	8·885	5·375	3·984	5·079
	4·821	3·837	2·703	3·552

(6) SMALL WHITCHES.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Month.	1901.	1902.	1903.	Totals.
January	...	3·504	4·067	3·841
February	...	3·529	3·064	3·470
March	...	2·128	1·077	1·564
April	0·887	1·214	0·676	0·906
May	1·751	2·376	0·511	1·437
June	3·423	1·299	0·545	1·475
July	1·638	0·570	1·220	1·171
August	2·560	0·343	0·299	0·963
September	1·564	0·936	0·547	0·841
October	1·764	1·666	0·423	1·183
November	3·020	1·211	0·634	1·388
December	4·314	2·804	1·211	2·085
	2·217	1·787	0·949	1·504

V. THE MEGRIM, OR SAIL-FLUKE (*Zeugopterus* (*Arnoglossus*) *megastoma*, Donovan).

The commercial importance of this fish is less than that of most of the other flat-fishes. The quantity and value of those landed are not distinguished in the official returns, but at Aberdeen the total amount is about 11,000 cwts. per annum, the value being about £11,000, and they are all taken by trawlers.

Like the Halibut, the Megrim feeds for the most part on fishes. In 59 stomachs containing food examined by Holt on the west coast of Ireland, 86 per cent. contained the remains of fish, 23 per cent. crustacea, in one was a cephalopod, and in another an annelid. The kinds of fish eaten appear to depend on the depth of the water; in shallow water they were mostly, as with the Turbot and Brill, Sand-Eels and Sprats, and in deeper water the Norway Pout and others.*

With regard to the period of spawning, Holt found on the west coast of Ireland that it spawned in March, April, and May, and probably to some extent in June, and ripe females were taken in depths of 53, 154, and 200 fathoms, and some nearly mature in 22 fathoms. He concludes that it spawns in moderately deep or deep water. He records mature females at 12 inches in length, the male becoming mature at a smaller size, probably as small as 9½ inches.† My own observations on more limited material furnished a ripe female at 18 inches, and one nearly mature at 15 inches.‡

So far as I am aware, the number of eggs has been determined in only a single specimen, 18 inches in length; they numbered 440,600.§

* *Roy. Dubl. Soc. Rep.*, 1901, p. 315.
† *Ibid.*, p. 258.
‡ *Eighth Ann. Rep. Fishery Board for Scotland*, Part III., p. 162; *Tenth Ann. Rep. Ibid.*, p. 239a.
§ *Ninth Ann. Rep. Ibid.*, p. 263.

Little is known about the younger stages of this form or as to the rate of growth, and it is to Holt again that our knowledge is due. He got a number of small forms, some undergoing transformation, in 80 fathoms, off the Skelligs, on the west of Ireland, on 19th August; they ranged in size from 19 to 56 mm. Others were obtained during the survey which measured up to 180 mm. Holt estimates the age of the specimens from 19 to 56 mm. at from three to seven months, belonging thus to the preceding spawning-period; those from 75 to 130 mm. (3–5⅛ inches) he reckons to belong to the previous year, and were about 15 to 19 months old; while the specimens from 150 mm. to 250 mm. (5⅞–9⅞ inches) he considers to be from 27 to 31 months old.* The growth of the Megrim, as with other flat-fishes, is thus rather slow.

Its distribution appears to be less extensive than some of the other flat fishes. It is found fairly abundant in the deep water as far south as the Bay of Biscay, off the coast of Spain, Morocco, and the Azores; in the north it is found as far at least as Bergen, Norway, and in the Skagerack, also at Iceland and the Faeroes, and on the west off the west coast of Ireland. As indicated above, the Megrim is rather a deep water fish. During the Irish survey it was taken in depths from 4 to 220 fathoms; I have taken it in the Moray Firth and Aberdeen Bay in from 7 and 10 fathoms upwards, but in small numbers. It is much more abundant, as the following records will show, in the deep water in the northern part of the North Sea.

Distribution.

The aggregate quantity of Megrims caught by the recording vessels in the three years from the whole of the area amounted to 7,547 cwts., the general average being 2·728 per 100 hours' fishing. Megrims were taken in greater or less numbers in 30 of the squares, the particulars being as follow:—

—	1901.		1902.		1903.		Total.	
	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.
Large ...	1,652⅞	2·44	1,601¾	1·97	2,600⅜	2·027	5,855	2·118
Small ...	417⅛	0·617	432⅝	0.531	841½	0·656	1,692	0·610
Total ...	2,070¾	3·062	2,034⅜	2·499	3,441⅞	2·68	7,547	2·728

The percentage of the large and small varied a little in the different years, the small being 20·2 in 1901, 21·3 in 1902, and 24·5 in 1903, the percentage for the whole period being large 77·6, small 22·4. The aggregate of both kinds shows that in 1901 Megrims were taken at the rate of 3·43 lbs. per hour's fishing, in 1902 at 2·8 lbs., and in 1903 at 3·0 lbs., the mean for the three years being 3·05 lbs. per hour.

The areas in which no Megrims were taken were XXII, XXXIV, XXXVII, XXXVIII, XLI, XLIII; but the amount of fishing in these squares was not great, the largest number of hours in any of them being 620 in XXXVII.

The squares with the highest averages are those in the northern parts of the North Sea, where the water is relatively deep. Thus the averages for VI, VII, and VIII, the three northern most areas, were 23·169, 16·092, and 14·822 cwts. per 100 hours' fishing; this was, however, in the spring months when

* *Trans. Roy. Dubl. Soc.*, V. 72.

the Megrim as a rule is most abundant. A still higher average was in square XIII, north of the Orkney Isles, where it was 37,605, but this exceptional figure depends on the enormous average for December 1903, when in 1,780 hours' fishing 1,078¾ cwts. were caught.

As one proceeds towards the south the averages rapidly diminish, and contrary to the experience in some other cases the averages of the areas bordering the Norwegian deep channel are less than those in the areas next to them towards the west. Passing down the central part of the North Sea from square VII to XXXV—that is, from north-east of the Shetlands to off the coast of Northumberland, the averages are as follows in succession :—16·092, 8·471, 1·570, 1·388, 0·901, 0·117, 0·086. The averages along the corresponding areas further to the east, from VIII, near the Norwegian coast, north of 61 N. latitude, to XLV south of the Dogger, are in succession these :—14·822, 6·403, 1·495, 0·288, 0·069, 0·023, 0·231, 0·000, 0·833. The averages transversely, from west to east, between the British and the continental coasts are as follows :—(1) from the Moray Firth to the coast of Jœderen, Norway, squares XVII to XXI, 1·451, 8·351, 1,388, 0·288, 0·066 ; (2) from Aberdeenshire to the Skagerack, squares XXIII to XXVII, 1·664, 0·901, 0·069, 0·013, 0·005 ; (3) from the south-east coast of Scotland to Jutland, squares XXVIII to XXXIII, 0·688, 0·193, 0·117, 0·023, 0·158, 0·115 ; (4) from the coast of Northumberland, squares XXXIV to XXXVIII, 0·000, 0·086, 0·231, 0·000, 0·000.

Comparison of the aggregate catch and the general average for the 16 squares north of 58° N. latitude, that is, beyond the 50-fathom line, and the 20 squares south of it, where the depth almost everywhere is under 50 fathoms, shows the great preponderance of Megrims in the deeper northern areas. The total quantity taken in the former was 6,765⅝ cwts., the general average being 5·401 cwts. per 100 hours' fishing, while in the southern moiety of the North Sea the quantity was 781⅜ cwts. and the average only 0·514 cwts. per 100 hours' fishing. In the northern portion Megrims are thus more than ten times more numerous than in the southern part. I have been informed by trawlers that they get large catches of Megrims at depths a little over the 100-fathom line, that is, in the deepest water in which they fish, and it is not improbable that the averages in these depths would exceed those in depths below 100 fathoms.

Seasonal Abundance.

Beginning again with the squares in which the quantity taken was large and the fishing well distributed throughout the year, we find that in XVIII, lying off the Moray Firth, the total quantity was the largest of any area, viz., 1,382¼ cwts., the general average being 8·351 cwts. per 100 hours' fishing, or 9·35 lbs. per hour. There was trawling in each month of the year, the averages being as follow :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	6·3	38·8	7·4	3·56	5·5	5·8	2·9	3·8	6·1
1902 ...	4·47	9·93	13·95	15·15	...	...	3·6	0·00	1·84	0·00	2·3	1·39
1903 ...	1·1	11·4	18·3	...	...	20·0	3·8	4·94	25·2	11·88	6·3	...
	4·039	10·059	14·495	9·000	38·81	11·848	3·656	4·771	7·195	3·977	3·700	4·649

The trawling was not complete in each year, there being blanks in May and June, 1902, and in April and May, 1903. In each year, however, there is clear evidence of the presence of a cone of maximum abundance in spring. In 1901 it is formed by the average for May, those for April and June being low ; in the other years the parts of the curves that exist also reveal its presence. During the rest of the year, from

June, 1901, and July, 1902, the line of averages is low and irregular, showing minimum abundance of Megrims ; in 1903 there is a cone in autumn formed by the averages for September and October, but the amount of fishing was limited (121 and 177 hours respectively), and there is no distinct trace of it in the other years. The compound curve shows a period of maximum abundance in spring, very pronounced, the part above the mean extending from February to June, the position in May being very high. From July to the end of the year the line is low and nearly level, save for a slight elevation in September, as above described, and January is equally low. In this area, then, Megrims abound in spring, and are scarce at other times of the year.

In XIV lying between the above area and the Shetland Isles the curve is much the same. The quantity taken was 621¼ cwts., the average being 3·254 cwts. per 100 hours' fishing, and there was trawling in each month in one or the other of the years. The following are the monthly averages :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	7·8	16·4	2·6	1·07	1·2	2·3	4·6	1·9	2·14
1902 ...	2·34	3·47	3·50	15 0	2·08	...	...	0·63	2·3	1·91	1·33	1·37
1903 ...	0·55	3·06	8·06	6·4	...	...	1·25	...	4·4	3·6	3·02	5·4
	0·811	3·463	6·655	8·317	9·159	2·624	1·129	1·021	3·491	3·219	2·265	3·662

The compound curve in this case closely resembles that for square XI, described below, there being a large cone in the early part of the year, a depression in late summer, and a secondary cone in autumn. It differs, however, in the latter being relatively smaller. From the January position, which is the minimum, the line rises to May, where the maximum occurs, then there is a rapid descent to June and July, the average for the latter being a trifle higher than that for August, which is the second lowest ; the line then rises abruptly to September, sinks a trifle in October, somewhat more in November, and then rises in December. The curves for the individual years are not in any of the years complete, but so far as they exist they agree with the compound one.

In this area, then, Megrims abound in spring, especially April and May, are very scarce in summer, about July and August, increasing a little in autumn, and they are scarce in winter.

In XI, lying to the east of the Shetlands, the spring cone of maximum abundance also predominates. The quantity taken was 989 cwts., the average being 8·47, and in each year the maximum abundance of Megrim is in spring. In 1901 the highest position is in April and May, in 1902 it is in May and June, there being a sudden descent from 22·0 in the latter month (100 hours' fishing) to July with 0·0 (75 hours' fishing) ; in 1903 the maximum was in May, and there was no fishing in June. The minimum in the first two years was in August, and in each of the three years the averages after are higher, but not very regular. The compound curve for the three years is very symmetrical, presenting two maxima and two minima. The spring cone is symmetrical, the line rising from a low point in January to the maximum in April–May, and descending regularly to the minimum point in August. There is a smaller but distinct cone of maximum in October–November. The part above the level of the mean is from the end of March to the end of June, the centre of the cone being at the end of April and the beginning of May, and also to a much smaller extent October and November. The period of chief scarcity is from July to September, and mostly in August, the second period of scarcity is from December to February, and mostly in January.

This type of curve is also present in square XXIV, where the fishing was less regular, the compound

curve showing a chief maximum in March–May, and mostly in April, and a secondary maximum chiefly in September, the periods of scarcity being June–July, and, less marked, October–February, but there was no fishing in January.

It is also seen in XIX to the north of the above, in this case the autumn cone being emphasised. In 1901 and 1902 there are two periods of maximum abundance, the first in both years in May, and the second, also in both years, in August–September. In 1903 the autumn cone is the outstanding feature, from August to October, with the highest point in September, the spring cone being represented by a rudiment in May. The compound curve shows the two waves of maximum abundance, the crests in May and September, and a period of scarcity from October to March. Thus the periods of maxima are close together but they are very distinct.

In the above square there is a suggestion, especially in 1901–1902, of a slight rise in winter, and in those in contiguity with the east coast of Scotland we find this character well developed, as in XIII, XVII, XXIII, and XXIX, passing finally into the cup-shaped "Whitch type" of annual curve.

In the least modified of these, XXIII, off the coast of Aberdeen, the spring cone referred to above is conjoined with a second high maximum in winter. In 1901 the spring cone is formed entirely by the June average, which is also the maximum for the year ; in 1902 it is formed principally by the May average, but also by that of June ; and in 1903 it is formed by the June average. In each case it is the highest for the year, but the wave of maximum numbers of Megrims is strictly limited in time—to a month or little more. The winter maximum is less intense and more prolonged. In 1901–1902 it may be said to extend from August to February, but the August average in 1901 is exceptionally high, the highest point is January to February, 1902. In the winter 1902–1903 it is more regular, extending from October to March, the highest part being December to February. In the winter months of 1903, however, there is a change, for the averages are then low. The compound curve is a little complex. There are two periods of maxima, viz., January to February and May to June, the position in the three last months of the year being rather under the mean owing to the low averages in 1903. The lowest point is in April and the next September, while the August position is up to the mean due to the exceptional average in 1901.

In XVII the fishing in the various years was rather irregular and there was none in January. The curve for the three years combined is cup-shaped, the line falling from the second highest average in February to the minimum in autumn and rising to the maximum in November. The November position depends on the fishing in 1901 and 1903, and the low December average is due to 1903 (33 hours) and is probably imperfect. Here, then, we have great scarcity of Megrims in summer and abundance in winter. The spring cone is not, however, entirely obliterated, it exists as a cusp in the bottom of the cup formed by the average in May.

In XIII, where the fishing was still less regular, the annual curve is of the same form, showing a great abundance of Megrims in winter and scarcity in summer ; in December, 1903, the average was the phenomenal one of 60·6 cwts. per 100 hours' fishing (1,780 hours), while none at all were got in June, July, and August (275 hours). There was no fishing in May in any of the years.

In XXIX also, lying along the east coast of Scotland, we find the same type. There is one great wave of maximum abundance in winter, here limited to a few months, and great scarcity during the rest of the year, most marked in July and August. Only in one of the years, 1901, is there a little cusp indicated in April to June to suggest the spring cone so common in many squares.

I may here say that these facts are in agreement with the conclusions drawn from my investigations in the Moray Firth, both Megrims and Whitches being more abundant in the winter months, and extending

then into comparatively shallow water. The facts suggest the hypothesis of a shoreward migration in winter and an offshore migration in spring and summer, especially at the spawning-season.

In the areas on the Fisher Bank plateau Megrims are very scarce (Table, p. 414). So far as the scanty information serves they seem to be most numerous in autumn and are practically absent in winter. None of the curves for this part of the North Sea shows the cup-shaped form so characteristic of the Whitch in the same region. Megrims were not taken in the south-eastern squares.

Combining now the squares into groups as in the former cases I have made the following groups :—

(1) A deep water group in which the fish is most abundant, XI, XII, XIV, XV, XVI, XVIII, XIX. The quantity caught in these areas was 3,742 cwts., or 49·5 per cent. of the whole, the average being 4·42 per 100 hours' fishing.

(2) A coastal group, IX, X, XIII, XVII, XXIII, XXVIII, and XXIX. The quantity taken here was 2,524⅛ cwts., or 33 per cent., the average being 7·94 (including the great catches in December in XIII).

(3) A Fisher Bank group, XXV, XXVI, XXXI, and XXXII. The quantity was only 32⅛ cwts., or 0·5 per cent., and the average 0·066 cwts. per 100 hours.

The monthly averages for these groups are as follow :—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(1) ...	1·6	3·34	5·04	7·01	12·2	5·11	1·93	2·09	3·33	3·59	2·05	2·19
(2) ...	3·75	4·26	2·58	3·16	6·06	1·22	0·89	0·57	1·89	0·67	5·77	13·0
(3) ...	...	0·00	0·00	0·00	0·16	0·11	0·003	0·46	0·04	0·1	0·020	0·012

In the first group the curve shows one period of great maximum abundance in April and May, the highest point being in May, and the averages for the four months, March to June, above the level of the mean for the year. There is also a small cusp in autumn, in September and October, but not rising quite to the level of the mean. The minimum periods are in winter, from November to January, and in July and August, the averages for these five months being on nearly the same level. While the apex of the tall spring cone is in May the central ordinate on the base is at the end of April or beginning of May.

In this part of the North Sea, then, where Megrims are most abundant, the period of their greatest numbers coincides with the spawning-season.

In the second group the curve is different. The spring cone is indeed present, formed by the May average and partly by that of April, its apex (May) being the second highest of the year, only inferior to December ; but the rest of the curve partakes of the "Whitch" type. The period of greatest abundance is winter, November to February, especially December, from the high average for XIII. If this be excluded the November average is a little higher than that for December (5·066) which is third, but the exclusion is unnecessary. The period when Megrims are very scarce is from July to October, but the September average makes a small cusp in the floor of the hollow.

In the third group the quantities represented are very small, and the curve (quite unlike the corresponding curve for Whitches) shows maximum abundance in August ; there is also a minute cusp in May to June. The minimum is from November to April ; there was not any trawling, however, in January.

Megrims, obviously, do not appear in numbers on the shallower eastern and south-eastern parts of the North Sea in winter, as the Whitch does.

Contrasting in similar fashion all the squares north and south of 58° N. latitude we have the following averages :—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
North ...	1·51	3·83	6·19	10·28	8·32	4·52	1·56	2·41	4·26	2·36	2·71	8·87
South ...	3·14	2·85	1·10	0·44	0·53	0·43	0·14	0·40	0·35	0·44	0·37	0·64

In the northern section the quantity of Megrims taken was 6,765⅝ cwts., or 89·67 per cent. of the total, the average being 5·401 cwts. per 100 hours' fishing, or 6·05 lbs. per hour ; in the southern section the quantity was 781⅜ cwts., or 10·33 per cent. of the whole, the average being 0·514 cwts. per 100 hours' fishing, or 0·6 lb. per hour.

In the northern section the character of the curve is a great spring cone extending on the mean from the end of February to the middle of June, the apex is in April, and the central ordinate on the line of the mean about the middle of April. There is a small cusp with the apex in September barely touching the mean, and the high average for XIII in December carries up the end of the curve to a high point.

In this region as a whole, then, the chief character is abundance of Megrims from February to June, the spawning-season, with scarcity during the remainder of the year, especially in July and August, except in December.

The character of the curve in the southern section is different. In January and February the line is very high ; there is a sudden descent in March and April, and thereafter the line continues fairly level to the end of the year, the lowest point being reached in July. In the region as a whole, then, there is relatively great abundance of Megrims in January and February, and to a less extent in March, and scarcity during the rest of the year.

Summing up the information for the whole of the North Sea, fished over by the recording vessels, we have the following averages for the three years and for the whole period :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	6·627	6·141	2·899	0·751	2·072	1·888	1·313	1·490	2·522
1902 ...	3·448	3·786	7·430	10·871	2·962	0·838	0·275	0·225	0·544	1·165	0·519	1·064
1903 ...	0·995	2·459	3·210	7·423	3·034	1·486	0·494	0·525	1·771	1·200	1·800	6·444
	1·974	3·617	5·165	8·032	4·260	1·698	0·515	0·882	1·540	1·219	1·397	4·480

The curves for the separate years present the same characters, with the exception of December, 1903. The outstanding feature is a great spring cone of maximum abundance and a summer period of scarcity, In each year the apex of the tall narrow cone is in April (Fig. 20). In each year all the averages after May are below the mean for the year (except December, 1903), and the period of greatest scarcity is in July–August. In each year there is a small cusp in the autumn hollow, in 1901 in August–September, in 1902

in October, and in 1903 in September. The winter averages are higher than those in summer, but only in three months (January, February, 1902 ; December, 1903) do they exceed the mean for the year.

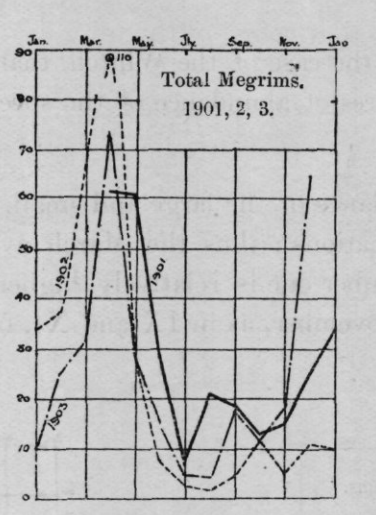


FIG. 21.

Finally, the curve for the whole region and period (Fig. 23) shows the same features—a cone of maximum abundance in spring, extending on the line of the mean from the beginning of February to the end of May, and with the apex, denoting greatest numbers of fish, in April. From June to November there is scarcity of fish, most marked in July and August ; there is a slight elevation in September, the trace of the cusp so often referred to, while in December the line runs above the mean, owing to the average in XIII, previously described.

Large and Small Megrims.

The description above given refers to the total quantity of Megrims, irrespective of the size of the fish. It has been stated (p. 561) that the "small" Megrims form about 22 per cent. of the total and the "large" about 78 per cent. The size of the small fish range from the extremes of about 17 cm. ($6\frac{3}{4}$ inches) to 42 cm. ($16\frac{1}{2}$ inches), their mean size being about 30 cm. ($11\frac{3}{4}$ inches). The large Megrims range from about 29 cm. ($11\frac{1}{2}$ inches) to about 61 cm. (24 inches), their mean size being approximately 41 cm. (16 inches). The point of division lies about 35 cm. ($13\frac{3}{4}$ inches) ; the great proportion of those above that size are "large" and the great proportion below it are "small."

With regard to the distribution of the large and small fish, the proportion varies a little on different squares. In those in which the fish are most numerous the proportion of small is as a rule highest. In XIII the small were in a high ratio, nearly half, and in the deep water northern areas they usually formed about one-third of the large. In IX, indeed, the averages for the two were not very different, viz., 1·7 for the large and 1·21 for the small. In XI, XII, XIV, XV, XVIII, the principal areas, the proportion is rather under a third by weight. In XVIII it is a little over a third. In those embracing coast there is a difference according to the position in the north or south. Thus in XIII, as we have seen, the ratio is very high, and in XVII it is over a third ; but in XXIII the proportion of the small to the large is about one-seventh, in XXIX it is about one-sixteenth, in XXVIII one-tenth. As one passes towards the eastern side of the North Sea the proportion also diminishes. In XIX it is about one-eighth, in XX about one-

sixth, in XXIV one-ninth, in XXXII one-twelfth, in XXXI over a twentieth, while the Megrims caught in squares XXVI, XXX, XXXIII, and XLV, or at least brought to market, were all large, but the quantities taken there were small.

Nevertheless the facts show, as in the case of the Whitch, that the large fish predominate more and more as one passes from the chief centres of abundance of the species. The fact is not without a bearing on the problems of migration.

With regard to the seasonal abundance of the large and small, the curves for the whole period are the same (Fig. 23) with insignificant variations; thus the March average for the small is nearer the April one than with the large, and the November one is relatively higher. In some of the squares the small fish are relatively more numerous in November, as in IX and XI, or in December, as in XIII; but stress cannot at present be laid on this.

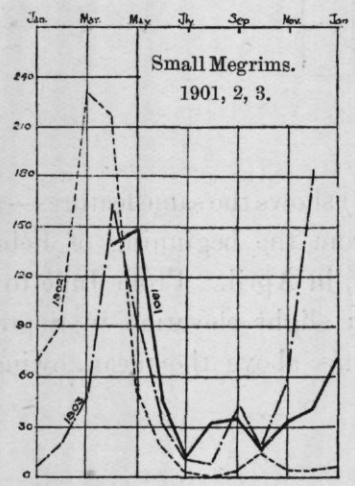


FIG. 22.

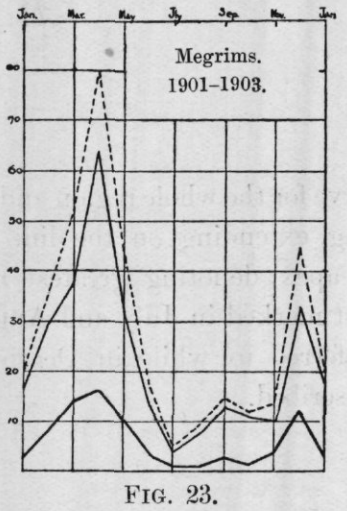


FIG. 23.

Total Megrims .....
Large Megrims ———
Small Megrims ———

(1) TOTAL MEGRIMS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	19·054	21·292	39·189	...	...	...	...	...	...	..	23·169
VII	...	...	6·778	16·667	16·496	...	...	...	...	...	...	...	16·092
VIII	...	...	...	17·610	15·741	...	...	...	...	2·692	...	...	14·822
IX	4·375	...	...	...	6·926	...	0·522	0·371	1·693	0·242	15·367	3·932	2·905
X	5·600	7·857	8·852	11·604	24·723	...	4·062	0·000	8·416	1·496	16·774	22·678	11·670
XI	1·268	2·802	5·632	10·991	12·143	6·104	2·419	0·139	0·819	6·172	5·487	2·715	8·471
XII	...	...	3·339	13·491	17·321	...	...	...	...	4·875	0·938	1·667	6·403

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XIII	...	71·875	...	2·750	...	0·000	0·087	0·000	0·852	0·000	1·250	60·604	37·605
XIV	0·811	3·463	6·655	8·317	9·159	2·624	1·129	1·021	3·491	3·219	2·265	3·662	3·254
XV	1·070	1·525	1·926	3·941	2·556	2·342	1·667	2·035	1·565	1·223	1·012	0·985	1·570
XVI	...	1·000	3·871	0·704	1·000	...	...	...	0·625	5·000	0·162	0·944	1·495
XVII... ...	...	4·207	1·692	0·961	1·999	0·511	0·112	0·549	0·000	1·351	5·287	1·241	1·451
XVIII ...	4·039	10·059	14·495	9·000	38·810	11·848	3·656	4·771	7·195	3·977	3·700	4·649	8·351
XIX	0·802	1·205	0·389	1·707	4·418	2·616	0·767	2·500	6·278	0·684	0·798	0·738	1·388
XX	0·000	2·000	0·233	1·107	0·210	0·090	0·000	0·472	0·000	0·359	0·125	0·365	0·288
XXI	...	...	...	...	...	...	...	...	...	0·073	...	0·000	0·066
XXII ...	...	...	...	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	3·256	3·374	1·385	0·336	1·944	3·142	0·847	1·749	0·729	1·404	1·509	1·371	1·664
XXIV ...	...	0·312	1·084	5·000	1·832	0·000	0·000	0·774	2·037	0·571	0·565	0·427	0·901
XXV... ...	...	...	0·000	0·000	0·106	0·024	0·000	1·602	0·041	0·082	0·053	0·016	0·069
XXVI ...	...	...	...	...	0·000	0·000	0·000	0·000	0·000	0·043	0·000	0·000	0·013
XXVII ...	...	...	...	...	0·000	...	...	0·000	0·006	0·000	...	...	0·005
XXVIII ...	...	0·000	0·000	...	0·664	2·239	0·621	1·190	1·389	0·000	0·000	0·000	0·688
XXIX ..	1·779	2·500	0·982	0·155	0·151	0·205	0·011	0·118	0·124	0·214	0·179	1·185	0·193
XXX... ...	...	...	...	...	...	...	...	0·000	0·000	0·000	0·222	0·034	0·137	0·117
XXXI ...	...	...	0·000	...	0·015	0·014	0·012	0·041	0·021	0·041	0·008	0·032	0·023
XXXII ...	...	0·000	...	...	0·510	0·408	0·000	0·207	0·098	0·229	0·020	0·000	0·158
XXXIII ...	...	...	...	...	...	0·000	0·000	...	0·000	0·391	...	...	0·115
XXXIV ...	...	...	...	...	...	...	...	0·000	0·000	0·000	...	..	0·000
XXXV ...	...	...	...	...	0·000	...	0·000	0·000	...	0·000	0·000	1·071	0·086
XXXVI ...	...	0·000	...	...	0·000	...	...	0·000	0·000	0·877	0·000	0·000	0·231
XXXVII ...	...	...	...	...	0·000	...	...	0·000	0·000	...	...	0·000	0·000
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	...	...	...	0·833	...	...	...	...	...	...	...	0·833

(2) LARGE MEGRIMS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	16·216	16·625	30·942	...	...	..	...	...	...	...	18·292
VII	...	...	4·445	13·386	12·890	...	...	...	...	...	...	...	12·803
VIII	...	...	...	14·059	11·937	...	...	...	...	2·692	...	...	11·833
IX	2·500	...	...	...	6·632	...	0·302	0·371	1·251	0·242	4·816	2·915	1·696
X	4·000	6·250	2·491	8·893	18·421	...	4·062	0·000	6·493	1·320	10·298	14·087	8·223
XI	1·268	2·473	4·314	8·702	8·998	4·127	0·806	0·139	0·819	4·801	3·664	2·210	6·505
XII	...	...	2·912	11·330	11·964	...	...	...	...	4·375	0·938	1·667	5·232
XIII	...	71·875	...	1·500	...	0·000	0·087	0·000	0·710	0·000	1·250	42·922	26·848
XIV	0·811	2·714	5·005	6·063	7·530	2·376	1·060	1·021	3·173	2·666	1·882	2·808	2·676
XV	0·928	1·344	1·549	3·776	2·010	1·920	1·667	2·035	1·334	1·223	0·997	0·985	1·324
XVI	...	1·000	3·078	0·704	0·625	. .	...	...	0·625	5·000	0·162	0·944	1·254
XVII... ...	...	3·125	1·307	0·735	1·342	0·302	0·096	0·384	0·000	1·013	3·768	1·241	1·042
XVIII ...	3·205	6·813	9·529	6·619	25·715	9·596	2·936	3·972	5·423	3·652	2·972	3·754	6·179
XIX	0·750	1·026	0·389	1·479	3·981	2·177	0·716	2·130	5·392	0·590	0·688	0·674	1·226
XX	0·000	2·000	0·233	0·639	0·173	0·090	0·000	0·472	0·000	0·359	0·125	0·365	0·243
XXI	...	...	...	...	...	...	...	...	...	0·073	...	0·000	0·066
XXII... ...	...	...	...	...	...	...	..	...	...	...	0·000	...	0·000
XXIII ...	2·718	2·574	1·356	0·297	1·720	2·387	0·711	1·505	0·657	1·364	1·338	1·296	1·445
XXIV ...	...	0·312	1·084	4·916	1·832	0·000	0·000	0·774	1·738	0·400	0·509	0·427	0·808
XXV... ...	...	...	0·000	0·000	0·075	0·024	0·000	1·301	0·041	0·082	0·053	0·016	0·054
XXVI ...	..	...	...	...	0·000	0·000	0·000	0·000	0·000	0·043	0·000	0·000	0·013
XXVII ...	...	...	...	...	0·000	...	...	0·000	0·006	0·000	...	...	0·005
XXVIII ...	...	0·000	0·000	...	0·664	1·866	0·621	1·190	1·389	0·000	0·000	0·000	0·623
XXIX ...	1·779	2·500	0·958	0·155	0·126	0·184	0·011	0·114	0·124	0·179	0·179	1·156	1·182
XXX... ...	...	...	...	...	. .	...	0·000	0·000	0·000	0·222	0·034	0·137	0·117
XXXI ..	...	...	0·000	...	0·015	0·014	0·012	0·041	0·014	0·041	0·008	0·032	0·022
XXXII ...	...	0·000	...	...	...	0·408	0·000	0·207	0·098	0·175	0·020	0·000	0·145
XXXIII ...	...	...	...	...	0·510	0·000	0·000	...	0·000	0·391	...	..	0·115
XXXIV ...	...	...	..	...	...	...	...	0·000	0·000	0·000	...	...	0·000
XXXV ...	...	...	...	...	0·000	...	0·000	0·000	...	0·000	0·000	1·071	0·086

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXXVI ...	...	0·000	...	...	0·000	...	...	0·000	0·000	0·626	0·000	0·000	0·165
XXXVII ...	...	...	...	..	0·000	...	...	0·000	0·000	...	...	0·000	0·000
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	..	...	...	...	...	...	0·000
XLV	...	...	...	0·833	...	...	...	...	...	...	...	...	0·833

(3) SMALL MEGRIMS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	2·838	4·667	8·243	...	...	...	...	...	...	...	4·877
VII	...	...	2·333	3·281	3·506	...	...	...	..	..	...	...	3·289
VIII	...	...	...	3·551	3·704	...	...	...	...	0·000	...	...	2·989
IX	1·875	...	...	...	3·294	...	0·220	0·000	0·442	0·000	10·551	1·017	1·209
X	1·600	1·607	2·361	2·711	6·302	...	0·000	0·000	1·923	0·176	6·476	8·591	3·447
XI	0·000	0·329	1·318	2·289	3·145	1·977	1·613	0·000	0·000	1·371	1·823	0·505	1·966
XII	..	...	0·427	2·161	5·357	...	...	...	...	0·500	0·000	0·000	1·171
XIII	...	0·000	...	1·250	...	0·000	0·000	0·000	0·142	0·000	0·000	17·682	10·757
XIV	0·000	0·749	1·650	2·254	1·629	0·248	0·069	0·000	0·318	0·553	0·383	0·854	0·578
XV	0·142	0·181	0·377	0·165	0·546	0·422	0·000	0·000	0·231	0·000	0·115	0·000	0·246
XVI	...	0·000	0·793	0·000	0·375	...	...	...	0·000	0·000	0·000	0·000	0·241
XVII... ...	...	1·082	0·385	0·226	0·657	0·209	0·016	0·165	0·000	0·338	1·519	0·000	0·409
XVIII ...	0·834	3·246	4·966	2·381	13·095	2·252	0·720	0·799	1·772	0·325	0·728	0·895	2·172
XIX	0·052	0·179	0·000	0·228	0·437	0·439	0·051	0·370	0·886	0·094	0·110	0·064	0·162
XX	0·000	0·000	0·000	0·468	0·037	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·045
XXI	...	...	...	...	...	...	..	...	...	0·000	...	0·000	0·000
XXII... ..	...	...	...	...	...	...	...	...	...	...	0·000	..	0·000
XXIII ...	0·538	0·800	0·029	0·039	0·224	0·755	0·136	0·244	0·072	0·040	0·171	0·075	0·219
XXIV ...	...	0·000	0·000	1·111	0·000	0·000	0·000	0·000	0·299	0·071	0·056	0·000	0·093
XXV... ...	...	...	0·000	0·000	0·021	0·000	0·000	0·301	0·000	0·000	0·000	0·000	0·015
XXVI ...	...	...	...	...	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
XXVII ...	...	...	...	...	0·000	...	...	0·000	0·000	0·000	...	...	0·000

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXVIII ...	...	0·000	0·000	...	0·000	0·373	0·000	0·000	0·000	0·000	0·000	0·000	0·065
XXIX ...	0·000	0·000	0·024	0·000	0·025	0·021	0·000	0·004	0·000	0·035	0·000	0·029	0·011
XXX... ...	...	...	...	...	...	...	0·000	0·000	0·000	0·000	0·000	0·000	0·000
XXXI ...	...	...	0·000	...	0·000	0·000	0 000	0·000	0·007	0·000	0·000	0·000	0·001
XXXII ...	...	0·000	...	...	0·000	0·000	0·000	0·000	0·000	0·054	0·000	0·000	0·013
XXXIII ...	...	...	...	...	...	0·000	0·000	...	0·000	0·000	...	...	0·000
XXXIV ...	...	...	...	...	...	...	...	0·000	0·000	0·000	...	...	0·000
XXXV ...	...	...	..	...	0·000	...	0·000	0·000	...	0·000	0·000	0·000	0·000
XXXVI ...	...	0·000	...	...	0·000	...	...	0·000	0·000	0·251	0·000	0·000	0·066
XXXVII ...	...	...	...	...	0·000	...	...	0·000	0·000	...	..	0·000	0·000
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	..	...	0·000	...	...	...	...	...	...	...	...	0·000

(4) TOTAL MEGRIMS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Totals.
January	...	3·448	0·995	1·974
February	...	3·786	4·313	3·814
March	...	7·430	3·210	5·165
April	6·627	10·871	7·423	8·032
May	6·141	2·962	3·034	4·260
June	2·899	0·838	1·486	1·698
July	0·751	0·275	0·494	0·515
August	2·072	0·225	0·525	0·882
September	1·888	0·544	1·771	1·540
October	1·313	1·165	1·200	1·219
November	1·490	0·519	1·800	1·397
December	2·522	1·064	6·444	4·480
	3·062	2·499	2·683	2·728

(5) LARGE MEGRIMS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Totals.
January	...	2·751	0·937	1·668
February	...	2·828	4·106	2·991
March	...	5·125	2·495	3·714
April	5·245	8·701	5·783	6·354
May	4·655	2·403	2·113	3·227
June	2·438	0·646	1·160	1·370
July	0·616	0·241	0·405	0·428
August	1·750	0·225	0·453	0·763
September	1·525	0·504	1·438	1·267
October	1·151	1·022	1·019	1·056
November	1·181	0·473	1·217	1·029
December	2·114	1·018	4·596	3·328
	2·444	1·967	2·027	2·118

(6) SMALL MEGRIMS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Totals.
January	...	0·697	0·058	0·306
February	...	0·958	0·207	0·823
March	...	2·305	0·715	1·451
April	1·382	2·170	1·640	1·678
May	1·486	0·523	0·921	1·033
June	0·461	0·192	0·326	0·328
July	0·135	0·034	0·089	0·087
August	0·322	0·000	0·072	0·119
September	0·363	0·040	0·443	0·273
October	0·162	0·143	0·181	0·163
November	0·309	0·046	0·583	0·368
December	0·408	0·046	1·848	1·152
	0·617	0·531	0·656	0·610

VI. THE LEMON DAB (*Pleuronectes microcephalus*, Donov.).

From the economic point of view this fish is not so important as many of the other flat-fishes, but it is still of considerable value. In 1902 the quantity landed in England and Wales was 41,575 cwts. of the value of £94,112, by far the greater proportion being landed on the east coast. In Scotland 26,611 cwts. were landed in 1903, valued at £53,741. The fish is not separately distinguished in the Irish returns.

More perhaps than any of the other edible Pleuronectids the Lemon Dab has a partiality for hard bottom, or gravel, but it is also got in quantity on sand and sand and mud. The trawlers get the best catches of this fish as a rule on the edge of the "rough," in water of moderate depth.

The food on which the Lemon Dab subsists is for the most part worms, but it also takes crustaceans, mollusks, and echinoderms in small amounts. In the Firth of Forth of 448 which contained food, annelids were present in 78 per cent., crustacea in 24 per cent., mollusks in 6 per cent., echinoderms in 2 per cent., and fish in 1 per cent. Its chief food was annelids and hermit crabs.*

On the west coast of Ireland Holt found that annelids were also found in 78 per cent.

At Faeroe Hörring found the Lemon Dabs feeding mostly on worms, which sometimes formed a tightly-packed mass, mixed up with fragments of algæ and bottom material.†

It is a summer spawner, and the duration of the spawning-season is considerable. On the east coast of Scotland I found that it extended from about the middle of April to well on in September, the maximum being in June.‡

On the west coast of Ireland Holt found ripe females from March to July, and principally in April, May, and June. At Grimsby he states that mature females are found from the latter part of April to well on in September, and most abundantly in June and July; he searched for spent females, but found none till the latter part of August, the eggs maturing slowly and in succession.§

Cunningham got ripe females on the south-west coast as early as February and March (Marketable Marine Fishes, p. 238). Heincke and Ehrenbaum give the spawning-period for the Heligoland region as from the middle of April to the beginning of September; they found the floating eggs in April to August inclusive.‖

In Lochfyne Williamson found the floating eggs in June, July, and August, and especially in the two former months.¶

Judging from two specimens I examined, the number of eggs produced is considerable; one, 15 inches long, had about 672,200 and the other, 12½ inches in length, had 150,200.** The eggs, which measure, according to Heincke and Ehrenbaum, from 1·195 to 1·446 mm., hatch in six days at a temperature from 53° to 55° F.†† At the Board's Hatchery at Dunbar several millions of the eggs were

* Ramsay Smith, *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 213.

† *Fiskeri-Beretning for* 1900–1901, p. 204.

‡ *Seventh Ann. Rep. Fishery Board for Scotland*, Part III., p. 188; *Eighth Ann. Rep.*, p. 262; *Tenth Ann. Rep.*, p. 234, pl. vi.

§ *Roy. Dubl. Soc., Rep. to Council for* 1901, p. 260; *Journ. Mar. Biol. Ass.*, II., p. 378.

‖ *Op. cit.*, p. 227.

¶ *Seventeenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 98.

** *Ninth Ann. Rep. Fishery Board for Scotland*, Part III., p. 264.

†† Cunningham, Marketable Marine Fishes, p. 238.

obtained from females impounded in the spawning-pond, in July and August, 1905, and Dannevig found that they hatched on the sixth or seventh day after fertilisation.*

The rate of growth of the Lemon Dab has not been well ascertained. Cunningham examined some specimens and was inclined to think that four, caught early in November, and measuring from 155 to 175 mm., were about one year and five months old.† Williamson, with rather more material, came to the conclusion that at one year old the Lemon Dab is not more than 90 mm. long. He records two specimens, a post-larval one 9·75 mm. long, caught on 27th April, and one 25 mm. in length, caught on 27th May, and he concludes that the occurrence of the former shows that spawning may take place in March on the east coast of Scotland or early in April, and in that case the other specimen might belong to the same season. It might on the other hand represent a specimen spawned late in the previous year. To specimens measuring 180 and 183 mm. (a little over 7 inches) taken in May, he assigns a probable age of two years and ten months, and three years to specimens caught in August and measuring 198 and 208 mm.‡ Of some importance in this connection is the fact that Holt procured considerable numbers of small Lemon Dabs, measuring from 2 to $3\frac{1}{2}$ inches, on the shrimping grounds of the Humber between 19th October and 17th November.§

He also mentions having got three, measuring $2\frac{3}{4}$, 4, and 5 inches respectively, on the Tetney ground, in the same locality, on 7th April.‖ Small Lemon Dabs have also been caught in considerable number by Cunningham. At the beginning of June, on the shrimping ground in the Wallet, Essex, in from two to five fathoms, he found many from three to five inches long, and he concludes that they were about one year old. He is also of opinion, and I think probably rightly, that Holt's specimens got in October and November, referred to above, were from the previous year's spawning, and were thus over one year old.¶ This view receives support from the data regarding the younger and post-larval forms. Those procured by the *Garland* in the Moray Firth towards the end of October ranged mostly from 8 to 18 mm., and one was procured off the mouth of the Firth of Forth on 7th May, measuring 25 mm.** Holt obtained two incompletely metamorphosed examples from 62 to 80 fms. on the west coast of Ireland in August; one measured 27 mm.††

The Lemon Dabs taken at Faeroe by Hörring measured mostly between 10 and 15 inches; young forms were never taken, but brood (Yngel) about $\frac{3}{4}$ of an inch long are stated to have been occasionally got in the stomachs of fishes.‡‡

It seems probable from the information at present available that the Lemon Dab does not grow with great rapidity, and that the estimate of the rate of growth put forward by Williamson is approximately correct.

As for the size at which this fish attains maturity, I found male specimens mature when $7\frac{1}{2}$ and 8 inches long, and females at 11 inches, and others approaching maturity when $8\frac{1}{2}$ inches in length.§§ On the west coast of Ireland Holt got one male ripe at $7\frac{1}{2}$ inches and a female at 8 inches,‖‖ and at Grimsby he found males ripe at 6 inches and upwards, and females at from 10 inches, while others approaching ripeness were

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* *Fourteenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 151.
† *Journ. Mar. Biol. Ass.*, II., p. 102.
‡ *Eleventh Ann. Rep. Fishery Board for Scotland*, Part III., p. 271.
§ *Journ. Mar. Biol. Ass.*, III., p. 93.
‖ *Journ. Mar. Biol. Ass.*, III., p. 121.
¶ Marketable Marine Fishes, p. 241.
** McIntosh and Masterman, British Marine Food Fishes, p. 370.
†† *Sci. Trans. Roy. Dub. Soc.*, V., 91.
‡‡ *Op. cit.*, p. 203.
§§ *Eighth Ann. Rep. Fishery Board for Scotland*, Part III., 162; *Tenth Ann. Rep.*, p. 239*a*.
‖‖ *Op. cit.*, pp. 274, 298.

as small as 8 inches.* He is of opinion, however, that few females spawn before they are 12 inches long.† Cunningham found at Plymouth that both males and females from 7 inches were ripe.‡ Lately I have described the occasional occurrence of ripe males and females smaller than the sizes given above. Thus in the Clyde, on 5th September, a female of 173 mm. ($6\frac{3}{4}$ inches) and another of 147 mm. ($5\frac{3}{4}$ inches), and weighing 26·03 grammes, or less than one ounce, were quite ripe ; on 14th March a male of $5\frac{1}{2}$ inches was fully ripe, and two of $3\frac{5}{16}$ and $3\frac{7}{16}$ inches were approaching ripeness. In the Moray Firth, in June, a female of only 138 mm. ($5\frac{3}{8}$ inches) and weighing only 22·6 grammes, and another of 145 mm., were ripe, as also a male of 131 mm.§ Considering that this fish may reach a size of 18 or 19 inches—the largest measured by me was 48·2 cm.—these facts are remarkable. At Plymouth Cunningham found Lemon Dabs as large as 17 inches ; the largest got by Ekstrom at Bohuslanw as 40 cm.; and Lilljeborg mentions having seen one of 46 cm.

With regard to its distribution, the Lemon Dab is found from the White Sea to the neighbourhood of Arcachon, on the west coast of France ; it is absent from the Mediterranean ; it is found on the west coast of Ireland, and is also present at Iceland and in still greater abundance at the Faeroes.‖ The Lemon Dab is a moderately deep water fish ; I have recorded examples from 65, 69, 75, and 85 fms. in the northern part of the North Sea ; two of those got at the latter depth (22 miles east of Flugga, Shetland) measured 113 mm. ($4\frac{3}{8}$ inches) and 117 mm., which shows that the young of this species are not confined to the shallow inshore waters.¶ The fish is, however, most abundant in water of less depth than those stated above.

Distribution.

The aggregate quantity of Lemon Dabs taken by the recording vessels in the course of the three years from the whole area was considerable, amounting to $9{,}068\frac{7}{8}$ cwts., the general average being 3·268 per 100 hours of fishing, or 3·7 lbs. per hour. The fish was taken in 35 of the 36 squares. The particulars for each of the three years are as follow :—

—	1901.		1902.		1903.		Total.	
	Cwts.	Average per 100 hours.	Cwts.	Average per 100 hours.	Cwts.	Average per 100 hours.	Cwts.	Average per 100 hours.
Large ...	$2{,}091\frac{3}{8}$	3·09	$2{,}011\frac{5}{8}$	2·47	$4{,}344\frac{1}{4}$	3·37	$8{,}447\frac{1}{4}$	3·04
Small ...	$140\frac{7}{8}$	0·209	$120\frac{5}{8}$	0·148	$360\frac{1}{8}$	0·28	$621\frac{5}{8}$	0·224
Total ...	$2{,}232\frac{1}{4}$	3·3	$2{,}132\frac{1}{4}$	2·62	$4{,}704\frac{3}{8}$	3·65	$9{,}068\frac{7}{8}$	3·27

In this case the fish are distinguished as "large" and "small ;" the percentage of the small in the various years was :—1901, 6·3 ; 1902, 5·7 ; 1903, 7·65 ; and for the whole period, 6·85 ; the large fish forming 93·15 per cent. of the gross catch. Lemon Dabs are thus well represented in the catches of the trawlers, the proportion for the three years and the whole region being at the rate of 3·66 lbs. per hour.

* *Journ. Mar. Biol. Ass.*, II., p. 378.
† *Ibid.*, III., p. 380.
‡ *Ibid.*, III., p. 66.
§ *Twenty-first Rep. Fishery Board for Scotland*, Part III., p. 48.
‖ *Fiskeri-Beretning*, 1900–1901, p. 203. Copenhagen, 1902.
¶ *Twenty-first Ann. Rep. Fishery Board for Scotland*, Part III., p. 47.

The abundance of Lemon Dabs varied much in different areas. The squares with the highest averages were those adjacent to our own east coast ; as one passes eastwards towards the continental coast the averages diminish, and they diminish still more towards the deeper water in the northern region between the Shetlands and the coast of Norway. Making a comparison here again between the areas north and south of 58° N. latitude—that is, broadly, beyond the 50-fathom line and under it—it will be found that the Lemon Dab resembles the Turbot and Brill in its distribution rather than the Halibut. In the 16 northern squares (VI–XXI) the general average is 1·13 cwts. per 100 hours' fishing, while in the 19 southern squares in which Lemon Dabs were taken the average was more than four times greater, viz., 5·03 cwts. per 100 hours' fishing—the duration of the fishing being 152,060 hours for the southern squares and 124,666 for the northern areas. So far as bathymetrical distribution is concerned, the averages show that the fish is most abundant between 30 and 50 fathoms ; but it has also to be noted that the areas with the highest averages are those bordering rocky shores and where stony and gravelly bottom is present. This fish and the Whitch both live chiefly upon annelids, but the latter lives mostly on oozy bottoms and devours the worms found there, while the Lemon Dab prefers (as its colours also indicate) a hard bottom and eats the worms found among algae.

The square which has the highest average is XXIX, lying off the east coast of Scotland between Aberdeen and St. Abb's Head, viz., 8·544 cwts. per 100 hours' fishing, the total quantity taken in it being 3,090$\frac{3}{8}$ cwts. The averages for the squares adjoining it are also high. Thus that for XXVIII the narrow strip between it and the coast is 7·470 ; that for the one immediately to the north of it, XXIII, to 7·333, while in the one to the south of it it is 7·007. The average for the squares in relation to the Moray Firth are also high. For XXII it is 8·214, but the fishing here was only 70 hours, and for XVII, off the coast of Caithness and the southern part of the Orkney Isles, it was 7·943. The Lemon Dab is thus specially abundant in the waters adjacent to the east coast. In one or two of the areas further out towards the east the averages are also fairly high. In XXIV, off the coast of Aberdeen and containing part of the Long Forties, the average is 6·500 ; in the one to the south and containing the Gut, XXX, the average is 2·076 ; and in that further to the south, XXXV, it is 3·429. The averages for the more easterly areas embracing the plateau of the Fisher Bank are not so high, but still they are considerable. Squares XXV and XXXI on the western portion have averages of 1·777 and 1·835 respectively ; those on the eastern side, XXVI and XXXII, have averages of 1·225 and 1·562. Square XXVII at the mouth of the Skagerrack has an average of 1·216, and the one below adjacent to the coast of Jutland, XXXIII, has an average of 1·843. The fishing in the latter area, however, was for only 434 hours. The averages for the four other squares to the south, XXXVII, XLI, XLIII, and XLV, are all under 1 cwt. per 100 hours, and the duration of the fishing on them was comparatively small.

As already stated, in the areas in the northern portion the Lemon Dab is poorly represented. With the exception of IX, lying to the west of the Shetlands, where the average is 2·549, and XVIII off the Moray Firth, where it is 1·960, the averages are under 1 cwt. per 100 hours, and in most cases much under that figure. The lowest of all is for square VII, north of 61° N. latitude, where it is only 0·089, the total weight obtained for 4,203 hours' fishing being 3$\frac{3}{4}$ cwts. In the more easterly square, VIII, only 1 cwt. was caught, the average being for the smaller number of hours' fishing, 0·127. It is worth noting, though both the quantities and the averages are small, that the Lemon Dab appears to be, like the Turbot, a little more common in the northern areas adjoining the Norwegian deep water than in those immediately to the westwards of them. This is especially noticeable in XII, which contains the Viking Bank.

Seasonal Abundance.

In considering the seasonal abundance of the Lemon Dab, it will be well to begin with some of the offshore areas in which the amount of fishing was most regular, because with this fish, as with most of the others, the variations are less irregular in the deeper water than near to the shores.

The quantity taken in square XIV, lying south of the Shetlands, was 182¾ cwts., the general average being 0·956. The monthly averages are as follow :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·2	0·26	0·33	0·27	0·63	1·0	1·2	0·32	0·16
1902 ...	0·00	0·07	0·43	0·41	0·29	...	...	0·53	1·85	0·58	0·33	0·56
1903 ...	0·18	0·56	0·24	0·8	...	...	1·25	...	4·05	2·5	0·75	0·4
	0·156	0·094	0·302	0·376	0·273	0·331	0·346	0·599	2·932	1·783	0·532	0·381

The curve in this case presents as its chief feature an autumn cone depending on the averages for September mostly, but also on those for October ; during the rest of the year the averages are not markedly different from one another. In each of the years it will be noticed the averages in these two months are the highest of any, so that the condition may be regarded as a normal one. The curves for the individual years, indeed, show considerable uniformity ; each presents the autumnal cone, that in 1903 being much the highest and, like that in 1902, having its apex in September, the apex in 1901 being in October, with the September average nearly as high.

In this area, then, Lemon Dabs are at their maximum abundance in autumn, and especially in September, and comparatively scarce during the rest of the year ; there is the merest trace of a spring elevation in the compound curve, and it is most marked in 1902.

Square XIX is of the same type. The quantity taken was 96½ cwts., the general average being 0·449 cwts. per 100 hours. The averages are :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·1	0·25	0·16	0·00	0·00	1·9	3·0	0·2	0·044
1902 ...	0·17	0·04	0·18	0·21	0·00	0·6	0·96	0·33	0·00	0·00	1·46	0·38
1903 ...	0·074	0·38	0·33	0·55	0·7	0·225	0·03	2·9	3·0	0·65	0·6	0·27
	0·102	0·134	0·305	0·322	0·301	0·325	0·286	2·060	2·252	1·721	0·449	0·283

The outstanding feature of the curve is the presence of a great cone in autumn, due to the relatively high averages of August, September, and October, that for September being rather greater than that for August, and the latter greater than that for October. The line of the first part of the graph shows a very slight rise in March, and almost complete uniformity thence to August. The curves for the individual years do not quite agree ; those for 1901 and 1903 exhibit the conspicuous cone in autumn, the apex being in October in the former year and in September in the latter ; the curve for 1902 has two small cones, one with the apex in July and the other with the apex in November, there being a depression in September and October, but the fishing was not very extensive in the months named.

Whether the little cusp in June and July in 1902 represents another maximum, indicated in some of the other squares, it is difficult to say.

Another square in the deep water presenting the same type is XX. In this area 58¼ cwts. were caught and the average was 0·755. The monthly averages are :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·00	0·81	0·45	2·1	...	1·1	1·5	0·2	0·00
1902 ...	0·35	0·2	0·37	0·21	0·46	1·16	5·88	5·66	2·5	0·00	0·53	0·76
1903 ...	...	...	0·43	0·55	0·76	...	...	0·9	...	...	1·2	0·8
	0·350	0·200	0·424	0·362	0·636	0·994	2 946	3·144	1·421	1·143	0·447	0·469

The curve in this case resembles that of the last area, having a prominent pyramid, but it is earlier in the year, in July and August. Up to May the line rises but slightly, from June to July the rise is rapid, and the August point, where the maximum occurs, is higher ; there is then a rapid decline to September, the October average is about the same, and then a fall occurs. In 1901 the maximum is in July, but the averages for May, September, and October are fairly high ; in 1902 the maximum is also in July, the August average coming close to it ; in 1903 the fishing in this area was partial, and the highest average is for November.

The maximum abundance in this area, then, is in late summer and early autumn, chiefly in July and August, and Lemon Dabs are relative scarce at all other times of the year.

Contrasting with this simple type, we find another not quite so simple, in which two maxima are present. Thus in the curves for XV, XVIII, and X we find two cones represented. In XV the first is in spring, April and May, and the second in autumn, the highest point being in August ; the June and July averages are low, as are also those for January and February. In the different years the trawling was not very regular in this square, and while the autumn maximum is common to all the years, the high spring position is confined to 1901. In XVIII the averages show maxima in 1901 in April—the highest —and in August–September, the lowest averages being in June and December. In the next year the maxima are in April and in July and August, the minimum averages being in October and February. In 1903 there was no fishing in April or May, and the highest position is in July, the minimum being in January and February. The compound curve shows two periods of maximum abundance, the first in April, the second in July, the position in the first three and last three months of the year and in May being low.

Considering now the more important areas near the coast, in which the greater quantity of the fish were caught, we shall see that the curves are somewhat more complex.

In XXIII, adjoining the coast of Aberdeen, the total quantity caught was 2,511⅛ cwts., or 27·7 per cent. of the whole, the general average being 7·333 per 100 hours, or 8·2 lbs. per hour. The averages for each of the months in the three years and for the whole period are as follow :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	5·70	7·40	8·00	8·40	9·40	9·20	7·40	7·70	5·40
1902 ...	2·64	6·80	10·18	10·20	7·39	3·55	11·96	14·18	10·92	5·91	4·46	5·55
1903 ...	4·85	5·03	6·07	7·70	8·60	7·22	11·76	13·33	11·13	7·8	6·25	6·20
	3·768	6·496	7·038	6·815	7·768	6·645	10·551	12·225	10·771	6·985	6·172	5·933

The curve for the whole period for this area has a resemblance to that for the whole region, referred to below, the most striking difference being the transformation of the ascending slope into a separate but badly developed cone between February and June—corresponding to the irregularity in the ascending slope of the compound curve. The outstanding feature of the curve is the presence of a well defined symmetrical cone from the latter part of June to nearly the middle of October. Its apex is in August, where the maximum thus occurs, and the minimum average is in January. The formation of the compound curve for this square is explained by those for the separate years. In 1903, and still more markedly in 1902, a distinct secondary cone exists in spring. It is formed in 1902 by an ascent from the January minimum to March and April, and by a fall therefrom to June, where the second lowest average exists ; the line then rises to July and August, where the maximum is situated, and thereafter it falls to November. In the following year the spring cone is less distinct, its apex is in May, and the depression in June is not nearly so deep as in 1902. The main autumnal cone has its apex in August, the line thereafter falling to the end of the year. The minimum for the year is here also in January. From the want of averages for the first three months of 1901 the curve is incomplete, and what remains of it does not present the same distinct features as in the other two years. The line rises from April, but not steeply, to August and September, the averages for which are nearly the same, and it then falls to the end of the year.

In this square, then, it may be said that there are generally two maxima, as shown in 1903 and especially in 1902, one in spring about April, and the other in autumn about August ; the period of greatest scarcity is in winter, November, December and January, and the next is for a brief period in the middle of the year, viz., in June.

In the adjoining square, XXIX, to the south and off the coast of Scotland, a very large quantity of Lemon Dabs was taken, viz., 3,090⅜ cwts., or 34·1 per cent. of the aggregate for the North Sea, the average being 8·544 cwts. per 100 hours, or 9·57 lbs. per hour's fishing. The monthly averages are as follows :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	5·90	8·00	8·90	10·1	9·00	10·40	6·30	5·05	6·90
1902 ...	...	...	10·71	8·35	8·54	9·37	8·81	9·46	7·18	6·31	5·92	5·38
1903 ...	4·00	7·50	4·97	6·97	13·70	10·76	9·64	8·60	8·90	7·84	5·37	5·60
	3·969	7·500	5·206	7·050	11·670	9·640	9·671	8·961	9·012	7·022	5·444	5·604

Here the compound curve is somewhat irregular. The chief feature is averages above the mean from May to September, but the apex or maximum is in May, the line descending irregularly thereafter to September, and the descent then is rapid. There is a small peak in February caused by a high average for that month in 1903, when there was only 40 hours' fishing, and a depression in March. An examination of the curves for the individual years shows considerable diversity. In 1901 the three highest averages are in July, August, and September, but there is not such a great range of difference between the various monthly averages as in the case of some of the other areas. The minimum (for the nine months) is in April, the next lowest being for October. In the next year the maximum is in March, and the averages for the months April–August, while lower, do not greatly differ from one another. After August there is a descent to the end of the year. In 1903 the range of the averages is greater. From the minimum in January the line rises to February and then falls in March, from which it ascends

to the maximum in May, after which it falls to the end of the year, interrupted by a trifling rise in September.

In this area the feature of importance is the maximum in summer, especially in the earlier part of it, with the greatest abundance usually about May. The greatest scarcity is in winter and late autumn.

Another of the same group of areas is XXVIII, lying to the inside of the above, and containing the mouths of the Firth of Forth and St. Andrew's Bay, the depths being, as a rule, small. The quantity taken here was 57 cwts. for 763 hours' fishing, the average being 7·47 cwts. per 100 hours, or 8·37 lbs. per hour. The averages are these :—

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	...	5·70	22·50	8·50	14·88	0·00	6·25	7·00	8·50
1902 ...	...	7·03	1·00	...	...	...	16·66	...	..	0·39	...	...
1903 ...	...	...	...	...	...	8·90	17·60	...	...	...	...	...
	...	7·031	1·000	...	5·752	9·887	13·975	14·881	0·000	1·562	7·000	8·526

The fishing, it will be seen, was not evenly distributed, and the quantities are not large. Nevertheless, the maximum in each year and in the combined curve is in summer—in June, July, and August in 1901, and in July in the other two years. It is interesting to note the high averages in this inshore area in the early part and the end of the year, and which give a second maximum in the compound curve, about December, making it thus resemble what I have termed the " Whitch " type.

In XVII, adjacent to the Moray Firth, the quantity was 585$\frac{1}{8}$ cwts., and the average 7·94 cwts. per 100 hours, or 8·9 lbs. per hour. Each year shows a maximum, but the position does not correspond. In 1901 it is in June and July, the minimum being in November, but only six months are represented in this year. In 1902, with nine months, the maximum is in March and April, the averages in May, July, and August being low. In 1903 the highest average is in December, but it depends on only 33 hours' fishing ; the cone of real maximum abundance extends from May to September, the peak being in June. The compound curve shows three peaks on the line of the mean, in April, June, and September, but the main feature of the curve is abundance of Lemon Dabs from about April to about September.

Going now to the other side of the North Sea, to the region of the Great Fisher Bank, we find the areas there characterised by relative abundance of Lemon Dabs in summer ; though the quantities taken as a rule were not large, the averages are fairly high.

In square XXV, where 360 cwts. were taken, the average being 1·8 cwts. per 100 hours, the fishing was almost confined to the last eight or nine months of the year. In 1901, with more or less fishing from May to October, the maximum was in the latter month, the next highest average being in July, while the minimum was September. In the next year, with data from May to December, the maximum was in October–November, the minimum being in August. In 1903 the maximum was in September, minima being in March, and then in August. The averages in each year in May were relatively high, and in the compound curve for the three years the maximum is in this month. The curve shows four peaks above the mean, in May, July, September, and November, and an indication of two cones by the deep depression in August, one from May to July, and the other from September to November.

In XXVI the quantity taken was 47¼ cwts., the average being 1·225. The trawling in this area was mostly in 1903, and the maximum in that year was in July, and the minimum in November and December, the latter being the lowest.

In XXXI the quantity was 469¾ cwts., and the average 1·83. There was little fishing in 1901, the maximum abundance recorded for May, August, October, and November being for October (4·3). In 1902 there was fishing in the last eight months, and the maximum was in May, the next highest being in November. In 1903 the maximum was in September, and in the compound curve, the broad feature is abundance from July to November. Throughout the year in this area the averages are well maintained; only in one instance is an average under 1 cwt. per 100 hours, viz., in December, 1903.

In XXXII, lying further to the east, 116¾ cwts. were taken, the average being 1·567. In 1901, in trawlings from May to October, the maximum was in August, September and October, and the minimum in May and June. In 1903 the maximum was in June–September, and the minimum in December, trawlings having occurred in each month except January, March, and April. In 1902 fishing was limited to May and August–November; the maximum was in May and the minimum in August. The compound curve for the three years shows a maximum in autumn, about September, the averages for all the rest of the year, except August, September, and October, being under the mean.

In the areas in the south-eastern part of the North Sea comparatively few data exist as to the Lemon Dab. In squares XXXVI, which includes part of the Dogger Bank, the fishing was limited to seven months in 1903 and October, 1901. The quantity taken was 23⅛ cwts., the average being 1·52. The fishing took place in February, May, and August to December, and the maximum was in September, the next highest averages being in February and May. The data are too few to enable any statement to be made as to the seasonal abundance here.

I proceed now to combine the information for groups of squares. Taking first of all those along the east coast of Scotland adjacent to the shores, viz., X, XIII, XVII, XXIII, XXVIII, XXIX, in which 6,358⅝ cwts., or 70·1 per cent. of the whole, were taken, the general average being 5·6 cwts. per 100 hours' fishing, we get the following monthly averages :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2·61	4·33	3·88	5·84	6·53	5·53	7·54	8·13	6·08	4·10	4·18	4·73

The maximum abundance here is in autumn, about August, and the minimum in winter. The part above the line of the mean for the year extends from April to September, but the June position touches the line, so that there is an indication, as in XXIII, of two cones, the smaller with its maximum about May, and the larger as indicated. The minimum is in January.

The broad feature along this great stretch of coast is, therefore, abundance of Lemon Dabs in summer and scarcity in winter.

Another group consists of those in deeper water, XI, XIV–XVI, XVIII–XX. The quantity taken in these was 730½ cwts., or 8·05 per cent. of the aggregate for the North Sea, the average being 0·673 cwts. per 100 hours.

The monthly averages of this group for the three years are as follow :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·16	0 07	0·22	1·21	0·37	0·76	2·55	1·49	1·41	1·05	0·34	0·26

The pronounced feature of the curve is a tall cone of maximum abundance in autumn, and there is a smaller cone in spring. The larger one has its apex in July, but the part above the line of the mean extends from the middle of June to October, the central ordinate being in August. The little spring cone is formed by the average for April. The averages below the mean are those for January, February, March, May, November and December, the lowest being for the first three months of the year.

A third group of squares are those in relation to the Fisher Bank plateau, viz.: XXV., XXVI., XXXI., and XXXII. The total quantity taken here was 993¾ cwts., or 10·96 per cent. of the whole, the average being 1·6 cwts. per 100 hours' fishing. The monthly averages are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
—	0·62	0·76	1·36	1·78	1·38	1·78	1·60	2·0	1·6	1·45	0·81

The broad feature of the curve here is the abundance of Lemon Dabs from May to October and their scarcity in winter and early spring. Since, however, the amount of fishing in the early part of the year was limited, and none took place in January, the averages for the opening months of the year are not very strong. The maximum was in September, and the minimum in February, March and December being nearly as low. But from April and May to November there is really little variation in the averages, and the only descent below the mean from May to October is in June, and it is slight.

The broad results of another grouping of the areas may be given :—

(1) Squares XIV, XV, XVIII, XIX. There are two periods of maxima, first, a small cusp formed by the April average ; second, a larger one extending from June to October and with its highest point in July. The winter and early spring averages are low, the minimum being in February. The part above the line of the mean for the year is April and June–October, June and October being almost on it.

(2) X, XI, XIII, XVII, XX. There is one great maximum period extending from May to September, the top of the cone being in June–July. The only three months high above the line of the mean for the year are June, July and August ; September coincides with it and May is a trifle below it. April, on the other hand, has a somewhat higher average, and the upward line of the curve is thus interrupted, and a suggestion of a spring cone indicated. The averages for March, April, May and June are respectively :— 1·28, 2·32, 2·13, 5·50. The lowest averages are—January, February, December.

(3) XXIII, XXIV, XXV, XXIX. The period of maximum abundance is July–September, the highest point being August. All the other averages are below the mean except that for April, which is on it. The winter averages are low, that for January being lowest ; June is the fourth lowest. The curve shows two cusps, the August one referred to, and another formed by the sub-equal averages from February to May, just reaching the mean in April, the two cusps being separated by the depression in June.

The averages are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3·78	5·96	5·95	6·59	6·26	4·95	8·95	9·49	8·96	6·18	4·65	4·87

Taking now the two sections of the North Sea, the quantity from the northern section—north of 58° N. lat.—was 1,423⅛ cwts., the percentage being 16·48 of the total landed, and the average 1·13. Here the line of the curve rises from the minimum in January to April, there is a trifling fall in May, and a rise therefrom to July, where the maximum is placed; the line afterwards falls to the end of the year. The portion above the line of the mean extends from the beginning of April to the early part of October, and the central ordinate would be in July. The pronounced part of the curve is from the middle of May to the early part of October and the ordinate is at the end of July.

The monthly averages for the whole period are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·116	0·156	0·62	1·48	1·21	2·28	3·61	2·14	1·75	1·16	0·48	0·29

The broad feature in the northern section is therefore a summer maximum, mostly about August, and great scarcity in winter; there is also an indication of a secondary maximum in April.

In the southern section the quantity was 7,645¾ cwts., or 83·52 per cent. of the total, the average being 5·03 cwts. per 100 hours' fishing. Two cones or blunt pyramids are here shown on the line of the mean, one from early in February to late in May, the other from late in June to the beginning of October. The first is a little irregular from a slight depression in March; the apex is in April, and the central ordinate at the beginning of that month. In the other the averages for July and August are the same (6·9), forming the maximum, and the ordinate is a little before the middle of August.

The averages are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3·78	5·8	5·5	6·51	5·41	4·12	6·91	6·9	5·89	4·33	3·55	3·27

There are here two maxima of abundance, the first from February to May, and mostly about April, the second and greater from July to September, while the minimum is in winter, mostly about December.

Combining the data for each year, and for all the years, from the whole region of the North Sea trawled over by the recording vessels, we get the following averages :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	2·779	2·782	2·685	5·177	5·033	5·080	3·921	1·427	1·258
1902 ...	0·962	1·315	0·905	2·107	2·692	3·586	5·076	5·631	3·756	1·950	2·232	1·689
1903 ...	1·276	2·008	2·074	2·870	4·410	3·976	7·526	6·356	4·786	3·352	2·597	2·127
	1·154	1·403	1·532	2·627	3·398	3·546	6·042	5·764	4·633	3·046	2·203	1·883

The combined curve for all the years (Fig. 25) shows a slow rise from January to March, a rapid rise to May and June, a sudden ascent to July, where the maximum is reached, and a gradual fall thereafter to the end of the year, the average for August being however but little below that for July. It is to be

remarked that the descending slope of the curve is more regular and symmetrical than the ascending slope.

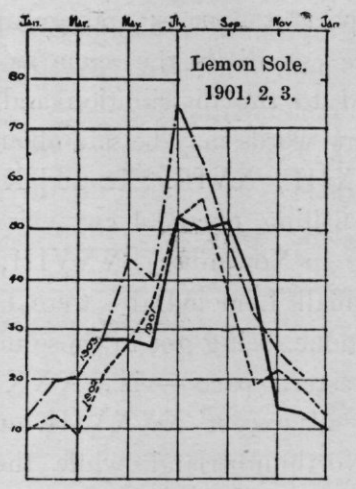


FIG. 24.

The curves for each of the separate years (Fig. 24) show the same general features as the combined curve. In each case there is a cone in late summer and autumn, and a depression in winter and spring. That for 1901 departs more from the type than the others, the averages for April, May, and June being almost uniform, and the period of abundance is a little later in the year. The maximum is in July, but the averages for August and September are almost as high; in 1902 the maximum is in August, the average for July being a little lower; in 1903 the maximum is in July, the August average being somewhat lower.

The minimum average in 1901 occurred in December, but in this year the averages for the first three months of the year are wanting. In 1902 the minimum was in March, the next lowest being January; in 1903 the minimum was in January. In each of the cases the November and December averages are higher than those in the early months of the year.

The presence of a minor spring maximum, which is indicated with more or less clearness in the curves for the groups of squares and for the two main divisions of the North Sea, is suggested in the compound curve only by the convexity of the upward slope from March to June and the relatively low position of the latter.

In the region of the North Sea fished over by the recording vessels, taken as a whole, and for the whole period, or for the separate years, we thus see that the maximum abundance of the Lemon Dab is in late summer and early autumn, about July and August, while the minimum is in winter and early spring.

The Large and Small Fish.

So far I have dealt entirely with the total quantity of Lemon Dabs taken, irrespective of size. As previously stated, they are divided into "large" and "small," the division being made by the fishermen, by the eye, and the two groups thus overlap. The "small" range from the extremes of 16 centimetres ($6\frac{1}{4}$ inches) to 36 centimetres (12 inches), the mean size being about 24 cm. ($9\frac{1}{2}$ inches). The "large" range from the extreme of 23 cm. (9 inches) to 52 cm. ($20\frac{1}{2}$ inches), the mean size being about 36·5 cm. ($14\frac{3}{8}$ inches). The division between the two groups is a trifle above 30 cm. ($11\frac{3}{4}$ inches), the great bulk of those above that size being "large" and the great bulk below "small." From what I say above as to the size at which maturity is reached (p. 575), it is clear that the small Lemons contain many adults or mature fish, both females and, especially, males.

The proportion of the small Lemons to the large in the catches of the trawlers as landed is, as we have seen, insignificant, amounting to less than 7 per cent. of the aggregate weight. The influence on the averages, especially in the more important squares and groups, is therefore extremely slight, and the curves for the "large" Lemon Dabs are essentially the same as those for the totals of large and small. The description above given in regard to the distribution and seasonal abundance of the total Lemon Dabs thus applies to the "large." A few words may be said about the small ones. The highest averages were in squares XXII., XXVIII., XXIII., XVII., IX., and XXIX. In only three squares did the average quantity taken per 100 hours' fishing exceed 1 cwt., viz., in XXII, where the average was 1·786 (but only for a small amount of fishing in November), XXVIII, where it was 1·098, and XXIII, where it was 1·041. As with the large, the small Lemon Dabs were taken in greatest numbers in the areas near the shore, few, and in some cases none, being got in those in the deeper water, as VIII, XVI, XXI, and none were taken on the south-eastern parts—viz., XXXVII, XXXVIII, XLI, XLIII, XLV, though large fish were got there in all except XXXVIII, and that, too, in considerable quantities. In XXXIV, lying off the coast of Northumberland, while the large Lemon Dabs had an average of 6·723, the small had an average of only ·284 cwts. per 100 hours. It would appear, therefore, that the small fish are rather scarcer in the south and east.

In regard to difference of seasonal abundance, a glance at the chart showing the curves for each square shows that in some areas the small fish are relatively to the large more abundant in spring than in autumn, while in other areas the opposite prevails. As examples of the former condition, it may be stated that in XIX, XX, XV, XXIX, the period of maximum abundance of large fish is in summer and autumn, while for the small it is in spring. In XIII it is the opposite; and in XXIII, while the maximum for both is in autumn, the abundance of small is much less in spring compared with the large. The numbers are, however, in most cases too small to allow much stress to be laid on the fact.

Taking the whole region for the three years together (Fig. 25), the curve for the small fish differs from that for large in having the spring cone more pronounced, the April average being higher than those for May and June. The great autumnal cone of maximum abundance is present, the apex being in August, and its form symmetrical. The parts above the mean are April and July to October; November coincides with it, and December is above it. The lowest averages are for February and March. The winter position is thus higher relatively than with the large fish, and several of the curves for the squares show an upward tendency at the end of the year not represented in the corresponding curves for the large fish, as XXIV, XXIX, and XXXII.

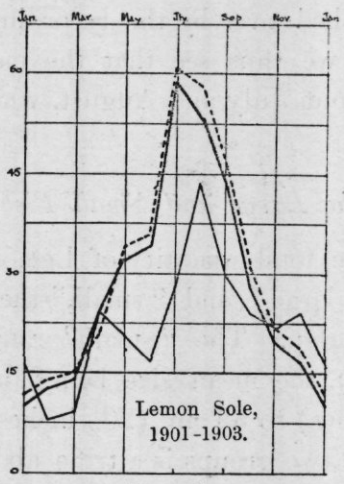


FIG. 25.

Total Lemon, ...
Large Lemon, ————
Small Lemon, ———— : on a scale ten times that of the other two.

(1) TOTAL LEMON DABS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	0·203	0·128	2·567	...	...	...	...	...	...	...	0·429
VII	...	...	0·000	0·130	0·000	...	...	...	...	...	...	...	0·089
VIII	...	...	...	0·192	0·000	...	...	...	...	0·000	...	...	0·127
IX	0·313	...	...	...	2·103	...	4·698	3·337	3·202	2·609	1·835	0·626	2·549
X	0·100	0·268	0·123	1·048	0·450	..	0·312	1·360	1·719	1·848	0·481	0·851	0·971
XI	0·073	0·000	0·054	0·117	0·234	0·000	3·871	0·278	0·451	0·062	0·368	0·221	0·199
XII	...	...	1·602	0·000	0·000	...	...	...	...	0·875	0·521	0·000	0·756
XIII	...	2·65	...	5·000	...	0·475	3·049	2·400	4·190	1·231	2·500	0·274	1·314
XIV	0·156	0·004	0·302	0·376	0·273	0·331	0·346	0·599	2·932	1·783	0·532	0·381	0·956
XV	0·032	0·027	0·088	0·372	0·332	0·021	0·104	0·697	0·231	0·334	0·163	0·156	0·202
XVI	...	0·000	0·132	0·136	0·250	...	...	...	0·625	1·667	0·097	0 111	0·191
XVII... ...	...	2·043	6·038	9·304	7·019	12·028	7·666	8·956	10,795	5·968	3·498	5·584	7·943
XVIII ...	0·242	0·037	0·230	6·809	0·535	2·891	7·750	2·136	1·933	0·650	0·348	0·230	1·960
XIX	0·102	0·134	0·305	0·322	0·301	0·325	0·286	2·060	2·252	1·721	0·449	0·283	0·449
XX	0·357	0·200	0·424	0·362	0·636	0·994	2·946	3·144	1·421	1·143	0·447	0·469	0·755
XXI	...	...	...	...	...	...	...	...	...	0·441	...	1·250	0·526
XXII... ...	...	...	...	...	...	...	...	...	...	...	8·214	...	8·214
XXIII ...	3·768	6·496	7·038	6·815	7·768	6·645	10·551	12·225	10·771	6·985	6·172	5·933	7·333
XXIV	0·938	4·096	0·000	1·401	11·176	13·511	11·594	11·309	6·328	3·102	2·714	6·500	
XXV	...	...	0·278	1·364	2·167	1·350	1·906	0·941	1·991	1·536	1·913	1·501	1·777
XXVI	...	...	...	...	1·420	1·413	2·218	1·398	1·190	1·311	0·867	0·406	1·225
XXVII	...	...	...	...	1·500	...	...	8·223	0·926	6·250	...	...	1·216
XXVIII	7·031	1·000	...	5·752	9·887	13·975	14·881	0·000	1·562	7·000	8·526	7·470	
XXIX ...	3·969	7·500	5·206	7·050	11·670	9·640	9·671	8·961	9·012	7·022	5·444	5·604	8·544
XXX... ...	...	...	...	...	...	...	5·807	2·733	6·367	2·733	2·335	1·354	2·076
XXXI ...	...	...	1·250	...	2·422	1·384	1·847	1·851	2·284	1·925	2·047	0·852	1·833
XXXII ...	...	0·625	...	...	1·122	1·377	1·159	2·224	2·535	1·628	0·964	0·477	1·567
XXXIII ...	...	...	...	...	...	1·364	1·515	...	2·381	2·539	...	...	1·843
XXXIV ...	...	...	...	...	...	...	...	5·417	8·159	5·833	...	...	7·007
XXXV ...	...	...	...	...	2·000	...	8·333	2·639	...	2·500	5·392	1·768	3·429
XXXVI ...	...	1·875	...	...	1·875	...	...	1·010	2·166	1·378	1·737	1·250	1·524

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXXVII ...	...	...	...	...	1·666	...	...	0·333	0·666	...	...	0·071	0·484
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	...	0·000
XLI	...	...	...	...	...	...	...	0·833	...	...	...	...	0·833
XLIII ...	...	...	...	...	0·926	...	...	...	...	...	...	...	0·926
XLV	...	...	...	...	0·833	...	...	...	...	...	...	...	0·833

(2) LARGE LEMON DABS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	0·203	0·128	2·432	...	...	...	...	...	...	...	0·413
VII	...	...	0·000	0·078	0·000	...	...	...	...	...	...	...	0·053
VIII	...	...	...	0·192	0·000	...	...	...	...	0·000	...	...	0·127
IX	0·313	...	...	...	1·850	...	4·011	2·861	2·463	2·306	1·835	0·587	2·174
X	0·100	0·268	0·123	1·034	0·450	...	0·312	1·046	1·493	1·584	0·481	0·851	0·886
XI	0·073	0·000	0·054	0·117	0·234	0·000	3·548	0·278	0·451	0·062	0·368	0·221	0·195
XII	...	...	0·961	0·000	0·000	...	...	...	...	0·875	0·521	0·000	0·540
XIII	...	2·20	...	5·000	...	0·375	2·265	0·834	2·983	1·231	1·875	0·260	0·974
XIV	0·157	0·094	0·302	0·376	0·273	0·331	0·346	0·599	2·889	1·783	0·516	0·381	0·950
XV	0 026	0·027	0·088	0·372	0·273	0·021	0·104	0·699	0·231	0·327	0·163	0·156	0·193
XVI	...	0·000	0·132	0·136	0·250	...	...	...	0·625	1·667	0·097	0·111	0·191
XVII... ...	...	2·043	5·423	8·703	6·563	11·321	6·850	7·857	9·375	4·842	3·010	4·255	7·290
XVIII ...	0·242	0·037	0·230	6·476	0·535	2·808	7·437	2·047	1·847	0·569	0·348	0·151	1·876
XIX	0·095	0·089	0·305	0·322	0·282	0·325	0·286	2·060	2·252	1·721	0·449	0·281	0·444
XX	0·357	0·200	0·414	0·319	0·630	0·994	2·946	3·144	1·421	1·143	0·447	0·469	0·748
XXI	...	...	...	...	...	...	...	...	...	0·441	...	1·250	0·526
XXII... ...	...	...	...	...	...	...	...	...	...	...	6·428	...	6·428
XXIII ...	3·183	6·132	6·692	5·892	6·908	5·650	9·599	9·857	9·262	5·487	5·141	5·111	6·291
XXIV ...	...	0·938	4·096	0·000	1·293	10·588	13·084	11·524	11·100	6·236	3·003	2·097	6·379
XXV... ...	...	...	0·278	1·364	2·122	1·347	1·892	0·941	1·991	1·495	1·913	1·469	1·760
XXVI ...	...	...	...	...	1·349	1·364	2·218	1·398	1·190	1·289	0·867	0·406	1·205
XXVII ...	...	...	...	...	1·500	...	...	8·223	0·836	6·250	...	...	1·132
XXVIII ...	...	7·031	0·667	...	4·425	8·395	12·267	11·905	0·000	1·562	6·000	7·386	6·373
XXIX ...	3·741	6·250	5·108	6·447	11·217	9·337	9·415	8·565	8·614	6·678	5·093	5·055	8·181

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXX... ...	...	...	...	...	...	...	5·555	2·733	6·338	2·719	2·324	1·342	2·057
XXXI ...	...	...	1·250	...	2·411	1·384	1·832	1·837	2·240	1·915	2·027	0·861	1·812
XXXII ...	...	0·625	...	...	1·122	1·377	1·159	2·190	2·516	1·608	0·945	0·434	1·550
XXXIII ...	...	...	...	...	...	1·364	1·515	...	2·381	2·148	...	...	1·728
XXXIV ...	...	...	...	...	...	...	...	5·000	7·812	5·833	...	...	6·723
XXXV ...	...	...	...	...	2·000	...	8 333	2·500	...	2·000	5·391	1·785	3·328
XXXVI ...	...	1·875	...	...	1·875	...	...	1·010	1·833	1·378	1·646	1·250	1·467
XXXVII ...	...	...	...	...	1·666	...	...	0·333	0·666	...	...	0·071	0·484
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	...	0·000
XLI	...	...	...	...	...	...	...	0·833	...	...	...	...	0·833
XLIII ...	...	...	...	...	0·926	...	...	...	...	...	...	...	0·926
XLV	...	...	...	0·833	...	...	...	...	...	...	...	...	0·833

(3) SMALL LEMON DABS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901-1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
VI	...	...	0·000	0·000	0·135	...	...	...	...	...	...	...	0·016
VII	...	...	0·000	0·052	0·000	...	...	...	...	...	...	...	0·035
VIII	...	...	...	0·000	0·000	...	...	...	...	0·000	...	...	0·000
IX	0·000	...	...	...	0·253	...	0·687	0·476	0·739	0·303	0·000	0·039	0·375
X	0·000	0·000	0·000	0·014	0·000	...	0·000	0·314	0·226	0·264	0·000	0·000	0·084
XI	0·000	0·000	0·000	0·000	0·000	0·000	0·323	0·000	0·000	0·000	0·000	0·000	0·004
XII	...	...	0·641	0·000	0·000	...	...	...	...	0·000	0·000	0·000	0·216
XIII	...	0·45	...	0·000	..	0·100	0·784	1·606	1·207	0·000	0·625	0·014	0·340
XIV	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·043	0·000	0·016	0·000	0·006
XV	0·006	0·000	0·000	0·000	0·059	0·000	0·000	0·000	0·000	0·007	0·000	0·000	0·008
XVI	...	0·000	0·000	0·000	0·000	...	...	...	0·000	0·000	0·000	0·000	0·000
XVII... ...	...	0·000	0·615	0·601	0·456	0·707	0·816	1·099	1·420	1·126	0·488	1·329	0·653
XVIII ...	0·000	0 000	0·000	0·333	0·000	0·083	0·313	0·039	0·086	0·081	0·000	0·079	0·084
XIX	0·007	0·045	0·000	0·000	0·019	0·000	0·000	0·000	0·000	0·000	0 000	0·002	0·005
XX	0 000	0·000	0·010	0·013	0·006	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·007
XXI	...	...	...	..	...	...	...	...	...	0·000	...	0·000	0·000
XXII... ...	...	...	..	...	...	...	...	...	...	...	1·786	..	1·786
XXIII ...	0·585	0·364	0·346	0·923	0·850	0·995	0·952	2·368	1·509	1·498	1·031	0·822	1·041
XXIV ...	...	0·000	0·000	0·000	0·108	0·588	0·427	0·070	0·209	0·092	0·099	0·617	0·121

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
XXV	...	...	0·000	0·000	0·045	0·003	0·014	0·000	0·000	0·041	0·000	0·032	0·018
XXVI ...	...	...	...	...	0·071	0·049	0·000	0·000	0·000	0·022	0·000	0·000	0·019
XXVII ...	...	...	...	...	0·000	...	...	0·000	0·089	0·000	...	...	0·084
XXVIII ...	...	0·000	0·333	...	1·327	1·492	1·708	2·976	0·000	0·000	1·000	1·140	1·098
XXIX ...	0·228	1·250	0·098	0·603	0·453	0·303	0·256	0·396	0·398	0·344	0·351	0·549	0·361
XXX	...	...	...	...	...	...	0·252	0·000	0·029	0·014	0·011	0·012	0·019
XXXI ...	...	...	0·000	...	0·011	0·000	0·015	0·014	0·044	0·010	0·020	0·000	0·023
XXXII ...	...	0·000	...	...	0·000	0·000	0·000	0·024	0·019	0·020	0·019	0·043	0·017
XXXIII ...	...	...	...	...	...	0·000	0·000	...	0·000	0·391	...	...	0·115
XXXIV ...	...	...	...	...	...	...	..	0·417	0·347	0·000	...	...	0·284
XXXV ...	...	...	...	...	0·000	...	0·000	0·139	...	0·000	0·156	0·000	0·100
XXXVI ...	...	0·000	...	...	0·000	...	...	0·000	0·333	0·000	0·091	0·000	0·058
XXXVII ...	...	...	...	...	0·000	...	...	0·000	0·000	...	...	...	0·000
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	...	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	0·000	...	...	...	...	...	...	...	0·000
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(4) TOTAL LEMON DABS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Total.
January	...	0·962	1·276	1·154
February	...	1·315	2·008	1·403
March	...	0·905	2·074	1·532
April	2·779	2·107	2·870	2·627
May	2·782	2·692	4·410	3·398
June	2·685	3·586	3·976	3·546
July	5·177	5·076	7·526	6·042
August	5·033	5·631	6·356	5·764
September	5·080	3·756	4·786	4·633
October	3·921	1·950	3·352	3·046
November	1·427	2·232	2·597	2·203
December	1·258	1·689	2·127	1·883
	3·301	2·619	3·655	3·268

(5) LARGE LEMON DABS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Totals.
January	...	0·881	1·061	0·994
February	...	1·259	1·751	1·321
March	...	0·760	2·023	1·438
April	2·516	1·941	2·608	2·391
May	2·617	2·502	4·156	3·193
June	2·590	3·503	3·727	3·376
July	5·006	4·877	7·084	5·760
August	4·774	5·386	5·670	5·329
September	4·861	3·617	4·404	4·336
October	3·605	1·764	3·120	2·807
November	1·238	2·122	2·402	2·031
December	1·049	1·534	1·929	1·695
	3·092	2·471	3·375	3·044

(6) SMALL LEMON DABS.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Totals.
January	...	0·081	0·215	0·160
February	...	0·056	0·257	0·082
March	...	0·145	0·050	0·094
April	0·264	0·167	0·262	0·237
May	0·165	0·139	0·254	0·205
June	0·094	0·083	0·251	0·170
July	0·171	0·199	0·442	0·282
August	0·259	0·245	0·686	0·435
September	0·219	0·138	0·382	0·297
October	0·316	0·187	0·232	0·239
November	0·189	0·110	0·195	0·172
December	0·209	0·155	0·198	0·188
	0·209	0·148	0·280	0·224

VII. THE PLAICE (*Pleuronectes platessa*, L.).

Both in regard to quantity and value the Plaice is the most important of all the flat-fishes so far as the North Sea is concerned, or the British fisheries generally. In 1902 the quantity landed on the coasts of England and Wales was 1,276,637 cwts., of the aggregate value of £1,034,482. The quantity and value of the Plaice landed in Scotland cannot be stated, since the statistics include this fish with other four species under the general designation of "Flounder, Plaice and Brill"; but at Aberdeen the quantity landed by trawlers in 1903 amounted to 39,667 cwts., valued at £68,319. In Ireland the quantity returned as landed in 1903 was 19,242 cwts., of the value of £19,018.

Partly for the reason stated—the value of the fish—and partly because it has been made the subject of legislation and legislative proposals, the natural history of the Plaice has been more studied than that of any other flat-fish, and our knowledge concerning it is proportionally great. In this place, however, only a general sketch of the leading points in its life-history will be given.

The food of the Plaice consists for the most part of mollusks and annelids; it varies to some extent on different grounds and at different stages of life. In the Firth of Forth 883 stomachs containing food, and in St. Andrew's Bay 509 containing food, had the various groups represented as follows, in per-centages.* I also include the results of Holt's examination of 255 stomachs of Plaice taken during the Irish Survey.†

——	Mollusks.	Annelids.	Echinoderms.	Crustacea.	Fish.
Firth of Forth...	37·0	54·0	10·0	4·0	5·0
St. Andrew's Bay	59·0	54·0	10·0	16·0	0·2
West Ccast of Ireland	54·0	27·0	23·0	8·0	0·4

The mollusks consist almost solely of bivalves, especially *Scrobicularia*, Razor-Shells (*Solen*), Cockle, Clam (*Pecten*), &c.; the worms are of various kinds, and the fish are nearly always Sand-Eels. Young Plaice, a few inches in length, seem to live more upon crustacea than when older.‡ As Herring remarks, the proportions of the various organisms that may be found in the stomachs of Plaice depend to a great extent on their relative abundance on the grounds where the Plaice examined are caught. He found the proportions to vary accordingly within wide limits at different places. This catholicity of appetite on the part of the Plaice is not without importance in the study of the statistics of its distribution.§

The spawning-time of the Plaice in the North Sea generally may be fixed as extending from the early part of January to the middle of May, the chief time being in March.‖ It varies, however, as regards the time of commencement and cessation, in different years, apparently, according to the

* *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., pp. 212, 217.

† *Roy. Dub. Soc. Rep. to Council for* 1891, p. 317.

‡ Scott, *Twentieth Ann. Rep. Fishery Board for Scotland*, Part III., p. 524.

§ Additional observations on the food of the Plaice will be found, for the Baltic, in Schiemenz' able account, *Abhandlungen des Deutschen Seefischerei-Vereins*, Bd. VII., p. 180, Berlin, 1902, fully illustrated by tables; by Petersen, in the *Fourth Report of the Danish Biological Station*, p. 29; by Hörring and Johansen, for Iceland and Faeroe, in *Fiskeri-Beretning for* 1900–1901 and 1901–1902, pp. 200, 230, Copenhagen, 1902, 1903.

‖ *Tenth Ann. Rep., Fishery Board for Scotland*, Part III., p. VI.

temperature, as has been shown in the operations at the Fish Hatchery at the Bay of Nigg, Aberdeen.* In 1903 I found plaice spawning in the Moray Firth towards the end of December. In the Baltic the spawning-season is earlier ; Petersen states it lasts from November to April (floating eggs were got on 21st November).† On the west coast of Ireland, Holt got ripe fish from March to August—in the latter month five females and three males—so that it appears to continue later there ; but no observations were made before March 21st.‡ Williamson found the floating eggs in Lochfyne from 19th February at various dates on to 10th June.§ At Iceland the Plaice spawns later than in the North Sea, according to Holt, who examined specimens at Grimsby and found them in April not ready to spawn, and many still spawning in June.‖ According to Johansen, however, the spawning seems to come to an end in May, and no Plaice, with ripe eggs, were found in the *Diana's* investigations in June, July or August, while he was informed that many spawn in March and April.¶ The fish examined by Holt no doubt came from deeper water or another part of the coast.

With regard to the place of spawning, this fish, as a rule, spawns at some distance from the shore in the North Sea,** and Holt describes it as distinctly an offshore spawner there.†† On coasts however where the water is deep, and probably also where currents affect the distribution of the eggs, it may spawn near the shore. Thus, on the west coast of Ireland Holt found spawning Plaice in Blacksod Bay and Kenmare River ; Williamson found the floating eggs far up Lochfyne, and is of opinion that they were spawned in the Loch ; shoals of spawning Plaice are mentioned by reliable trawlers as frequenting Sandside Bay in the Pentland Firth ; and I have myself got spawning Plaice, although not in very large numbers, in 12 fathoms, in the Moray Firth.

The number of eggs produced by the Plaice is not very large in comparison with the number produced by some other flat-fishes. In five specimens, varying from 17½ to 22¼ inches, I found the number of eggs to vary from 148,470 to 487,087.‡‡ Reibisch found 736,250 in a Plaice of 16 inches, but several larger ones had fewer eggs ; one measuring a little over 21 inches had 223,350.§§

The rate of growth of the Plaice has been investigated on several occasions, but there is not yet complete agreement on the question ; it may however be said that the more recent researches tend to show that its growth is not so rapid as was previously believed. In 1891 Cunningham expressed the opinion, based on the measurements of a number of specimens, that it could not reach a size of 12 inches in less than two years, and that it did not begin to breed until it was two years old and over eight inches in length, on the south coast of England, where the species is relatively smaller than in the North Sea. Later he expressed similar views, judging that specimens from the North Sea averaging about 13 inches in December were scarcely two years old, and that those taken off the Danish and German coast in spring and summer, and ranging from 7 to 10 inches in length, were one year old.‖‖

From certain marking experiments I carried on, I concluded in 1893 that Plaice of 10 or 11 inches in length grow at least 3 or 4 inches longer in the course of a year.¶¶ In the same year Petersen stated

* *Twentieth Ann. Rep. Fishery Board for Scotland*, Part III., p. 344.
† *Ibid.*, p. 13.
‡ *Ibid.*, pp. 181–259.
§ *Seventeenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 97.
‖ *Journ. Mar. Biol. Ass*, III., pp. 134–135.
¶ *Fiskeri-Beretning for Finansaaret* 1901–1902, p. 226.
** *Seventh Ann. Rep. Fishery Board for Scotland*, Part III., p. 188 ; *Eighth Ann. Rep. Ibid.*, p. 261.
†† *Jour. Mar. Biol. Assoc.*, III., p. 395.
‡‡ *Ninth Ann. Rep. Fishery Board for Scotland*, p. 263.
§§ *Wissensch. Meeresuntersuch., Abt. Kiel*, IV., p. 231.
‖‖ *Journ. Mar. Biol. Assoc.*, II., p. 99. 1891.
¶¶ *Eleventh Ann. Rep. Fishery Board for Scotland*, Part III., p. 192.

that the Plaice generally required three years to reach maturity, but might do so in its second year, and 10 inches was assigned as the average size at maturity in the Baltic.* In 1898 Dannevig concluded from an investigation at Dunbar that the average growth of the Plaice in its first year was about 77 mm. (3 inches), in its second year 79 mm. ($3\frac{1}{8}$ inches), and in the third year 76·5 mm. ; when one year old he concluded the average size of the Plaice was about 77 mm. ; when two years old about 157 mm. ($6\frac{1}{4}$ inches), and when three years old about 233 mm. ($9\frac{1}{4}$ inches) ; and further that the Plaice did not reach maturity until it was four years old.† Later investigations I made on the subject showed that the Plaice in the Solway grow more slowly than in the North Sea, where the male probably reaches maturity when four, and the female when five, years of age.‡ Among later researches may be mentioned those of Reibisch,§ Schiemenz,‖ and Apstein.¶

With regard to the size at which the Plaice becomes mature for the first time, investigation has shown that it varies in different seas or regions, maturity being attained at a smaller size in the Baltic than in the North Sea, and the same is true of the south coast and Channel. In the North Sea Holt came to the conclusion that 17 inches represented the average size of the female, but many were found mature at 15 inches. At Plymouth Cunningham found that females may spawn when 10 or even 9 inches in length, and that the size at maturity differed in certain parts of the North Sea.**

Like so many other flat-fishes, the early stages of the Plaice are passed in the shallow waters inshore and on the beaches, and they gradually move out into deeper water as they increase in size. There is thus a definite migration with age, but there are also migratory movements from one part of the sea to another at different seasons, a fact well known to trawlers, and which is now being dealt with in the International investigations. It is evident that the Plaice may perform very extensive migrations in the course of its life. In experiments I made a number of years ago by marking large numbers of them in the Firth of Forth, it was found that their movement was in a definite direction westwards along the south shore and eastwards along the north shore ; that they remained as a rule within the Firth or inshore waters during their period of immaturity ; and that the general course of migration was northwards along the east coast of Scotland, in a contrary direction to the prevailing current. A year and more later some of the Plaice which were marked in the Firth of Forth were caught in the Moray Firth, in some cases more than 150 miles distant from the place of liberation ; in one instance the fish had travelled round Duncansby Head and was taken off Dunnet Head to the west of the Orkney Isles, over 200 miles from the point of liberation. Another proof of the great migrations of the Plaice is to be found in the presence of adults in large numbers on the offshore fishing grounds, as the Fisher Bank, whither they must have wandered from the shallow water along the coast, where alone they are found in their young stages.††

In regard to bathymetrical distribution, while the great majority are got in water of moderate depth, they occasionally are found in deep water far from the coast ; I have recorded them from the northern part of the North Sea in depths of 65 and 70 fathoms. In the statistics of trawlers' catches here dealt with, they are recorded from depths up to 100 fathoms.

The areal distribution of the Plaice is very wide. On the north it is found along the whole of the Norwegian coast, in the White Sea and off the Murman coast, at Iceland and the Faeroes ; on the other

* *Ibid.*, pp. 6, 22, 33.
† *Seventeenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 232.
‡ *Twentieth Ann. Rep. Fishery Board for Scotland*, Part III., p. 359.
§ *Ibid.*
‖ *Ibid.*
¶ *Wissensch. Meeresuntersuch., Abt., Kiel*, N. F. Bd., 8.
** *Journ. Mar. Biol. Assoc.*, IV., pp. 16, 100.
†† *Eleventh Ann. Rep. Fishery Board for Scotland*, p. 185; *Fifteenth Ann. Rep.*, p. 374; *Twenty-first Ann. Rep.*, p. 40.

side of the Atlantic it exists in the Behring Sea and Alaska; it is found in the Baltic and the Mediterranean.

Distribution.

The aggregate quantity of Plaice taken by the recording vessels in the three years was 14,326⅛ cwts., the general average for the whole period and region being 5·166 cwts. per 100 hours, or 5·8 lbs. per hour. The fish are in three classes, large, medium and small, and the particulars for the three years are as follow:—

—	1901.		1902.		1903.		Total.	
	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.	Cwts.	Average per 100 Hours.
Large ...	282⅞	0·418	292⅝	0·36	1,144⅝	0·89	1,720⅛	0·62
Medium ...	1,939⅛	2·87	2,192¼	2·69	7,731⅞	6·03	11,863¼	4·278
Small ...	77	0·114	92⅞	0·114	572⅞	0·446	742¾	0·268
Total ...	2,299	3·4	2,577¾	3·167	9,449⅜	7·366	14,326⅛	5·166

The percentage proportion of the various classes specified are these:—

—	1901.	1902.	1903.	Total.
Large	12·3	11·3	12·1	12·0
Medium	84·4	85·0	81·8	82·8
Small	3·3	3·6	6·7	5·2

The figures for 1901 and 1902, it will be observed, closely correspond, while in 1903 the averages are higher as well as the quantity, This was due to a greater amount of fishing in the latter year on certain squares. The only areas in which Plaice were not taken, according to the returns, were VIII and XII in 1901 and XII in 1902.

The variation of the averages in different squares is very considerable. The most productive of Plaice were those on the south-eastern side of the North Sea. The highest average is for XLIII, situated in the German Bight, viz., 165·1 cwts. per 100 hours, but it was limited to a single month's fishing, in May, and is of little value. The next highest was 49·8 for XXVII, off the Danish coast, at the mouth of the Skagerack, but here again the fishing was limited to four months, May and August–October. Another high average was 30·625 for XXXVIII, situated likewise off the coast of Denmark, but the fishing was confined to October and December. The higher averages in those areas in which the fishing was most complete are IX, to the west of the Shetlands, and really meaning around the island of Foula, where it was 27·24, no fishing taking place in February–April or June; XIII, embracing the northern part of the Orkney Isles, the average being 12·26, no trawling occurring in January, March and May; XVII, including the southern part of the Orkney Isles, with 11·2, all months except January being represented, and the areas on the Fisher Bank plateau, where, however, there was little or no fishing in the early months of the year.

A general idea of the distribution of the Plaice in the North Sea may be obtained by contrasting the averages for series of squares from north to south and from west to east, confining the comparison to those in which the fishing was fairly well distributed.

Thus from XI, on the east of the Shetlands, to XXXV, on the north-west side of the Dogger Bank, we have the following averages in succession :—0·484, 0·574, 0·318, 1·403, 1·125, 3·69 ; the fishing in the two last was confined to the latter half of the year.

In the parallel series, XVI to XXXVI, *i.e.*, from off the Norwegian coast, opposite to Bommel Fjord, to the Dogger, the averages are :—0·55, 3·52, 9·83, 5·54, 4·35 ; the fishing in the last-named area was confined to seven months.

In the series from the Orkney Isles to Norway, XIII to XVI, the averages run as follows :—12·26, 3·78, 0·574, 0·55.

In the series next south, from the Moray Firth to Jœderen, Norway, the averages are 11·2, 0·57, 0·318, 3·518. Here the influence of the deep water in XVIII and XIX is apparent.

In the next series from west to east, from Aberdeenshire to the Skagerrack, the averages are 4·64, 5·21, 1·403, 9·83, 17·8 and 49·8. The third and low average refers to XXIV, where there is deep water in a part of it, and the last depends on four months' fishing.

In the next series to the south, from the east coast of Scotland to Jutland, the averages range as follows :— 12·6, 4·98, 1·12, 5·54, 14·1 and (for three months' fishing only) 14·4.

In the last series, from the coast of Northumberland to Denmark, the fishing was incomplete, and confined mostly to the autumn ; the averages show the same general change, viz. :—2·4, 3·69, 4·35, 9·1, 30·62.

Thus, as was to be expected, the Plaice is most abundant in the areas around the coasts and in the shallower parts of the North Sea, especially towards the south-east, from the Fisher Bank areas onwards. The averages in the south-western parts, where, however, the amount of fishing was not large, are relatively small, and in some cases surprisingly so, as in the areas around the Dogger Bank.

Plaice are least abundant in the deep water areas in the north, but the averages there are larger than might have been anticipated, as in XIV, with 3·78, XI with ·48, XVIII with ·575, XV with ·574, &c. The area with the smallest average is XIX, where it is ·318. The fact that even these averages were got in the deep water far from land is of importance in connection with the migrations of the fish.

Seasonal Abundance.

As a rule, the curves for the monthly abundance of Plaice are not so simple as in most of the other cases, and it will be best to begin the study of the seasonal abundance with the areas in which the variations are least complex.

In XIV, south of the Shetlands, the type is simple, there being two periods of maximum abundance, namely, in spring and autumn, as in one of the years, 1903, or one maximum in autumn, as in the other two. The monthly averages are :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	1·1	0·94	0·5	1·7	1·94	1·7	6·9	2·25	0·7
1902 ...	0·00	0·23	0·00	0·00	0·33	...	...	1·91	2·75	1·60	12·14	0·02
1903 ...	0·00	0·28	0·26	42·7	...	...	0·00	...	10·7	9·15	1·84	2·7
	0·000	0·239	0·179	11·323	0·630	0·516	1·636	1·937	7·039	6·847	4·237	1·592

In 1901 there was great scarcity of Plaice in April, May and June, the minimum for the year being in the latter month ; from July to September Plaice were somewhat more abundant, and then, in October, there was a great increase in numbers, but only for a brief period, as the average in November is nearly as low as in September, and the December average is next the minimum. In 1902 the greatest scarcity was from January to May ; there was no trawling in June or July, but in August, September, and October, the fish were much more numerous, and then in November there was a great increase, the average jumping up from 1·6 to 12·14, and it was as brief as the corresponding rush in the preceding year, the December average falling to ·02. In 1903 these features are repeated, with this difference, that the average for April is enormously high, 42·7 (124 hours' fishing). The averages for January-March are very low : there was no fishing in May, June or August, but in July the average was at zero, no Plaice being taken ; the maximum point in the autumn curve is, moreover, in this year in September. There is thus a variation of two months in the maximum abundance. In the compound curve the two periods of maximum abundance are shown, the apex in one case being in April (1903) and in the other September-October.

Another curve of the same type is presented by the averages for XV., 1903 being again exceptional. In 1901, in which there was fishing throughout, except in the three first months of the year, the May average is relatively high, 0·9, the minimum being in June ; there is a small autumn cone of maximum abundance about September (1·3), and the remaining averages are rather low (Table, p. 402). In 1902, in which July was the only month in which there was no fishing, there was great and almost uniform scarcity of Plaice until September–December, the November average being the highest. In 1903 there was no fishing from June–September, and the averages for January–April are much as in the concluding months of 1902. In May, however, there is a great rise to 7·0 (100 hours' fishing), and the next average, for October, is also high, 6·04. In the compound curve for the three years there is thus a cone of maximum abundance in May, and another in autumn, about October.

In another of the deep water squares, XIX., the curve resembles the above. In 1901 there is a small cusp in May–June ; no fish were taken in July or August (270 and 95 hours), while a somewhat larger cusp of maximum abundance exists in September–November. In 1902 no Plaice were taken in February-April (1,330 hours' fishing), and the curve thereafter is irregular, but all the averages, except in August and October, are relatively high, and the highest point was in July ; in August and September the fishing was for only 75 and 60 hours ; in the other months some hundreds.

In 1903 there is a tall cone formed by the March average ; from April, which is moderately high, there is a regular descent to a minimum in July, while there is a tall cone of maximum abundance in October and November.

In square XI., lying to the east of the Shetlands, the curves for 1901 and 1902 each have a very tall cone of maximum abundance in July and a smaller cone in autumn, in November. The fishing in 1903 was less regular, but what exists of the curve agrees with the others. In the first five or six months of the year Plaice are extremely scarce ; there is then a sudden and brief but great increase, and a sudden scarcity, equally brief, followed by an increase in October and November and a fall thereafter.

In XVIII, another deep water area, lying off the mouth of the Moray Firth, the fishing was not quite regular in each year. In 1901, in which it was most regular and greatest in amount (8,133 hours), the averages form a symmetrical curve, the maximum abundance being in April, from which there is a fall to May and June, and after a period of greatest scarcity in June–July there is a second cone of maximum abundance in autumn, mostly in September, followed by scarcity in the winter months and on to March, 1902. In this year the April position is also high ; there was no fishing in May and June, but the July–

September averages are relatively high (but with comparatively little fishing) and they fall thereafter. In the following year there was no fishing in April, May, or December; the maximum abundance is in July, and there is a second cone in October.

Thus, while in these deep water areas Plaice are got in small numbers in most months of the year, they are very scarce in winter and there is a high but brief wave of maximum abundance in late summer or autumn, and sometimes also one in spring. The combined averages for the three years for XIV, XV, XVIII and XIX, representing 999½ cwts. of Plaice, with an average of 1·32 cwts. per 100 hours' fishing, are these :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·074	0·127	0·375	2·704	0·607	0·235	1·111	0·759	3·092	3·59	1·902	0·543

Here the curve shows two periods of maximum abundance, the lesser in April, the larger in autumn, about October and September; the periods of greatest scarcity are in winter, especially in January and February; also in the middle of summer, about June.

Again, in XXIII, lying off the coast of Aberdeen, where the quantity was 1,784 cwts., or 12·4 per cent. of the total for the North Sea, the average being 5·209 cwts. per 100 hours, the curve in each year shows with remarkable regularity two periods of maximum abundance, one in spring and the other in autumn. The monthly averages are these :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	10·3	5·0	4·0	3·7	2·14	7·3	5·0	6·0	5·3
1902 ...	3·13	5·56	10·91	3·65	2·80	1·39	2·70	3·13	2·59	5·58	9·15	4·10
1903 ...	2·04	2·0	11·89	7·0	7·4	6·52	2·41	3·585	3·379	8·94	4·36	4·8
	2·579	4·956	11·654	8·598	5·208	5·599	3·666	3·054	3·795	6·515	5·719	4·772

In 1901 the maximum was in April, there being no data in that year earlier. After that the abundance diminishes rapidly to June, July, and especially August, the minimum for the year, and they increase again in autumn from September to December, the highest point in this year being in September. In the next year the spring cone is formed partly in February but chiefly in March, the maximum abundance for the year, after which scarcity prevails from April to September, the lowest point being reached in June, while there is a tall cone of second maximum abundance in October and November, especially in the latter month. In 1903 the maximum scarcity is in January and February, in March there is a sudden uprush to the maximum for the year, Plaice being then six times more abundant than in January and February. The numbers diminish in April to about half, and remain thus to June, when there is a sudden decrease to July, the second lowest position for the year; after that the abundance increases, especially in October, where the second maximum occurs, while in November and December the position is lower.

The compound curve shows the period of greatest maximum abundance in spring (contrasting thus with the more northerly areas in deeper water, referred to above, in which the greatest maximum is in autumn), especially in March and also April, the period of scarcity in summer—July–September—a second and lesser maximum about October and November, and a second minimum period in winter, in December–January. The lowest position of all is January.

The curves for this square for each of the years thus exhibits two waves of maximum abundance, one of which, and by far the greater, coincides with the spawning-period of the species. One might therefore conclude that Plaice congregate here for spawning, forsaking the area in summer, returning in numbers in autumn, and diminishing in abundance again in winter, particularly in January and February.

The area to the south of the above, viz. XXIX, lying off the east coast of Scotland, in which 1,801¾ cwts., or 12·6 per cent. of the total for the North Sea, were taken, the average being 4·98 cwts. per 100 hours, agrees with it so far as concerns the abundance in spring, but differs in that there can scarcely be said to be a second maximum in autumn. The monthly averages are these :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	5·1	3·6	6·2	5·5	5·4	7·4	3·6	5·1	1·4
1902 ...	...	...	34·52	6·32	4·94	3·98	3·74	4·17	3·88	6·80	3·54	3·53
1903 ...	4·92	5·0	15·34	8·30	4·703	4·03	5·7	5·03	4·95	4·41	4·0	2·8
	4·927	5·000	16·134	6·953	4·439	4·547	5·046	4·909	5·453	4·629	4·108	2·909

In 1901, as previously stated, the number of hours' fishing was not recorded in January–March, and the first average, for April, is low. But that Plaice were extremely abundant in this year in March, as in the two following years, is shown by the fact that in that month five landings of vessels gave 44 cwts., or nearly 9 cwts. per landing, while in April 13 landings gave 27½ cwts. During the rest of this year there was not much variation in the averages until December, the minimum, but they were highest from June to September, especially in the latter month. In 1902 there was no fishing in January and February ; the March average is by far the highest for the year, while, during the rest of the year, they are fairly uniform and low, a little peak in October being the highest. In 1903 there are the same features, the March average much exceeding the others, and in this case the April average is higher than in the other years, and the autumn averages as well as the summer ones are low.

The compound curve thus shows one cone of maximum abundance in March, the minimum being in November and December and next in June. All the autumn averages are low compared with the March or the April one, but those from July to October are a little higher than the others.

In this area, then, in the month of maximum spawning for the species on the east coast, there is a notable maximum in the abundance of the fish.

Taking next the area lying to the inside of the above, viz., XXVIII, which embraces the mouths of the Firth of Forth and St. Andrews Bay, where the quantity was small, 96⅛ cwts., the average 12·598, and the fishing irregular, we find in the compound curve the maximum average in February and the next in October, while the summer and early autumn averages are low.

The outstanding character of the areas along the east coast are thus great abundance of Plaice in spring, at the height of the spawning-season, paucity in summer, with, in the northern part (XXIII) where the water is deeper, a second smaller maximum in autumn, comparable to the chief maximum period in the areas in still deeper water to the north, while there is scarcity in winter.

Combining the data for the two great areas XXIII and XXIX (representing 25 per cent. of the aggregate from the North Sea), we have the following averages :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	7·7	4·3	5·1	4·6	3·8	7·3	4·3	5·5	3·3
1902 ...	3·1	5·6	22·7	5·0	3·9	2·7	3·2	3·6	3·2	6·2	6·3	3·8
1903 ...	3·5	3·5	13·6	7·6	6·1	5·3	4·1	4·3	4·2	6·7	4·2	3·8

The compound curve shows the same thing—in each year a great maximum in March, a smaller maximum in autumn, and scarcity in summer and winter.

In connection with the periodicity in these areas adjoining the coast, it is of interest to compare the periodicity in the areas lying immediately to the east, that is, further off-shore.

In XXIV, contiguous to XXIII, where the quantity taken was small, 139¼ cwts., the average being 1·4, the curve shows the opposite of the shoreward areas, there being scarcity in spring and abundance in summer, as well as fair numbers in early autumn. The fishing was not quite regular. In 1901 the April average was 0·0, and the next, in July and August, were the maximum (4·1 and 4·7) ; in September–November the averages were about 1·0, and in December 0·0. In 1902 no Plaice at all were taken in February–May ; in June the average was 3·23, July showed a fall to 0·55, and after that, from August to November, Plaice were much more abundant, decreasing again in December. In 1903, in March and May, Plaice were scarce, the next, in July, was the maximum abundance ; a decrease in August and September was followed by a slight increase in October–November, and by the minimum for the year in December. In the last two years there is thus really a double maximum, the greatest and briefest in the middle of summer and the next later in the year. At the spawning season Plaice are very scarce in this offshore area.

Going to the next square to the east, viz., XXV, we come to the Fisher Bank plateau, and in this area the quantity taken was large, 1,989¾ cwts., the largest from any square, the average being 9·83 cwts. per 100 hours' fishing. Here the fishing was confined to the ten last months, and mostly to the eight last months, of the year.

In 1901 the period of maximum abundance is May and, especially, June and July, and the minimum is in August–October ; there was no fishing in the other months. In 1902 the maximum is at the same time, but mostly in May and June, and the minimum is in August and September ; in October and November the average is higher, and it is still higher in December ; the fishing was limited to the months named. In 1903 the minimum is in March and April ; May, June and July are high and level, and in this year August (with only 184 hours' fishing) is the maximum, the other averages, September-December, being about the same level as in May-July, those for September and December being lowest. The curves for the three years thus do not quite correspond, but as the amount of fishing in August, 1901–1902, was greater than in 1903 (300 and 400 hours) the average in these years probably better represent the normal. At all events, the curves and the compound curve show that Plaice are abundant in May, June and July, at the time they are scarce on the western areas, and are also numerous in the later months of the year.

As a contrast to the averages for XXIII–XXIX given above, I give here the averages for XXIV–XXV combined :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	0·00	7·65	10·0	7·37	3·13	1·95	1·35	0·9	0·00
1902 ...	...	0·00	0·00	0·00	4·32	5·03	3·13	2·10	2·13	2·79	2·77	3·60
1903 ...	...	...	0·75	1·4	7·1	13·1	9·12	12 4	6·5	8·5	7·67	5·76

In the other areas on the Fisher Bank plateau, the maximum abundance was also in summer and autumn.

In square XXXI, where 1,419¾ cwts. were taken, the average being 5·54 cwts. per 100 hours' fishing, most of the fishing was in 1903 and 1902. The monthly averages for the various years are these :—

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	...	3·2	...	...	10·0	...	1·0	0·8	...
1902 ...	...	...	...	...	6·32	7·03	5·76	4·26	3·74	4·86	2·57	1·03
1903 ...	...	...	5·95	...	7·16	7·99	6·63	6·04	6·89	5·912	6·09	1·6
	...	...	5·937	...	5·668	7·912	6·169	5·273	5·728	5·465	5·109	1·543

There was little fishing in 1901, but the highest average was in summer, as in the other years, viz., in August, those in October and November being low. In 1902 the maximum abundance was in May–July, and after that period there is gradual diminution in abundance, save for a slight rise in October, the December average showing the point of greatest scarcity. In 1903 the March average (80 hours' fishing) is high ; there was no fishing in April ; May and June indicate the time of maximum numbers, the June average being the highest for the year ; there is a slight fall in July and August, but practically from July to November the level is about the same, while in December there is a marked decrease. The compound curve shows a maximum from May to July, chiefly in June, a period of nearly uniform abundance from August to November, and a sudden diminution in December.

In square XXXII, lying nearer the Danish coast, the quantity of Plaice taken was 1,050¼ cwts., the average being the high one of 14·1. The fishing in 1901 and 1902 in this area was confined to a few months. In 1901 the averages for May–July are relatively high, in August and September less, and in October again somewhat high ; so far as the data go they show a maximum in June–July, but there was no trawling in November or December. In 1902 May is high, the next, in August and September, low, and those in October and November highest of all. In 1903 the fishing was chiefly in September, October and November, but nine months are represented. The line of the curve is zig-zag throughout, a high average being followed by a low one, the higher being in May, July, September and November ; and while the lower averages in February, June, August, October and November are all about the same level, the other averages gradually rise, the highest of all being in November (43·3 cwts. per 100 hours, with 840 hours). In the compound curve the averages present are almost uniform to August, and rise

thereafter. In this area, then, the period of maximum abundance is at the end of the year, chiefly November.

In the areas on the south-eastern grounds the fishing was confined to a few months, but such averages as exist point to increased numbers towards the end of the year, as in XXVII, XXXIII, XXXVII, XXXVIII.

On the other hand, the curves for the areas to the west, on the Dogger and west of it, so far as they go, rather show the same type of periodicity as the curves to the north and north-west, the line sloping down from summer to winter, when Plaice are the least abundant.

Turning now to the areas in relation to the Orkney and Shetland Isles, we find the characters of the curves of seasonal variation to be as follows :—

In XVII, the fishing was not very regular in any of the years. In 1901 there is only a fraction of a curve from April to September. In 1902 the maximum abundance was in March (68·01 cwts. per 100 hours, with only 68 hours' fishing) ; in summer, with the exception of July, the averages were relatively low, and in the latter part of the year they rise to December. In 1903 the highest average is in December and the next in March, and between them the smoothed curve forms a hollow with the minimum in summer, July to August.

In XIII, to the north of the above, the fishing was practically limited to 1903, but of the two averages for 1902, April and July, the latter was much the higher. In 1903 the maximum was also in July and June, and the lowest in February and December.

From what has been said it will be seen that the periodicity in the abundance of the Plaice varies considerably in different parts of the North Sea. In the deep water areas in the north they are most abundant for a brief period in autumn, very scarce in winter, in some of them becoming again numerous in March or April, and less numerous in summer. Along the east coast of Scotland the maximum abundance is in spring, at the spawning-season, the greatest scarcity is in winter, they are scarce in summer, and may increase in numbers in autumn. On the Fisher Bank plateau they are most abundant in summer, and towards the eastern side, so far as the somewhat scanty evidence goes, they are most numerous towards the end of the year.

I may contrast the variations in the periodicity by combining together a number of squares, as before. We have already seen that in XXIII and XXIX, representing a fourth of the Plaice landed, there is a great preponderance in spring, during the spawning-season, with a smaller wave of increased abundance in autumn, and that in XIV, XV, XVIII, and XIX, taken together, while these two periods exist, the autumn one is that of maximum abundance. If X, XI, XIII, XVII, and XX be grouped together we get the following monthly averages :—

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0·00	4·70	4·88	3·93	4·33	8·42	12·68	10·73	7·02	5·97	5·29	5·30

The mean is here 5·52, and we see from the curve that while the spring cone is represented, the outstanding feature is a great cone of maximum abundance in summer, chiefly about July.

Taking the whole area fished over by the recording vessels in each year, the combined averages (Fig. 26) are as follows :—

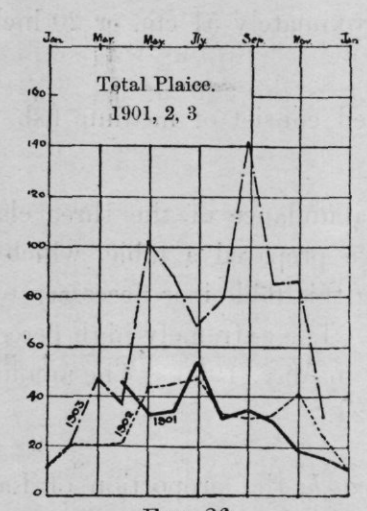


FIG. 26.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1901 ...	...	...	...	4·626	3·270	3·403	5·402	3·117	3·446	3·049	1·939	1·622
1902 ...	1·085	1·956	2·021	2·185	4·265	4·519	4·794	3·329	3·192	3·442	4·076	2·325
1903 ...	1·067	1·982	4·780	3·733	10·179	8·838	6·807	7·983	14·162	8·530	8·664	3·224
	1·038	1·959	3·503	3·676	6·172	6·385	5·761	5·228	9·625	5·421	5·790	2·752

In each case the period of greatest scarcity is winter and chiefly January, but the averages are under the mean in 1901–1902 from October to the following April, and in 1902–1903 from December to April. The period of greatest abundance in 1901 is from April to September, but chiefly in April and July ; in 1902 it is from May to November, but chiefly in June-July, and there is a second maximum, just indicated in 1901, in November, August-October being lower ; in 1903 the period of greatest abundance is from May to November, but there are two distinct maxima, in May–June and in September.

Taking the whole period and region together we find the average number of cwts. of Plaice caught in the various months of the year to be as given above, the period of greatest scarcity being in winter, chiefly January-February, and the period of maximum abundance from May to November, and this is separated into two maxima, one in May–June and the other in September.

The Large, Medium, and Small Fish.

The quantities of the Plaice of the different market classes have been already mentioned (p. 595), and it is necessary now to consider some points in connection with their distribution and seasonal abundance. As regards size, the following Table gives the particulars :—

—	Large.		Medium.		Small.	
	Range.	Mean.	Range.	Mean.	Range.	Mean.
Cm.	40 —80	**59**	25—63	**42**	19 —46	**29**
Inches ...	$15\frac{3}{4}$—$31\frac{1}{2}$	**$21\frac{1}{2}$**	10—$24\frac{3}{4}$	**$16\frac{1}{2}$**	$7\frac{1}{2}$—18	**$11\frac{1}{2}$**

The assortment, it will be seen, is by no means exact, since among the "small" are some larger than some among the "large"; but such cases are of course very exceptional. The point of division between the large and the medium fish is approximately 51 cm. or 20 inches, and between the medium and the small 35·5 cm. or 14 inches.

The great bulk of the Plaice landed consist of medium fish, and it is these, therefore, which mostly determine the curves of periodicity.

With regard to the proportional abundance of the three classes, large, small, and medium, in the various parts of the North Sea, I have prepared a table, which is appended, showing the weights in percentages of the total. In considering this table it is necessary to bear in mind what has been said as to the limited fishing in some of the areas. The extremely high percentage of the small Plaice, for example, in XLIII depends on 108 hours' fishing in May, 1903. The amount of fishing has been referred to above and is set forth in the Tables on page 424.

Table showing, in *percentage of total catch*, the proportion of Large, Medium, and Small Plaice in the various Areas.

Area.	1901.			1902.			1903.			1901—1903.		
	L.	M.	S.	L.	M.	S.	L.	M.	S.	L.	M.	S.
IX ...	12·1	57·6	30·3	13·1	82·3	4·6	20·1	78·6	1·3	18·9	78·1	3·0
X ...	16·7	83·3	0·0	17·3	80·0	2·7	18·5	79·2	2·3	17·8	79·9	2·2
XIII ...	44·4	55·6	0·0	13·4	71·2	15·4	16·9	73·2	9·8	17·5	72·7	9·8
XXVIII..	8·1	83·8	8·1	3·4	76·7	19·9	7·1	92·9	0·0	5·6	82·7	11·7
XVII ...	17·9	79·8	2·2	21·0	74·1	4·8	22·3	71·0	6·6	19·8	76·2	4·0
XXIII ...	6·3	84·6	9·0	6·3	82·6	11·1	5·8	80·7	13·4	6·1	82·2	11·7
XXIX ...	6·1	93·5	0·4	7·2	91·9	0·9	5·1	93·0	1·9	5·8	92·8	1·3
XXV ...	14·2	84·7	1·3	12·2	86·5	1·2	11·8	84·5	3·7	11·9	84·9	3·1
XXVI ...	8·6	91·4	0·0	9·4	90·5	0·0	11·4	87·6	1·1	11·1	87·9	0·9
XXXI ...	5·6	94·3	0·0	9·9	87·9	2·2	9·3	89·0	1·7	9·3	88·8	1·8
XXXII ...	12·3	84·7	3·1	8·7	91·2	0·0	11·9	84·8	3·2	11·8	85·4	2·8
XX ...	15·4	84·6	0·0	9·3	90·7	0·0	9·0	91·0	0·0	11·0	89·0	0·0
XXI ...	12·7	87·3	0·0	0·0	100·0	0·0	...	...	...	11·0	89·0	0·0
XXIV ...	11·6	88·4	0·0	10·7	88·6	0·7	7·4	88·9	3·6	9·8	88·7	1·5
XXVII ...	...	...	...	..	...	...	17·0	78·1	4·9	17·0	78·1	4·9
XXXIII..	16·1	83·9	0·0	0·0	100·0	0·0	11·7	82·7	5·6	11·2	84·4	4·4
XXXVII..	...	...	...	26·4	73·6	0·0	2·3	39·7	57·9	5·9	44·7	49·2
XXXVIII	2·4	74·4	23·2	...	...	...	16·3	83·7	0·0	10·2	79·6	10·2
XLIII ...	...	...	...	...	...	...	0·2	2·0	97·7	0·2	2·0	97·7
XXXV ...	...	...	...	11·1	88·9	0·00	9·8	90·2	0·00	10·1	89·8	0·0

Area.	1901.			1902.			1903.			1901—1903.		
	L.	M.	S.	L.	M.	S.	L.	M.	S.	L.	M.	S.
XXXVI...	0·00	100·0	0·00	...	...	...	16·2	81·4	2·3	15·7	82·0	2·3
XLV ...	0·00	100·0	0·0	...	...	...	...	...	...	0·0	100·0	0·0
XXX ...	20·7	79·3	0·0	16·1	83·9	0·0	11·9	87·2	0·9	14·1	85·3	0·6
XXXIV...	5·9	94·1	0·0	0·0	100·0	0·0	...	...	...	4·0	96·0	...
XLI ...	33·3	66·7	0·0	...	...	...	...	...	...	33·3	66·7	0·0
VI ...	...	...	...	30·0	66·7	3·3	12·8	87·2	0·0	22·4	75·7	1·9
VII ...	0·0	100·0	0·0	25·0	75·0	0·0	0·0	100·0	0·0	13·8	86·2	0·0
VIII ...	...	...	...	0·0	100·0	0·0	11·5	86·9	1·6	11·1	87·3	1·6
XII ...	...	...	...	...	...	...	20·2	78·1	1·7	20·2	78·1	1·7
XXII ...	...	...	...	...	...	...	38·5	61·5	0·00	38·5	61·5	0·0
XIV ...	19·8	79·3	2·2	17·4	80·2	2·5	16·0	83·8	0·4	16·9	82·2	0·9
XI ...	20·4	79·6	0·0	38·4	61·6	0·0	32·0	68·0	0·0	25·2	74·8	0 0
XV ...	53·2	46·2	0·0	35·6	64·0	1·4	22·8	76·8	0·4	31·3	67·7	0·6
XVI ...	33·3	66·4	0·0	38·5	61·6	0·0	24·0	76·0	0·0	30·8	69·2	0·0
XVIII ...	20·4	79 5	0·0	10·5	82·8	6·6	10·4	89·2	0·4	15·8	83·2	1·4
XIX ...	25·0	75·0	0·0	25·6	74·4	0·00	28·5	70·7	0·6	27·6	72·6	0·4

From the above table it will be seen that the proportion of the large, small, and medium Plaice varies considerably in different quarters.

Taking first of all the large fish, as defined above, it is clear that they are present in greatest numbers compared with the other classes in the deep water squares in the north. In the areas most northerly, VI–VIII, the fishing was limited and the quantity taken was small, and the percentage ranges there from 11 to 38 ; but, as stated below, the high proportion of small Plaice taken in some of these as compared with the other deep water areas leads one to suspect that a mistake has been made as to the precise locality of some of the catches. In the more southerly deep water areas, where the fishing was greater, the proportion of large Plaice varied from 15·8 to 38·5 per cent., and in some years it was larger and in one or two smaller, the extreme range for a year being from 10·4 to 53·2 per cent.

The medium-sized Plaice were also abundant in these deep water areas, the proportion for the whole period varying in different squares from 61·5 to 87·3, and in different years from 46·2 to 100 per cent., but in the latter case the catch was small.

As was to be expected, the proportion of small Plaice in this part of the North Sea was insignificant. None were taken in any of the years in squares VII, XI, XVI or XXII, and the recorded proportion for the others varies from 0·4 to 1·9 for the whole period, and from 0·4 to 6·6 for the different years. In 1901 only one of the areas is recorded as having yielded any small Plaice, viz., XIV, and this area includes coast ; in 1902 there were four, and in 1903 six. In some of these cases it is probable a mistake was made as regards the place of fishing, for in square VIII, for example, there is no water under

70 fathoms, and the proportion of small Plaice recorded from it in 1903 is 1·6 per cent. ; and while in some of the other areas there are small portions with water of 40 to 50 fathoms, I think it unlikely that small Plaice, even of the size defined above, inhabit these tracts.

Going now to the areas in relation to the coast, it will be seen that the more northerly, where the water is also as a rule deeper, gave the largest proportion of large Plaice. For the whole period the percentage in IX was 18·9, in X it was 17·8, in XIII 17·5, and in XVII 19·8. The medium Plaice in these areas varied from about 73 to 78 per cent., and the small from 2·2 to 9·8. Further down the coast, in XXIII, XXVIII and XXIX, the proportion of the large Plaice was much less, the percentage for the whole period ranging from 5·6 to 6·1, and thus showing considerable uniformity. The medium Plaice varied from 82·2 to 92·8. The proportion of small Plaice in XXIII and XXVIII was exactly the same, viz., 11·7 per cent., while in XXIX it amounted to only 1·3 per cent.

In the areas in relation to the Fisher Bank plateau, the proportions varied. In XX, which also extends into deep water, 11 per cent. of the Plaice taken were large, 89 per cent. were medium, and none were small. In the adjoining area, XXI, the proportions were exactly the same ; but in the latter the fishing was limited to two months and 190 hours, while in XX there was fishing in each month, the total being 7,720 hours. In XXIV, which touches the plateau on its western side, the proportion was 9·8 large, 88·7 medium, and 1·5 small.

In the most productive areas in this quarter, XXV, XXVI, XXXI, and XXXII, the uniformity was considerable, the large Plaice ranging from 9·3 to 11·9 per cent., the mediums from 84·9 to 88·8, and the small from 0·9 to 3·1. Small Plaice are, therefore, scarce in this quarter of the North Sea.

On the areas further to the south-east, small Plaice were got in far greater proportions, though it must be borne in mind that the fishing in this part was less, and less regular. In XXXIII, lying off the west coast of Denmark, near the mouth of the Skagerrack, the proportion of the large Plaice amounted to 11·2 per cent., the medium to 84·4, and the small to only 4·4 per cent. The total fishing here was only 434 hours, and confined to June, July, September and October. In the areas to the south (with less fishing, however) the proportion of small Plaice was high. In XXXVII the percentages of the three classes were, large 5·9, medium 44·7, and small 49·2. In XXXVIII the corresponding percentages were 10·2, 79·6, and 10·2. In XLIII, where the fishing was limited to 108 hours in May, the proportions were, large 0·2, medium 2·0, and small 97·7, which was probably exceptional.

It is well known that in this part of the North Sea small Plaice abound, and it has been shown by Archer that they form a chief item in the catches of trawlers, especially in April and May.*

With regard to the seasonal abundance of the Plaice of the various sizes (Figs. 27–30), the mediums

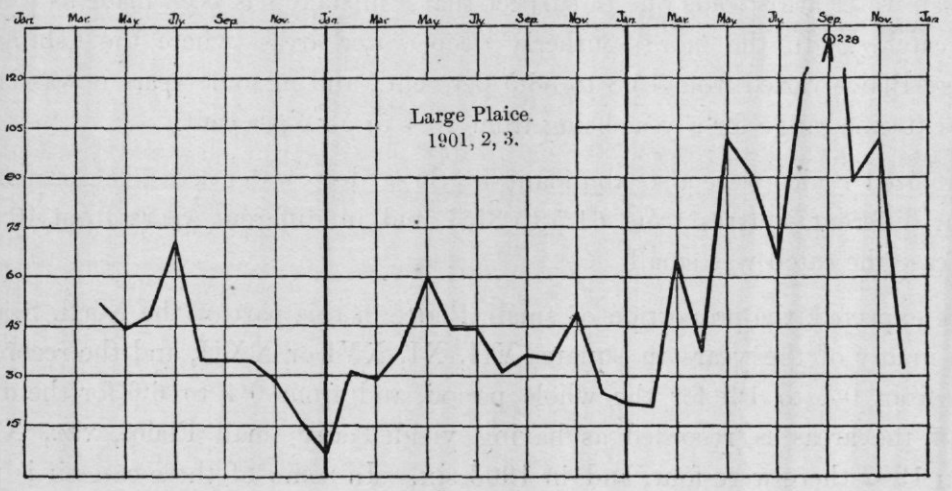


FIG. 27.

* Report on Sea Fisheries Bill (H. L.) 1904 (36), p. 181.

show practically the same variations as the total Plaice, as above described, and the same may be said of the large, the curves being almost identical for each of the years; the chief point of difference is the

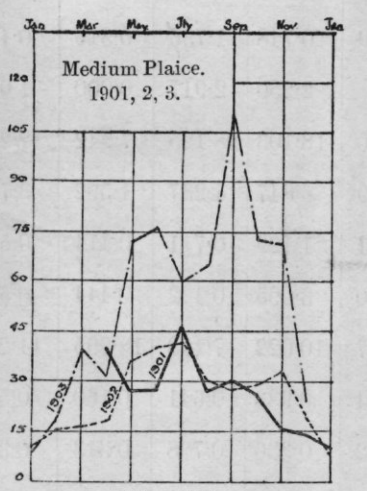


FIG. 28.

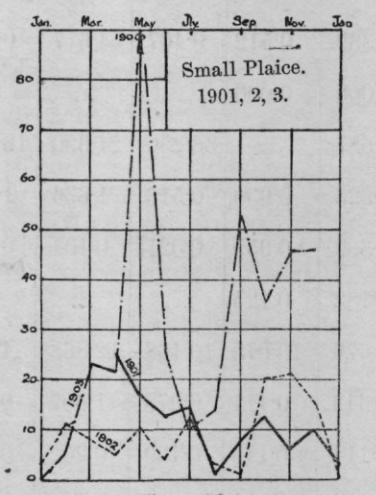


FIG. 29.

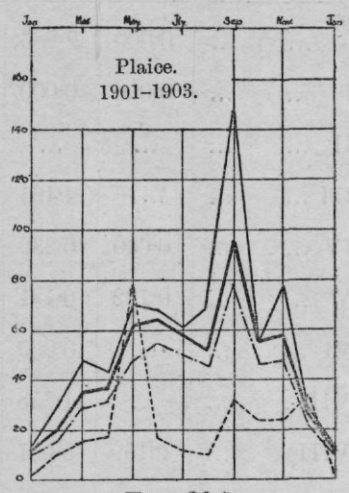


FIG. 30.*

Total Plaice
Large Plaice
Medium Plaice
Small Plaice

exaggeration of the maximum in September, 1903, in the case of the large as compared with the mediums.

The curve for the small Plaice differs somewhat. From the exceptional catch in XLIII in May referred to above, the average in that month is very greatly increased in 1903; in 1901 the maximum was in April and May, and the minimum in August; in 1902 the averages were irregular and low except those in October–December. In 1903 there are two maxima, one in March–May and one in September–Deceember, the minima being in January–February and July–August.

In looking at the curves for some of the chief squares for the three years it would appear that there is little regularity in the times of maximum and minimum in the various years (see Table). Thus in XXIX, small Plaice were taken in 1901 only in October and November; in 1902 they were taken in small numbers in May, June, July, August and November, in moderately large numbers in April, and in great numbers in March; in 1903 they were also taken chiefly in March and in April and May, and a few were got in each month except January and February. In XXIV they were only taken in June in 1902, and only in November in 1903. One of the most regular areas in point of periodicity is XXIII, where each year shows two maxima, in spring and autumn, corresponding to those in the curve for the total Plaice above referred to, and only differing in the autumn one being the larger.

(1) TOTAL PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	3·581	0·490	0·545	...	...	...	...	...	...	...	0·867
VII	...	...	0·000	0·126	0·000	...	...	...	...	...	...	...	0·086
VIII	...	...	...	2·927	0·000	...	...	...	...	0·385	...	...	2·004
IX	32·812	...	...	...	36·993	...	25·824	30·085	19·027	34·102	54·587	19·288	27·243

* In Fig. 30, the curves for Large and Small Plaice are on a scale ten times that of Medium and Total Plaice.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
X	0·000	9·286	3·934	9·582	6·717	...	0·000	35·983	2·794	8·627	8·999	6·734	8·059
XI	0·000	0·000	0·009	0·339	0·512	0·407	4·677	0·416	0·819	0·748	1·736	0·316	0·484
XII	...	...	0·588	0·000	0·000	...	...	...	...	2·250	2·917	0·000	1·027
XIII	...	4·464	...	4·687	...	36·250	24·390	19·167	20·810	18·103	28·125	7·942	12·258
XIV	0·000	0·239	0·179	11·323	0·630	0·516	1·636	1·937	7·039	6·847	4·237	1·592	3·783
XV	0·122	0·181	0·176	0·399	0·955	0·021	0·104	0·291	0·694	1·129	0·711	0·414	0·574
XVI	...	0·000	0·982	0·182	0·125	...	...	...	0·000	3·095	0·422	0·444	0·552
XVII... ...	...	11·658	21·769	10·676	10·073	10·168	12·868	4·038	8·807	10·022	7·158	18·995	11·202
XVIII ...	0·159	0·037	0·157	1·643	0·417	0·278	1·607	0·524	1·124	0·933	0·641	0·160	0·575
XIX	0·036	0·022	1·066	0·114	0·145	0·129	0·202	0·370	0·222	0·330	0·798	0·313	0·318
XX	0·000	0·000	1·689	1·009	3·661	5·873	8·250	2·044	12·589	0·214	3·564	2·557	3·518
XXI	...	...	...	...	...	...	...	...	...	10·882	...	10·000	10·789
XXII... ...	...	...	...	...	...	...	...	...	...	...	4·643	...	4·643
XXIII ...	2·579	4·956	11·654	8·598	5·208	5·599	3·666	3·054	3·795	6·515	5·719	4·772	5·209
XXIV ...	...	0·000	0·728	0·000	0·108	3·235	4·339	2·313	1·588	1·319	1·434	0·278	1·403
XXV... ...	...	...	0·555	1·364	11·510	11·058	8·220	7·982	7·645	5·551	9·226	9·387	9·826
XXVI ...	...	...	...	...	16·122	11·111	16·129	28·618	21·905	13·778	24·144	12·093	17·797
XXVII ...	...	...	...	...	9·000	...	...	51·316	49·934	191·667	...	...	49·826
XXVIII ...	...	45·312	10·833	...	10·398	11·750	7·609	6·548	0·000	31·875	9·500	15·341	12·598
XXIX ...	4·927	5·000	16·134	6·953	4·439	4·547	5·046	4·909	5·453	4·629	4·108	2·909	4·982
XXX... ...	...	...	...	...	...	...	7·474	4·582	1·777	2·053	0·887	0·562	1·125
XXXI ...	...	...	5·937	...	5·668	7·912	6·169	5·273	5·728	5·465	5·109	1·543	5·542
XXXII ...	...	8·125	...	...	8·367	8·367	9·613	6·310	16·961	9·271	32·399	9·592	14·096
XXXIII ...	...	...	...	...	...	8·182	9·343	...	30·375	21·094	...	...	14·401
XXXIV ...	...	...	...	...	...	...	...	3·333	2·257	1·667	...	...	2·367
XXXV ...	...	...	...	...	6·333	...	5·833	4·055	...	4·167	1·875	0·357	3·686
XXXVI ...	...	8·750	...	...	9·062	...	...	4·545	3·500	4·323	4·146	2·812	4·351
XXXVII ...	...	...	...	...	7·083	...	...	3·333	16·000	...	...	9·536	9·093
XXXVIII ...	...	...	...	...	...	...	...	...	...	22·917	...	53·750	30·625
XLI	...	...	...	...	...	...	...	3·750	...	...	...	...	3·750
XLIII ..	...	...	...	...	165·046	...	...	...	...	...	...	...	165·046
XLV	...	...	...	1·250	...	...	...	...	...	...	...	...	1·250

(2) LARGE PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	1·081	0·064	0·140	...	...	...	...	...	...	...	0·195
VII	...	...	0·000	0·017	0·000	...	...	...	...	...	...	...	0·012
VIII	...	...	...	0·336	0·000	...	...	...	...	0·000	...	...	0·223
IX	1·125	...	...	...	4·729	...	5·769	6·885	3·879	5·825	7·339	3·051	5·182
X	0·000	2·857	0·410	1·609	1·246	...	0·000	8·996	0·328	0·176	1·517	0·851	1·439
XI	0·000	0·000	0·009	0·076	0·054	0·291	0·645	...	0·163	0·125	0·702	0·127	0·123
XII	...	...	0·134	0·000	0·000	...	...	...	...	0·250	0·750	0·000	0·207
XIII	...	0·000	...	0·937	...	6·964	2·857	3·333	3·551	5·418	3·750	1·032	2·147
XIV	0·000	0·031	0·000	1·303	0·084	0·124	0·300	0·317	1·810	0·974	0·798	0·191	0·639
XV	0·116	0·036	0·088	0·179	0·409	0·000	0·104	0·058	0·231	0·136	0·403	0·144	0·182
XVI	...	0·000	0·340	0·091	0·000	...	...	...	0·000	0·714	0·097	0·166	0·170
XVII... ...	...	3·364	5·116	2·050	1·969	1·704	2·209	0·604	1·137	1·000	1·627	5·520	2·216
XVIII ...	0·000	0·000	0·054	0·238	0·118	0·088	0·125	0·000	0·087	0·243	0·233	0·032	0·091
XIX	0·026	0·011	0·149	0·000	0·000	0·069	0·050	0·046	0·000	0·047	0·321	0·085	0·087
XX	0·000	0·000	0·212	0·000	0·375	0·662	0·482	0·000	1·696	0·143	0·502	0·208	0·389
XXI	...	...	...	...	...	...	...	...	...	1·323	...	0·000	1·184
XXII... ...	...	...	...	...	...	...	...	...	...	...	1·786	...	1·786
XXIII ...	0·090	0·382	0·854	0·286	0·434	0·592	0·489	0·261	0·315	0·296	0·555	0·282	0·316
XXIV ...	...	0·000	0·065	0·000	0·000	0·294	0·517	0·159	0·150	0·125	0·176	0·013	0·136
XXV... ...	...	...	0·000	0·000	1·408	1·288	1·016	1·243	1·426	0·758	0·844	0·703	1·174
XXVI ...	...	...	...	...	2·770	0·631	1·008	2·796	1·409	1·495	2·902	1·524	1·793
XXVII ...	...	...	...	...	0·500	...	...	11·184	8·521	12·500	...	...	8·453
XXVIII ...	...	1·562	0·667	...	0·885	0·276	0·808	0·000	0·000	0·000	1·000	1·136	0·704
XXIX ...	0·274	0·000	1·277	0·642	0·305	0·309	0·256	0·340	0·312	0·242	0·073	0·097	0·290
XXX... ...	...	...	...	...	...	...	0·656	0·241	0·415	0·583	0·045	0·060	0·159
XXXI ...	...	...	0·000	...	0·769	0·637	0·751	0·654	0·626	0·513	0·451	0·092	0·519
XXXII ...	...	0·625	...	...	0·561	0·765	1·328	0·962	2·594	0·502	4·307	0·261	1·657
XXXIII ...	..	...	...	...	...	0·758	0·506	...	5·970	2·149	...	...	1·613
XXXIV ...	..	...	...	...	...	...	...	0·000	0·174	0·000	...	...	0·095
XXXV ...	...	...	...	...	1·333	...	0·416	0·333	...	0·833	0·000	0·000	0·371
XXXVI ...	...	1·250	...	...	0·625	...	...	0·378	0·667	1·065	0·822	0·000	0 684
XXXVII ...	...	...	...	...	1·875	...	...	0·333	0·000	...	...	0·250	0·544

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
XXXVIII ...	...	...	...	...	...	...	...	...	...	3·750	...	3·250	3·125
XLI	...	...	...	...	...	...	...	1·250	...	...	...	...	1·250
XLIII ...	...	...	...	...	0·463	...	...	...	...	...	...	...	0·463
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(3) MEDIUM PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	2·365	0·426	0·405	...	...	...	...	...	...	...	0·656
VII	...	...	0·000	0·109	0·000	...	...	...	...	...	...	...	0·074
VIII	...	...	...	2·543	0·000	...	...	...	...	0·385	...	...	1·749
IX	21·562	...	...	...	3·150	...	17·736	22·616	14·901	28·034	46·330	15·610	21·273
X	0·000	4·911	3·524	7·973	5·402	...	0·000	25·835	2·421	8·451	7·366	5·881	6·446
XI	0·000	0·000	0·000	0·263	0·458	0·116	4·032	0·000	0·656	0·623	1·034	0·189	0·361
XII	...	...	0·401	0·000	0·000	...	...	...	...	2·000	2·167	0·000	0·802
XIII	...	4·467	...	3·750	...	28·750	20·296	15·833	15·625	12·131	21·875	3·728	8·916
XIV	0·000	0·208	0·179	9·669	0·546	0·392	1·336	1·479	5·229	5·865	3·345	1·401	3·112
XV	0·006	0·145	0·088	0·220	0·546	0·021	0·000	0·233	0·463	0·993	0·420	0·262	0·389
XVI	...	0·000	0·642	0·091	0·125	...	...	...	0·000	2·381	0·325	0·278	0·382
XVII... ...	...	7·933	16·038	8·131	7·814	7·573	10·595	3·379	7·670	7·220	5·531	12·411	8·537
XVIII ...	0·159	0·024	0·103	1·167	0·298	0·190	1·482	0·524	1·037	0·690	0·408	0·128	0·477
XIX	0·010	0·011	0·899	0·114	0·148	0·060	0·152	0·324	0·222	0·283	0·477	0·228	0·230
XX	0·000	0·000	1·477	10·009	3·286	5·211	7·768	2·044	10·893	0·071	3·062	2·349	3·130
XXI	...	...	...	...	...	...	...	...	...	9·559	...	10·000	9·605
XXII... ...	...	...	...	...	...	...	...	...	...	...	2·857	...	2·857
XXIII ...	2·443	4·547	10·002	7·418	4·404	4·269	3·086	2·723	3·361	4·859	4·210	3·806	4·222
XXIV	...	0·000	0·663	0·000	0·108	2·647	3·822	2·154	1·438	1·194	1·145	0·265	1·244
XXV... ...	...	...	0·555	1·364	9·970	9·679	7·119	6·739	6·219	4·793	5·898	8·684	8·349
XXVI	...	...	...	...	13·281	9·552	15·121	25·822	20·476	12·196	21·160	10·569	15·565
XXVII	...	...	...	...	8·500	...	...	40·132	38·802	175·000	...	...	38·901
XXVIII	...	37·500	8·833	...	7·522	11·474	6·801	6·548	0·000	19·375	8·500	14·205	10·419
XXIX ...	4·653	5·000	14·145	6·117	3·966	4·199	4·783	4·525	5·122	4·386	3·971	2·596	4·626
XXX... ...	...	...	...	...	...	...	6·818	4·341	1·362	1·415	0·842	0·502	0·959

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
XXXI	...	...	4·687	...	4·714	7·030	5·517	4·530	5·075	4·942	4·658	1·451	4·923
XXXII	...	7·500	...	...	7·704	7·449	8·140	4·655	14·053	8·414	28·092	5·512	12·033
XXXIII	...	...	...	...	...	7·424	7·576	...	24,405	17·773	...	...	12·154
XXXIV	...	...	...	...	...	...	...	3·333	2·083	1·667	...	...	2·274
XXXV	...	...	...	...	5·000	...	5·417	3·722	...	3·333	1·875	0·357	3·314
XXXVI	...	7·500	...	...	8·437	...	...	4·167	2·833	3·258	3·324	2·187	3·567
XXXVII	...	...	...	...	5·208	...	...	2·667	8·000	...	...	3·143	4·072
XXXVIII	...	...	...	...	...	...	...	...	...	19·167	...	40·000	24·375
XLI	...	...	...	...	...	...	...	2·500	...	...	...	...	2·500
XLIII	...	...	...	...	3·241	...	...	...	...	...	...	...	3·241
XLV	...	...	...	1·250	...	...	...	...	...	...	...	...	1·250

(4) SMALL PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR EACH SQUARE OR AREA. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	0·135	0·000	0·000	...	...	...	...	...	...	...	0·016
VII	...	...	0·000	0·000	0·000	...	...	...	...	...	...	...	0·000
VIII	...	...	...	0·048	0·000	...	...	...	...	0·000	...	...	0·032
IX	0·000	...	...	...	0·760	...	2·308	0·582	0·246	0·243	0·919	0·626	0·826
X	0·000	1·518	0·000	0·000	0·069	...	0·000	1·192	0·045	0·000	0·116	0·000	0·174
XI	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
XII	...	...	0·053	0·000	0·000	...	...	...	...	0·000	0·000	0·000	0·018
XIII	...	0·000	...	0·000	...	0·536	1·223	0·000	1·633	0·554	2·500	1·292	1·195
XIV	0·000	0·000	0·000	0·351	0·000	0·000	0·000	0·141	0·000	0·008	0·094	0·000	0·032
XV	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·017	0·008	0·004
XVI	...	0·000	0·000	0·000	0·000	...	...	...	0·000	0·000	0·000	0·000	0·000
XVII... ...	...	0·361	0·615	0·495	0·290	0·891	0·064	0·055	0·000	1·802	0·000	1·064	0·448
XVIII ...	0·000	0·012	0·000	0·238	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·008
XIX	0·000	0·000	0·018	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·001
XX	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
XXI	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XXII... ...	...	...	...	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	0·046	0·027	0·798	0·894	0·370	0·738	0·091	0·070	0·119	1·460	1·354	0·684	0·671
XXIV ...	...	0·000	0·000	0·000	0·000	0·294	0·000	0·000	0·000	0·000	0·113	0·000	0·023

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
XXV	...	...	0·000	0·000	0·132	0·091	0·085	0·000	0·010	0·000	2·484	0·000	0·303
XXVI ...	...	...	...	...	0·071	0·828	0·000	0·000	0·000	0·087	0·082	0·000	0·170
XXVII ...	...	...	...	...	0·000	...	...	0·000	2·611	4·167	...	...	2·472
XXVIII ...	...	6·250	1·333	...	1·991	0·000	0·000	0·000	0·000	12·500	0·000	0·000	1·475
XXIX ...	0·000	0·000	0·712	0·194	0·168	0·039	0·007	0·044	0·019	0·001	0·064	0·216	0·066
XXX	...	...	...	...	...	...	0·000	0·000	0·000	0·055	0·000	0·000	0·007
XXXI ...	...	...	1·250	...	0·185	0·245	0·201	0·089	0·027	0·010	0·000	0·000	0·100
XXXII ...	...	0·000	...	...	0·102	0·153	0·145	0·793	0·314	0·355	0·000	3·819	0·379
XXXIII ...	...	...	...	...	...	0·000	1·261	...	0·000	1·172	...	...	0·633
XXXIV ...	...	...	...	...	...	...	...	0·000	0·000	0·000	...	...	0·000
XXXV ...	...	...	...	...	0·000	...	0·000	0·000	...	0·000	0·000	0·000	0·000
XXXVI ...	...	0·000	...	...	0·000	...	...	0·000	0·000	0·000	0·000	0·627	0·100
XXXVII ...	...	...	...	...	0·000	...	...	0·333	8·000	...	...	6·143	4·476
XXXVIII ...	...	...	...	...	...	...	...	...	...	0·000	...	10·500	3·125
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	...	...	...	161·342	...	...	...	...	...	...	...	161·342
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(5) TOTAL PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Total.
January	...	1·085	1·067	1·038
February	...	1·956	1·982	1·959
March	...	2·021	4·780	3·503
April	4·626	2·185	3·733	3·676
May	3·270	4·265	10·179	6·172
June	3·403	4·519	8·838	6·385
July	5·402	4·[illegible]94	6·807	5·761
August	3·117	3·329	7·983	5·228
September	3·446	3·192	14·162	9·625
October	3·049	3·442	8·530	5·421
November	1·939	4·076	8·664	5·790
December	1·622	2·325	3·224	2·752
	3·399	3·167	7·366	5·166

(6) LARGE PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Total.
January	...	0·065	0·229	0·133
February	...	0·308	0·205	0·296
March	...	0·292	0·651	0·484
April	0·522	0·369	0·366	0·430
May	0·442	0·599	1·023	0·701
June	0·482	0·442	0·897	0·681
July	0·696	0·443	0·660	0·609
August	0·354	0·306	1·187	0·691
September	0·346	0·357	2·282	1·474
October	0·341	0·346	0·876	0·561
November	0·278	0·491	1·011	0·785
December	0·160	0·254	0·335	0·287
	0·418	0·359	0·893	0·620

(7) MEDIUM PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Total.
January	...	0·989	0·838	0·893
February	...	1·541	1·738	1·565
March	...	1·653	3·894	2·856
April	3·858	1·763	3·151	3·062
May	2·672	3·566	7·257	4·684
June	2·802	4·040	7·677	5·534
July	4·562	4·234	6·048	5·033
August	2·654	2·998	6·658	4·441
September	3·042	2·829	11·349	7·830
October	2·592	2·900	7·307	4·623
November	1·598	3·277	7·197	4·769
December	1·369	1·925	2·429	2·141
	2·867	2·693	6·027	4·278

(8) SMALL PLAICE.

MONTHLY AND ANNUAL AVERAGES (CWTS. PER 100 HOURS' TRAWLING) FOR THE WHOLE REGION. 1901–1903.

Months.	1901.	1902.	1903.	Total.
January	...	0·031	0·000	0·012
February	...	0·107	0·039	0·098
March	...	0·076	0·237	0·162
April	0·246	0·053	0·216	0·184
May	0·156	0·100	1·899	0·787
June	0·119	0·037	0·264	0·170
July	0·144	0·117	0·099	0·119
August	0·009	0·025	0·138	0·096
September	0·058	0·006	0·531	0·321
October	0·116	0·196	0·347	0·237
November	0·063	0·208	0·456	0·236
December	0·093	0·146	0·460	0·324
	0·114	0·114	0·446	0·268

VIII. THE COMMON DAB (*Pleuronectes limanda*, L.).

This fish is one of the least important of the flat fishes, both in regard to quantity and value. The quantity landed by trawlers at Aberdeen in 1903 was 2,096 cwts., valued at £863. It is chiefly taken by trawl, but many are also taken by line.

The Common Dab is rather a promiscuous feeder, the main constituents of its food varying considerably on different grounds. The following shows the percentage proportions of the contents of the stomachs of (1) 579 from the Firth of Forth, (2) 356 from the Bay of St. Andrew's, and (3) of 101, examined by Holt, on the west coast of Ireland :—

——	Crustacea.	Annelids.	Echinoderms.	Mollusks.	Fish.
Firth of Forth	48	16	21	19	5
St. Andrew's Bay ...	22	43	43	18	3
West Coast of Ireland ...	26	13	53	16	2

The spawning-period in the North Sea extends from the middle of February to the middle of July,* or, according to Ehrenbaum and Heincke, from the end of January to the middle of July† ; on the west coast of Ireland Holt found them spawning in March, April and May, and thinks the period probably

* Fulton, *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 234, pl. VI.
† *Op. cit.*, p. 215.

commences at the end of February.* The number of eggs produced by this fish is not very large, compared with the fecundity of most other flat fishes; in three examined the number varied from 79,000 to 128,800.† As with other flat fishes, the growth is comparatively slow. From the observations I made a few years ago, it appears that the average size when one year old is about $2\frac{5}{8}$ inches, when two years old about $5\frac{1}{2}$ inches, and when three years about $8\frac{1}{2}$ inches.‡ The young are found mostly in the shallow inshore waters, but, unlike the Plaice and Flounder at corresponding stages, they are not confined to this situation, being also distributed in the moderately deep water some distance from shore, although absent from the deeper waters in the North Sea.

With regard to its distribution, it is found on the Murman coast and Finmark, and south as far as the Bay of Biscay; it is abundant round the British and Irish coasts, at Iceland and Faeroe, and is also found in the Baltic.

Distribution.

The aggregate quantity of Dabs taken in the three years by the recording vessels was $807\frac{1}{8}$ cwts., the general average being 0·291 cwts. per 100 hours of fishing. The quantities and averages for each of the years are as follow:—

Year.	Cwts.	Average Cwts. per 100 Hours.	Lbs. per Hour.
1901	225	0·333	0·37
1902	$186\frac{3}{4}$	0·229	0·26
1903	$395\frac{3}{8}$	0·308	0·345

With regard to the general distribution of the Dab in the various areas in the North Sea in which the recording vessels fished, no Dabs were taken in 13 of the 36 squares, in some of which, however, the amount of fishing was small. The highest averages, as a rule, were in the areas contiguous to the shore, where the water was of moderate depth, as may be seen from the Tables and Chart. The highest averages of all were for squares XXXVI and XXXVII, in the neighbourhood of the Dogger Bank, but the amount of fishing there was extremely limited. No Dabs were caught in the three most northerly areas, VI, VII, and VIII; and the other squares from which none were brought were XII, XV, XX, XXI, XXII, XXXIV, XXXV, XXXVIII, XLI, and XLV. The averages in the areas extending down the middle of the North Sea from VII to XXXV were as follow, in succession:—0·000, 0·009, 0·000, 0·019, 0·035, 0·037, 0·000. Along the corresponding series of areas to the eastward, VIII to XLV, they were as follow:—0·000, 0·000, 0·026, 0·000, 0·007, 0·059, 4·400, 0·000, 0·000. In the series extending between the British and the Continental coasts, the averages ranged as follow:—(1) From the Moray Firth to Joederan in Norway, XVII to XXI, they were 0·509, 0·056, 0·019, 0·000, 0·000. (2) From Aberdeenshire to the Skagerrack, XXIII to XXVII, they were 0·913, 0·035, 0·007, 0·026, 0·034. (3) From the south part of the Scotch coast to Jutland, XXVIII to XXXIII, they were 0·852, 0·309, 0·037, 0·059, 0·030, 0·058.

By far the greater part of the Dabs landed by the recording steamers came from the areas along the east coast of Scotland. From IX, XIII, XVII, XXIII and XXIX, the quantity was $585\frac{3}{4}$ cwts.,

* *Tenth Ann. Rep. Fishery Board for Scotland*, Part III., p. 263.
† *Ninth Ann. Rep. Ibid.*, Part III., p. 265.
‡ *Twentieth Ann. Rep. Ibid.*, Part III., p. 360.

or 72·6 per cent. of the whole; from the two squares XXIII and XXIX the quantity was 424¼ cwts., or 52·6 per cent. of the whole. The more northern of these areas had much the larger averages, IX and XIII having 2·65 and 1·82 respectively, while the average for XXIII was 0·91 and for XXIX ·309.

In connection with the distribution and seasonal abundance of the Dab, however, it must be borne in mind that the trawlers do not always bring this fish ashore, and that the proportion brought to market of those caught may be very variable with different boats, from different grounds, or at different times of year.* Further, in all cases it is only the larger Dabs that are brought in.

Seasonal Abundance.

Commencing again with the squares in which the fishing was most regular and large quantities of Dabs taken, we find that in XXIII, off the coast of Aberdeen (312⅝ cwts.), the monthly averages show two periods of maximum abundance in each year, one in spring and the other and greater in autumn, the minima being in winter and, still more noteworthy, in summer. In 1901 and 1903 the maximum was in October; in 1902 it was in November and October. The compound curve for the three years shows these points, the minimum being in July–August. In XXIX there is less regularity, except that the minimum is in summer. In 1901 the maximum was at the end of the year, chiefly in December; in the next year it was also in the latter months, chiefly November, and it extended into January, 1903. In the latter year the maximum is in May and June, and there is a slight rise in the latter months. Several of the other squares show the double maximum, the position varying somewhat, and the minimum being in summer, but it is scarcely necessary to go into them in detail.

In the curve for each of the three years over the whole region the maximum is in autumn, the second and lesser maximum being in spring and the minimum in summer, and in the curve for the whole period and region there are the same features, the minimum being in June–July and the greater maximum in October.

From what I have said above as to the irregular way in which this fish is brought ashore or thrown away, little stress can be put on the averages for the various months. It is not unlikely that the summer minimum might be in part accounted for in this manner, the Dabs, unless when large catches are obtained, being thrown back into the sea rather than put in ice.

(1) Monthly and Annual Averages of Dabs (Cwts. per 100 Hours' Trawling) for each Square or Area. 1901–1903.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
VI	...	...	0·000	0 000	0·000	...	...	...	...	...	...	...	0·000
VII	...	...	0·000	0·000	0·000	...	...	...	...	...	...	...	0·000
VIII	...	...	...	0·000	0·000	...	...	...	...	0·000	...	...	0·000
IX	0·312	...	...	...	0·253	...	0·275	3·125	2·956	2·184	4·816	4·969	2·647
X	0·000	0·000	0·000	0·046	0·000	...	0·000	4·288	0·158	2·817	0·613	0·000	0·510

* *Vide Twenty-second Ann. Rep. Fishery Board for Scotland*, Part III., p. 13.

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
XI	0·000	0·000	0·000	0·022	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·009
XII	...	...	0·000	0·000	0·000	...	...	...	...	0·000	0·000	0·000	0·000
XIII	...	0·000	...	0·000	...	1·607	1·829	6·657	8·098	2·832	8·750	0·351	1·819
XIV	0·000	0·000	0·027	0·601	0·084	0·000	0·046	0·422	0·043	0·604	0·485	0·036	0·279
XV	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
XVI	...	0·000	0·113	0·000	0·000	...	...	...	0·000	0·000	0·000	0·000	0·026
XVII... ...	...	1·442	0·115	0·608	0·490	0·184	0·256	0·165	2·273	1·690	0·434	1·950	0·509
XVIII ...	0·000	0·172	0·127	0·190	0·000	0·035	0·027	0·000	0·173	0·000	0·000	0·000	0·056
XIX	0·026	0·044	0·195	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·019
XX	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
XXI	...	...	...	...	...	...	...	...	...	0·000	...	0·000	0·000
XXII... ...	...	...	...	...	...	...	...	...	...	...	0·000	...	0·000
XXIII ...	0·755	0·727	0·885	1·235	0·679	0·324	0·091	0·108	0·615	2·142	1·228	1·089	0·913
XXIV ...	...	0·625	0·361	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·057	0·000	0·035
XXV... ...	...	...	0·000	0·000	0·026	0·000	0·000	0·000	0·020	0·000	0·000	0·000	0·007
XXVI ...	...	...	...	...	0·000	0·195	0·000	0·000	0·000	0·000	0 000	0·000	0·026
XXVII ...	...	...	...	...	0·000	...	...	0·000	0·036	0·000	...	...	0·034
XXVIII ...	...	1·562	0·333	...	3·097	0·000	0·000	1·190	0·000	1·857	1·000	1·136	0·852
XXIX ...	1·095	0·000	0·638	0·466	0·415	0·174	0·085	0·029	0·113	0·667	0·745	0·842	0·309
XXX... ...	...	...	...	...	...	...	0·000	0·000	0·000	0·000	0·000	0·060	0·037
XXXI ...	...	...	0·000	...	0·015	0·099	0·109	0·201	0·068	0·055	0·056	0·000	0·059
XXXII ...	...	0·000	...	...	0·000	0·000	0·000	0·034	0·039	0·080	0·000	0·000	0·030
XXXIII ...	...	...	...	...	...	0·000	0·252	...	0·000	0·000	...	...	0·058
XXXIV ...	...	...	...	...	...	...	...	0·000	0·000	0·000	...	...	0·000
XXXV ...	...	...	...	...	0·000	...	0·000	0·000	...	0·000	0·000	0·000	0·000
XXXVI ...	...	0·000	...	...	0·625	...	...	1·515	0·000	14·812	1·707	3·750	4·400
XXXVII ...	...	...	...	...	0·000	...	...	12·667	2·667	...	...	3·786	3·992
XXXVIII ...	...	...	...	...	...	.	...	...	...	0·000	...	0·000	0·000
XLI	...	...	...	...	...	...	...	0·000	...	...	...	...	0·000
XLIII ...	...	.	...	...	1·620	...	...	...	...	...	...	...	1·620
XLV	...	...	...	0·000	...	...	...	...	...	...	...	...	0·000

(2) Monthly and Annual Averages of Dabs (Cwts. per 100 Hours' Trawling) for the Whole Region. 1901–1903.

Month.	1901.	1902.	1903.	Total.
January	...	0·292	0·190	0·230
February	...	0·244	0·051	0·219
March	...	0·165	0·196	0·182
April	0·427	0·138	0·188	0·271
May	0·231	0·180	0·134	0·183
June	0·021	0·057	0·138	0·088
July	0·075	0·144	0·068	0·092
August	0·074	0·004	0·497	0·232
September	0·388	0·010	0·371	0·300
October	0·980	0·348	0·650	0·639
November	0·327	0·467	0·290	0·344
December	0·422	0·439	0·427	0·429
	0·333	0·229	0·308	0·291